

Authentic Alignment:
Toward an Interpretative Phenomenological
Analysis (IPA) informed model of the learning
environment in health professions education

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Abstract

It is well established that the goals of education can only be achieved through the constructive alignment of instruction, learning and assessment. There is a gap in research interpreting the lived experiences of stakeholders within the UK learning environment toward understanding the real impact – authenticity – of curricular alignment. This investigation uses a critical realist framework to explore the emergent quality of authenticity as a function of alignment.

This project deals broadly with alignment of anatomy pedagogy within UK undergraduate medical education. The thread of alignment is woven through four aims: 1) to understand the alignment of anatomy within the medical curriculum via the relationships of its stakeholders; 2) to explore the apparent complexity of the learning environment (LE); 3) to generate a critical evaluation of the methodology, Interpretative Phenomenological Analysis as an approach appropriate for realist research in the complex fields of medical and health professions education; 4) to propose a functional, authentic model of the learning environment.

Findings indicate that the complexity and uncertainty inherent in the LE can be reflected in spatiotemporal models. Findings meet the thesis aims, suggesting: 1) the alignment of anatomy within the medical curriculum is complex and forms a multiplicity of perspectives; 2) this complexity is ripe for phenomenological exploration; 3) IPA is particularly suitable for realist research exploring complexity in HPE; 4) Authentic Alignment theory offers a spatiotemporal model of the complex HPE learning environment: the T-icosa.

Table of Contents

Abstract	2
Table of Contents	3
List of Figures	16
List of Tables	20
List of Abbreviations	22
Acknowledgements	24
List of Contributions from this Doctoral Work	26
Publications	26
List of Contributions from Doctoral Training	27
Presentations	28
Manuscripts in progress:	29
“Just resuscitate me if I stop breathing”– An IPA study of an experienced surgeon reflecting on the nature of anatomy in practice. 29	
“They’re still talking about the curriculum?” – An interview with Fred Hafferty, PhD.	29
“I wouldn't say I'm passionate about anatomy” – an IPA study of junior doctors reckoning with the authenticity of their education.....	30
Author’s Declaration	31
Chapter 1: Introduction to Thesis	32
1.1 Introduction to the Introduction	32
1.2 Alignment in Context	32
1.3 Authenticity and Alignment	33
1.4 Constructive Alignment	38
1.5 Domains and Perspective.....	39

1.5.1	Research Questions.....	40
1.6	Complexity – a personal reflection	41
1.7	The Value of Models.....	42
1.8	Aims of this Thesis.....	44
1.9	Research Questions, reiterated.....	44
1.9.1	Overarching Question: How can the UK health professions learning environment (LE) be most authentically modelled?	44
1.9.1.1	Sub-questions.....	44
1.10	Thesis Overview	45
1.11	Thesis Summary Infographic.....	46
1.12	Chapter Summary	49
Chapter 2:	Reflexive Overview	51
2.1	Alignment of this Thesis	51
2.1.1	Chapter 1: Introduction to Thesis.....	51
2.1.2	Chapter 2: Reflexive Overview.....	51
2.1.3	Chapter 3: Reconsidering Constructive Alignment via Critical Realism.....	51
2.1.3.1	Chapter 3 Reflexivity Statement	52
2.1.4	Chapter 4: Constructive Alignment – Fit for Purpose? Study	53
2.1.5	Chapter 5: Uncovering Hidden Curricula: Use of Dark Humour in Anatomy Labs and its Implications for Basic Sciences Education.....	53
2.1.5.1	Chapter 5 Reflexivity Statement	54

2.1.6	Chapter 6: Interpretative Phenomenological Analysis (IPA) in the health professions literature – A Qualitative Evidence Synthesis.....	55
2.1.6.1	Chapter 6 Reflexivity Statement	55
2.1.7	Chapter 7: “Preparing them for the profession” – an IPA study of anatomy educators coping with complexity in the UK curriculum.....	56
2.1.7.1	Chapter 7 Reflexivity Statement	56
2.1.8	Chapter 8: Authenticity, Uncertainty, Complexity, Multiplicity – Proposing Authentic Alignment Theory.....	59
2.1.8.1	Chapter 8 Reflexivity Statement	59
2.1.9	Chapter 9: Tensegrity Icosahedron – Authentically Aligned	60
2.1.9.1	Chapter 9 Reflexivity Statement	60
2.1.10	Chapter 10: Toward Authenticity – An Integrative Discussion.....	61
2.1.11	Chapter 11: Thesis Conclusion	62
2.1.12	Appendix A: Anatomy of Wholeness – Considering Narrative and Paradigmatic Alignment	62
2.1.13	Appendix B, C, D & F:.....	63
2.2	A Guide to Navigating the Terrain	63
2.2.1	The Researcher by Any Other Name.....	64
2.2.2	Heteroglossia – The “Many Tongued” Voice of This Thesis	64
2.3	A Note on co-authors	67
2.4	Chapter Summary	68
	Chapter 3: Reconsidering Constructive Alignment via Critical Realism	69

3.1	Chapter Introduction.....	69
3.2	Background	69
3.2.1	From Flexnerian Reforms to Complexity	71
3.2.2	Paradigm of choice: Critical realism	74
3.2.2.1	A stratified ontology: the 'what'.....	75
3.2.2.2	Epistemological considerations: the 'how'.....	77
3.2.2.3	Axiology: the "why"	82
Chapter 4: Constructive Alignment – Fit for Purpose?		84
4.1	Methods.....	84
4.1.1	Data analysis	87
4.2	Results.....	89
4.2.1	Theme One: Inconsistent relationship between involvement in anatomy Learning Outcomes and the LOs of the wider programme.....	90
4.2.2	Theme Two: Conflicting responses to the question: what drives learning?	94
4.2.3	Theme Three: Disconnect between how the participants describe the curriculum vs their concentration of their own involvement	96
4.2.4	Theme Four: Alignment is flux and hard to quantify	100
4.3	Discussion	101
4.3.1	Explanatory hypothesis / working theory.....	103
4.3.2	Contextualising findings in the paradigm of critical realism	105
4.3.3	Limitations of the study	109
4.4	CONCLUSIONS.....	110
4.5	Chapter Summary	111

Chapter 5: Uncovering Hidden Curricula: Use of Dark Humour in Anatomy Labs and its Implications for Basic Sciences Education.....	113
5.1 Chapter Introduction.....	113
5.1.1 Summary of linkage	114
5.2 Background	116
5.3 Methods	119
5.4 Results.....	121
5.4.1 Demographics and Experiences.....	121
5.4.2 Frequency of Negative Lab & Humour Experiences..	123
5.4.3 Content of Humour: From Appetite to Actions	125
5.4.4 Why Use Humour? Morbidity as Justification	127
5.4.5 Inappropriate Humour	127
5.4.6 Gauging Appropriateness: The Use of 'Barometers'.	128
5.4.7 Humorous and 'Dirty' Mnemonics	128
5.5 Discussion	129
5.5.1 Differences in Opinions	131
5.5.2 Humour as a Hidden Curriculum of Anatomy Labs ..	132
5.6 Limitations, Considerations, & Future Directions	134
5.7 Conclusions	136
5.8 Acknowledgements	136
5.9 Chapter Summary	137
Chapter 6: IPA in the HPE Literature – A Qualitative Evidence Synthesis.....	140
6.1 Chapter Introduction.....	140
6.2 Background	141

6.2.1	Fusion of horizons.....	144
6.2.2	Research question.....	146
6.3	Methods.....	147
6.3.1	Study Design.....	147
6.3.2	Search strategy & study selection	149
6.4	Results.....	153
6.4.1	Educators' experiences (n=3)	154
6.4.2	Student/Trainees' experiences (n=10)	155
6.4.3	Clinicians' experiences (n=8).....	158
6.4.4	Patients' experiences (n=7).....	161
6.4.5	Composite (n=5)	163
6.5	Discussion	166
6.5.1	Top Tips for using IPA in HPE.....	168
6.5.2	Limitations, Future Directions	172
6.6	Conclusions	172
6.7	Chapter Summary	174

Chapter 7: "Preparing them for the profession": an IPA study of anatomy educators coping with complexity in the UK curriculum 175

7.1	Chapter Introduction.....	175
7.2	Background	175
7.2.1	The curriculum	176
7.2.2	Reflective practice in anatomy	178
7.2.3	From content to competency to complexity.....	180
7.2.4	The Gap	184
7.2.5	Rationale for using IPA	184

7.3	Methods	186
7.3.1	Design.....	186
7.3.2	Data collection and analysis	189
7.4	Results.....	190
7.4.1	Theme one: Awareness and empowerment as a stakeholder in the medical curriculum	190
7.4.2	Theme two: Variations in discussing curricular integration	193
7.4.3	Theme three: Managing expectations to perform within paradoxical situations	196
7.4.4	Theme four: Emergence of innovative teaching within curricular constraints	198
7.5	Discussion	200
7.5.1.1	The Complexity Turn.....	202
7.5.1.2	Uncertainty.....	207
7.5.2	Limitations of the study	214
7.6	Conclusions	215
7.7	Acknowledgements	216
7.8	Chapter Summary	216

Chapter 8: Authenticity, Uncertainty, Complexity, Multiplicity: Proposing Authentic Alignment Theory 218

8.1	Chapter Introduction.....	218
8.1.1	Chapter Purpose	218
8.2	Summary of Findings, Rationale for Progression	219
8.2.1	From Chapter 3 & 4.....	220
8.2.2	From Chapter 5	220
8.2.3	From Chapter 6	220

8.2.4	From Chapter 7	221
8.2.5	Integrated overview of findings with interpretative discussion	221
8.3	An Authentic Model of the LE.....	224
8.3.1	Conceptual Models: realism, fidelity, authenticity, uncertainty	224
8.3.2	Educational Theory—Practice—Philosophies	228
8.3.2.1	Nativist Approach	229
8.3.2.2	Behaviorist Approach	230
8.3.2.3	Constructivist (aka Interactional) Approach	231
8.3.2.4	Vygotskian Approaches	233
8.3.2.5	Curriculum as a problem space.....	234
8.4	From Curriculum to Learning Environment	235
8.4.1	Describing the LE – toward authentic alignment	236
8.4.1.1	Prescriptive models such as competency based medical education	237
8.4.1.2	Seeking a descriptive model for the LE	239
8.5	Embracing uncertainty using analytic dualism.....	239
8.5.1	Agency-structure relationship in terms of CR	240
8.5.1.1	Disambiguating Reduction	241
8.5.1.2	Reducing for Complexity.....	243
8.5.2	Multiplicity: a confluence of complexity	246
8.5.2.1	Mitchell, Castellani, and Manson: relevant overviews of complexity.....	247
8.5.2.2	Flavours of complexity in Manson’s conceptual framework: algorithmic, deterministic, and aggregate	249
8.5.2.3	The multiplicity of complexity	251

8.5.3	Dialectic of Structure-Agency in the pursuit of Complexity Theory for HPE	252
8.5.3.1	Structuration and the persistent collapse of agency	254
8.5.4	The Freedom of Separation: Archerian Morphogenesis	256
8.5.4.1	Emergence	258
8.5.4.2	Meta-philosophical interpretation of the structure-agency dialectic	261
8.5.4.3	Authentic Alignment: embracing uncertainty	264
8.6	Authentic Alignment Theory	265
8.7	Chapter Summary	266
Chapter 9: Tensegrity Icosahedron: Authentically Aligned		
269		
9.1	Chapter Introduction.....	269
9.2	Geometric Models.....	270
9.2.1	Icosahedron	271
9.2.2	Tensegrity	274
9.3	The Tensegrity icosahedron (T-icosa)	278
9.3.1	Embodied complexity	279
9.4	Tensegrity in living systems	281
9.5	Ruling principle: Simultaneity & Circularity.....	282
9.5.1	Holarchy	283
9.6	Cellular Tensegrity.....	286
9.7	Prestressed and nonlinear.....	290
9.8	Modularity	292
9.9	Reciprocity	293

9.10 Vectors in the round	294
9.11 Nonlinear pedagogy	295
9.11.1 Non-proportionality	297
9.11.2 Multi-stability	299
9.11.3 Parametric controls - constraints.....	302
9.11.4 Noise & the Hidden Curriculum	303
9.12 Creativity, authenticity & empowerment: the rewards	305
9.12.1 Practical Considerations for using the T-icosa.....	305
9.12.1.1 Make your own: DIY T-icosa	307
9.13 Chapter Summary	308

Chapter 10: Toward Authenticity – Integrative Discussion

311

10.1 Chapter Introduction.....	311
10.2 Reflecting on Thesis aims	311
10.2.1 Aim Number 1:.....	312
10.2.2 Aim Number 2	312
10.2.3 Aim Number 3	313
10.2.4 Aim Number 4	313
10.3 Contextualising Findings in the Conceptual Framework – revisiting the thesis research questions.....	314
10.4 Interpretation of Integrated Thesis Findings	316
10.4.1 Hermeneutics	317
10.4.2 HPE: A suitable home for hermeneutics.....	318
10.4.2.1 The Hermeneutic Circle.....	320
10.4.3 Integrating IPA findings with critical realism	322

10.4.3.1	Reconciling critical realism as a paradigm with IPA as a methodology	322
10.4.3.2	Critical realism and complexity: a conversation .	323
10.4.3.3	Separating agency and structure to serve the analytic process	330
10.4.4	Dynamics, self-organisation and coevolution.....	332
10.4.4.1	Dynamics & self-organisation	333
10.4.4.2	Coevolution: conflation and the Agency-Structure dialectic	335
10.5	Multiplicity, authenticity, complementarity	337
10.6	Limitations, Considerations, Future directions.....	339
10.6.1	Limitations of critical realism	339
10.6.2	Considerations for multi-methods.....	341
1.1.1	Meeting the challenge of using trending keywords correctly	342
1.1.2	Future directions.....	344
10.7	Chapter Summary	344
Chapter 11:	Thesis Conclusion	347
11.1	Chapter Introduction.....	347
11.2	Thesis Conclusion Summary.....	347
11.3	Original Contributions	347
11.3.1	To Methodology	348
11.3.2	To Educational Theory	351
11.3.3	To HPE research	352
11.3.4	To the wider field.....	353
11.4	Concluding Personal Remarks.....	354
Chapter 12:	List of References	359

Chapter 13: Appendix A: Anatomy of Wholeness – Considering Narrative and Paradigmatic Alignment	416
Introduction	416
Reflexivity Statement	416
Dear PhD student new to Health Professions Education,	418
Paradigm	419
Ontology – the “What”	420
Epistemology – the “How”	421
What about Phenomenology?	425
Methods vs Methodology	426
Methodology	428
Your Project, X-rayed	432
Why choose critical realism?	436
The practical challenges of critical realism.....	439
Embracing the Real	440
Abduction: how critical realism works its magic.....	443
Abduction: confidence in Maybe	447
Critical realist axiology	450
Chapter 14: Appendix B: Anatomy Pedagogy: Constructive Alignment Questionnaire.....	452
Chapter 15: Appendix C: Link to Google Sheet used for coding the qualitative evidence synthesis presented in Chapter 4	504
Chapter 16: Appendix D: Summary Table of Group Experiential Themes (GETs) from Chapter 5.....	505
Chapter 17: Appendix E: Selected Tables of Personal Experiential Themes (PETs) from Chapter 5	506

Chapter 18: Appendix F: The IPA process of generating PETs
606

List of Figures

Note: This thesis contains a number of original images designed by the author as noted in the captions where Canva is cited (<https://www.canva.com/>).

Figure 1: Triangle of curriculum alignment	34
Figure 2: Standardised testing in the wild, source @wearecognitive on Twitter.....	35
Figure 3: Abduction links the voices of first, second, and third person. Image designed by the author using Canva, adapted from Coghlan (2021).	65
Figure 4: Constructive Alignment, image by the author using Canva adapted from Biggs' model (1996).	70
Figure 5: Stratified reality as per CR, image designed by the author using Canva, ideas adapted from Bhaskar (1978)	75
Figure 6: Deduction, Induction, Abduction. Image designed by the author using Canva, inspired by Syll (2016).	79
Figure 7: Sources of Learning Outcomes.....	91
Figure 8: Q12 – For each year of the MBBS programme, select the level of your awareness of that year's learning outcomes	93
Figure 9: _____ drives learning? Participant responses.	94
Figure 10: Please rank the following influences on the design of your teaching/learning activities (in order of importance).....	96
Figure 11: Responses to Q3 – During which years is your teaching concentrated? (Choose all that apply)	98
Figure 12: Q24 - Looking at each year of the MBBS course, please tell us how much anatomy is taught in each year (to the best of your knowledge)	99
Figure 13: Q25— How would you rate the alignment of learning outcomes, teaching methods, and assessment?	100

Figure 14: Q29 Participant response to the question: How would you rate the alignment of the anatomy curriculum with the wider medical curriculum in the MBBS programme at your institution?	101
Figure 15: from two dimensions (A) to a multi-dimensional triangulated model (B) used in Biggs' (1996) CA. Image designed by the author using Canva.	102
Figure 16: Participant responses to frequency statements	124
<i>Figure 17: Search strategy flow visualisation. Image designed by the author using Canva.</i>	151
<i>Figure 18: Endnote exclusion. Screenshot by the author.</i>	152
<i>Figure 19: See the far-right column: Representative quote/s, screenshot from Malik & Mahboob (2021)</i>	160
Figure 20: Diagram of a CAS. Image designed by the author using Canva.	245
Figure 21: Map of the Complexity Sciences by Brian Castellani and Lasse Gerrits (2018).	248
Figure 22: Structuration sees the system as a unification of agency and structure. Image designed by the author using Canva.	253
Figure 23: Agency-Structure feedback loop. Image designed by the author using Canva.	255
Figure 24: Agency-Structure feedback loop over time. Image designed by the author using Canva.	258
Figure 25: Adapted from Archer (1998)'s MST model of social action (p.376).	260
Figure 27: Icosahedron. Image by the author using Canva elements.	271
Figure 28: Image credit Tomrueen Attribution-ShareAlike 4.0 International.	272
Figure 29: Authentic Alignment: ILAs mapped onto the vertices of the icosahedron. Image designed by the author using Canva elements.	273

Figure 30: Needle Tower, 1968. This influential floating compression artwork by American sculptor Kenneth Snelson stands outside of the Hirshhorn Museum and Sculpture Garden in Washington, DC, United States. Photograph by the author. 274

Figure 31: Authentic Alignment of ILA - instruction, learning, assessment triangulated in a T-icosa. Image created by the author using a photograph of the Skwish toy with Canva text overlay... 278

Figure 32: Vacuolar system. Image courtesy of Guimberteau & Armstrong (2015)..... 280

Figure 33: The Janus face metaphor for holons. Image created by the author using Canva elements..... 284

Figure 34: Cellular tensegrity model introduced by Stamenović & Ingber (2009): (a) Tensegrity model: Top left- A simplified version with compression struts and tensed cables exemplifying that stress levels regulate cytoskeletal rigidity. Top right- In the cellular context, microtubules (gold rod) apply compression on cell-matrix adhesions (represented by actin linking modules in pink and integrin dimers) while the actin filaments (red) experience the cellular tension and hence stiffen accordingly. (b) Semiflexible chain model is represented by the flexible actin cables (red) that locally rigidify at points of stress application i.e., myosin (blue bundle) contraction. (c) Dipole polarization model: Formation of contractile actomyosin dipoles is represented by the arrow pairs. According to this model, they freely orient in response to applied stress as experienced at a particular point. Image source: <https://www.mechanobio.info/what-is-mechanobiology/what-are-some-common-themes-in-mechanobiology/> <https://creativecommons.org/licenses/by-nc/4.0/> 288

Figure 35: Multistability in graphical representation. Image created by the author using Canva elements. 300

Figure 35: DIY T-icosa, designed and built by the author 307

Figure 36: Hermeneutics, the link that connects critical realism & IPA. Image created by the author.	318
Figure 37: The Cynefin Framework [adapted from https://itrevolution.com/articles/cynefin-four-frameworks-of-portfolio-management/	330
Figure 38: Paradigm as a gradient	424
Figure 39: Mixed methods research	427
Figure 40: "Project X-ray" - a visualisation of my thesis framework. Image designed by the author using Canva elements.	434
Figure 41: The domains of reality as per critical realism. Image designed by the author using Canva elements.	441
Figure 42: The bi-directional flow of reasoning. Image designed by the author using Canva elements.....	444
Figure 43: The holism of reasoning. Image designed by the author using Canva elements.	449
Figure 44: See link for coded sheets, click here: https://docs.google.com/spreadsheets/d/1rh54XIidhUul2RKODLeAJ0DF6RDRxstBHCT7VGR_IY/edit?usp=sharing	504

List of Tables

Table 1: Traditional Instruction (TI) versus Authentic Teaching & Learning Activities (TLAs) Adapted from Mueller (2018).	33
Table 2: Curricular Approaches at UK Medical Schools (BMA)	36
Table 3: Nested domains of critical realism adapted from Bhaskar (2008, p.13 & p.56).....	40
Table 4: Questionnaire questions.....	85
Table 5: Steps of explanatory TA for critical realism adapted from Fryer (2022)	88
Table 6: Demographic information	89
Table 7: Other sources of Learning Outcomes.....	91
Table 8: Responses on curriculum design.....	97
Table 9: Q24 Anatomy concentration across the years.....	99
Table 10: Abduction, deduction, and induction compared (Bellucci & Pietarinen, 2020), Table adapted from Grass (2021).	107
Table 11: Abductive reasoning using retroduction	108
Table 12: Demographic information	121
Table 13: Themes & Quotes arising from thematic analysis	125
Table 14: SPIDER tool showing the search constraints.	147
Table 15: Semi-structured interview guide.....	187
Table 16: Participant roles as anatomy educators.....	188
Table 17: Glossary of Uncertainty Definitions (Stephens et al. 2021)	208
Table 18: Definitions of Realism, Fidelity, and Authenticity (Lavoie et al., 2020)	225
Table 19: Comparison of modes of reasoning and their trajectories, designed by the author inspired by Garbuio (2019)	316
Table 20: Example of the syllogistic structure used by the retroductive argument as applied to this project.	346
Table 21: Evolutionary Overview of Grounded Theory & Phenomenology, adapted from Burns et al. (2022).....	430
Table 22: Deductive, Inductive, and Abductive reasoning.....	444

Table 23: Retroductive process.....	446
Table 24: Example of a retroduction with Peirce's (1878) three steps applied to the HPE context.....	448

List of Abbreviations

AI – Authentic Instruction

BMA – British Medical Association

BMBS – Bachelor of Medicine, Bachelor of Surgery

CAS – Complex Adaptive System

CR – Critical realism

CRT – Criterion-referenced testing

CS – Complexity science

CT – Complexity theory

GETs – Group Experiential Themes

HC – Hidden Curriculum

HE – Higher Education

HPE – Health Professions Education

HYMS – Hull York Medical School

ILA – Instruction, Learning & Assessment (after Biggs' (1996) original triangulated model of Constructive Alignment),

LE – Learning Environment

LOs – Learning Outcomes

MBBS – Latin: Medicinae Baccalaureus, Baccalaureus Chirurgiae

MLA – Medical Licensing Assessment

NRT – Norm-referenced testing

PETs – Personal Experiential Themes

PID – Personal Identity Development

PIF – Personal Identity Formation

TI – Traditional Instruction

MBBS— Latin: *Medicinae Baccalaureus, Baccalaureus Chirurgiae*,
sometimes BMBS— Bachelor of Medicine, Bachelor of Surgery

MLA – Medical Licensing Assessment

TLAs – Teaching and Learning Activities

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List of Contributions from this Doctoral Work

Publications

Kirkness, K.B., Bazira P., Finn G.M., Nizza I.E., 2022. "Preparing them for the profession": An interpretative phenomenological analysis of anatomy educators coping with complexity in the United Kingdom curriculum. (Kirkness et al., 2023)

The candidate was the lead author of this publication. Co-authors contributed to methodological oversight, structuring, and editing of the work at all stages of revision. Extracts of this work are included in Chapters 2, 3, and Chapter 4 of this doctoral thesis.

Dueñas, A. N., **Kirkness, K.B.** & Finn, G. M. 2020. Uncovering Hidden Curricula: Use of Dark Humour in Anatomy Labs and its Implications for Basic Sciences Education. (Dueñas et al., 2020)

List of Contributions from Doctoral Training

The following works are included here as a demonstration of commitment and sustained contribution to the field in parallel with the publications directly related to the candidate's doctoral training.

Kirkness, Karen (2021) Spiral Bound: Integrated Anatomy for Yoga. Handspring Publishing.

Kirkness, K.B., Sharkey, J.J. & Avison J.E. (2021) An Innovative Technique in Anatomy Pedagogy: The Flexagon as a Model of Gastrulation in Embryology. *International Journal of Anatomy and Applied Physiology*

The candidate was lead co-author of this abstract which was accepted for publication as well as a poster presentation at the 2021 International Symposium of Clinical Anatomists at The University of Padova.

Sharkey, J.J. & **Kirkness, K.B.**, (2021) Proposal For A New Pedagogical Approach In Teaching Anatomy To Medical Students, Part I: Fascia Continuity In The Anatomy Curriculum. *International Journal of Anatomy and Applied Physiology*

Presentations

December 2018: Anatomy of a 3D print: morphologic constraints of polygon mesh from theory into practice. Poster presentation Anatomical Society Winter Meeting at York, December 2018.

November 2021: The Fascial Spine, webinar hosted by The Fascia Hub

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December 2021: Revealing the Heart, webinar hosted by The Fascia Hub

February 2021: Integrated Biotensegrity Global Symposium: Complexity in Anatomy

May 2022: "Constrain to Set Free: Fascia and Complexity" multimedia lecture presented at The British Fascia Symposium

June 2022: Guest Faculty at the Full Body Dissection hosted by John Sharkey at London King's College.

Manuscripts in progress:

“Just resuscitate me if I stop breathing” – An IPA study of an experienced surgeon reflecting on the nature of anatomy in practice. This manuscript uses IPA to understand the lived experience of a surgeon at an advanced stage in his career. Findings are presented in the context of their empirical usefulness, as per the IPA praxis, that hermeneutic accounts of individual cases can provide rich insight into multifaceted phenomena. This study also contributes to the nuanced picture of IPA as a methodology that suits a larger investigation, especially in the paradigm of critical realism. The findings are presented as a table of Personal Experiential Themes (PETs) that shed further light on the meaning of being prepared for a profession in UK healthcare.

This manuscript is being prepared for submission to *Teaching and Learning in Medicine*

“They’re still talking about the curriculum?” – An interview with Fred Hafferty, PhD.

This manuscript utilises a unique form of IPA, the “gems” approach, to present key insights generated from an interview with Fred Hafferty, PhD, expert in the hidden curriculum and professor in medical education at the Mayo Clinic. This manuscript reveals more about the power and flexibility of IPA as a methodology for harnessing the nuanced insights of individuals relating their truth without the imposition of preconceived theories. Key here is the notion that “the curriculum” as such may well be an outdated term, as the advent of authentic learning pushes stakeholders to accept the totality of the learning environment and its inherent complexity.

This manuscript is being prepared for submission to *Perspectives in Medical Education*

“I wouldn't say I'm passionate about anatomy” – an IPA study of junior doctors reckoning with the authenticity of their education.

This manuscript presents our study exploring how junior doctors made sense of their education in real terms – from the “authentic setting” of their new, clinical role. The interviews were semi-structured, particularly concerned with the phenomenon of recently graduated medical students adapting their training to the complexity of their burgeoning professional practice. The study used Interpretative Phenomenological Analysis (IPA) to focus on the lived experiences of participants coping with the phenomena in question: how do junior doctors working in the UK make sense of their training?

IPA offers insight into the lived experiences of junior doctors whose experiential interpretations of the authenticity and usefulness of their training can better equip stakeholders in health professions policymaking.

This manuscript is being prepared for submission to *Health Professions Education*

Author's Declaration

I confirm that this work is original and that if any passage(s) or diagram(s) have been copied from academic papers, books, the internet, or any other sources these are clearly identified by the use of quotation marks and the reference(s) is fully cited. I certify that, other than where indicated, this is my own work and does not breach the regulations of HYMS, the University of Hull or the University of York regarding plagiarism or academic conduct in examinations. I have read the HYMS Code of Practice on Academic Misconduct, and state that this piece of work is my own and does not contain any unacknowledged work from any other sources.

Chapter 1: Introduction to Thesis

1.1 Introduction to the Introduction

This introductory chapter describes the focus and rationale of the doctoral work presented. It features an overview of the context, setting out its broad aims, followed by a structural summary with signposting to aid the navigation of the thesis overall. The overview flows into the next chapter providing appropriate paradigmatic context for the doctoral work submitted.

1.2 Alignment in Context

Anatomy has long been considered the foundation of medicine (Turney, 2007). It could be argued that memorising anatomical parts is the most straightforward approach to learning about the human body. Indeed, rote memorisation of individual components has served legions of medical students over centuries to pass their anatomy exams (Kwan et al., 2016). However, when it comes to understanding the rhythm of bipedal gait, personal sensory experience, childbirth, presentation of disease, ageing, consciousness, or any other aspect of human experience, pointing to an inert list of parts falls short of providing adequate explanation for authentic experience. It isn't the parts, but the *alignment* of those parts and their *relationships* within the living system, that orchestrate our experience of health and disease.

This doctoral project was conducted in a United Kingdom (UK) medical school, nested within a research group called the Health Professions Education Unit (HPEU). The work sets out in the critical realist paradigm, starting with an exploration of stakeholders' experiences of alignment. It looks specifically at how anatomy aligns within medical programmes and what that could mean in terms of real experience. This enquiry develops into a hermeneutic phenomenological study examining the system of medical education

in this country, and the more recent interventions seeking increasingly “authentic” learning experiences for medical students. As defined by Gulikers (2004), an “authentic” task is one that demands the student to synthesise their knowledge and skills in a manner that is demonstrably in accordance with real-life situations.

1.3 Authenticity and Alignment

One simple way of contextualising authenticity is to compare it with so-called traditional instruction, as shown in Table 1 adapted from Mueller (2018).

Table 1: Traditional Instruction (TI) versus Authentic Teaching & Learning Activities (TLAs) Adapted from Mueller (2018).

Traditional	Authentic
Selecting a Response	Performing a Task
Contrived	Real-life
Recall/Recognition	Construction/Application
Teacher-structured	Student-structured
Indirect Evidence	Direct Evidence

The traditional frontal classroom instruction (TI) is where facts are taught and subsequently assessed through conventional means such as multiple-choice question (MCQ) tests. The curriculum triangle pictured in Figure 1 is generic to education - instruction, learning and assessment (ILA) (Napper, 2012). The ILA practices in TI are characterised as an instructional approach with the goal of knowledge transmission. Biggs’ (1996) model of Constructive Alignment (CA) uses triangulation of these three points with slightly different terminology: teaching and learning activities (TLAs), intended learning outcomes (ILOs), and assessment (see Figure 4). The triangle of alignment pictured in Figure 1 will come up again in connection with CA as it forms a central tenet of this thesis.

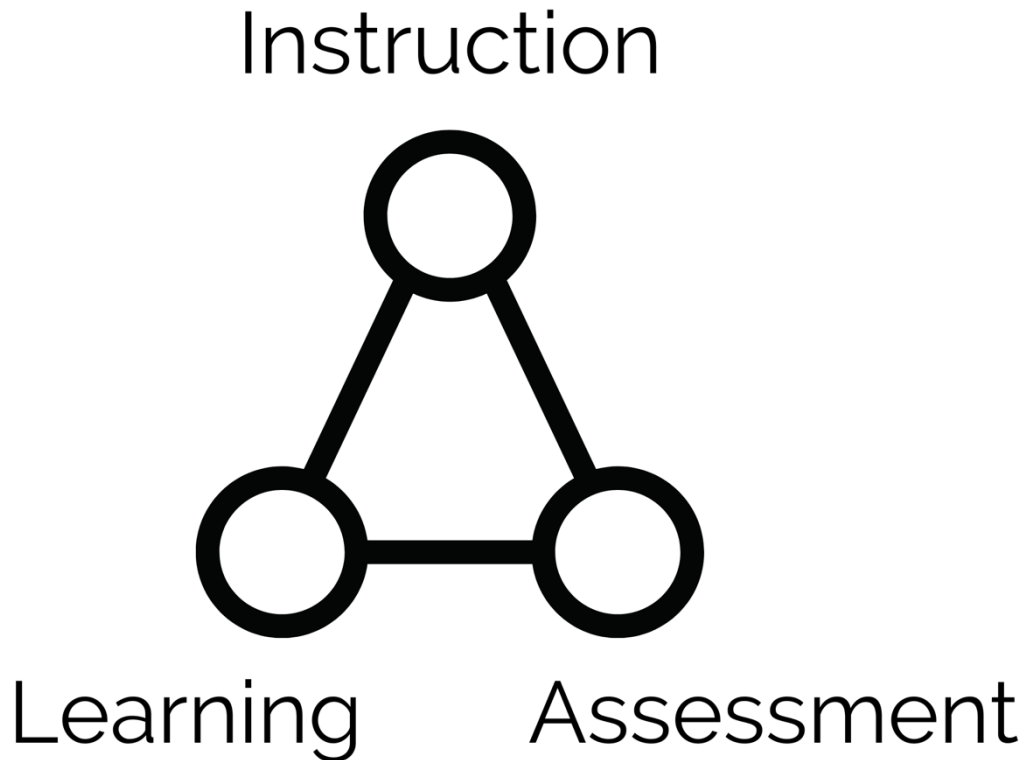


Figure 1: Triangle of curriculum alignment

The learning approach of TI equates to rote memorization with assessment carried out through standardised testing (Birenbaum, 2003). This model was coined the “testing culture” by Birenbaum & Dochy (1996), consisting of “decontextualized, psychometrically designed items in a choice-response format to test for knowledge and low-level cognitive skill acquisition” (Gulikers et al., 2004). TI primarily utilises summative tests to rank students by achievement in convenient accordance with testing culture norms that have dominated selection criteria in medical schools for decades.

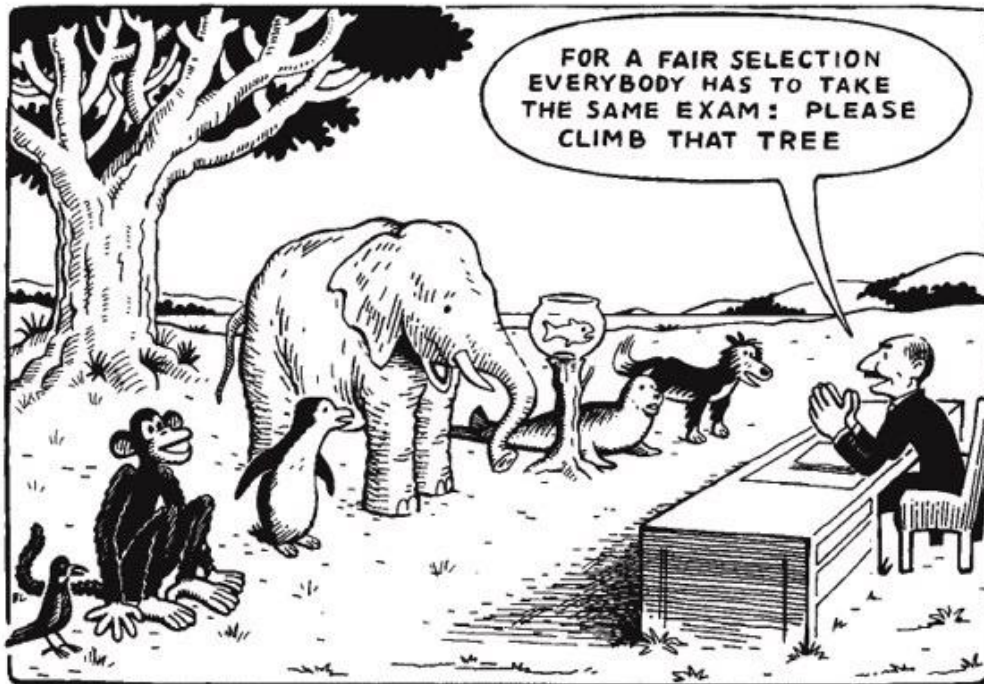


Figure 2: Standardised testing in the wild, source @wearecognitive on Twitter

As educational goals have changed in recent years, so too has the landscape of alignment. Current educational goals focus more on the development of competencies than on knowledge acquisition (Brydges et al., 2021). At the time of this writing, the British Medical Association (BMA) website reports six approaches to the training generally provided at medical schools in the UK with representation distribution indicated in Table 2. It is worth noting that the BMA (2022) acknowledges:

"There are subtle, theoretical differences between learning styles of integrated learning courses provided at medical schools; problem based learning (PBL), enquiry based learning (EBL) and case based learning (CBL), but in most cases the lines between each of these are significantly blurred."

Table 2: Curricular Approaches at UK Medical Schools (BMA)

Curricular Approach	Number of Institutions using it
Traditional pre-clinical and clinical courses	2
Integrated/systems-based courses	unlisted
Problem-based learning (PBL)	11
Case-based learning (CBL)	3
Enquiry-based learning (EBL)	1
Multi or inter-professional learning	unlisted

Foreshadowed here are the uncertainty and complexity found by this project to form the authentic terrain of the learning environment (LE). It becomes important to define authenticity not just by what it is *not*, but by trying to figure out what it *is*. It turns out that defining authenticity is a subjective project, one that informs the trajectory of this thesis through critical realism (we'll get much deeper into that later). The term "authentic assessment" was introduced into the literature by Grant Wiggins (1991) in the context of K-12 education and was developed into a framework by Gulikers et al. (2004, p. 69) who define authentic assessment as:

"An assessment requiring students to use the same competencies, or combinations of knowledge, skills, and attitudes that they need to apply in the criterion situation in professional life."

Authenticity in assessment is now widely considered as the degree to which an assessment resembles the criterion situation (Gulikers, et al., 2004). In medical education, there are two major categories of tests: criterion-referenced tests (CRT) and norm-referenced tests

Chapter 1: Introduction

(NRT) (Turnbull, 1989). NRTs rank competing students against one another for a limited number of grades intending to project achievement differentials to produce a reliable rank order, or “grading on a curve”.

In CRTs, students are evaluated individually against a set of predefined achievement standards where their grade is not influenced by the wider range of performance. As such, CRTs are also known as ‘domain-referenced’ tests because they are designed to identify “the proportion of a domain of tasks that an examinee can successfully complete” (Ricketts, 2009). NRTs, in contrast, do not reveal anything about the examinee’s ability in relation to a domain of tasks. NRTs are arguably designed to vet those who are better than their peers at taking the exams.

As the literature reveals, the medical education community has expanded from the NRT in recent decades, embracing criterion as the dominant reference for assessment. However, as pointed out by Royal & Guskey (2015), both references of assessment have their merits: NRTs are useful for *sorting* talent for example in admissions, residency programs, etc. whereas CRTs are useful for *developing* talent. The upshot is that medical educators, having received their cohort following the sorting process, will be primarily concerned with developing their learning. The criterion reference prevails, and educators are tasked with providing increasingly “authentic” learning environments. But what does authentic really mean and how can it be modelled?

With the advent of digital technologies, the biomedical research landscape and its associated learning techniques have mushroomed exponentially (Owolabi & Bekele, 2021). Rote memorisation and regurgitation of facts, once the *terra firma* of medical students, is an untenable strategy for contemporary clinicians who are now also expected to develop clinical competency and problem solving along

with gaining anatomical knowledge via their medical training (Black, 2016). As Koh explains (2017), “authentic assessment has played a pivotal role in driving curricular and instructional changes in the context of global educational reforms.” One of the main aims of this project was to ascertain whether the traditional pedagogical models, Biggs’ triangle of pedagogy, is fit for purpose considering the complex learning environment it is still meant to represent.

1.4 Constructive Alignment

Biggs’ (1996) influential Constructive Alignment (CA) model of evaluating a curriculum based on ILA triangulation (pictured in Figure 1) is seated in the convergence of what Biggs refers to as “two lines of thinking” (Biggs, 1996). The first has its origins in constructivist learning theory, while the second has emerged out of the instructional design literature. As such, the CA model is better understood in the context of educational theory, while the concept of authenticity and its itinerant philosophical discourse are more appropriately aligned with the larger paradigm that will be developed throughout this thesis via the nested ontological lens of Critical Realism (CR).

This rationale pulls alignment through and beyond its constructivist roots as a causal mechanism of authenticity, to be explored throughout this thesis. Through the abductive process of CR, this project will show that experiences of authenticity emerge from alignment, and this alignment can be modelled. The degree of accuracy with which a model reflects the structure in question is considered its fidelity. The higher its fidelity, the more accurate the model is. These terms will be further explored in Chapter 6 (6.4.1) as relevant to an HPE-specific understanding of authenticity.

But is it authentic?

Chapter 1: Introduction

Are fidelity and realism the same as authenticity? Chapter 6 goes on to unpack further the application of these terms as applied to the experience of having an education and applying it to real life in the case of educators interpreting their experiences. The concept of model making is central to this thesis; from the syllogistic form of modelling logic to the multi-dimensional ways in which systems are modelled for the purpose of understanding and promoting their evolution.

1.5 Domains and Perspective

This project has been submitted for the degree of Doctor of Philosophy in the field of Medical Sciences. The original studentship directive was to explore "Authentic Assessment". Without further specifications, the candidate was encouraged to refine and focus the brief to align with her background and personal areas of research interest. Thus, the project shifted to an exploration of authentic learning in general, starting specifically with an investigation of kinaesthetic activities in anatomy pedagogy.

The original research began with a pilot study setting out to understand the use of kinaesthetic learning amongst anatomy educators in the UK. This study is presented in Chapter 4. The candidate's perspective matured through the concurrent philosophical enquiry that inevitably accompanies doctoral work, and this shift naturally steered the course of that pilot and the direction of subsequent studies. Ultimately, the conceptual threads woven through the resulting thesis have remained the same: authenticity, alignment, and anatomy pedagogy. The framework is delivered via the nested ontological domains of CR: the real, the actual, and the empirical as set out in Table 3. The epistemological and ontological rationale will be further developed in Chapters 2 & 3, with a reflective discussion in the final two chapters.

Table 3: Nested domains of critical realism adapted from Bhaskar (2008, p.13 & p.56)

	Domain of the Real	Domain of the Actual	Domain of the Empirical
Mechanisms	X		
Events	X	X	
Experiences	X	X	X

1.5.1 Research Questions

The theoretical framework of CR depth ontology and its evidence-gathering mechanism of abduction and retroductive argument will be explored in subsequent chapters. This paradigm fosters an enquiry seeking answers for the research questions as well as internal coherence for processing the questions:

1. How can the curriculum be modelled?
2. Can the authenticity of a curriculum be understood through its model of alignment?
3. What does the experience of authentic learning feel like?
4. Who decides what is authentic?

These questions are directly and indirectly answered via the retroductive argument central to CR epistemology, utilising phenomenological methodology to generate data from the empirical domain. This project seeks to find resonance in the logical alignment of abduction via retroductive logic, as this remains the central evidence generating activity in realist-informed research (Mukumbang et al. 2021) with its knowledge characterised by emergence. In *The Possibility of Naturalism*, Bhaskar (1979, p. 125) describes “*synchronic emergence*, on which the higher principles cannot be completely explained in terms of lower-order ones.”

Chapter 1: Introduction

Emergence is linked to complexity, “where a combination of elements on another level of structural organization yields properties or powers that are qualitatively different from the original elements without being mere aggregations” (Stausberg, 2021, p. 273). In other words, the “emergent wholes are more than the sums of their parts” (Pratten, 2013, p. 256).

These research questions are posited within a theoretical framework contextualising choices made by the researcher over the total period of study, choices that reflect a key challenge of the brief. That is, dealing with the subjectivity of ‘authenticity’ as a qualifier of experience within the historically positivist research culture of medical sciences. Thus, the research questions are explored via mixed methods, drawing on phenomenological methodology in the maturing empirical chapters of this thesis. The findings are integrated using a STEM¹-friendly conceptual framework (critical realism) to model the results.

1.6 Complexity – a personal reflection

An important topic in this doctoral work arose as part of the abductive process: complexity science (CS). Although various disciplines are at different stages in their appropriation of complexity, it is generally accepted that complexity arose in its current form in the 1940s (Manson, 2009). According to Castellani & Hafferty (2009), the two original proponents of CS are the mathematician Norbert Wiener (protagonist of cybernetics), and the biologist Ludwig von Bertalanffy (systems theory). I began my research with only a surface understanding of complexity. As my first study carried out a survey exploring what appeared to be a complex relationship (between anatomy as a subject and the

¹ STEM: science, technology, engineering, mathematics

Chapter 1: Introduction

curriculum as a programme), the concept of complexity features in this thesis from relatively early in my empirical journey.

However, I did not acquire a mature understanding of complexity, nor did I grasp the widespread ambiguity of its usage in HPE and medical education, until after the completion of the study presented in Chapter 7, *"Preparing them for the profession": in IPA study study of anatomy educators coping with complexity in the UK curriculum*. After a close reading of the literature in complexity and critical realism, I began to understand the depth of the discourse. My journey – a progressive, emergent understanding – is presented through the following chapters and leads to a robust rationale for proposing Authentic Alignment theory, with the tensegrity icosahedron (T-icosa) as its structural model.

1.7 The Value of Models

Establishing cogent research questions also means justifying the rationale of why it is worth the challenge of answering them. Why is it important to model a curriculum? What is the value in appraising the authenticity of that model? Who will benefit from the experience of authentic learning? How can such authenticity be achieved and sustained? Who has the privilege of deciding what "authentic" means? What overarching factors must be present to produce authenticity?

This thesis presents several original graphic representations, conceptual models designed to unpack the philosophical position of this project in terms of CR. As the next chapters will explain, modelling experiences is where this paradigm comes into its own. Projects such as this one, situated between the social sciences of medical education within a STEM-based academic base, are tasked with the challenge of translation. Models are a well-established tool of scientific literacy. As Hallstrom (2019) points out, "more urgent

Chapter 1: Introduction

educational research is needed on *how* modelling can be developed to meaningfully link the STEM disciplines.”

Further, Hallstrom’s argument (2019) for the use of models in STEM education is based on a synthesis that yielded results rooted in the relationship between authenticity and modelling, compelling for their potential application in medical education research:

“The implications of their synthesis are as follows: authenticity must be viewed as a cornerstone of STEM literacy; models and modelling processes can bridge the gap between STEM disciplines through authentic practices; models and modelling should be used as a means to promote STEM literacy and the transfer of knowledge and skills between contexts, both in and out of the STEM disciplines; modelling activities can serve as a meaningful route toward authentic STEM education; teaching authentic modelling processes must be rooted in explicit and tested frameworks that are based on the practice of the STEM disciplines; and, authentic STEM education should be driven by developing interaction between STEM subjects in parallel with maintaining the integrity of each subject.”

Considering the clear interdisciplinary links between medical education and STEM education, their findings (Hallstrom, et al. 2019) provide a strong precedent for considering the value of modelling in the pursuit of authenticity. Is there a post-Biggs model of alignment for the learning environment best suited to health professions education (HPE)? This doctoral work explores the potential of CR to justify asking if the medical curriculum could – and *should* – be modelled, and how do we keep that model current in light of the spiralling complexity involved? In Chapter 9 of this thesis, the value of models and their application to education will be discussed and a “new” spatiotemporal model proposed.

1.8 Aims of this Thesis

This doctoral work includes three empirical chapters with results that inform the trajectory of the project via abductive reasoning. Abduction represents an alternative (from within, going away) to the usual modes of coming to know about the world via deduction (top down) and induction (ground up). As such, the aims of this work revolve around understanding not only the alignment of the curriculum, but the alignment of the thesis itself and its original contribution to the field of medical sciences.

There are more specific aims and research questions presented in each results chapter, as they relate to study details. The integrative thread of alignment is woven through four major aims in the paradigm of crucial realism:

1. to understand the alignment of anatomy within the medical curriculum via the relationships of its stakeholders.
2. to explore the apparent complexity of the learning environment (LE).
3. to generate a critical evaluation of the methodology, Interpretative Phenomenological Analysis (IPA) (Smith, 1996) as an approach appropriate for research in the complex fields of medical and health professions education.
4. to propose a functional, authentic model of the learning environment.

1.9 Research Questions, reiterated

1.9.1 Overarching Question: How can the UK health professions learning environment (LE) be most authentically modelled?

Sub-questions

How can the curriculum be modelled?

Can the authenticity of a curriculum be understood through its model of alignment?

Chapter 1: Introduction

What does the experience of authentic learning feel like?

Who decides what is authentic?

1.10 Thesis Overview

This project began with the topic of Authentic Assessment in medical education, essentially looking at how assessment conditions match up with real life professional scenarios. The overarching research question: How can the UK health professions learning environment (LE) be most authentically modelled?

I read the concept of knowing authenticity as an inherently subjective project. As such, I used the paradigm of critical realism in my aims 1) to understand the alignment between anatomy and the overall UK undergraduate medical curriculum; 2) to explore the apparent complexity of this relationship; 3) to generate a critical evaluation of Interpretative Phenomenological Analysis (IPA); 4) to propose an explanatory model of authentic alignment based on the results of my studies.

The peak study of this thesis, presented Chapter 7, used IPA to explore the lived experiences of 11 anatomy educators who are tasked with teaching anatomy in the face of often conflicting constraints as a normalised aspect of their professional lives. My discussion of the findings develops the concept of professionalism as an emergent quality fostered through navigating Complex Adaptive Systems (CAS). These results foreground the alignment between the curriculum (as agency) and the learning environment (as structure), using the agency-structure dialectic as the principle hermeneutic device.

Through abduction, my explanatory work builds on the agency-structure dialectic to rationalise moving from the static triangle of Biggs' 1996 Constructive Alignment model to a multidimensional

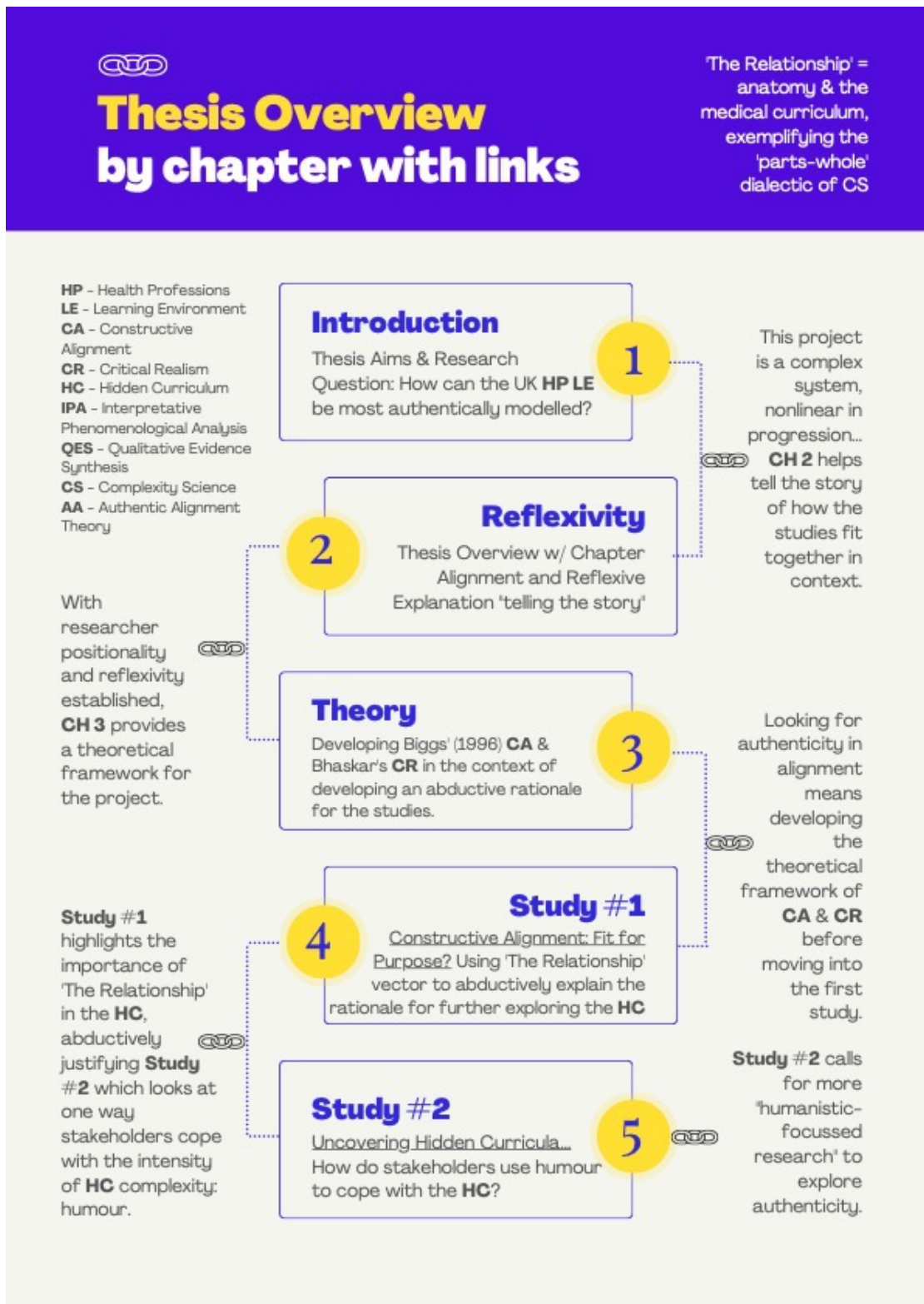
Chapter 1: Introduction

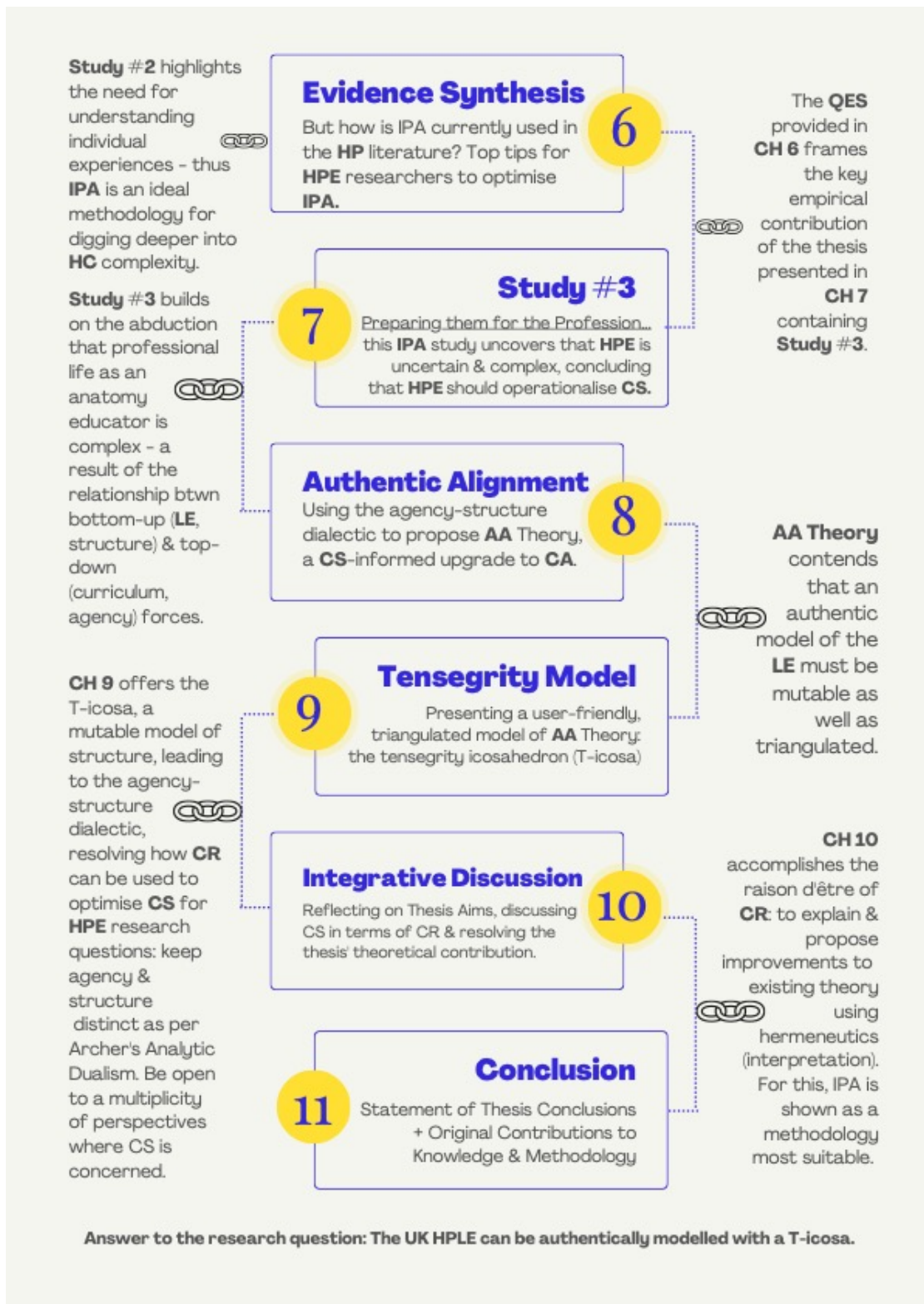
tensegrity model representative of what I refer to as Authentic Alignment theory.

The studies presented demonstrate that the authenticity of a curriculum can be structurally interpreted through its model of alignment. The studies are linked by their focus on increasingly humanistic questions that aim to find out what it feels like to be a stakeholder in the LE. In reference to my primary research question, alignment feels authentic when it is complex, uncertain, and changeable. My thesis presents authenticity as an emergent, intersubjective experience of alignment that is co-created by all stakeholders over time.

1.11 Thesis Summary Infographic

(see next page)





The infographic features a dark blue header with a white chain-link icon and the title 'Thesis Conclusions practical takeaways for educators' in yellow and white text. Below the header, four numbered points are presented in white boxes with blue borders, each accompanied by a yellow callout box. Point 1: 'HPE is hard' with a callout 'Don't pretend everything is linear/tidy!' and a side note 'Do acknowledge that the curriculum is fraught with complexity...'. Point 2: 'Complexity is real' with a callout 'Don't throw around the term 'complexity' without doing your research!' and a side note 'Do understand the depth of Complexity Science...'. Point 3: 'Reflexivity is an asset' with a callout 'Don't be afraid to co-create data.' and a side note 'Do lean into the increasingly reflexive, subjective nature of HP research...'. Point 4: 'Mutable is more authentic' with a callout 'Don't get attached to static models.' and a side note 'Do use critical realism's emancipatory axiology...'. The background is a light grey gradient.

Thesis Conclusions practical takeaways for educators

- HPE is hard**

The alignment of anatomy within the medical curriculum is complex and forms a multiplicity of perspectives.

Don't pretend everything is linear/tidy!

Do acknowledge that the curriculum is fraught with complexity, sell it as an appropriate way for medical students to prepare for their career in complex, uncertain healthcare settings.
- Complexity is real**

This complexity is ripe for phenomenological exploration.

Don't throw around the term 'complexity' without doing your research!

Do understand the depth of Complexity Science and how it fits with qualitative methodology in HP research.
- Reflexivity is an asset**

IPA is particularly suitable for realist research exploring complexity in HPE.

Don't be afraid to co-create data.

Do lean into the increasingly reflexive, subjective nature of HP research and encourage your students to own their story.
- Mutable is more authentic**

Authentic Alignment theory offers a spatiotemporal model of the complex HPE learning environment: the T-icosá.

Don't get attached to static models.

Do use critical realism's emancipatory axiology to upgrade old theories; to be authentic is to change.

1.12 Chapter Summary

This Introductory Chapter has established the domains, aims, and structure of this multimethod doctoral project. Situated in critical

Chapter 1: Introduction

realism, the work explores how authenticity of anatomy pedagogy may be modelled as a function of its alignment in medical education. The next chapter provides a reflexive overview of the thesis.

Chapter 2: Reflexive Overview

2.1 Alignment of this Thesis

Chapter 2 provides an overview of this thesis in terms of its alignment with a reflexive rationale to establish context for relevant chapters and to explain how the studies link together. As the project came together in a typically nonlinear way with studies that were carried out concurrently, this chapter aims to clarify where the studies came from and how each aspect informs the larger body of work.

2.1.1 Chapter 1: Introduction to Thesis

The introductory chapter presents an overview of this multimethod doctoral project situated in Critical Realism (CR). Chapter 1 states the aims and research questions, setting the stage for the results chapters that follow and subsequent theoretical work contextualising the findings, presented in the final chapters. The key concepts of Constructive Alignment (Biggs 1996) and authenticity in terms of curriculum design are introduced.

2.1.2 Chapter 2: Reflexive Overview

Here thesis alignment is presented chapter-by-chapter including reflexivity statements included where relevant.

2.1.3 Chapter 3: Reconsidering Constructive Alignment via Critical Realism

This chapter provides the theoretical rationale for the study presented in chapter 4. The concept of Constructive Alignment is further discussed in the context of CR, and here the importance of axiology is established: CR is used to discuss, explain, and ultimately to improve received social theories. This chapter contextualises the studies that follow.

Chapter 2: Reflexive Overview

2.1.3.1 Chapter 3 Reflexivity Statement

This study was my first experience of research. At this point in my project, I was dealing with the theme of alignment in anatomy pedagogy within UK undergraduate medical education while also trying to understand what paradigm means. My focus was on authentic learning in consideration of Biggs' (1996) CA as a pedagogical tool for addressing the complexity of nested curricular constraints. I didn't know it then, but I was about to understand that alignment of systems is necessarily complex. As I have been a professional yoga educator for over 20 years in addition to my academic pursuits, one could say that alignment is what I do.

I began my doctoral research in the Autumn of 2018, post-MeToo but before the tsunami of educational changes pouring in from the pandemic, the Black Lives Matter movement, and identity issues that have all intensified since the brutal murder of George Floyd (Finn et al., 2021). Now in 2023, can anyone in biomedical education afford not to ask how the medical curriculum aligns with the furthering of social justice? Whether it is set up to evolve or stagnate? How effectively alignment is informed by global events?

These questions have taken priority as my project expanded from an interest in anatomy pedagogy to a deeper look at the curriculum as a complex system. Just as the human body is biologically constrained to adapt and evolve at various timescales, to what extent is the UK undergraduate medical curriculum a function of its alignment? Is it adequately updating itself?

This line of enquiry feeds into the research question for the study presented in this chapter: What do educators involved in the UK undergraduate medical curriculum have to say about its alignment? The most relevant outcome of this study turned out to be as much about my development as a researcher as it was about the data.

Chapter 2: Reflexive Overview

The results of the study are important mainly for their role in setting up context for the studies that follow.

2.1.4 Chapter 4: Constructive Alignment – Fit for Purpose? Study

This chapter provides a kind of “temperature check” where anatomy educators report on their experiences of working with the curriculum at their respective medical schools. This pilot questionnaire was developed to find out if educators were using kinaesthetic teaching methods, and whether they had a sense of their program being constructively aligned overall. The results pointed to the disparity in their experiences and views, emphasising the presence of the Hidden Curriculum (HC) that begs the appraisal of a post-Biggs model of alignment. Further, the use of Fryer’s Critical Realist informed data analysis distinguishes this study from traditional thematic analysis – the aim is to use the themes to explain and abductively propose grounds for further study.

2.1.5 Chapter 5: Uncovering Hidden Curricula: Use of Dark Humour in Anatomy Labs and its Implications for Basic Sciences Education

With results from the Fit for Purpose study pointing to the elephant in the room, The HC, this chapter presents the next logical step: uncovering that which is hidden in the obvious. This study provides qualitative data exposing the implicit, that the curriculum is not a tidy, linear progression of predictable phenomena. The Fit For Purpose study presented in Chapter 4 demonstrated the need for studies exploring aspects of the curriculum, in particular the relationship between those aspects. What can The Relationship between component parts, such as between anatomy as a subject and the wider medical programme as the curriculum, tell us about the learning environment? When I was presented with the chance to design and carry out the study looking at how humour is used to cope with the intensity of the anatomy/medicine learning environment, I saw this as a chance to unpack the nature of The

Chapter 2: Reflexive Overview

Relationship from a unique angle. Chapter 5 links the impact of the HC with the need for a phenomenological understanding of what it feels like to navigate the complexities of such a space. The wider impact of these results on the trajectory of my PhD will be discussed in the chapter summary. Chapter 5 is drawn from the manuscript accepted for publication by *Medical Science Educator* and adapted to the British English conventions used in this thesis.

2.1.5.1 Chapter 5 Reflexivity Statement

I was coming to the end of the first year of my researcher journey when two enormously significant milestones came to pass: one pastoral and one professional. The pastoral milestone was the imminent birth of my second child and subsequent maternity leave that would endcap my first year of doctoral work. Right around the time I was ready to pop, I was analysing my Fit for Purpose study data. I was also finishing the first set of interviews that would evolve into the IPA study presented in Chapter 6 exploring the complexity of the undergraduate medicine learning environment.

The second milestone came in the form of the study contained in this chapter. I was seeking to explore how humour may be used to cope with the challenges of the learning experience in the face of mortality, complexity, and the pressure of information overload. I joined forces with co-authors, taking an actively collaborative role in conceptualisation, design, study deployment, data analysis and the writing up process which included several iterations before it was accepted for publication through peer review.

The empirical significance of our study of individuals with anatomy lab experiences represented one of the most significant opportunities of my research journey to date. That it was presenting itself at precisely the wrong time in terms of my actual life is important to note, but it was one that was too valuable to pass up. As I reflect on my role over the year this study took to bring to

Chapter 2: Reflexive Overview

publication, I am reminded of the work I did whilst sleep deprived, parenting a newborn and a two-year-old. What came out of this study highlighted the significance of the HC in experience of the medical curriculum.

If the Fit for Purpose study demonstrated the need for understanding relationships and proposing abductive grounds for further studies of these relationships, then the Uncovering Hidden Curricula study showed the importance of studying these relationships from a humanistic perspective. By “humanistic”, I mean philosophically phenomenological and epistemologically subjective, looking at human experiences interpretatively to make sense of how relationships fit together in the learning environment. This called for the use of Interpretative Phenomenological Analysis.

2.1.6 Chapter 6: Interpretative Phenomenological Analysis (IPA) in the health professions literature – A Qualitative Evidence Synthesis

This chapter provides a review of the IPA literature relevant to medical and HPE to contextualise the empirical chapter that follows. Chapter 6 provides an explanation of how IPA is used in the HPE literature, setting the scene for the main empirical contribution of this thesis contained in Chapter 7. The qualitative evidence synthesis (n=33) presented in this chapter uses the SPIDER search tool, with a critical overview of selected texts and a set of 10 top tips for HPE researchers interested in using IPA.

2.1.6.1 Chapter 6 Reflexivity Statement

At the time of this writing, I am currently working with co-author and mentor in IPA, Isabella Nizza (IN), on revising the contents of this chapter for submitting to peer review when her schedule allows (tentatively Winter, 2023). My intention is to refine the analysis with her as a co-author to submit as a manuscript. I first contacted IN when I realised that I needed mentorship in IPA and she

Chapter 2: Reflexive Overview

collaborated with me on the IPA study that we eventually got published, provided in the next chapter.

In addition to IN, I am seeking a co-author for this literature review who has expertise in database searching, i.e., a specialist librarian and information scientist. Under the current time constraints, I chose with supervision to reduce the scope from my original plan (which was to utilize and compare several search strategies – PICO, PICOS as well as SPIDER). Focusing on one search mode allowed me to carry out the review solo. In my view, the constrained scope was sufficient for reporting in depth on the findings as well as contextualizing IPA in the HPE literature, which is the aim of this chapter and a central component of my doctoral work overall.

2.1.7 Chapter 7: “Preparing them for the profession” – an IPA study of anatomy educators coping with complexity in the UK curriculum

This is the peak empirical chapter of this thesis, an IPA study of the lived experiences of anatomy educators coping with complexity in the medical curriculum. The “Preparing them for the profession” study is a comparatively large one for IPA standards, with a sample size of eleven participants. A semi-structured interview guide was used to get a sense of what it was like for anatomy educators to reconcile their reality (from the ground up) with the top-down demands of the ever-changing curricular alignment. Here, findings are expressed through an interpretative discussion of Group Experiential Themes (GETs) centred around the complex nature of the UK curriculum, pointing to key properties of complex adaptive systems (CASs) that apply to the learning environment and the uncertainty tolerance apparently required to navigate it.

2.1.7.1 Chapter 7 Reflexivity Statement

This study is where I cut my teeth as a researcher.

Chapter 2: Reflexive Overview

As I mentioned in the previous chapter, the study that fills Chapter 6 was finished before I wrote up the Qualitative Evidence Synthesis of IPA that constitutes Chapter 5. In essence, I didn't know what I didn't know when I was trying to get this paper published. It was originally rejected as a much earlier iteration from Medical Education, so we reworked it and submitted the next version to Anatomical Sciences Education, who replied to say essentially that it needed revisions [of a number and scope I can only now laugh about when I say they were basically endless] before they would again consider it for publication.

Concurrently with this PhD, I was also working on my first book for Handspring Publishing. This semi-academic book for the holistic health market, *Spiral Bound: Integrated Anatomy for Yoga* (Kirkness, 2021) is centered on the tissue continuum that comprises anatomical structure, what is popularly referred to as 'the fascia'. The body as a vector field of continuous realignment is an analogy for pedagogy: how we study the body is an extension of the body itself. Moreover, these are not static structures but complex adaptive systems (CASs). In Autumn 2021, I co-authored a paper exploring just that, *Proposal for A New Pedagogical Approach in Teaching Anatomy to Medical Students, Part I: Fascia Continuity In The Anatomy Curriculum* (Sharkey & Kirkness, 2021). In this paper, anatomist John Sharkey and I explore a structural rationale for making more of the anatomical alignment of connectedness in the curriculum.

This is my positionality as a professional movement teacher invested in kinaesthetic methods of learning anatomy. I am a mature student coming to academia from the holistic health community, a white cisgender woman learning to acknowledge the privilege of being born into an established economy within a demographic that has access to "boutique health and fitness". I can

Chapter 2: Reflexive Overview

afford to ask questions about alignment in yoga poses, alignment within anatomical structure, alignment of constraints in pedagogical systems and how education realigns itself within societal changes over time (or not).”

The studentship for this project was originally granted based on authentic assessment in medical education. My mentor and supervisor, Prof Gabrielle Finn, has published extensively in medical education and in particular her work exploring innovative teaching such as anatomy body painting has always inspired me (Finn, 2010; Finn et al., 2011; Finn, 2015). I learned anatomy body painting from her on my MSc Anatomy course and modified her approach for use in the private sector with yoga and fitness teachers. She encouraged me to explore the connection between assessment and instruction within CA as essential constraints of learning. I recognised that I could make a more significant contribution to the literature by exploring the alignment of authentic assessment as a constraint for deep learning. To quote John Biggs, originator of the CA concept, “We should design learning activities and assessments, so they support students in achieving the learning outcomes.” (Biggs, 1996).

As my research unfolded, I could see that alignment is not a time-referenced constraint. In Balmer’s words, “Research in medical education will likely be impoverished if the focus remains on time as fixed” (Balmer et al., 2021). Indeed, spatiotemporal complexity is a current theme across biomedical sciences (Bittner & Goldberg, 2007; Gadomski et al., 2019). As Knight describes (2001), alignment in complexity govern the unfolding and adaptation of curricular systems across timescales. As such, the first theme is emergent: authenticity and alignment as constraints that may give rise to a multidimensional curriculum.

Chapter 2: Reflexive Overview

Through my interviews of anatomy stakeholders, I also experienced alignment as a researcher. As per the conceptual framework of Interpretative Phenomenological Analysis (IPA), I was co-constructing data through my interpretation of participants interpreting their experiences – the so-called ‘double hermeneutic’ of IPA praxis (Smith, 1996). IPA allowed me to harness this alignment.

It became clear that my data was as much about the anatomy educators themselves as it was the phenomena the interview questions were designed to uncover. Rather than explain away this emergent quality, I chose to develop my research framework as informed by IPA. IPA offers a methodology that illuminates – rather than subverts – the contextual alignment of individual interpretations. In this way, my project become fully immersed in the humanistic focus called for in the Uncovering Hidden Curricula study presented in Chapter 5.

2.1.8 Chapter 8: Authenticity, Uncertainty, Complexity, Multiplicity – Proposing Authentic Alignment Theory

With the empirical journey of this thesis now largely in rear view, this chapter reflects on the findings of the thesis. In this chapter, three further threads of discourse are presented: (1) conceptual models, (2) educational & curriculum theory, (3) the learning environment as a problem space. This chapter moves into the paradigmatic justification behind proposing a new theory: Authentic Alignment.

2.1.8.1 Chapter 8 Reflexivity Statement

All projects must take the shape of their container. I was five years into my doctoral work, and it was time to reflect on the aims of the project. I found that by the time I had set up the paradigm and provided four results chapters to fuel the reasoning structure for the findings of the results chapters (4 through 7), my project had

Chapter 2: Reflexive Overview

satisfied its aims while expanding to the outer limits of the maximal word count.

In the interest of crafting a clear and purposeful dissertation with adequate reflexivity and context, I decided to use Chapter 8 to bring together the empirical journey into the context of Critical Realism. The decision to reserve precious words and white space for the presentation and integration of findings has allowed me to focus on the aspects of this doctoral work that make it most unique and valuable: using critical realism to update Biggs' (1996) CA to a more authentic model appropriate for the complex HPE learning environment.

2.1.9 Chapter 9: Tensegrity Icosahedron – Authentically Aligned

This chapter offers the corresponding conceptual model for Authentic Alignment theory: the tensegrity icosahedron (T-icosa). This chapter furthers the description of complexity and nonlinear pedagogy, presenting the human body and learning environment as CASs. I offer the Tensegrity Icosahedron as a reasonable spatiotemporal model of CA in the learning environment.

2.1.9.1 Chapter 9 Reflexivity Statement

I was at a yoga trade show (pre-COVID) and got talking with a fellow yoga teacher about our respective work in anatomy. I find it hard to talk about my research in moments like these because it can sound pretty bonkers. In fact, given a choice, I'd rather talk about postures, my kids, even the weather, or just about anything *other* than the helical cross-ply of tubular tissue that governs movement at every size scale. On this occasion, I'd had two coffees, and she seemed genuinely interested, so before I knew it, the word "tensegrity" came out of my mouth. Gulp. There was no turning back.

Chapter 2: Reflexive Overview

As it happened, she smiled politely but did bristle at the term 'tensegrity' in a polite way that implied a yawn mixed with a rolling of the eyes. I pressed on, asked if she had the experience of tensegrity. Her response was refreshingly honest; she flashed me a knowing smile and said, "Well, the term *does* get bandied about." I had to laugh.

It was funny to me at the time because of the sheer Britishness of that expression, "bandied about," meaning to fling back and forth in a careless way. But it was funny also because it's true: tensegrity *does* get bandied about the physical culture scene. Reflecting on that perspective, I can see why many of us hear the term and dismiss it as somebody trying to sound clever (or just bonkers). If you're studying anatomy to be a better yoga teacher (complicated enough), why on Earth would kinetic sculpture or mid-twentieth century architecture be in the curriculum? I first got into tensegrity as an art student, but only later saw its relevance to tissue.

I came back into the tensegrity conversation when I started 3D printing anatomical models because the mesh underlying the "anatomy" of a 3D print is built on triangulated spheres. But it wasn't until I began making sticks and string models of tensegrity that it all came together for me as essential for understanding the interconnectedness and functionality of body materials, movement, and, essentially for the complexity narrative, *emergence*.

2.1.10 Chapter 10: Toward Authenticity – An Integrative Discussion

The major theoretical contribution of the thesis now resolved in the proposal of an updated theory in the form of Authentic Alignment. This chapter reflects on the aims and research questions of this doctoral thesis and provides my interpretation of the integrated findings in context of the conceptual framework and paradigm.

Chapter 2: Reflexive Overview

2.1.11 Chapter 11: Thesis Conclusion

The concluding chapter summarises the entirety of the project with the benefit of hindsight balanced with a fresh reiteration of the original questions. Contributions of this thesis to theory, knowledge, methodology, practice, and policy within the field of medical education are discussed. The work culminates in a presentation of personal reflections to close the thesis with concluding remarks.

2.1.12 Appendix A: Anatomy of Wholeness – Considering Narrative and Paradigmatic Alignment

Appendix A contains a monograph piece exploring the narrative power of changing the point of view as a tool to deliver nuanced insight into the philosophical framework of this thesis. This tool is presented in the first and second person voices as a “Letter to My Naïve Self”, where the accomplished candidate reflects on what she has learned for the benefit of cutting through what can seem like impenetrable jargon for the beginner doctoral candidate. This technique frames the author’s eventual stance in personal experience, lends immediacy and context to the paradigmatic alignment she aims to clarify in simple terms for the beginner, with the added benefit of increased readability.

Appendix A describes in detail the structural container of this thesis, using the metaphor of a theatre leading into a Beginners Guide to Philosophy relevant to a novice PhD researcher in HPE. Using first- and second-person perspectives, the manuscript contained in Appendix A explains key terms with definitions and context related specifically to the health professions literature. I chose to present the paradigmatic alignment of my thesis this way because using creative writing demonstrates a sustained engagement with the heteroglossic philosophical approach of critical realism (CR).

The lynchpin of the Beginners Guide in Appendix A is the introduction of *causal tendencies*, explaining how CR is

Chapter 2: Reflexive Overview

distinguished from other paradigms in its pursuit of causes. The Beginners Guide contends that positivism is preoccupied with correlation and that constructivist studies can be let down by their lack of internal structure. This monograph piece establishes my rationale for choosing CR as the most appropriate paradigm for the research questions involved in this doctoral work, and why I would recommend this paradigm for consideration by other PhD candidates in the field of HPE.

My choice to include the Beginners Guide and original graphics collectively bolster the originality of this thesis and its contribution to the field of knowledge. All the chapters in this thesis spiral back to the philosophical stance of CR and the itinerant methodologies of this project that carry the findings and give them meaning, building depth around the aims of the project overall. Each chapter provides further justification of the search for causal tendencies that forms the primary purpose of research from the CR perspective.

2.1.13 Appendix B, C, D & F:

Appendices contain data that support the depth and volume of work encompassed in this project.

2.2 A Guide to Navigating the Terrain

Any written thesis is necessarily linear, following the structural constraints of consecutive presentation in a chapter-by-chapter progression that is necessarily sequential. In life, most projects take the form of a nonlinear experiential journey. In that sense, this doctoral work is no different; what is learned in the final steps of the protagonist will largely inform how those first steps are framed. One of the significant ways in which this thesis is among the unique in medical education is its complete ownership of the nonlinearity and multimodality of the process involved in its output.

Chapter 2: Reflexive Overview

2.2.1 The Researcher by Any Other Name...

That this project happens to be concerned with authenticity and alignment makes it particularly suitable for a structural exploration of its deliverables, i.e., this thesis. How can the alignment of this work be presented most authentically? What *is* authenticity and how can it be known if at all? The subjective nature of this elusive and emergent quality, what it means to be authentic, lends itself to exploration using a combination of methodological approaches.

Each methodology has its own conventions and constraints whereby the protagonist refers to oneself using a particular term, i.e., 'candidate', 'researcher', 'primary researcher', 'author', and 'author of this thesis' will be used at various intervals throughout. Be assured that these characters are all one in the same, and you may expect the associated use of changing points of view not merely as an accident of the polyglot methods involved, but as an intrinsic aspect of the conceptual framework employing many tongues.

2.2.2 Heteroglossia – The “Many Tongued” Voice of This Thesis

This project explores the empirical domain through a phenomenological methodology to gain insight into the actual and real domains. Owing to the phenomenological aspects of “unpacking authenticity” in this way, the candidate has utilised hermeneutics (interpretation) to dwell within the alignment of the structure – the learning environment – addressed in the research questions.

Put simply, using the methodology of IPA means co-creating the data arising from the studies, injecting myself as the researcher into the data. The phenomenological vectors of this work add gust to the prevailing winds of multidisciplinary research that are increasingly encouraging the use of varied points of view in mixed & multimethods research (Cai, et al., 2016). As mixed & multimethods projects allow and exist for the exploration of research questions from different perspectives (Regnault et al., 2018), it follows that a

Chapter 2: Reflexive Overview

shifting voice fostering high fidelity communication of the changing perspectives serves the project overall.

Conventionally, scientific writing employs exclusive use of third person voice (Webb, 1992; Tang and John, 1999), although the advent of multidisciplinary research has encouraged its researchers to push the heteroglossic (use of multiple voices) boundaries (Cai et al., 2016). The use of the first person in academic writing is not new (Webb, 1992; Hyland, 2002), especially in qualitative research (Yilmaz, 2013). This thesis coheres with itself using changing voices. Utilising the interplay of different voices is well established in action research, as Coghlan points out (2021), “researchers need to pay careful attention to the discoveries that surface within or between first, second and third person dynamics.”

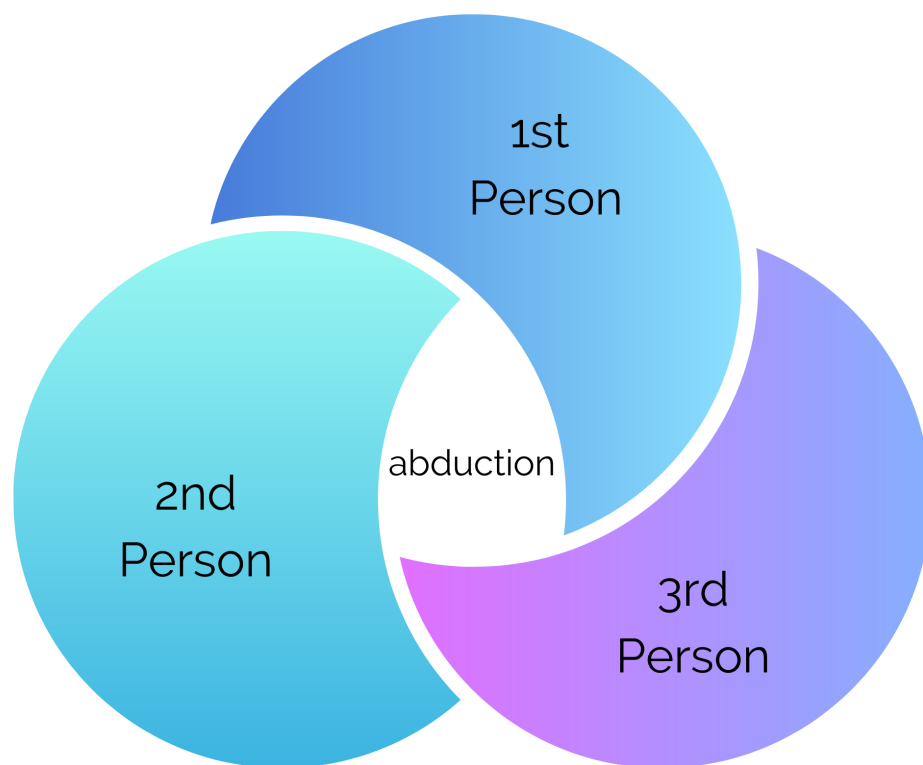


Figure 3: Abduction links the voices of first, second, and third person. Image designed by the author using Canva, adapted from Coghlan (2021).

Chapter 2: Reflexive Overview

Action research (AR) uses the interplay of voices as a core element of practice toward cogenerating actionable knowledge. These practices are couched in Torbert's claim (2013) that third-person theory is integrated from practices in the first- and second person, see Figure 3. Coghlan (2021) goes further with his assertion that abductive reasoning provides a lynchpin that couples the subjective dynamics of the first-person with the intersubjective, collaborative dynamics of second-person interaction, ultimately connecting them with the objective, third-person realm of actionable knowledge. Drawing on these insights from AR praxis, it is my position that acknowledging the various voices involved in a project is beyond merely justifiable, it is germane to the conceptual framework of this thesis.

This project is not following the conventions or trajectory of AR *sensu stricto*. However, the interest of AR in generating useful results out of research harmonises with the emancipatory axiology of critical realism explored in the next chapter. That research might have an impact in the real world provides compelling incentive for heeding the call to acknowledge, integrate, and harness the power of varied voices.

I have taken on the exploration of authenticity as an invitation to weave the qualitative (first-person, subjective) and quantitative (third-person, objective) as well as operationalising my reflexive voice in first person to enrich the landscape of rhetorical dimensions at play. In Appendix A, I utilise the second person voice as a tool of writing to improve readability and offer a novel approach to making my framework of experience understood. My hope is that such a fresh understanding may be of help to the next generation of health professions researchers. Ultimately, I want you, the reader of this thesis, to be drawn into the story as it unfolds and to this end it

Chapter 2: Reflexive Overview

serves us all for me to use every appropriate technique available to leverage the otherwise (let's face it) dense content.

Writing authentically means being true to my experience as a researcher in HPE, caught in the divide between STEM writing conventions and the innovative writing style encouraged by contemporary research in the social sciences. I use the technique of changing voice as a means of simply communicating complex phenomena in the most effective way possible. Drawing on Greene's (2007) call to reach across the proverbial aisle, I have grasped this project as an opportunity to "communicate across entrenched divides often separating writers from readers, in general, and qualitative from quantitative writers and readers, in particular" (Greene, 2007).

Further, I have heard the call of authenticity on personal terms as well, as any thesis emerges from the theoretical beliefs and methodological choices that researchers make – necessarily and indisputably based on personal experience, consciously and otherwise. Research questions are shaped by our individual interests, educational backgrounds, and the circumstances that surround and define the brief as well as our growth and maturity over the course of the project. I will continue using the first person when I need to clearly explain my choices, positionality, and insights that have made this journey what it is.

2.3 A Note on co-authors

Research is never carried out in a vacuum. This thesis represents a solo intellectual dive into the research question as I developed my understanding of the field to make an original contribution to knowledge. However, the empirical work involved a suitable level of collaboration with other researchers whose contributions are summarised as follows:

Chapter 2: Reflexive Overview

Chapter 4: the author with supervision from the PhD team

Chapter 5: the author in collaboration with Angelique Dueñas (first author responsible for correspondence with journals) and Gabrielle Finn (co-author).

Chapter 6: the author working solo on the material presented in this chapter, with intention to bring IPA expert, Isabella Nizza, in as an editor of the manuscript at a later date.

Chapter 7: the author carried out the study and data analysis plus the writing up (Kirkness as first author responsible for correspondence with journals), with IPA mentorship from Isabella Nizza and under supervision from Peter Bazira (co-author) and Gabrielle Finn (co-author).

2.4 Chapter Summary

Chapter 2 provides an overview of the Thesis chapters as well as a robust reflexive rationale for how the studies link together. Here, I have explained my rationale for using varied voices, pointing out that the different studies employed in this doctoral journey are integrated through the lynchpin of abductive reasoning. I offer further development of my conceptual framework – abduction – within the paradigm of critical realism, to show how the whole of authenticity is more than the sum of its parts.

Chapter 3: Reconsidering Constructive Alignment via Critical Realism

3.1 Chapter Introduction

The present chapter contextualises critical realism in a more formal sense to contextualise the data presented in the chapter that follows. The study included in Chapter 4 (Constructive Alignment – Fit for Purpose?) was carried out through a questionnaire posed to anatomy educators in the UK, seeking to understand educators' views on the alignment of their respective curriculum. The dominant model used to assess alignment is still Biggs' CA. As such, my first study aimed to find out: Do educators feel that the curriculum is constructively aligned?

As explained in the introductory chapter outlining the position of CR, the primary purpose of research is to theorise proposed explanations for 'tendencies' in observed phenomena. These explanations-cum-theories focus on the mechanisms (the Real domain) that can generate events (the Actual). Bhaskar (1975, p. 47) describes what he refers to as "the arduous task of science: the production of the knowledge of those enduring and continually active mechanisms of nature that produce the phenomena of our world."

3.2 Background

The UK medical curriculum poses a challenging problem space (Caverzagie et al., 2017; Hawick et al., 2017). The term "curriculum" has many definitions. Etymologically, the Latin *currere* means "to run," with related terms 'courier', 'corridor', and 'currency'. The formal curriculum, that which is explicit, sets out the intended course of study. It provides a container for learning that is typically measured in terms of its alignment.

Constructive Alignment (CA) is a principle coined by Biggs (1996, 2003), who describes it as representing “a marriage between a constructivist understanding of the nature of learning, and an aligned design for teaching” (Jervis et al., 2005). This triangular model states that the goals of education require the alignment of teaching & learning activities/instruction, learning outcomes, and assessment. Figure 4 shows the triangulated nodes of the Biggs (1996) concept which describes Instruction as ‘Teaching and Learning Activities’ (TLAs) as aligned with ‘Intended Learning Outcomes’ (ILOs) and Assessment.

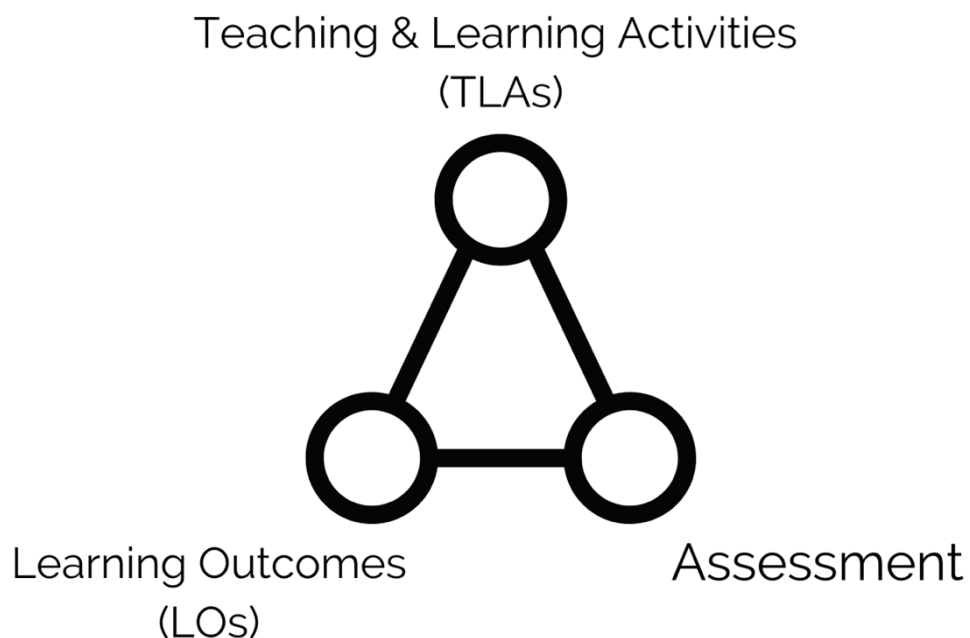


Figure 4: Constructive Alignment, image by the author using Canva adapted from Biggs' model (1996).

It is well documented that medical educators around the world are shifting their instruction away from the transmission/didactic style to more student-centered, self-directed styles. (Hsieh et al., 2015; Ramnanan & Pound, 2017; Singh & Kharb, 2013). (Kirch and Sadofsky (2021) highlight the reasons for this in respect to North American factors: increasing student engagement in learning, pursuing personal interests in education, and helping to ensure

medical students are prepared to improve future patient's life quality and to meet school accreditation requirements.

How does this philosophical shift toward student-centric "authentic" learning reconcile with the uptick in standardised testing required for medical school graduates to enter the profession? There seems to be a fundamental mixed message here. As curricular reforms move toward authenticity in the UK, the General Medical Council (GMC) continues using its Medical Licensing Assessment (MLA) that all graduating medical students must pass to continue accessing their pathway toward become a practicing clinician in the UK. Students are discouraged from rote memorisation in favour of developing a reflective learning practice around authenticity. However, ultimately, they will face the biggest MCQ test of their life as the final gateway. As Harrison puts it, "Although the need to ensure 'assessment for learning' is frequently mentioned, in practice the summative assessment culture is often so dominant and powerful that it acts as a barrier to learners processing feedback in any meaningful way" (Harrison, 2018).

3.2.1 From Flexnerian Reforms to Complexity

The shift to authentic learning in curriculum design could be considered the second major wave of reform in medical educational history. The first was Abraham Flexner's 1910 report (Flexner, 1910) in which he advocated a wide range of reforms, (Barzansky, 2010; Boelen, 2002), including as Riggs (2010) points out "a strong scientific basis, use of pedagogical methods, and faculty whose principal role is that of educator." Pointing to the unjust past of reform and reformers in history, Flexner has been shown as a racist (AMA J of Ethics 2021) who closed a disproportionate number of historically black medical schools. The report states that the few remaining black schools had a mission, including, to offer "the more promising of the race ... a substantial education in which hygiene

rather than surgery ... is strongly accentuated" (Savitt, 2006).

Raising the racially contentious nature of the Flexnerian reforms is an important part of bearing witness to the obstacles of social justice.

A century after the Flexnerian "reforms" first ushered in a variety of changes to medical education, another peak of reform has been washing over HPE. The pendulum swing that constrained medical education to be more didactic has now called for a student-centric "authentic" curriculum (Hoyek, 2023; Rabattu et al., 2023; Schlegel, et al., 2023; Winkel et al., 2023). This shift is taking place via the ever-growing number of learning theory–practice–philosophies that are continuously emerging. Medical education as a problem space is producing newly coined or joined philosophies/paradigms, theories of learning (i.e., near-peer learning), and instructional technologies (i.e., 3D anatomy apps) at an increasing rate (Owolabi & Bekele, 2021).

Kirch and Sadofsky (2021) point out that medical educators now have more than 150 theories, technologies/practices, and philosophies available to them. In 2022, these tools are increasingly heterarchical, placing the learner at the centre of their own web of learning. Each of the tools available offer a set of parameters, constraints for how individuals may go about co-creating a collective body of knowledge, skills, and understanding (Stetsenko, 2019). Integrative curricular interventions and novel teaching techniques such as kinaesthetic methods abound. Meanwhile, the vestiges of the conventional medical curriculum remain very much in place, where anatomy is heavily front-loaded in the early years and students learn it by rote memorisation.

Calls for a more integrated curriculum have dominated education literature for decades (Brauer & Ferguson, 2015; Gale, 1984; Lazarus et al., 2014; Quintero et al., 2016), which will be further

explored in Chapter 7 of this thesis. Regarding the integration of anatomy within the wider medical curriculum, Lazarus et al. introduced their "Situation, Background, Assessment, Recommendation" (SBAR) handoff framework within the anatomy laboratory. Their results suggested "that the introduction of a handoff process in anatomy education provided both a mechanism for learning anatomy and a unique opportunity for early exposure to an essential clinical skill" (Lazarus, et al., 2016). Pedagogical interventions such as these underscore the interest and benefits of integration.

However, action specifically based in an educational theory approach to identifying and modelling the alignment of anatomy within the medical curriculum has been limited. While acknowledging the importance of authenticity and alignment, few initiatives have explicitly attempted to incorporate this complexity into their models. Mennin (2010) has further developed a rationale for the consideration of the curriculum as a Complex Adaptive System (CAS) with PBL as a prime example of constraints-led CAS behaviour (S. Mennin, 2007).

Khanna et al. (2021) have introduced their 3Ps-6Cs approach to curricular design based on systems thinking. However, the triangulated model of alignment with 3 nodes remains the dominant *conceptual* model of the curriculum. This situation is unsurprising given the current lack of conceptual modelling looking at how anatomy knowledge and the wider medical curriculum interact and affect each other. Understanding how the relationship works in structural terms is a key step in furthering authentic learning scenarios and improving educational outcomes.

The curriculum represents a contested space where there are no simple problems. Bolman and Gallos (2011) refer to it as a politicised "jungle" where warring personalities and paradigms rage

in power struggles. Such drama amongst “tribes and territories” lead to the omission or inclusion of certain perspectives from the curriculum (Trowler, 2001). Given the contested nature of the curriculum, educators need practical strategies and tools to mitigate the complications and support the important relationships within its complexity.

For example, conceptualisations of anatomy pedagogy often fail to account for how new anatomical knowledge can be applied in clinically relevant scenarios. Lazarus’ SBAR model as previously mentioned is a notable exception and provides compelling justification for the need for more efforts toward vertical integration. Modes of assessment used to test anatomical knowledge in the early years are not normally vertically integrated throughout the medical programme, leading to the “once and done” mentality where students learn enough anatomy to pass their exams and never revisit the content.

Conceptual models used to understand and describe how basic sciences such as anatomy reinforce clinical competency are often limited to a narrow scope of causal pathways that reflect individual disciplinary views. Is it time to update Biggs’ (1996) triangle of CA for a more authentic model? Can critical realism guide us toward a spatiotemporal conceptualisation that accounts for the complexity of relationships involved in the curriculum? To develop a theory accounting for complexity, we developed a study to anchor our process in empirical data. The following section contextualises this study in the paradigm of critical realism.

3.2.2 Paradigm of choice: Critical realism

A key aspect of this study is its conceptual framework, the abductive reasoning of critical realism (CR). As a paradigm, CR holds a stratified ontology where reality is nested in three domains (Bhaskar, 1978) including the empirical (experiences and events),

the actual (causal mechanisms), and the real (structures of nature), as per Figure 5. As such, CR shares common ground with positivism in terms of their realist orientation. However, positivism (and the conventions of quantitative scientific writing) espouses an objective, third person epistemological perspective, whereas CR lends itself readily to the methodologies of qualitative research via its subjective approach to scientific enquiry. This section will set out a summary discussion of the ontological and epistemological rationale of the study.

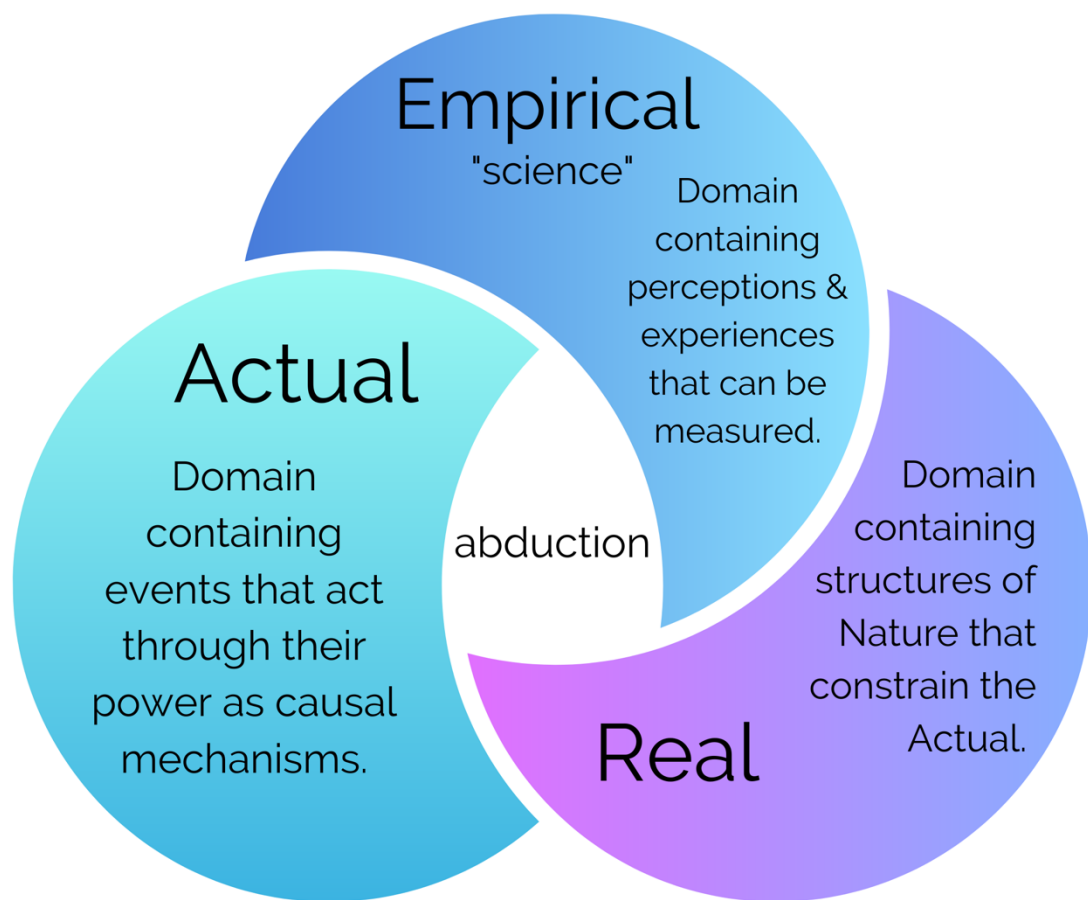


Figure 5: Stratified reality as per CR, image designed by the author using Canva, ideas adapted from Bhaskar (1978)

3.2.2.1 A stratified ontology: the 'what'

CR is known for its tripartite stance on reality where the domain of the real constrains the domain of the actual that, in turn, influences

the domain of the empirical. Researchers seeking to theorise about the Actual and Real use abduction as a means of reasoning, using their “best guess” to arrive at emergent hypotheses that can be tested at various stages of a project. *Emergence* is one of the central tenets of CR, a hallmark it shares with complexity theory (CT). In his approach to science, Bhaskar (the progenitor of *critical realism*) rejected reductionist norms (Carolan, 2005). Instead, he advocates an ‘emergent powers theory’, suggesting that ‘societies should be understood as emergent products of human behaviour or as emergent powers from people’ (Bhaskar and Harré, 2001) in (Kivinen & Piironen, 2004, p. 233).

The emergent properties we experience arise as a confluence of constraints both seen and unseen. As Scambler (2001) puts it, “the world is not composed ... merely of events (the *actual*) and experiences (the *empirical*), but also of underlying mechanisms (the *real*) that exist, whether or not detected, and govern or facilitate events”. This stratification of Real contrasts with positivism’s assumption that equates empirical findings to Truth. CR concerns itself with revealing the domain of the real, that is, those underlying *causal tendencies* that give rise to the empirical experiences of daily life.

The notion of ‘causal tendencies’, sometimes ‘generative mechanisms’, is key to the remit of science according to Bhaskar. For critical realists, the role of science is not limited to correlation, or *successionist causation* (wherein doing A to B leads to C). For a world increasingly attuned to its complexity, this is the crucial takeaway: CR is looking for *generative causation* wherein it is the *interplay* of conditions within the real that give rise to the events we observe in the domain of the actual (Bhaskar, 1978; Connelly, 2001; Clark, et al., 2008). As a researcher, I may investigate the actualities of my environment, picking up on the

emergent properties that may lead me via abductive reasoning to form theories about Nature. However, neither my theories nor the emergent properties under investigation can be reduced to the real domain.

Key points of **ontology** in CR:

- Realist position
- 3 Domains of reality:
 - The Real (Structures in Nature)
 - The Actual (Mechanisms of the Real)
 - The Empirical (Measurable events/experiences – “science”)
- CR is looking for *generative causation / causal tendencies in reality*.
- CR is concerned with the *interplay of conditions* within the real
- CR sees reality as *emergent*.

3.2.2.2 Epistemological considerations: the ‘how’

A central tenet of CR is that reality is emergent, rather than reduced – in the same way, critical realists point out that ontology cannot be reduced to epistemology. In other words, it is not appropriate to rely on the third person objective to report and discuss our findings. As DeForge and Shaw put it, “‘Being’ is very different from the ‘knowledge of being’ (DeForge & Shaw, 2012). The epistemological stance of CR owns the subjectivity of the researcher and invites a first-person account of our processes toward producing knowledge about the nature of reality.

In *A Realist Theory of Science*, a foundational text of CR, Bhaskar (1975) describes what he considers to be the “central paradox of science” (Stausberg, 2021):

“That men [sic] in their social activity produce knowledge, which is a social product much like any other, which is no more independent

of its construction and the men [sic] who produce it than motor cars, armchairs or books, which has its own craftsmen, technicians, publicist, standards and skills and which is no less subject to change than any other commodity. This is the one side of "knowledge". The other is that knowledge is "of" things which are not produced by men [sic] at all: the specific gravity of mercury, the process of electrolysis, the mechanism of light propagation. None of these "objects of knowledge" depend on human activity. [...] Let us call these, in an unavoidable technical neologism, the *intransitive objects of knowledge*. The *transitive* objects of knowledge are [...] the raw materials of science—the artificial objects fashioned into items of knowledge by the science of the day. They include the antecedently [sic] established facts and theories, paradigms and models, methods, and techniques of inquiry available to a particular scientific school or worker." (Bhaskar, 1975, p. 21).

As people often change, CR contends that the knowledge we generate is similarly mutable, meaning it not only *does* change but it is *likely* to change. Willmott contends (2005, p. 752) that 'Critical realists insist upon a fundamental, ontological difference between the (structured) reality of the natural and social worlds (the 'intransitive' realm) and knowledge of these worlds (the 'transitive' realm).'

According to CR, knowledge is *transitive* – our understanding of a phenomenon is likely to change. While accepting that "entities exist independent of our ability to perceive and conceive that they exist" (Haigh, 2019), we aim to construct knowledge about them. The critical realist continues the process of science even though she knows her knowledge will change and that it will be wrong sometimes. This brings us to the third point, that the construction of knowledge is not only changeable, but also *fallible*.

Regularly, we operate on misconceptions or incorporate mistaken theories into the process of knowing. Knowing is not an equilibrium state; rather, it is a state of flux that is open to challenge and change. As Haigh (2019) states, "The social world is a layered, complex and open system. Within this system, multiple entities are present, the types of entities are wide ranging, each entity may subsume other entities or be subsumed within other entities, and a vast array of these entities' mechanisms may be activated and in play moment by moment."

This epistemological perspective means that we recognize our pathway into knowing is fraught, never linear nor guaranteed of a conclusive outcome. Entry into the 'transitive realm' is granted via the process of generative (rather than linear) causality, or abduction. Critical realists aim for a "best guess" that fits with current assessments in the field and aligns with simplicity. The process of arriving at a hypothesis via abductive reasoning can be compared with induction and deduction. See Figure 6 for a comparison of reasoning methods.

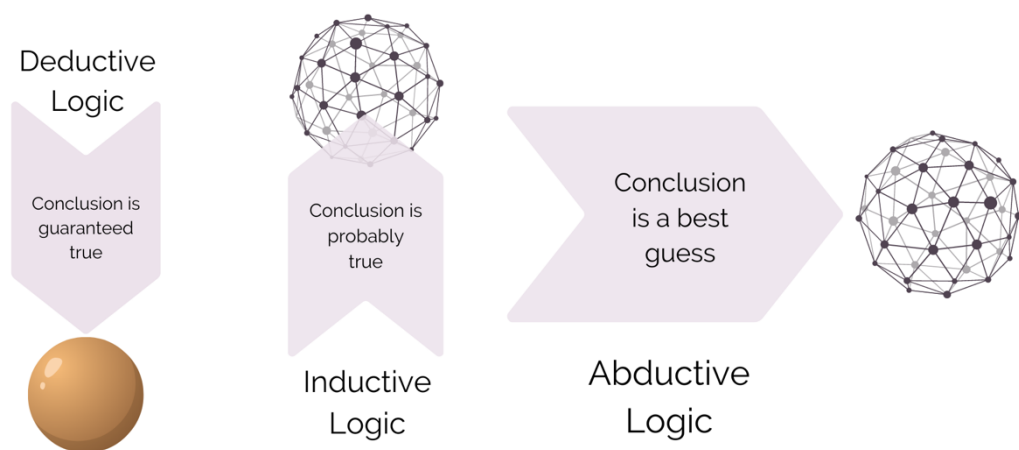


Figure 6: Deduction, Induction, Abduction. Image designed by the author using Canva, inspired by Syll (2016).

Where deduction leads *down* to a guaranteed conclusion and induction leads from the bottom up *into* a conclusion that is

probably true, abduction leads *away* to a conclusion as a best guess. Abduction is how critical realists enter the realm of the transitive, the experience of knowledge, accounting for their contention that knowledge is both transitive and fallible. The logic is that it is not possible to use knowledge to lead either *to* or *into* definitive conclusions when our knowledge is demonstrably ephemeral.

If abduction forms a subjective means of knowing the world, like the swimmer moving in the pool of knowledge, then we can talk about the different styles of swimming as hermeneutics – the theory and practice of interpretation. We have accepted that critical realists aren't aiming for logical conclusions *a priori*; they're working toward an immersive experience from which to make best guesses.

Hermeneutic dialectics (interpretative discourse) is another CR vehicle for getting inside the problem space, whereby the researcher becomes optimised for explaining what they are experiencing. As per Hartwig (2007, p. 175), abduction involves the

"...essential, triadic movement of the dialectic of explanation from knowledge of manifest phenomena to a structural account of what generates them, and criticism and correction of the initial hypothesis or theory in its light, can be seen, at the level of epistemology, to be one in which inconsistency ... caused by incompleteness generates a move to a greater completeness."

Seeking 'greater completeness' is distinct from seeking conclusions. This epistemological movement toward a more holistic understanding involves the active process of identifying causal tendencies and reconceptualising old models toward "transformation ...of our theories". CR asks us to be reflective, to accept the transitive fallibility of our knowledge while simultaneously using it to develop the latest best data for continuously updating our models and explanations of the world.

As noted by DeForge (2012), “this explanatory dialectic drawn on here is operationalized, often, through *dialectical hermeneutics*”. Dialectical hermeneutics, interpretative explanation, is a response to the hallmark aim of CR as stated by Hartwig (2007, p. 230), that ‘the fundamental aim of social science must be to elucidate its meaning and trace conceptual conditions, either by ... immersion in it ... or by (dialogical) fusion of horizons or meaning-frames. “Fusion of horizons” is a central tenet of intersubjectivity in hermeneutics. Gadamer (2004) describes a horizon as ‘the totality of all that can be realised or thought about by a person at a given time in history and in a particular culture.’ We may consider the dialectic process, where opposite views come to meet, as a fusion of horizons. Understanding manifests when our present understanding or horizon is moved to a new understanding or horizon by an encounter (Gadamer, 2004).

This brings us to the ‘why’. Note that this thesis will expand on hermeneutic dialectics in the last two chapters.

Key points of **epistemology** in CR:

- *Subjective* approach
- *Irreducible* to ontology – ‘Being’ is distinct from ‘Knowledge of being’
- Knowledge is *transitive* – the ‘Transitive realm’
- Knowledge is *fallible*
- The transitive realm is accessible to researchers via *generative causality*, using *abductive reasoning*
- Critical realists operate in the transitive realm via *dialectics* – theorising
- CR epistemological praxis moves from incompleteness to a state of greater completeness
- Critical realists use *dialectical hermeneutics* to examine the role of social sciences often by immersion or fusion

3.2.2.3 Axiology: the “why”

Drawing on the Gadamerian concept of fused horizons, critical realists embrace hermeneutics as a means of accessing the pool of knowledge. As Hartwig states (2007, p. 233), interpretative immersion invites an ‘openness to dialogue or the fusion of meaning-frames, in which prejudices are challenged and outlooks broadened [as] a precondition for access of wisdom and virtue.’ This final section briefs our readers on the axiology of CR, the values that drive motivation for undertaking research.

So far, we have established that CR backgrounds the pursuit of reductive conclusions in favour of foregrounding the researcher’s process of theorising a best guess. Such an immersive approach puts the researcher in touch with the qualitative state of a system, toward a more complete understanding of that system’s internal coherence. In short, we may nurture a more intimate sense of the system’s structural functionality (Realness). The point of getting closer to truth is not reducible to owning truth; the point is to continuously update our theories to free ourselves from previous misunderstandings. This is known as the ‘emancipatory’ axiology of CR.

In summary, we are looking for explanations to update our theories. We do this to provide future generations with better (yet still transitive and fallible) explanations that future researchers are, in turn, charged with updating based on their timely explanations of causal tendencies. These tendencies, or generative mechanisms, can show up in different ways. According to Haigh, et al. (2019), this may include recurrent and variable relationships between phenomena, or the absence of a relationship, all characterized by complexity in “the interactions between entities and their associated mechanisms.” Note: Appendix A provides a much deeper treatment of the philosophical framework employed in this doctoral work and

does so in the informal voice of a first-and-second-person perspective.

The following study represents the process of investigating the experiences of anatomy educators toward entering the transitive realm, that is, to gain an immersive experience of what it is like to be an anatomy educator.

Chapter 4: Constructive Alignment – Fit for Purpose?

The aims of this study were to understand how connected anatomy educators feel inside the web of the medical curriculum, and if the current model of CA could be effectively utilised to describe what they are experiencing. The initial aim was to develop a more complete picture of participants' views of alignment, how they would describe their working relationship as anatomists within the larger system of the medical curriculum.

The question guiding the study design was 'How do anatomy educators experience the relationship between anatomy pedagogy and the wider medical curriculum?' As I gained further experience, my explanations developed from the initial aim of 'better understanding' into a theoretical framework that would fundamentally shape my wider doctoral project.

4.1 Methods

Together with my supervisors, I formulated questions aimed at understanding how anatomy educators experienced their role in the wider curriculum. A 29-item, non-validated questionnaire was designed to collect demographic and alignment views from anatomy educators working in a UK institution. The questions are presented in Table 4 and full response data is presented in Appendix A. We (my supervisory team) implemented the University of York's Qualtrics (Qualtrics, Provo, UT) application account to design and disseminate the questionnaire. This study and survey were granted ethical approval by the Hull York Medical School (HYMS) Ethics Committee.

Table 4: Questionnaire questions

Number	Question
1	What is your role within the medical school at your institution?
2	Do you teach anatomy within the MBBS curriculum of medicine at your institution?
3	If you teach other healthcare disciplines, please select them here.
4	During which years is your teaching concentrated? (choose all that apply)
5	Do you participate in the design of the MBBS / MBChB curriculum at your institution?
6	How does your institution describe its curriculum? (tick all that apply)
7	Do you participate in the selection/implementation of the anatomy learning outcomes at your institution?
8	Do you participate in the formulation of the programme's overall MBBS learning outcomes?
9	Who gives you the selection of learning outcomes from which you design your teaching activities?
10	Rank the sources from which you derive your teaching activities in order of most important influence:
11	Are the learning outcomes (LO's) for years one through two on the MBBS programme at your institution separate from the LO's for years three to five?
12	For each year of the MBBS programme, select the level of your awareness of that year's learning outcomes:

Chapter 4: Study | Constructive Alignment – Fit for Purpose?

13	How the intended learning outcomes influence my teaching methods":
14	Please describe your process for planning your teaching activities around the learning outcomes you intend to deliver.
15	We define "kinaesthetic" learning as tactile, when learners carry out activities as part of th... - I consider these as kinaesthetic in nature
16	I use these methods in my teaching practice
17	Please rank the following influences on the design of your teaching/learning activities (in order of importance):
18	What are the current methods of assessment in years one through two of your programme? (tick all that apply):
19	What are the current methods of assessment in years 3 to 5 (tick all that apply):
20	Progress testing is an emerging assessment strategy for the integrated curriculum. Does your institution use "progress testing" as part of the assessment toolkit?
21	How much do your institution's methods of assessment influence your teaching methods?
22	How much does student-led curiosity influence your teaching methods?
23	Fill in the blank with the term you think fits best: " _____ drives learning."

24	Looking at each year of the MBBS course, please tell us how much anatomy is taught in each year (to the best of your knowledge):
25	How would you rate the alignment of learning outcomes, teaching methods, and assessment...
26	In your opinion, how well are the first two years integrated with the so-called "clinical years" on the MBBS at your institution:
27	Are you aware of the GMC's plans to develop a new Medical Licensing Assessment?
28	If your answer to the above was yes, please tell us a bit about how you feel the MLA could impact the alignment of your curriculum:
29	Finally, how would you rate the alignment of the anatomy curriculum with the wider medical curriculum in the MBBS programme at your institution?

Study design and data collection progressed in a phased approach. The survey was developed and refined amongst the supervisory team and later within the Health Professions Education Unit (HPEU) within Hull York Medical School prior to being launched within the United Kingdom. Participants were recruited via social media posts and virtual snowball sampling via email (Baltar & Brunet, 2012). The only inclusion criteria for the questionnaire were being currently an educator in a UK medical school.

4.1.1 Data analysis

Our research team took a view on the data analysis at the outset and reviewed my stages of coding. All open-ended responses were

anonymised. K.B.K., the lead researcher, used Google Sheets to perform a descriptive analysis of the items. Coding was carried out manually by K.B.K., using an inductive approach to thematically analyse free-text responses in the five steps of explanatory thematic analysis for CR as outlined by Fryer (2022), see Table 5.

Table 5: Steps of explanatory TA for critical realism adapted from Fryer (2022)

Step number	Description
Step 1: Develop your research questions	<ul style="list-style-type: none"> Identify the experiences and/or events of interest and develop one or more causal research questions.
Step 2: Familiarize yourself with the data	<ul style="list-style-type: none"> Skim read a large proportion of the data. <ul style="list-style-type: none"> Make notes on initial thoughts and questions.
Step 3: Apply, develop and review codes	<ul style="list-style-type: none"> Apply descriptive codes to the data using a data-led approach. <ul style="list-style-type: none"> Develop these codes by processes of standardization (use the same wording for similar codes) and consolidating (use theoretical terms to unite different codes). Review codes by assessing their validity.
Step 4: Develop and review themes	<ul style="list-style-type: none"> Develop themes (causal explanations of experiences/events). Review themes by assessing their validity.
Step 5: Generate conclusions and reports	<ul style="list-style-type: none"> Reflect on the overall analysis and review the validity of conclusions. Consider how to best communicate the conclusions.

4.2 Results

A total of 27 participants completed the survey. Table 6 provides a summary of the relevant demographic data, limited to the role of the educator within their institution. Full graphical representations of the data can be found in Appendix B. Four relationships of interest gleaned from the data are presented here as the major themes: 1) Inconsistent relationship between involvement in anatomy Learning Outcomes and the LOs of the wider programme; 2) Conflicting responses to what drives learning; 3) Disconnect between how the participants describe the curriculum vs their concentration of involvement; 4) Alignment is in flux and hard to quantify.

Table 6: Demographic information

#	Answer	%	Count
1	MBBS Programme Director	3.70%	1
2	Anatomy Department Lead/Head	14.81%	4
3	Professor of Anatomy	14.81%	4
4	Lecturer or Other staff	48.15%	13
5	Teaching Fellow	11.11%	3
6	Other (please specify) *	7.41%	2
*I was a former anatomy teacher and now I am a visiting Clinical Anatomist providing private anatomy courses to undergraduate and post-graduate specialists			
*Senior Lecturer in Anatomy. Lead for Educational Research and Scholarship			
	Total	100%	27

4.2.1 Theme One: Inconsistent relationship between involvement in anatomy Learning Outcomes and the LOs of the wider programme

The first point of comparison relates to understanding how much anatomy educators feel they have to do with wider curriculum development. 19 of the 24 (79.17%) respondents to Q2 reported that they teach anatomy within the MBBS curriculum of medicine at their institution (Q2). Of these, 15 (62.50%) said that they participated in developing the MBBS / MBChB curriculum where they teach (Q5). 69.57% reported that they participate in the selection/implementation of the anatomy learning outcomes (LOs) at their institution. See Questions 7 and 8 in Appendix B for graphical representations of this data.

Only 7 of the 23 respondents to Question 8 (30.43%) said that they participate in the formulation of the programme's overall MBBS learning outcomes. The data suggests that these participants are responsible for delivering anatomy LOs without knowing how these will fit into the longer-term alignment for assessment in the curriculum, a suggestion which is further supported by the data showing that only 44% of the participants were aware of the LOs for year five of their programmes (see Figure 8 in this chapter and Q12 in Appendix B).

The data also reflects that LOs are sourced inconsistently, as shown in Figure 7, with 42.86% coming from the Anatomy Department Head, 28.57% from the MBBS Programme Director, and 28.57% reporting "other" where these other sources are detailed in Table 7. The Anatomical Society shows up as a significant source, Santa Claus an outlier. It appears that none of the sources reported are linked directly to the MLA that ultimately constrains the MBBS programme.

We asked two questions about the MLA and were surprised to learn that 38.89% of the respondents at this time were unaware of the

GMC’s plans to develop a new MLA. We gave those who were aware of the impending MLA the chance to “tell us a bit about how you feel the MLA could impact the alignment of your curriculum”. The qualitative data gave rise to a feeling of overall uncertainty and some frustration arising from the unknowns presented by the MLA and how it would affect the curriculum. Uncertainty as an aspect of the anatomy/curriculum relationship will be explored as an emergent theme in Chapters 6 and 7.

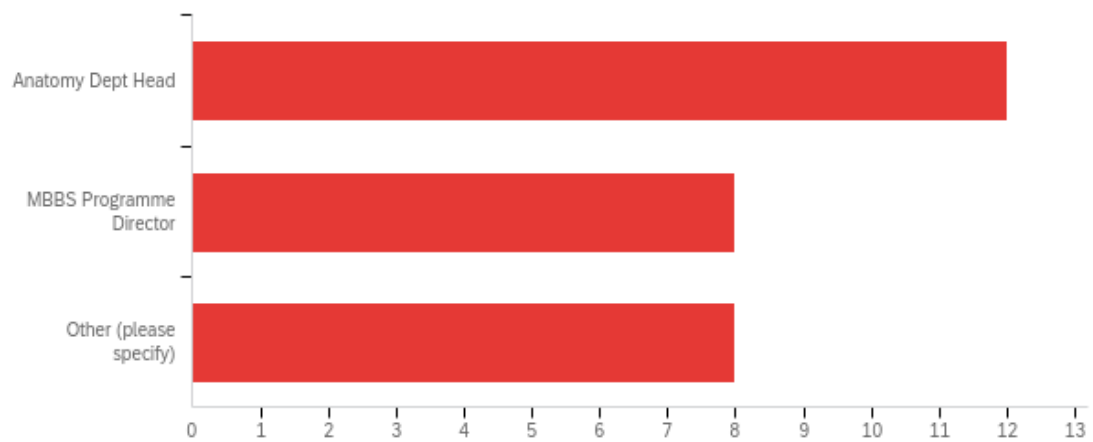


Figure 7: Sources of Learning Outcomes

Table 7: Other sources of Learning Outcomes

Other (please specify) – Text
Anat soc core curr
Block (topic specific) leads work with academic peers to review LOs. These are ultimately communicated through the Phase Lead (phase 1 is years 1 and 2 here)
We decide the outcomes following discussion with system leads, and align them with AnatSoc Syllabus as best possible.
Myself as anatomy lead to medical school

I provide them for the Anatomy team. I have mapped the Anatomical Society syllabus for UG medics to the curriculum, and the session LOs are taken from that.
Agreed upon via committee
I make them
Santa Claus

Another key insight relates to the separation of LOs of early years from those of the clinical years. Nearly 70% of responses indicated that the LOs of the years are separate, despite nearly 60% of respondents reporting that their curriculum is either integrated or spiral (Table 8). Given the separation we were seeing between LOs of early and clinical years, it was unsurprising that while most participants reported feeling aware of the LOs relating to the early years, there was a demonstrable reduction of awareness for years three to five as shown in Figure 8.

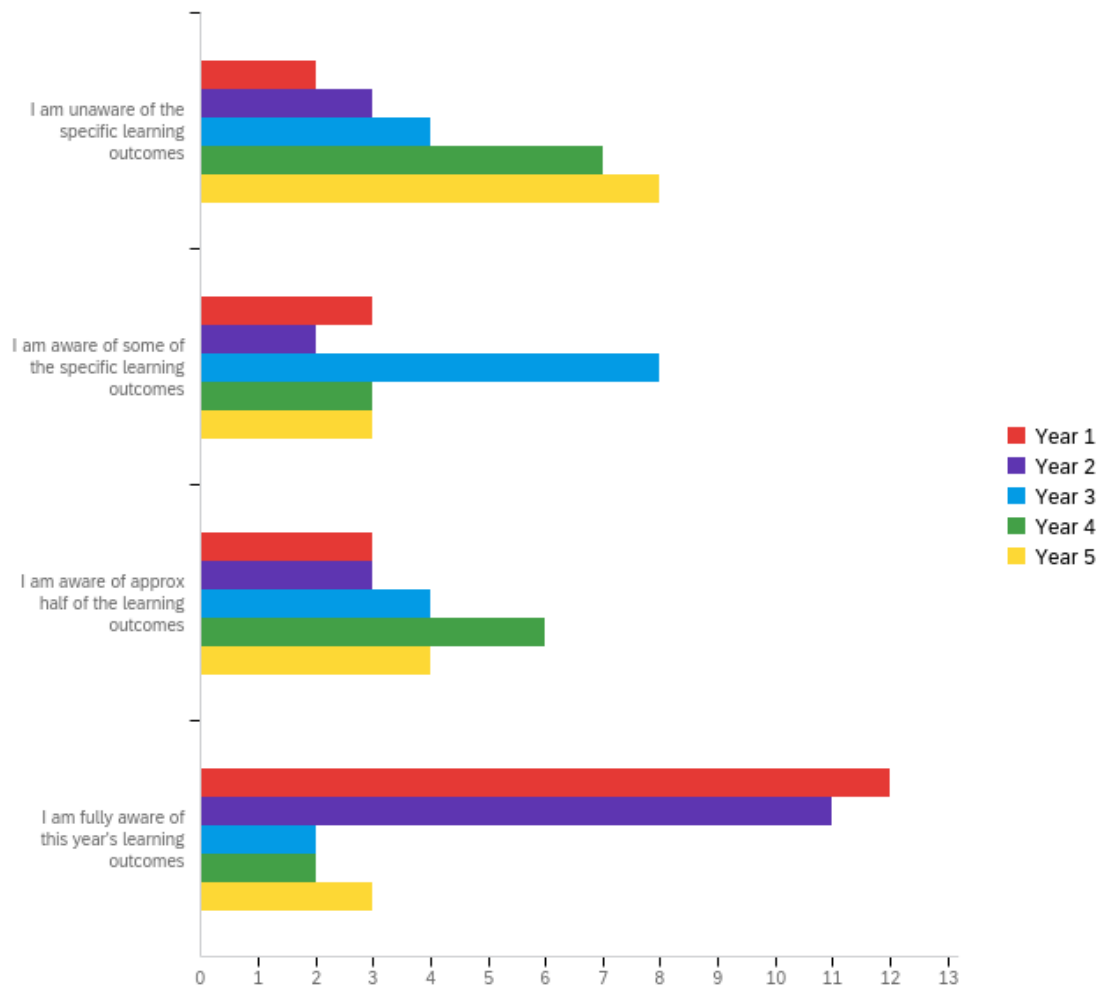


Figure 8: Q12 – For each year of the MBBS programme, select the level of your awareness of that year's learning outcomes

The upshot of the data presented in Theme One seems to be that the relationship between anatomy as a subject and medicine as a curriculum is inconsistent. The curriculum is pre-loaded with LOs that are supposed to relate to what will be assessed, but anatomy teachers do not uniformly participate in the formulation of LOs for the wider programme and many anatomy educators are not involved in making the LOs for the anatomy assessments. Most participants are not even aware of the LOs for the final years, and many were not even aware of the MLA. As we will see in figure 15, the MLA heavily influences teaching in the clinical years of teaching, yet the MLA is not mentioned as a source of LOs.

4.2.2 Theme Two: Conflicting responses to the question: what drives learning?

With so much attention given to LOs, we might have expected to see them featured in the data as a prominent driver of learning. However, when asked about what they believe drives learning, respondents were torn between curiosity and assessment, with the LOs a distant third as shown in the figure. Participants were asked to fill in the blank with the term they thought fits best:

“_____ drives learning?” Their response demonstrates that curiosity is at least as important as assessment to these participants, see Figure 9.

It appears that curiosity is an important consideration for educators, as it is shown in the data, at least as important as assessment as a motivator for students to learn. Curiosity was more than twice as important as the LOs that are ostensibly governing the teaching and learning activities that educators are tasked with delivering.

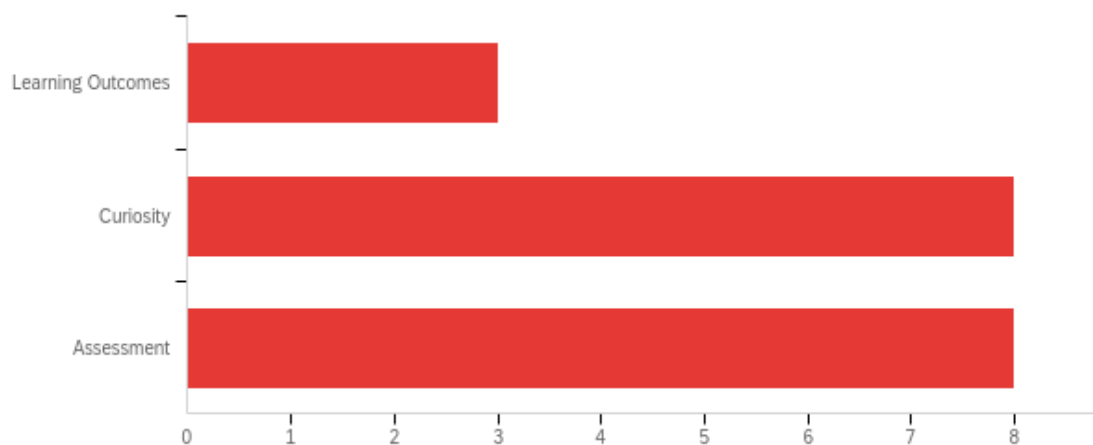


Figure 9: _____ drives learning? Participant responses.

The second piece of data relating to this theme that we chose to analyse is featured in figure 10. We have just seen how educators highly rate the importance of curiosity and course assessment as drivers of learning. When asked to rank what influences the design of their TLAs, 14 out of the 19 participants responding to this

question reported that in year 5, the MLA was their top influencer, while 0 selected curiosity or learning outcomes.

The data reflects that most anatomy educators surveyed (only 1.92% of reported teaching was delivered in year 5) do not participate in teaching during the final years of the medical programme, as shown in figure 13. It also reflects that for the one educator who reported teaching in every year of the five-year programme, it is the MLA that most heavily constrains what is taught in that final year. That 'personal interest' is the only other ranked influence highlights to us that 1) LOs seem to decrease in importance over the five years of a medical program, and 2) it is hard to design survey questions that unpack complex phenomena such as views on learning.

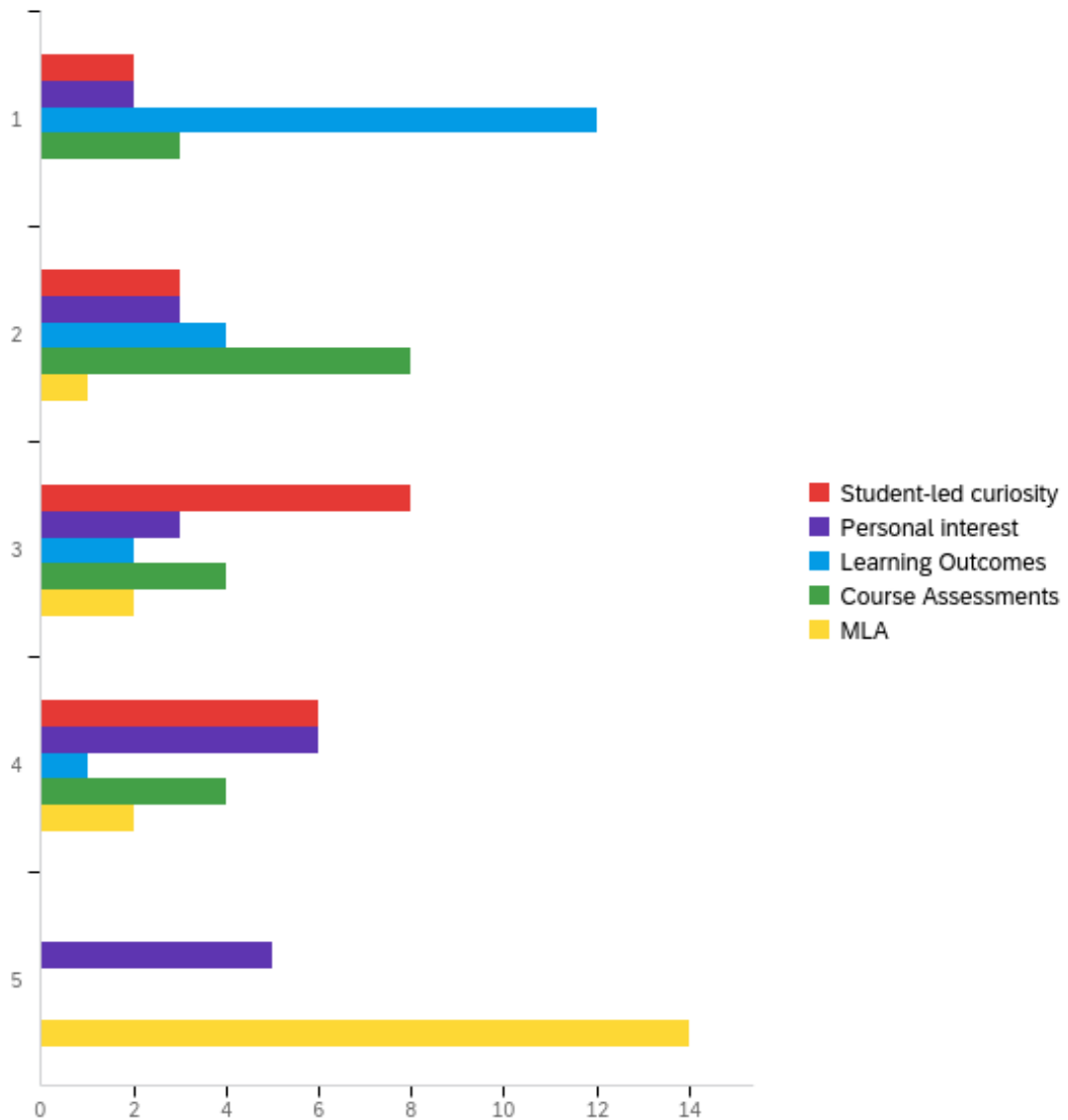


Figure 10: Please rank the following influences on the design of your teaching/learning activities (in order of importance)

4.2.3 Theme Three: Disconnect between how the participants describe the curriculum vs their concentration of their own involvement

Table 8 shows that 27.78% respondents described their curriculum as spiral and 31.48% as integrated. Both designs imply a continuous inclusion of anatomy throughout the years of the medical programme. However, as shown in Figure 11, most of the respondents report that their teaching time is heavily concentrated in years one and two of the programme.

Table 8: Responses on curriculum design

#	Answer	%	Count
1	Spiral (students will see the same topics throughout their course, with each encounter increasing in complexity and reinforcing previous learning)	27.78%	15
2	Integrated (one that connects different areas of study by cutting across subject-matter lines and emphasising unifying concepts)	31.48%	17
3	Learning Outcomes-driven (a curriculum designed around specific outcomes formulated by an authority)	14.81%	8
4	Classical (a Classical curriculum is language-focused; learning is accomplished through words, as in didactic lecture, rather than through images and experience)	5.56%	3
5	Innovative (the curriculum uses non-traditional methods such as technology-enhanced learning in its teaching activities and assessment methods)	16.67%	9
6	Other (please specify)	3.70%	2
	Total	100%	54

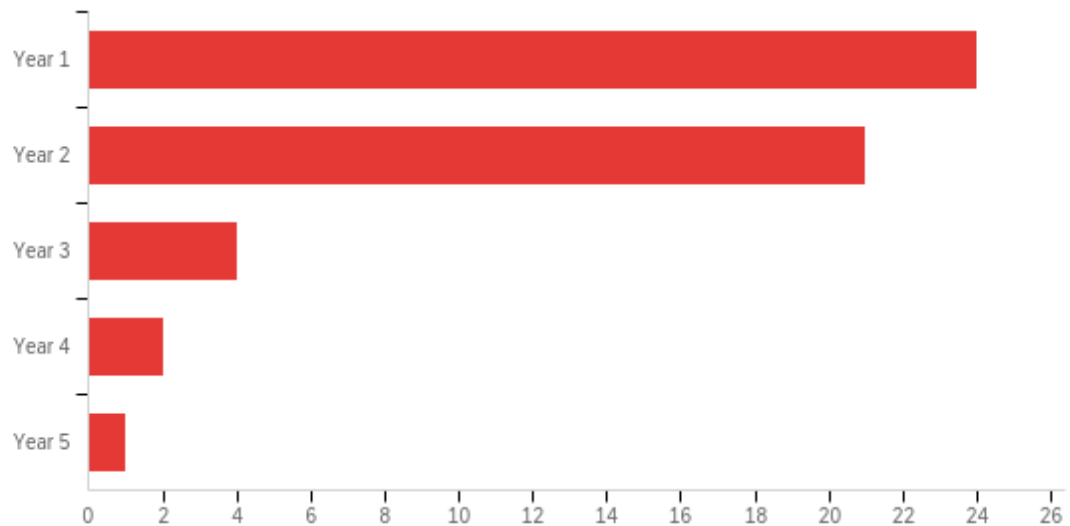


Figure 11: Responses to Q3 – During which years is your teaching concentrated? (Choose all that apply)

We would expect to see that anatomy tapers off in the final, “clinical” years of the programme, however, respondents confirmed that 0% would rate the last two years as “anatomy heavy” and a further 0% described years four and five as “zero anatomy”. All years were reported as having “some anatomy” which points to the inclusion of some level of anatomy in the curriculum across the board.

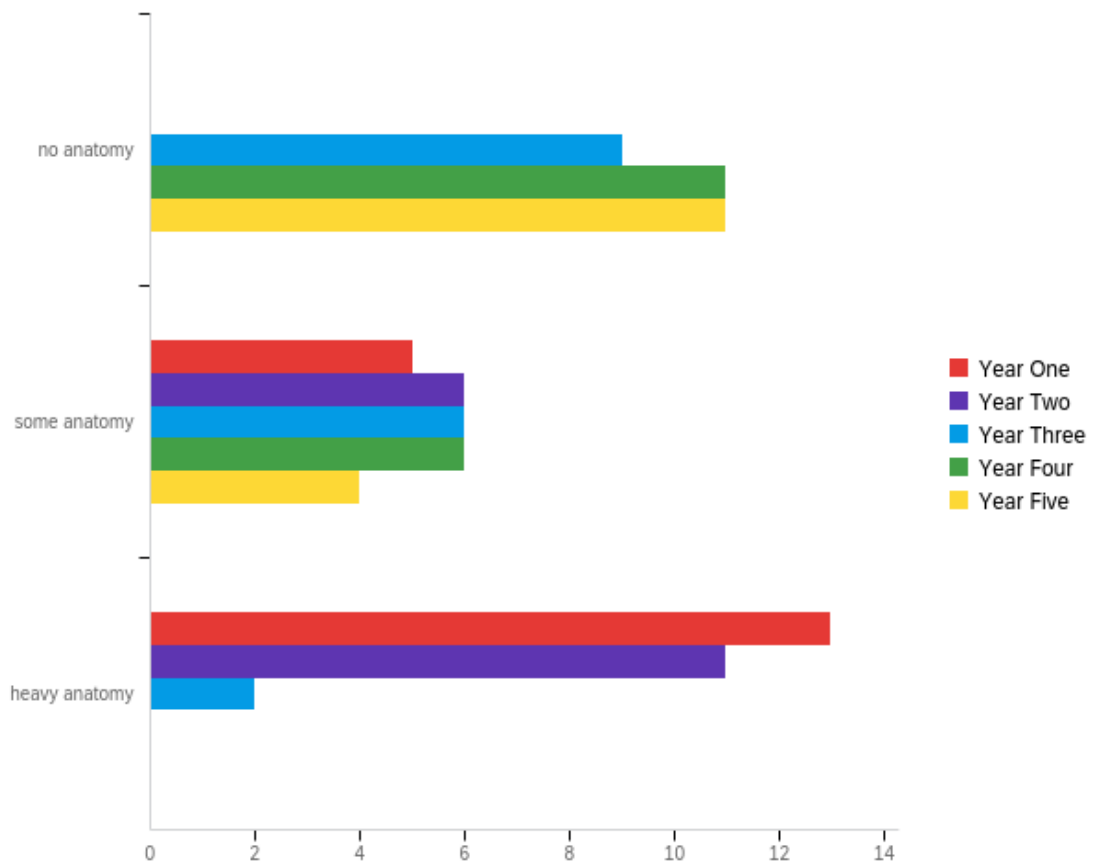


Figure 12: Q24 - Looking at each year of the MBBS course, please tell us how much anatomy is taught in each year (to the best of your knowledge)

#	Question	no anatomy		some anatomy		heavy anatomy		Total
1	Year One	0.00%	0	27.78%	5	72.22%	13	18
2	Year Two	0.00%	0	35.29%	6	64.71%	11	17
3	Year Three	52.94%	9	35.29%	6	11.76%	2	17
4	Year Four	64.71%	11	35.29%	6	0.00%	0	17
5	Year Five	73.33%	11	26.67%	4	0.00%	0	15

Table 9: Q24 Anatomy concentration across the years

4.2.4 Theme Four: Alignment is flux and hard to quantify

That alignment is a concern for educators is borne out in the data as the majority of respondents indicated they would rate their programme as “somewhat aligned” in respect to both the early and later years. See Figures 13 & 14. It makes sense that five times as many respondents rated the alignment as perfect for the first two years compared to years three through five, since that is where they spend the concentration of their teaching and have the highest degree of awareness and influence.

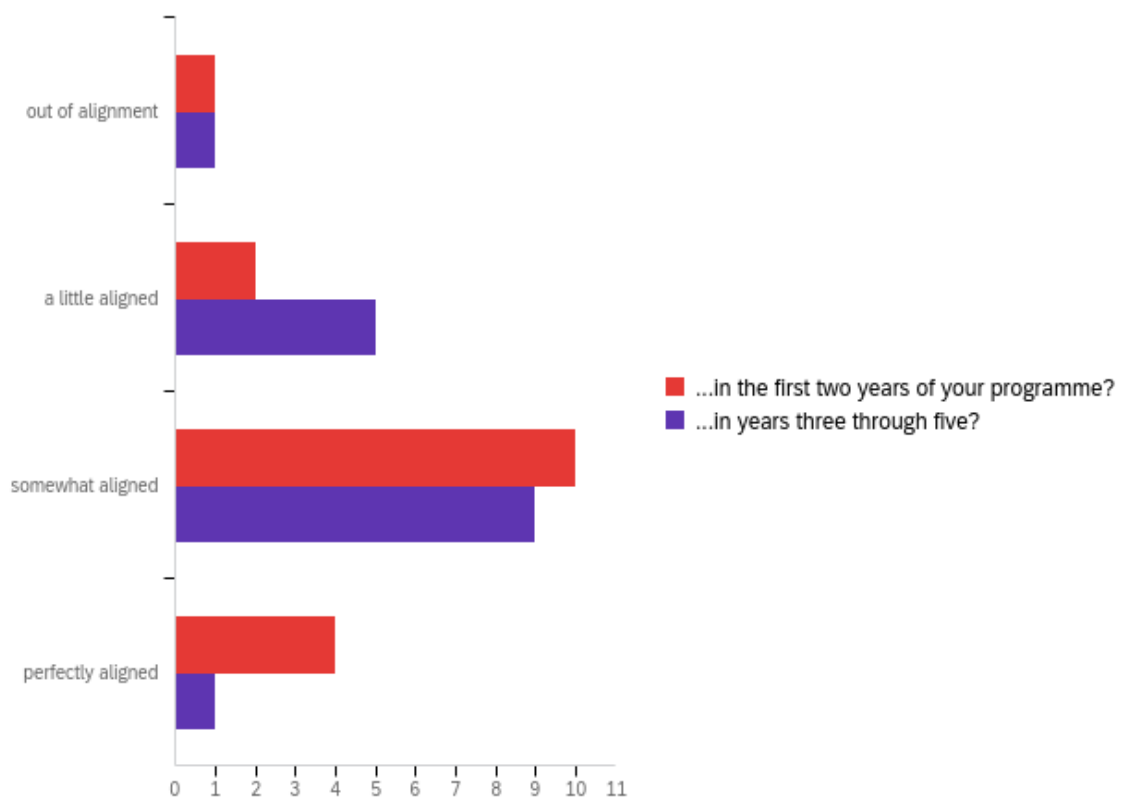


Figure 13: Q25— How would you rate the alignment of learning outcomes, teaching methods, and assessment?

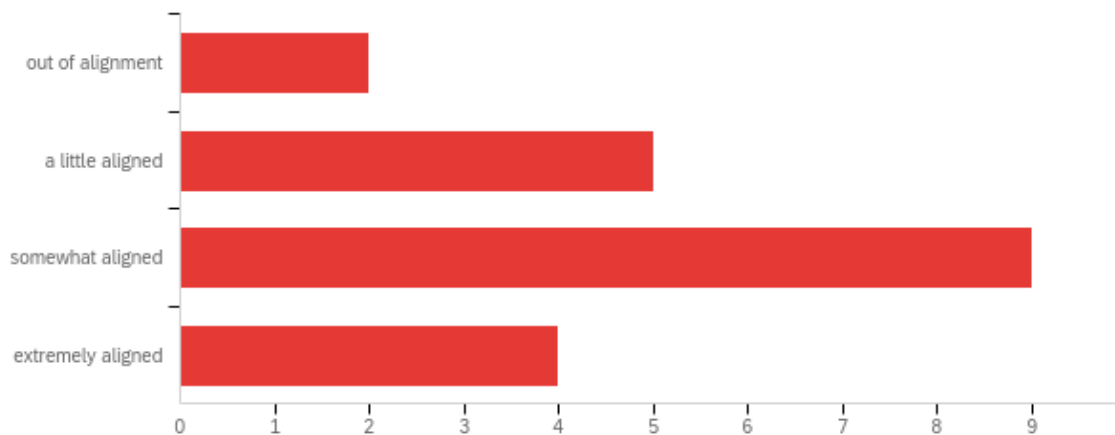


Figure 14: Q29 Participant response to the question: How would you rate the alignment of the anatomy curriculum with the wider medical curriculum in the MBBS programme at your institution?

4.3 Discussion

Critical realists are pragmatic and opportunistic in their approach to carrying out research (Miller et al., 2011). The stratified nature of reality calls for multiple disciplines and methodological approaches to converge around complex questions such as alignment. Such a collective approach is needed to understand the multilevel relationships between anatomists and medical curricula in terms of pedagogical alignment. The questions framed in this study were formulated as a lever into the 'intransitive realm', a starting point for the discussion around the practical adequacy of Biggs' (1996) triangular model of CA.

The results point to a complex interplay with fundamental inconsistency in the way LOs are formulated, implemented, and experienced by educators across the five years of a standard medical programme. How is it that LOs are represented by a fixed node on a triangle when their influence has been shown to vary widely from one year to the next? Variability of intended learning outcomes means they shift over the course of a program, and our participants downgraded the importance of LOs in comparison to curiosity. This variation in reported views around what drives

learning forms the basis of theme two. When asked to fill in the blank of the well-known axiom “assessment drives learning”, participants balked the norm and raised curiosity as a contender for driving learning. And yet, curiosity does not get a mention in Biggs’ triangular model of alignment. These findings point to the inadequacy of the simple, fixed arrangement of 3 nodes in a two-dimensional vector space. A more appropriate model would incorporate several nodes in triangulated, flexible relationships that form a mutable, volumetric whole in at least three dimensions as pictured in Figure 15.

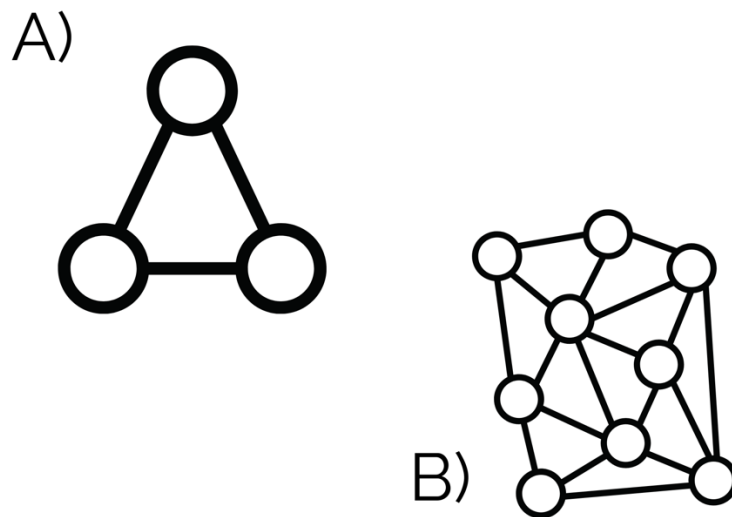


Figure 15: from two dimensions (A) to a multi-dimensional triangulated model (B) used in Biggs’ (1996) CA. Image designed by the author using Canva.

The third theme relates to the paradox of anatomy educators reporting on the ostensible integration of the medical programme within which they are teaching. They are given top-down directives to promote integration as if that was possible for educators so limited in their purview, but the reality is that many curricula are still rooted in the “2 and 2” where the first two years are anatomy-heavy and the last 2 or more are dominated by clinical placements where anatomy does not reappear – or at least anatomy educators do not reappear.

This is not to say that these curricula are not including anatomy in the clinical years, as many programmes factor in the anatomy as part of the clinical exposure, for example, in surgical placements. However, in terms of the relationship between anatomy educators teaching anatomy as a subject within the wider curriculum the connection is anything but directly linear. Using a multi-node triangulated conceptual model could account for anatomy as a node being connected indirectly via the heterarchical arrangement of factors coming to bear on the curricular entity.

The final point of discussion relates to the theme of alignment as challenging to quantify due to its constant flux. Teaching, Learning, and Assessment are not fixed elements of a stable system like a triangle in two dimensions. People experience the curriculum as a vector space that changes over time. As such, stakeholders are dealing with at least four dimensions in their engagement with the curriculum: each node (one dimension), direct relationships between nodes (two dimensions), indirect relationships creating volume (three dimensions), and the changing impacts of nodes and relationships (four dimensions).

The degree of influence represented by any node is wont to change, for example, as the importance of LOs was shown to diminish toward the final years of the program. This theme is crucial for two reasons: 1) that attempting to derive a reductive conclusion about the state of alignment within “the curriculum” using quantitative methods is in its essence an illustration of its own futility. Secondly, the theme of alignment being challenging to quantify (and hard to qualify as well) relates to the fact that it is always in flux.

4.3.1 Explanatory hypothesis / working theory

The possibility of movement is key to this discussion and proposal for a new model of curricular alignment. Triangulation is an important structural concept whereby joints (nodes) amongst

relationships *can* be both movable and stable. In two dimensions, a single triangle is essentially “too stable” in that its relationships are fixed, and the model is thus insufficient for talking about the mutability of the social/educational system it is tasked with representing. Moving away from the overly simplistic triad toward a mesh model – but keeping triangulation – is a move toward greater completeness while in conversation with historical theories such as Biggs’ (1996) model of CA. While these findings aim to upskill the triangle, there is no move to replace it. Rather, this discussion aims to bring the triangle into conversation with complexity as it remains relevant in its application to the curriculum as a system.

Results suggest that it is useful to incorporate Biggs’ model (the triangle) into the heterarchical mesh coming to define conceptual models of neural networks and CASs. The two-dimensional, static triangle model places assessment at the top of a hierarchy driving learners’ motivation, and LOs driving the design of teaching activities on the part of educators. As priorities change, such hierarchies are collapsing into a new form of orderliness. Hierarchy, from the Greek *hierarkhēs* ‘sacred ruler’, talks about a structural system of alignment often ruled by exogenous vectors – it also refers to nestedness in terms of size. A heterarchy, in contrast, from *heteros*, ‘the other’, refers to systems that are ruled from their unranked constituents, governed from within by their own endogenous logic.

The triangle and by extension, the tetrahedron, contain collaborative properties that endow systems with volume, mutability, communication, and resilience. Such arrangements foster internal coherence (intelligence), self-organisation and emergence. Instruction, learning outcomes and assessment remain key aspects in HPE, but findings suggest they ought to be mapped to a conceptual model that is fit for purpose. This discussion

contends that heterarchical triangulation is the next generation vehicle for CA. This conceptual model endows the CA concept with increased functionality that more accurately reflects what is happening in the wild.

The updated model of alignment scales up the triangle concept in terms of frequency and flexibility. This concept is not new – the neural network model is pervasive in fields embracing systems thinking in general (Slotine & Sanner, 1993) and is emergent in HPE (Tolsgaard et al., 2020). In terms of HPE, the mesh is not only applicable to Biggs' (1996) model of CA, but for other relational models seeking to describe multi-level relationships that change over time. As a conceptual wireframe, the triangle is pervasive in theories seeking to highlight relationships. As previously mentioned, while useful for pointing out connections, the triangle is not an adequate model for the temporal, emergent, and multidimensional qualities on the rise in HPE research.

4.3.2 Contextualising findings in the paradigm of critical realism

The use of critical realism as a paradigm for reconsidering the fitness for purpose issue is an important contribution that has potential to aid other HPE researchers asking multi-relational questions exploring phenomena that have a temporal quality. This study was motivated by an interest in how anatomy as a subject relates with the wider medical curriculum in the UK. To explore alignment within medical education, one needs to know how anatomy educators feel within that context. Ergo, this project started by asking them relevant exploratory questions.

Survey and questionnaire methods are necessarily constrained by their roots in quantitative methodology. The Qualtrics application offers a range of analytic functionalities as part of its comprehensive platform for data generation. Using the software puts you in touch with powerful tools for statistical analysis, with mean, standard

deviation, regression, and sample size determination all built into the results for each survey question. Ironically, using an application called “Qualtrics” may inadvertently put researchers intending to lean into qualitative data at increased risk of “positivism creep” (Braun & Clarke, 2023) where it is tempting to build arguments entirely around the numbers.

While this study began in the Qualtrix toolbox, its strengths are certainly not thanks to robustness in its quantitative analysis. Indeed, I readily acknowledge the quantitative limitations of the study and would use this as a moment to reiterate the aims of the enquiry as situated in the critical realist approach. The study aimed to explore how connected anatomy educators feel inside the web of the medical curriculum, and if the current model of CA could be effectively utilised to explain what they are experiencing. Critical realism contends that ultimately, research seeks causal explanations (Bhaskar, 2008). To do this, as Fryer argues (2022), “explanatory research should follow-on from exploratory research”.

In terms of the CR abduction, we are working toward our best guess as presented in Table 10. There are no claims about theme saturation, validity, generalisability, or universal laws. In short, I used the tools at my disposal to sample the participants who were available and used this method as a point of entry into the transitive realm. Appendix A presents a deeper account of the CR perspective, in which knowledge is both changeable and fallible, as we aim to find reasonable abductions for the purpose of getting to know more about reality via the empirical domain.

Charles Sanders Peirce (1878) introduced abductive reasoning into popular science when published *Deduction, Induction, and Hypothesis*. In this article, he presented the two ancient methods of reasoning alongside a contemporary approach: abductive reasoning. He outlined three steps in his approach, working toward what he

termed a 'case' (hypothesis) from a 'result' (conclusion) and a 'rule' (first principle). See Table 10 for a comparative account of the three methods of reasoning as Peirce presented in his example of the bag of beans, followed by Table 11 showing retroduction. Abduction is a key tool for researchers in HPE who are often tasked with realist questions couched in positivist-leaning communities alongside STEM colleagues, armed with seductive tools such as surveys and questionnaires.

As per Mukumbang (2023):

"While induction, deduction, and abduction each refer to a distinct form of logical inference, retroduction describes an overarching logical method that incorporates abduction, deduction, and induction for its full performance (Chiasson, 2021)."

The present study uses retroduction, building on exploratory aims to generate tentative explanatory findings that are further developed in subsequent chapters. *Retroduction* is a specific method of conceptualization, a syllogism, which requires the researcher to identify the circumstances without which something (the concept) cannot exist. Mukumbang (2023) describes it as "the systematic comparison of explanations obtained from different cases toward a more refined theory." This chapter moves toward the theory of Authentic Alignment proposed in Chapter 8.

Table 10: Abduction, deduction, and induction compared (Bellucci & Pietarinen, 2020), Table adapted from Grass (2021).

Peirce's three-step example comparison		
Abduction	Deduction	Induction

Rule (first principle): All the beans in this bag are white.	Rule (first principle): All the beans in this bag are white.	Case (hypothesis): These beans are from this bag.
Result (conclusion): These beans are white.	Case (hypothesis): These beans are from this bag.	Result (conclusion): These beans are white.
Case (hypothesis): These beans are from this bag.	Result (conclusion): These beans are white.	Rule (first principle): All the beans in this bag are white.

Table 11: Abductive reasoning using retroduction

Step	Premise	Syllogism
Rule (first principle)	You look at the views of anatomy educators and are surprised to find so much complexity vis-à-vis their relationship with the medical curriculum.	(X)
Result (conclusion)	But if the model of curriculum alignment was based on a heterarchical mesh, this would be unsurprising.	(If Y, then unsurprisingly, X)
Case (hypothesis)	Therefore, it is reasonable to conclude that modelling alignment as a heterarchical mesh reflects the complexity of the relationship between anatomy educators and the medical curriculum.	(therefore, presumably Z)

Ultimately, CR advocates the methods that allow researchers to gain an immersive experience into the transitive realm so we might catch a glimpse of the intransitive structures of the Real. Whether the methods are quantitative or qualitative, they act as levers to 'crack open' the field. The aims of CR take us into explanation, a running dialogue that keeps our research activities connected to historical accounts, current theories, and the wider field. The point of enquiry is not to report on the findings as if they are reduceable to facts; the point is to subjectively interpret and to apply informed interpretations to new theory, or as in this case with CA, to newly *updated* theory.

The heterarchical mesh as a mode of modelling and critical realism as a paradigm will be further explored in subsequent chapters. More research is needed in how heterarchical mesh can provide an updated vector space for other triangulated models in HPE. Future directions could further explore changing states to take full advantage of the temporal qualities afforded by new spatiotemporal conceptual models such as heterarchical mesh.

4.3.3 Limitations of the study

From a quantitative point of view, this mixed methods study is limited by its response rate $n=27$ participants, comparatively low for survey methods. The limitations of recruitment methods are another consideration. These findings suggest that complexity is experienced across the board amongst participants; however, given recruitment tactics for our study, the resulting participant totals displayed homogeneity in age and country of residence. An additional future direction would be to use more purposeful sampling methods, in lieu of snowball recruitment, to see if similarity in responses is still apparent when the overall sample is more heterogeneous in its demographics. This study would benefit

from further collaborative coding and is limited by the interpretation of the lead researcher working solo on the thematic analysis.

A central tenet of CR is that research design ought to be 'practically adequate' (Sayer, 1992), and, as Haigh (2019) reminds us, 'fit for purpose'. The themes presented here do not claim validity as quantitative conclusions. Rather, the aim was initially exploratory, looking for insights to explain the relationships forming the central topic: how anatomy relates to the medical curriculum and if the prevailing triangular model is itself, 'fit for purpose'.

4.4 CONCLUSIONS

The findings are reported with respect to four major themes borne out in the data:

1. Inconsistent relationship between involvement in anatomy Learning Outcomes and the LOs of the wider programme
2. Conflicting responses to what drives learning
3. Disconnect between how the participants describe the curriculum vs their concentration of involvement
4. Alignment is in flux and hard to quantify.

These findings, presented in the paradigm of critical realism, use the conceptual framework of abduction to conclude that modelling alignment as a triangulated heterarchical mesh reflects the complexity of the relationship between anatomy educators and the medical curriculum. Such arrangements foster internal coherence (intelligence), self-organisation and emergence. The conclusion contends that heterarchical triangulation may represent the next iteration of CA and this hypothesis warrants further exploration. A mesh-like conceptual model endows the Biggs' (1996) CA theory with increased functionality that more accurately reflects what is happening in the wild.

4.5 Chapter Summary

This chapter continued building the case for using critical realism in HPE and presents the results of my first study. Whilst I was still involved in carrying out the study presented in this chapter, I was concurrently involved in the studies presented in the following three chapters. That is to say, each one had an influence on the other as they unfolded in time. The relationship amongst these chapters is, as such, nonlinear.

These studies represent a volley of sustained enquiry into philosophy and what it means to understand authenticity. In the study of anatomy educators, I used the lever of alignment to gain access into the transitive realm so I could get an immersive experience of what it might feel like to be involved. When I began the study, I was new to research and new to the world of medical education. I thought I'd find more explicit structural norms between anatomy and the wider curriculum. What I found out surprised me – there is a lot more inconsistency and complexity in that relationship than I was expecting. As we carried out the study presented in the next chapter, I started to see that the complex relationship between anatomy (parts) and the curriculum (whole) had a lot to answer for.

Toward deepening my immersion into what it's like coping with the complexity of curriculum, I sought to gain insight into how stakeholders in HPE navigate the realities of the polarised curriculum. In this chapter, I reflect on my process of understanding the paradox whereby anatomy educators describe their curriculum as "integrated" even though they're often only teaching anatomy in years one and two and they have little involvement in the rest of the programme. The 2 + 2 model prevails, where there is an enormous amount of anatomy content front loaded in years one and two and a reduced number of hours allocated for teaching it. To compound the problem, educators receive their Learning Outcomes

from the “powers that be” and these LOs are, as I was to find out in the study presented in Chapter 7, very broad.

The upshot is that teaching and learning anatomy as part of a medical degree is perhaps as hard as it has ever been in the UK, firstly because anatomy historically demands rote memorisation and secondly because of the increasingly conflicting curricular constraints. I end this chapter wondering how medical students and educators alike are coping, and if the HC has anything to do with it.

Chapter 5: Uncovering Hidden Curricula: Use of Dark Humour in Anatomy Labs and its Implications for Basic Sciences Education

Published in Medical Sciences Educator (Dueñas et al., 2020)

5.1 Chapter Introduction

The previous chapter included results of a study exploring the views of anatomy educators on their perceptions of alignment within the curriculum where they teach. As previously discussed, that initial study of anatomy educators provided valuable insights into relevant phenomena at play in the educator experience and allowed me as a researcher to progress in my understanding of alignment as a key pedagogical influence. These insights (described in detail in the Results & Discussion sections of the previous chapter) are highlighted here for their role in shaping the present study and are summarised as follows:

1. Inconsistent relationship between involvement in anatomy Learning Outcomes and the LOs of the wider programme
2. Conflicting responses to what drives learning
3. Disconnect between how the participants describe the curriculum vs their concentration of involvement
4. Alignment is in flux and hard to quantify

The previous chapter described that learning anatomy in a medical degree is traditionally a process of rote memorisation whereby facts are learned and subsequently assessed. This happens in the early years when the basic sciences are taught, and students must pass the associated exams to get to their “clinical years”. The previous chapter described the paradox of anatomy teachers (normally only teaching anatomy in the first two years) are given the mandate to integrate anatomy into the curriculum, even though most anatomy

educators only teach on the first two years and don't have much say in the wider medical curriculum. They're given very broad LOs to teach medical students in a shrinking number of hours allocated to anatomy in the national curriculum (Smith et al., 2021). Under these circumstances, anatomy is harder to teach, harder to learn, and the alignment its stakeholders experience as nested inside the wider curriculum is complex and constantly changing.

One aspect of CASs that is particularly relevant here is that global interactions amongst nodes in a dynamical system often give rise to unintended results that stymie attempts to categorise relationships in terms of linear predictability. These unintended effects are referred to as "noise". In this chapter, we raise the HC as a kind of miscellaneous box that is used to categorize such unintended, unpredictable, and unruly qualities or experiences.

To enrich the understanding of how alignment impacts the curriculum experience, it would be useful to investigate stakeholder perceptions of student experiences: how are students in the dissection room coping with the anatomy-heavy early years? We hypothesised that using humour is a classically human way to cope with overwhelming circumstances. This chapter presents a survey consisting of demographic and qualitative items used to sample widely from the anatomy education field.

5.1.1 Summary of linkage

Study # 1, Constructive Alignment: Fit for Purpose? Used 'The Relationship' vector to abductively explain the rationale for further exploring the **HC. Study #1 highlights the importance of 'The Relationship' in the HC, abductively justifying Study #2 (the present study in this chapter) which looks at one way stakeholders cope with the intensity of HC complexity: humour.**

5.2 Background

Anatomy is a field notorious for its ethically questionable history. Despite and maybe in response to its dubious past, anatomical education has made leaps and bounds in recent years toward a more humanistic approach of working with cadaveric specimens. Humanism, originally coined by Maslow (1954), has been embraced by authors in psychology who argue that each individual is unique. They advocate for an emphasis on an idiographic approach, claiming “that the improvement of the human condition is at least theoretically possible” (Angyal et al., 1981).

Rightfully, the days when ‘cadaver antics’ and ‘cadaver stories’ were common enough to be considered rites of passage have largely disappeared from the contemporary anatomy lab (Hafferty, 1988; Watson, 2011). Further, there has been a movement away from ‘detached concern’ (Tseng et al, 2016) and viewing patients as objects in health professions, which has been mirrored in gross anatomy labs (Kumar Ghosh and Kumar, 2018). It is not uncommon to hear of anatomical donors now referred to as ‘first teachers’ or ‘first patients’ (Ferguson et al., 2008; Bohl et al., 2011).

There is now also a standard at many institutions to have a donor memorial ceremony honouring those whose remains are the focus of gross anatomy education (Pawlina et al., 2011; Jones et al., 2014a). There are unique takes: one program has students attend a luncheon with donor families *prior* to dissection, to humanise the gross anatomy educational experience from the start (Crow et al., 2012). Similarly, Her (2013) describes students within another program who have the opportunity to meet with family members prior to lab experiences, and place large focus on preserving and caring for the donor, or ‘mentor.’

“When they have finished using a body the students sew it together again, stitching inch by inch, to reinstate its appearance; they then dress it, and participate in a memorial ceremony. They thus express their gratitude and say a proper good-bye.” (Her, 2013).

Additionally, many programmes now incorporate ethics and humanities curriculum formally into anatomy education (Rizzolo, 2002; Jones and King, 2017). For example, many medical schools include reflective writing tasks or donor-focussed writing as a component of their formal anatomy requirements (Ferguson et al., 2008; Gregory et al., 2009; Wagoner and Romero-O’Connell, 2009). An institution in Finland has designed formal death and dying lectures for their medical students, run by an interdisciplinary team, including a psychiatrist, anatomist, and hospital pastor (Tuohimaa et al., 1993). These lectures precede any gross lab experiences and have been generally well received by students.

Alongside such interventions in the formalised curriculum, there has also been an increase in the understanding of humanistic and emotional aspects associated with anatomy labs (Talarico Jr., 2013; Williams et al., 2014). Some research suggests that anatomy labs can be a stressful environment, and for many students, can be a first experience in extreme close proximity to death (Finkelstein and Mathers, 1990; Dinsmore et al., 2001; Kumar Ghosh and Kumar, 2018). As Dinsmore et al. (2001) note in their study, the students that report higher levels of associated stress make up a small percentage of the whole. This may be key, considering there are mixed findings on the level of adversity the average student faces—some studies suggest that labs might prove more challenging compared to other academic demands, rather than outright distressing (O’carroll et al., 2002; Cahill and Ettarh, 2009; Reverón and Romero, 2010).

Regardless of extremeness or specific cause of stress, these studies highlight that general anatomy lab associated stress is well documented. However, there is a paucity of research relating to how students, or staff, might cope with the activities of gross anatomy lab experiences. One study of medical student experiences with dissection in the United Kingdom highlighted potential negative reactions as a small component of initial anatomy perceptions but does not explore how specifically such emotions were regulated (Lempp, 2005).

Arráez-Aybar et al. (2004) have suggested that the anxiety associated with anatomy lab experiences may be most strongly mediated and diminished simply with repeated exposure. But in a follow-up study investigating anatomy lab stress mediators, a large number of health professions students highlighted the potential of humour or jokes as a means to deal with lab associated anxiety (Arráez-Aybar et al., 2008). Another study of medical students found anatomy labs to be a low stressor for students initially, but that a high percentage of students used humour to cope with stress and keep their dissection group on task (Mc Garvey et al., 2001). Similar findings were presented by Kotzé and Mole (2013) in a study that highlights the benefits of peer talk, and also humour, to mitigate aspects of death and dying associated with dissection.

These anatomy-specific findings align with a subset of medical education research that suggests one of the most common coping mechanisms for acutely stressful and morbid medical experiences is dark humour (Wear et al., 2006; Wear et al., 2009; Watson, 2011). Dark humour, often synonymous with black, gallows, or cynical humour, is described as a comic style that makes light of typically taboo subjects normally considered too painful to discuss (Watson, 2011). Dark humour has been shown to be a common element of medical practice, bringing teams together and helping individuals

cope with traumatic and high-stress situations often relating to illness, trauma, and death (Dharamsi et al., 2010; Rowe and Regehr, 2010; Charman, 2013; Launer, 2016).

Yet, there have been no humour-focused studies in anatomy education, despite similar themes of death associated with gross anatomy and the findings that humour may be used as a coping mechanism in labs, as discussed above. There are no studies investigating the details of when and why humour is used specifically in anatomy labs, and if the use of humour, particularly dark humour, is viewed as an 'appropriate' means of coping with lab-associated stressors.

Thus, this study was designed with the aims of first understanding if and when humour is utilised in anatomy labs. Further, if humour is being used in labs, what is the perceived purpose of humour? And lastly, is humour viewed as an 'appropriate' aspect of lab life? Given the highly variable opinions on what constitutes 'humour,' this study focused on black humour. This type of humour was selected due to its definition of being humour that treats serious or possibly taboo subjects (such as death or working with human specimens) in a light or satirical fashion (Watson, 2011). Given that previous studies in medical education have found dark humour to be a common coping mechanism, particularly in the face of trauma, death, and dying, we hypothesised that dark humour would be acknowledged as used in anatomy labs and justified as an 'appropriate' means of coping with working around cadaveric materials.

5.3 Methods

A 15-item, non-validated survey was designed to collect demographic and humour views from individuals with anatomy lab experiences. Most questions related to if, when, and how much participants viewed humour to be utilised in anatomy lab settings.

There was also a follow up as to why and when humour might be used in anatomy labs, and an opportunity to respond to a hypothetical situation. Google's survey software was implemented to disseminate the survey. This study and survey were granted ethical approval by the Hull York Medical School Ethics Committee (Ref #18 34).

Data collection commenced in 3 phases. The survey was first piloted within the Hull York Medical School, prior to being launched first within the United Kingdom, then finally, on an international scale. Participants were recruited via social media posts and virtual snowball sampling via email (Baltar and Brunet, 2012). The only inclusion criteria for the survey were anatomy lab experience of any kind.

Descriptive analysis for items was performed in Microsoft Excel®. All open-ended responses were anonymized from the rest of the data and provided to co-authors to code. Coding was conducted independently by three authors, before negotiating and agreeing on both final themes and illustrative quotes. Coding was conducted manually, using an inductive approach to thematically analyse free-text responses (Braun et al., 2014). Authors were reflexive in their qualitative approach (Berger, 2015; Dowling, 2006) by acknowledging their preconceived notions towards the research; all authors noted their experiences hearing dark humour, and various other modes of humour in anatomy labs. However, frequency statements and a closed-ended questions were implemented to directly sample participants on their beliefs or experiences on humour in labs.

5.4 Results

5.4.1 Demographics and Experiences

A total of 185 participants completed the survey. Table 12 provides a complete summary of demographic data. Nine countries were represented, although the majority of the participants indicated the United Kingdom as their country of residence. There was a greater majority of females who completed the survey. Age of participants ranged from 18-65 years old, although younger age groups were more greatly represented. There was also variability in the positions that respondents identified as, although the majority indicated that they were in some type of student role, either associated with a health care program or some anatomical associated degree.

Table 12: Demographic information

Demographics	Survey, <i>n</i> (%)
What country do you reside in?	
UK	120 (65%)
USA	32 (17%)
Canada	15 (8%)
Australia	8 (4%)
India	2 (1%)
Germany	1 (< 1%)
Hong Kong	1 (< 1%)
Jamaica	1 (< 1%)
New Zealand	1 (< 1%)
Did not disclose	4 (2%)

Which gender do you identify as?	
Female	114 (62%)
Male	71 (38%)
Prefer not to say/other	0 (0%)
What is your age? (years)	
18–22	59 (32%)
23–27	44 (24%)
28–32	24 (13%)
33–37	18 (10%)
38–42	16 (8%)
43–47	4 (2%)
48+	14 (8%)
Did not disclose	6 (3%)
Which of the following best describes your position?	
Anatomy academic staff/faculty	58 (31%)
Year 1–2 health care program student	32 (17%)
Year 3–5 health care program student	30 (16%)
Undergraduate student	18 (10%)
Master’s level student	16 (9%)
PhD level student	14 (8%)
Anatomy lab technical staff	5 (3%)
Health care program graduate	6 (3%)

Anatomy program graduate	4 (2%)
Anatomy research staff	2 (1%)

When asked to describe their general anatomy lab experience, the majority of participants (25%) reported a combination of prosection, dissection and teaching. This was followed by 22% with prosection only experience. A total of 38% of respondents reported some combination of dissection experiences, either associated with prosection, teaching, forensic work, or other laboratory activities, such as histology. 5% of participants reported teaching anatomy in some capacity with no further details, and 10% of participants did not disclose the details of their anatomy lab experiences.

5.4.2 Frequency of Negative Lab & Humour Experiences

The majority (34%) of respondents reported experience of such dark humour only on occasion, and 27% did report humour to be an 'often' experience. Interestingly, 27% of participants also reported that they often experienced moments where humour was used to cope with stress/distress in labs. This was compared to 16% of participants who reported never noticing the use of such a coping mechanism in labs, and 12% who reported never noticing black humour at all. Figure 21 depicts all responses for the frequency statements.

Participant responses to frequency statements indicated that witnessed or personal distress about working with cadaveric specimens was not a common occurrence. However, use of black or cynical humour in labs was experienced at higher rates, as was general use of humour to cope with stress and distress. While objectification of specimens appeared to be not an uncommon experience, many participants also noted that discussions and reflections of the emotional aspects of anatomy were reported to

happen frequently. Also of note, the majority of participants (86%) reported that discussions or reflections about the emotional aspects were an 'occasional' to 'often' occurrence for them.

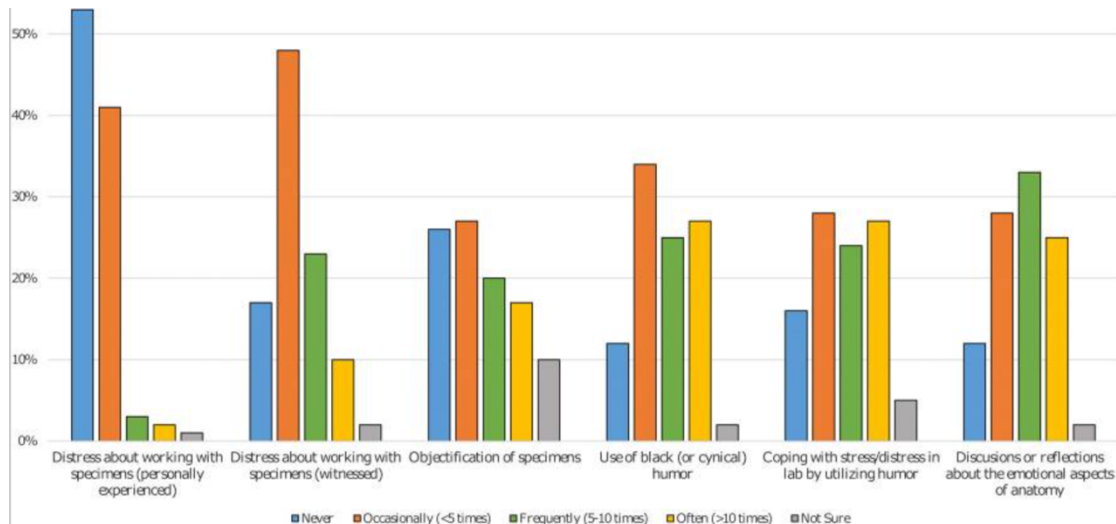


Figure 16: Participant responses to frequency statements

Participant responses to frequency statements indicated that witnessed or personal distress about working with cadaveric specimens was not a common occurrence. However, use of black or cynical humour in labs was experienced at higher rates, as was general use of humour to cope with stress and distress. While objectification of specimens appeared to be not an uncommon experience, many participants also noted that discussions and reflections of the emotional aspects of anatomy were reported to happen frequently.

When coding the closed-open combination question, asking if participants had ever heard or used black humour employed in anatomy labs, 72% of participants reported they 'Yes,' 20% reported 'No,' and 8% were 'Unsure' or did not disclose. Of the 72% who acknowledged dark humour in labs, only 16% reported using it, 15% both using and hearing it, and 41% only hearing it.

In response to the presence of humour, data was also analysed to examine whether any correlations between country or age were reflected in the data. Compared to overall participant percentages, for the top 3 reported countries in our study, each had only about a 50% rate for acknowledging hearing and/or using humour in anatomy labs with 54% for the United Kingdom, 56% for the United States, and 53% for Canada. 23% of UK respondents specifically answered 'No' to this question, compared to 7% of Canadian and 16% of American participants. All age ranges also reported similar rates of acknowledging 'Yes' to hearing and/or using humour in anatomy labs, with 78% for 18–22-year-olds, 73% for 23-27, 71% for 28-32, 69% for 38-42, 75% for 43-47, and 64% for the 48+ group. Specific themes related to humour experiences were also identified from open-ended elaborative responses. Table 13 highlights specific identified themes, as well as longer, illustrative quotes from participants.

5.4.3 Content of Humour: From Appetite to Actions

A large number of participants reported the most common use of what they perceived to be 'black humour' was the frequent comparison or mention of food in labs. Many also reported that common jokes also involved the acts of dissection, specifically, such as "situations where we have had to hemisect the bodies we have used humour... on using the saws." Some elaborations were quite dark, as one participant commented, "sometimes there's jokes of self-harm or suicide with the equipment."

Table 13: Themes & Quotes arising from thematic analysis

Theme	Illustrative quotes
Related to content of humour	

<p>Food</p>	<p>“In my experience most black humour comes in the form of comparison of the tissue to other things; normally food. For example, students would compare a muscle to “pulled pork” or fat to cheese.”</p>
	<p>“Lymph looking like black beans and laughing about how we will not be able to eat it again.”</p>
<p>Acts of dissection</p>	<p>“The technician was holding a skin flap, using a clamp, to allow me to dissect. The clamp slipped and the skin fat hit them in the face. We both laughed at this quite a bit. I this dissolved the nervous tension...”</p>
<p>Why use humour</p>	
<p>To cope with morbidity</p>	<p>“I sometimes hear and use black humour when in the anatomy lab... I think this is a coping mechanism to seeing such explicit and graphic imagery live. I have not thought much about it but I do tend to feel less heavy when there is humour around the lab.”</p>
	<p>“It seems to help build a bit of that emotional disconnect that’s necessary to perform something that’s morbid and gruesome like human dissection.”</p>
	<p>“Sometimes the job of [an] anatomist involves gruesome or “unnatural” interactions with deceased humans and making light of the situation through humour almost acts like a coping mechanism.”</p>
	<p>“Dark/offensive humour can be used as a tool to overcome difficult situations, particularly ones</p>

	regarding mortality. If it helps those undertaking the dissection get through the task, why not?"
To cope with stress	"Given the intensity of the situation [dissection] for the students involved that this may be a form of coping mechanism and reciprocal chuckling is a way to release tension."
	"Wanting to lighten the mood, even in anatomy, is perfectly acceptable."
	"Under immense stress, and doing an activity that is not "normal," humour seems to be the only go to way to lighten the mood and encourage the team to get on with the work [dissecting]."

5.4.4 Why Use Humour? Morbidity as Justification

It seems that to many participants, the nature of anatomical lab work made dark humour a natural facet of the work. As one participant noted, "we joke to make some of the dissection less morbid," and another commented that if one was not conscious of anatomy lab actions, it was easy to get "caught in a rabbit hole of morbidity." However, in addition to dealing with morbidity, some participants noted that occupational humour associated with the lab did not always have to be dark in nature. Puns and anatomical word play were often brought up as an example of extremely common humour, though not considered to be 'dark.'

5.4.5 Inappropriate Humour

As reported, 20% of respondents declined the presence of dark humour in labs when asked if they had ever heard or used it. As one noted, "I seek to maintain a professional face in teaching and the students themselves are always very professional." But beyond those who did not acknowledge humour, a large proportion of respondents admitted that dark humour could be viewed as

acceptable, given that it did not “cross a line.” Particularly, many participants reported being quite sensitive to humorous comments that could be perceived to be at the ‘expense’ of a donor; donor respect was frequently regarded as a key tenet of anatomy labs.

5.4.6 Gauging Appropriateness: The Use of ‘Barometers’

This theme pertains to the metric participants described when assessing the appropriateness of humour within the anatomy laboratory. This barometer had two manifestations: the internal barometer and the external barometer. The barometer was described almost as a process flowchart, with objective ‘yes/no’ decisions made along the way.

The internal barometer related to participants using self as a gauge for judgments of appropriateness. Instances and internal thoughts included: Would this cause me personal offense? Is this my type of humour? Is the intent malicious? The external barometer pertained to the impact of external factors when assessing appropriateness. Sub-themes included: Is this occupationally acceptable? Is this appropriate with a living audience? Is this acceptable within my institutional culture? Is there any learning benefit associated with the humour?

5.4.7 Humorous and ‘Dirty’ Mnemonics

So-called “dirty mnemonics” as a topic indicated another area of polarity amongst participants. Most acknowledged the use of mnemonics as a whole, although there was high variability in whether participants condoned their use or not. The influence of internal and external barometric factors appeared to shape the way respondents conditionally condoned this form of dark humour.

Responses regarding the use of dirty mnemonics in the anatomy lab yielded opinions ranging from ambivalent to strongly in favour or strongly opposed to their use. The most robust finding from our

data on the use of dirty mnemonics is that by far, most respondents conditionally condone their use.

Interestingly, the percentage of respondents (16%) who expressly did not condone the use of such mnemonics was roughly the same as those who unconditionally condoned their use (15%). 69% of the responses indicated they would condone the use of these mnemonics based on certain conditions. These conditions represent a subset of data reflecting what circumstances would make such usage appropriate. A significant theme in this subset is that out of those who reported conditional use of dirty mnemonics, many would only do so passively, i.e., would not directly teach the devices, but would hint at where students could discover them on their own.

5.5 Discussion

Humour is Utilised in Anatomy Labs to Cope

Our study confirms the presence of humour in anatomy labs and highlights some explanations to how and why it is used.

This aligns with previously discussed anatomy studies, that highlighted humour to be a means of coping with lab associated distresses (Mc Garvey et al., 2001; Arráez-Aybar et al., 2008; Kotzé and Mole, 2013). Our findings go a step further, by truly highlighting the use of humour as a coping mechanism for specifically the surreal or morbid acts of dissection. Such findings are supported by broader humour theory. As far back as Freud, humour was theorized to be mature defence mechanism, to express the feelings of unconscious discomfort (Freud, 1971). Jokes and laughter are considered by some to provide psychological and physical health benefits (Martin, 2002; Hayashi et al., 2016; Savage et al., 2017). And it is theorized that in intense situations, laughter can prove a better means of catharsis, than say screaming or breaking down (Rowe and Regehr, 2010). While anatomy labs are

certainly not regarded as emergency scenarios, and the majority of our participants did not report high frequencies of experience or witnessed distress in labs, the same theories might still apply, just on a less extreme scale.

The presence of humour as a means of coping and team bonding is also documented in the clinical components of healthcare and medical education, which aligns better with the educational considerations of anatomy labs (Parsons et al., 2001; Dharamsi et al., 2010; Smyth, 2011). Wear and colleagues provided some more in-depth evidence towards how and why dark humour is used, particularly from a medical training standpoint, in a set of focus-group studies with medical students, residents, and attending physicians (Wear et al., 2006; Wear et al., 2009). Of particular interest to the findings in our study, Wear and colleagues highlight the presence of 'unspoken rules' that guide humour in the healthcare setting. These rules include the hierarchy for initiation of humour (i.e., always started by the more senior practitioner), patient populations considered 'fair game' (i.e., difficult or non-compliant patients), and limitations to humour. Such limitations included the importance of tone and delivery, as well as respecting 'off-limits' patients, such as those with terminal illness.

Our findings support the presence of similar 'rules' in anatomy labs. Whether directly communicated, or an unspoken value, our study indicated that one of the biggest determinants in the importance of humour is regard for the donor. As our illustrative quotes exemplify, anatomical donation being regarded as a true "gift" implies that there is a responsibility of respect towards the donor that might be considered an important 'rule' of the anatomy lab. This may be related to the increasingly standardised practice in anatomy education of referring to donors in a more humanistic fashion (Ferguson and Ford, 2008; Bohl et al., 2011).

5.5.1 Differences in Opinions

Our results also highlight that there is a subset of individuals who believe that maintaining 'professional behaviour' in labs means that humour is never appropriate to use. In our open-closed coding question, 20% of respondents put they had never heard or used dark humour in the lab. Our frequency statement analysis revealed that 12% of participants put they had 'Never' experienced the use of black (cynical) humour in lab.

The differences in these responses may be explained by the wording of the question, with a greater percentage denying humour when asked to elaborate on their views. However, if the range can be considered 12-20% of individuals who believe that this type of humour simply does not exist, it begs the question as to why they are at odds with the majority. Based on our analysis of open-ended questions, we hypothesize that individuals who believe that humour is always inappropriate might be making up this majority. However, our study does not indicate what the implications from such stark differences in professional opinions may be, although we hypothesize that such strong professional stances may also shade teaching and learning opinions.

For example, when asked about views on "dirty mnemonics," a humorous approach to learning/recalling information, participants were split in responses. A review of the literature suggests that this concern is related to the pervasive use of acronyms in healthcare as a whole (Koczmara et al., 2005; Kleinman, 2012), since a widespread reliance on potentially confusing acronyms has been identified as inherently problematic (Awan et al., 2016). Such rapid and voluminous recall has an especially rich tradition in the classical study of anatomy (Irving and Smith, 1939; McLachlan, 2000). But this very tradition points to the even greater need for future physicians to build a deeper fundament of long-term understanding

of medical and anatomical concepts, rather than a mere rote recall of data encoded in letters that could all too easily be accidentally interchanged (with disastrous results). Such depth is key to related issues of professionalism (Hilton and Slotnick, 2005).

Less than 2% of respondents denied knowledge of the existence of mnemonics in the anatomy lab. The data showed almost all respondents (nearly 99%) were aware of the use of mnemonics in the anatomy lab. There is a common theme in the belief amongst respondents that mnemonics are in general, dirty or otherwise, an effective albeit lower-level learning tool that should not feature as a planned teaching device. Polarity appears in how much “ownership” they are prepared to take in the dissemination/tolerance of their use in professional practice, which points back to the internal and external barometer.

Many respondents indicated that mnemonics ought to be left to students to discover on their own (as part of the “hidden curriculum”). Other respondents reflected on their own use of mnemonics to memorize structural anatomy, and 12% responded with an unprompted mention of the “cranial nerves mnemonic” as an example. Smith and Border (2018) point out that mnemonics “build a construct for subsequent deeper layers of knowledge.” In our study, difference of opinion on the use of dirty mnemonics in the anatomy lab reflects to issues of identity in professional practice.

5.5.2 Humour as a Hidden Curriculum of Anatomy Labs

Given our findings in the variability of humour experiences and questions that arise from such diversity, our study confirms that humour is a facet of the HC of anatomy labs. It also highlights the need for more recognition of HC in anatomy. As Hafferty and Finn (2015) highlight, the anatomy lab in particular can be considered a space for professional formation, related to HS. As they describe it,

the HC can be considered the differences in what an organization says and what it actually does, as well as the non-formal aspects of organizational functioning.

In considering the anatomy lab as an “organization,” the HC of the implications of an “in-group” for example, align with the humour findings from our study. The morbidity described by many of our participants is an informal and in-group characteristic; most lay people do not know much about the human body, let alone the act of dissection. Therefore, using humour within this in-group can be viewed as a normal means of coping. Further, qualifying humour as HC, while our study highlights the view that this type of coping is frequently experienced, it is not an apparent facet most labs openly address, as exemplified in our variable response.

HC is often linked to implications for professional practice. And as Escobar-Poni and Poni (2006) highlight, in line with medical competencies in particular, there is opportunity for gross anatomy curriculum to play a major role in professionalism-related training for medical students. Their article highlights particular curricular learning activities by the way this may happen, but also encourages the need for peer review evaluations of such activities. Swick (2006) also highlights some professionalism aspects of anatomy experiences, such as adherence to ethical and moral standards, demonstrating humanistic values, and dealing with complexity/uncertainty, that might be considered more hidden rather than formal curriculum. Both of these articles make excellent arguments for more professionalism-focused research and evaluation in the anatomical sciences. And as our study highlights, there may be interesting findings for those who instruct the anatomical sciences, such as the argument for more direct discussions of HC.

5.6 Limitations, Considerations, & Future Directions

While our study highlights that humour is widely used by many individuals in anatomy labs, there are a number of considerations that should be recognized as limitations of our findings.

First, while our study attempted to recruit a wide scope of international participants, it should be noted that it was written in British English. Only approximately 3% of participants reported their country of residence to be a country where English is not the predominant language used in higher education institutes.

Language and cultural differences can be considered a limitation of this study from a truly international perspective. Even the concept of humour is a complex cognitive process that can be influenced by an individuals' culture (Bell, 2007). This thus limits a true cross-cultural understanding of humour utilization in anatomy labs, particularly when considering the native language and cultures (American and British) of the research team. Future directions for similar studies might include international collaboration, or use of formal translation services for recruitment and data collection.

The limitations of recruitment methods should also be considered in our comparison of international and age groups. Our findings suggest that the presence of humour was reported to be roughly the same across our top three countries of responses, as well as across age groups. However, given recruitment tactics for our study, the resulting participant totals displayed homogeneity in age and country of residence. An additional future direction would be to use more purposeful sampling methods, in lieu of snowball recruitment, in order to see if similarity in responses is still apparent when the overall sample is more heterogeneous in its demographics.

Another consideration we wish to note was the occasional ambiguity of our study design. As highlighted in our survey details and results, frequency statements were based on numeric values determined by the research team in order to provide some context, but not limit participation. This presents the limitation of the possible confounding factors related to time that may be reflected in our data. For example, to a participant who has been teaching anatomy for 15+ years (reported by numerous respondents), hearing something 'Often,' or more than 10 times, may be interpreted quite differently than an 'Often' rating reported by a Year 1 health professions student with limited lab experiences. While it is exponentially challenging to attempt to account for such considerations without limiting inclusion criteria, we do not think that this discounts our results.

Our results provide strong evidence to confirm the presence of HC in anatomy labs (Hafferty and Finn, 2015), and encourages more specific research into subdivisions of this curriculum, often related to the emotional, professional, and ethical considerations of anatomy. We suggest and encourage more specified work be targeted at these potential curricular components, to best understand how curriculum are being implemented, and the benefits. It may also be key to investigate the curricular decisions to not include more humanistic aspects. For example, our results highlight that about 12% of respondents stated that they never have experienced discussion or reflections about the emotional aspects of anatomy. Could this be due to the documented restraints of contact hours in many anatomy courses (Drake et al., 2002; Drake, 2009; Drake et al., 2014; McBride and Drake, 2018), or is this a personal decision made by these individuals? Perhaps, while there has been an increase in donor-focused activities (Pawlina et al., 2011; Crow et al., 2012; Jones et al., 2014b), not all

institutions host or focus on such humanistic activities, or do not require them to be mandatory for students and staff. Further research might allow us to better understand the breadth and differences we as anatomy educators certainly possess.

5.7 Conclusions

Humour is widely regarded to be a coping mechanism in anatomy labs, particularly when dealing with what are regarded as 'morbid' or 'surreal' acts of working with human specimens. However, humour does not reign unconstrained in labs. This study highlights that while dark humour may be a perceived tension release, many individuals make use of very specific internalised gauges to determine when and what humour may be appropriate. And one of the most important of these is that donor respect be of the utmost importance at all times. Still, there are a minority of people who believe that humour is never appropriate in lab regardless of its potential advantages as an innately human coping response. The dichotomy in professional views indicated in this study highlight the need for future humanistic-focused anatomy education research, to better understand curricular alignment and promote optimal educational experiences. Finally, this study further highlights the impact of the HC within educational and professional settings.

5.8 Acknowledgements

We would like to thank all those who completed our survey, and particularly those who assisted with our virtual snowball recruitment efforts, especially: Bill Laughey, Michelle Lazarus, and Tim Wilson. Additionally, we would like to thank anatomical donors. While it presents its unique challenges, the privilege of working and learning from anatomical donors is undeniable. We thank all those who participate in the selfless act of anatomical donation.

Portions of the pilot and United Kingdom phase of this data was presented in a poster presentation at the 2019 Annual Meeting of the American Association of Anatomists. Material in this manuscript has also been accepted for an oral presentation at the 19th Congress of the International Federation of Associations of Anatomists.

5.9 Chapter Summary

The Conclusion section of this study highlights the dichotomy apparent between professional views and the significance of the HC in medical education, particularly in basic sciences such as anatomy. The results invite the medical education community to consider the need for more “humanistic-focused anatomy education research”. The dichotomy in views revealed here resonate with the professional disparity observed in the Fit for Purpose survey presented in Chapter 4. In short, educators did not merely disagree, they disagreed to an extreme degree on concepts at the core of the curriculum.

For example, some educators openly sanction the use of humour. Others *conditionally* sanction its use, i.e., only humour that is not sexually explicit would be appropriate for use with regards to cadaveric study. Still others declare that the use of humour is wholly inappropriate in the anatomy lab under any circumstances. And then there is the puzzling 20% who deny its existence completely. How can such a disparity of reported experiences be reconciled with the reality of what is going on in the curriculum? This gnawing question deeply impacted my wider epistemological stance as I continued unpacking the framework of my original research question: How does alignment of the curriculum relate to its authenticity?

Despite the apparent disagreement, the phenomena in question continued playing out within their shared experiences regardless of

what is prescribed in the formal curriculum. This is where the complexity appears, hidden in the obvious. The HC has been described in the literature as evidence of a complex system. As previously discussed, Biggs' (1996) CA is based on the triangulation of three points, resulting in a triangulated two-dimensional structural model. Could the disparity of lived experiences within phenomena be a consequence of a more complex alignment? The complex curriculum would require a multidimensional spatiotemporal methodology to investigate the research question nested in principles of curricular alignment.

This chapter and the previous one present studies using a nomothetic approach to the gathering and analysis of data. Both studies employ thematic analysis of quantitative and qualitative data in an attempt to reveal themes seated in defence of generalisability. After we published the Uncovering Hidden Curricula paper presented in this chapter, I realised that the complex nature of the HC gives rise to unique experiences for each individual stakeholder. I was at this point feeling much more confident with critical realism as a paradigm and its quest for access into the intransitive realm via hermeneutic dialectics – interpretative discourse. My paradigmatic stance was well established, but I had to find the right methodology for carrying out the primary empirical study of my doctoral work: the semi-structured interviews of anatomy educators presented in Chapter 7 of this thesis.

If I could find a methodology suited to exploring lived experiences, there would be more potential to reveal the phenomena from a hermeneutic (interpretative), inductive perspective rather than relying on methods such as surveys and questionnaires that are inherently seeking generalisability and ever tasked with the burden of minimising bias. In short, I had realised that to make a genuinely unique contribution with my project, my project needed to hone its

methodology. In the next chapter, I provide an overview of Interpretative Phenomenological Analysis (IPA), the methodology that I turned to at this point in my research.

In the next two chapters, I will demonstrate the progression from thematic analysis of data to the use of semi-structured interview questions seeking a more interpretative relationship between participants and their experiences as well as between me as the researcher and my participants. I will demonstrate the IPA is well suited as a methodology of choice for projects situated in the paradigm of critical realism. This reflects the simultaneity of nested relationships in the iterative, heuristic, parts-whole conversation that forms the both the Hidden Curriculum and the Hermeneutic Circle.

Chapter 6: IPA in the HPE Literature – A Qualitative Evidence Synthesis

6.1 Chapter Introduction

The results of the previous chapter raised the need for more “humanistic-focused anatomy education research”. In this chapter, the term “humanistic-focused” will be interpreted as phenomenological – research concerned with individual, human experiences. This chapter came from the need to develop the humanistic focus using a suitable methodology. Since Interpretative Phenomenological Analysis (IPA) is well known for its idiographic (single person) focus with methods designed for vertical depth in its data analysis, this methodology was chosen for the main empirical contribution of this thesis presented in Chapter 7.

Although Chapter 7 contains a suitable literature review, I chose to expand and develop that review into the evidence synthesis provided in the current chapter. The rationale for this is based on the need to ‘tell the story’ of this project – readers will find that the story flows clearly from the introduction to IPA presented in this chapter to the study developed in the next one. This chapter describes how IPA is used in the wider field of HP and gives the reader a sense of what is necessary to do “good” IPA.

Most anatomy education activities take place within the context of medical school curricula. However, the postgraduate and professional training context of anatomy is well-established and significant. As such, the need for more phenomenological research will be considered as situated within the context of HPE. This chapter provides results in the form of a systematic review with a narrative synthesis in the Discussion.

6.2 Background

Interpretative phenomenological analysis (IPA) has become a dominant cross-disciplinary qualitative research methodology. It draws influence from phenomenological psychology (Eatough & Smith, 2017) and hermeneutic (interpretative) theory (Smith, 1996). IPA is an experiential approach that relies on a detailed examination of a relatively small group to interpret phenomena via the sense-making of the individuals within that group. The data produced by IPA is rooted in experience and necessarily co-created by the researcher's interpretation in a parts-whole reflexive process referred to as the 'hermeneutic circle' further explored in section 9.4.2.1 of this thesis.

IPA is well established in the healthcare research (Biggerstaff & Thompson, 2008), especially in nursing and patient experience (Mole, 2019; Probst et al., 2020). It remains an emergent approach in the medical education literature (Sabel et al., 2014; Wang, 2016; Anderson et al., 2019; Coakley et al., 2019; Ritchie et al., 2020; Bynum et al., 2021;) and HPE literature (Rietmeijer & Veen, 2022). In light of Neubauer's (2019) encouragement of health professions researchers to further utilize phenomenology to approach their questions and Rietmeijer and Veen's (2022) advice to tread there with caution, the authors now consider how hermeneutic phenomenology is being used in the field and, in particular, how IPA has risen to dominance in the health sciences and medical literature.

Medical sciences typically draw from horizontal generalization as large (experimental) studies with representative samples such as randomised controlled trials that are analysed deductively. In education, it is also important to generalize conceptually and to develop that picture from the bottom up, from the data set itself,

rather than focusing on statistical generalizations. In medical sciences, qualitative research is normally theory-laden (Brown & Nestel, 2020). Collins defines theory (2018) as “a big idea that organizes many other ideas with a high degree of explanatory power”— top-down, essentially. Hermeneutic phenomenology offers a process by which researchers interpret phenomena and co-create the data inductively (bottom-up). The analytic experience is open to, but not serving, a particular theoretical framework, and as a process, it relies on researchers as active participants (Lopez & Willis, 2004).

In hermeneutic phenomenology, the consideration of researcher bias is moot, as researchers embrace their stance explicitly as part of the data. Analysis is carried out via iterative reflexivity as researchers continuously “go back to the things themselves” (Husserl, 1900) while openly reflecting on and attending to their subjectivity (Bynum & Varpio, 2018). Tomkins and Eatough (2013) have called for experiential investigation that suspends the “organizational attitude” obscuring access to “the things themselves” –

“If the “phenomenological attitude” means identifying and suspending scientific, thematic, and institutionalized ways of constructing the world, then the “organizational attitude” means seeing the world specifically and exclusively through these scientific, thematic and institutional constructs” (Tomkins & Eatough, 2013).

IPA contends that these “things” – the words people use to relate their experiences – have intrinsic value as data, value that becomes *optimised* rather than *disqualified* with the addition of researcher interpretation. The nature of this value frustrates the quantitative, theory-suffused systems of analysis classically used by positivist STEM disciplines to measure and report on the results of a study.

Chapter 6: IPA in the Literature – A Qualitative Evidence Synthesis

And yet, the use of IPA in health sciences is on the rise. Peer-reviewed journals concerned with health sciences and education are publishing not just qualitative research, but research that hails itself as IPA – a staunchly qualitative, ideographic, theory-hesitant, essentially anti-positivist form of qualitative research. Syntactically, health sciences papers are rooted in the conventions of the third person objective and focus on Results as separate from the Discussion, whereas with IPA the experience is recounted in the first person where interpretative discussion essentially *forms* the Results.

Nevertheless, researchers are getting their IPA-titled studies published at an increasing rate. This phenomenon itself begs the question, how are researchers from the health sciences even doing that? Are authors seeking peer-reviewed publication in their field having to “tone down” or otherwise modify aspects of their study design, methods, and writing to fit through the eye of the needle? Health sciences researchers, enthusiastic in their championing of IPA, are perhaps more vulnerable to the long arm of what Braun & Clarke refer to as ‘positivism creep’ (2023), or as they paraphrase from Marecek (2003), “swimming unknowingly in the waters of positivism”. The primary question guiding this review is: how is IPA being used in the HPE literature?

This study aims to integrate the classic realist perspective of health sciences grounded in a reflexive practice with qualitative analysis to relate its findings – a qualitative evidence synthesis. Critical realism gives social scientists a paradigm to elucidate meaning through hermeneutic methodologies. Using a systematic review allows us to speak the conventional language of science, reporting first on the quantifiable data obtained under controls. Systematic, realist methods underpin the practice of evidence gathering and has traditionally dominated health care policy (Stevens, 2001; Higgins

et al., 2019) so we can safely say that it isn't going anywhere. Systematic reviews are normally carried out through an objective and quantitative approach (Dixon-Woods et al., 2006). Most qualitative researchers would argue that such researcher objectivity is impossible since we are all consciously and unconsciously biased. The next section reframes the systemic review in hermeneutic terms.

6.2.1 Fusion of horizons

The literature review method in general is a kind of fusion of horizons (*Horizontverschmelzung*), the dialectical concept coined by Gadamer first mentioned in Chapter 3.2.2.2. The fusion of horizons concept arose in the context of translation, where the text and the interpreter can be located within their respective "horizon." Each horizon finds expression via language as the medium, within which both the text and interpreter find belonging. In this way, text and interpreter participate in and belong to history and language. As per Gadamer (2002), "History does not belong to us; we belong to it."

This "belongingness" to language is the conduit linking the text and interpreter, making understanding possible – "Being that can be understood is language" (Gadamer 2008). The act of seeking understanding catalyses the fusion of horizons between the interpreter and the text. This fusion is not a guarantee of full understanding, where the interpreter can now claim to possess an objective meaning. Rather, the fusion of horizons is "an event in which a world opens itself to him." (Palmer, 1969, p. 209). The deeper understanding gained from such an event is normally considered with respect to a single human and a single text in a 1:1 ratio. In this chapter, we will explore the fusion of horizons concept in terms of the qualitative evidence synthesis, a practice that calls for multiple fusion events.

The value of any review is tied to the breadth of its search. A systematic review consists of a comprehensive search to identify all relevant articles which are then processed through statistical analysis. Comprehensiveness has been reported as crucial in providing a true representation of available research (Tacconelli, 2010) and preventing bias; however, the qualitative stance is that while the former may be a reasonable methodological goal, the latter is plainly impossible if the goal of the researcher is to truly fuse their horizon with each text.

Quantitative reviews remain prized, and there is an associated focus on developing methods for providing the most comprehensive and bias-free searches possible (Helmer et al., 2001). The trade-off of time and resources involved in carrying out a highly comprehensive systematic search is considerable, as the more comprehensive the search, the greater the return of irrelevant articles. To mitigate the time-intensity of searches, there has been considerable investigation of how the sensitivity of searches can be modified, making the search more efficient (Stevinson & Lawlor, 2004) for researchers whose horizons are constrained by personal bandwidth – the time and energy it takes to catalyse true understanding of each text.

Comprehensive searching is not the exclusive remit of systematic reviews; the practice also forms the basis of narrative reviews, now also known as qualitative evidence syntheses (QES) (Snilstveit, 2012). Although QES are widely regarded as a necessary and valuable approach to health services research (Noyes et al., 2015; Kelly et al., 2018), there are challenges to carrying out a search of qualitative literature that is both sensitive and comprehensive. These challenges are especially rampant in qualitative literature: poor indexing and use of key words of qualitative studies, the lack of keywords in titles, and unstructured abstracts (Evans, 2002;

Cooke et al., 2012; Noyes et al., 2019). The upshot is that the nature of the articles being searched either lends itself to being searched, like quantitative research tends to do, or throws researchers off the scent, as is the case with the preponderance of qualitative literature.

Like hunters chasing their quarry, researchers devise their search strategy to give themselves the best chance of capturing the most articles that *are relevant to their study*. Relevance is another key aspect of the search strategy aiming to be both time efficient and comprehensive. This strategy, known as the search tool, is used as an organising framework to list terms by the main concepts in the search question for the purpose of catching the most relevant returns.

The chosen framework takes on heightened importance for solo researchers or teams without the guidance of an experienced information specialist. The PICO model (population, intervention, comparison, outcome), is commonly used as a systematic search strategy tool for exploring quantitative research questions (Aars & Bruusgaard, 1989). Since the PICO tool does not account for terms relating to qualitative research or specific qualitative methodologies such as IPA, it is frequently modified in practice as "PICOS". The "S" refers to the study design (Tacconelli, 2010), aiming to reduce the return of irrelevant articles. Cooke et al. (2012) have further dealt with the issue of relevance by developing the SPIDER search tool (sample, phenomenon of interest, design, evaluation, research type).

6.2.2 Research question

IPA has grown in popularity to become a dominant approach in multidisciplinary qualitative research. Smith provided an integrated analysis of how IPA has been used in the literature (Jonathan A.

Smith, 2011), where 24% of the articles using IPA focussed on illness experience. It is being adapted for use in the field of health care professions, where Biggerstaff & Thompson (2008) evaluated it with suggestions for teaching IPA drawing on their experiences “in the context of HCP [health care professions] education.”

Peat et al. (2019) have offered an instructive primer for use in healthcare research. More recently, Starr & Smith (2023) have demonstrated the use of IPA in the genetics literature through an interpretative overview of selected studies. The question guiding the search and analysis was: How is IPA currently being used in the health professional education (HPE) literature? With this study, we aim to explore the SPIDER tool as an approach to generating an evidence synthesis that can form a robust basis for developing an interpretative overview.

6.3 Methods

6.3.1 Study Design

This review adapted the SPIDER search tool in conducting a narrative literature review because it was specifically designed to identify relevant qualitative and mixed-method studies (Cooke 2012). As the lead researcher, I used SPIDER to carry out a review of the literature to identify all the relevant publications concerning Interpretative Phenomenological Analysis, anatomy education, and health professions education. See Table 14 for the details of the SPIDER search. The question guiding the search and analysis was: How is IPA being used in the HPE literature? No ethical approval was required for this study.

Table 14: SPIDER tool showing the search constraints.

	Inclusion	Exclusion
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Sample	Articles with IPA and either Health Professions Education (HPE) or Anatomy Education (AE) or Medical Education (ME) mentioned in the title or abstract.	Articles not containing IPA and HPE/AE/ME in the title or abstract.
Phenomenon of interest	Studies utilising IPA to examine and report on HPE/AE/ME phenomena	Studies investigating other related themes (IPA studies exploring health psychology); studies not specifically utilising IPA (i.e., hermeneutic or phenomenological approaches not explicitly using IPA)
Design	Theoretical (i.e., reviews) or empirical peer-reviewed articles utilising IPA	Non-peer reviewed articles, i.e., grey literature (theses, dissertations, conference proceedings, editorial and opinion pieces)
Evaluation	Synthesis, quantitative or qualitative or mixed methods analyses using IPA to report on HPE/AE/ME phenomena	Any article not pertaining to the research question

<p>Research Type</p>	<p>Peer-reviewed journal articles published between 2010 and 2023 with full text available in English, French, German, Polish, Spanish, Italian, or Portuguese.</p>	<p>Literature published before 2000; grey literature (theses, dissertations, conference proceedings, editorials and opinion pieces)</p>
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6.3.2 Search strategy & study selection

Between January and March 2023, I conducted a literature search using Pubmed and CINAHL Ultimate (EBSCO) [formerly CINAHL Complete]. Searches were carried out using the following search terms (interpretative phenomenological analysis) AND (health professions education OR health professional education OR anatomy education OR medical education). The original database searches were constrained to return only hits of peer-reviewed articles with full texts available. Conference abstracts and proceedings, editorials, opinion pieces and commentaries were not included. CINAHL returned 8 articles and Pubmed 463. These were downloaded and entered the citation manager, EndNote (version 20). Following a review of titles and abstracts, duplicates were removed in the first stage of sifting and the EndNote group, SPIDER, emerged from this early consolidation. See Figure 22 for the graphical representation of the process.

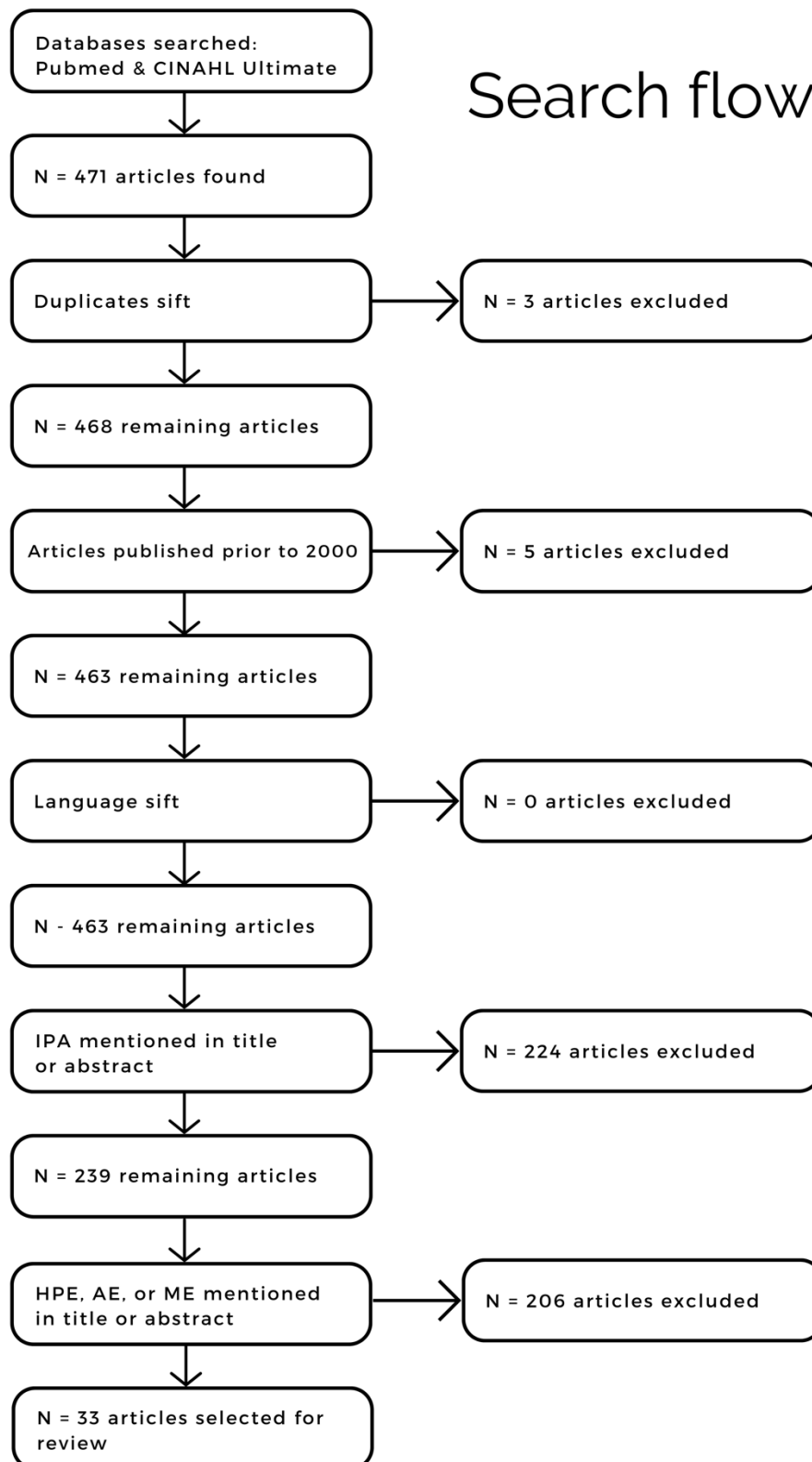


Figure 17: Search strategy flow visualisation. Image designed by the author using Canva.

In the next stage, the EndNote search tool was used to select for studies containing “interpretative phenomenological analysis” in the title or the abstract. Those studies not utilising IPA specifically were excluded, i.e., studies using a hermeneutic approach, phenomenological explorations drawing on Pierre Bourdieu's theory of practice, and other related approaches not specifically stated as IPA were excluded at this stage. This narrowed down the relevant articles significantly, all of which were copied into the next Endnote group, IPA SPIDER.

The next round of exclusions was crafted by using the Endnote search tool to find only those articles in the IPA SPIDER group that contained “health professions education OR health professional education OR anatomy education OR medical education” in any field. See Figure 17 for the search visual. Two papers that reported on IPA study protocol, Slobodin et al. (2020) and Walls et al. (2020), were included. This narrowed the relevant results down to 33 articles, a reasonable number in consideration of the research question, the resources available, and the circumstances of the study overall.

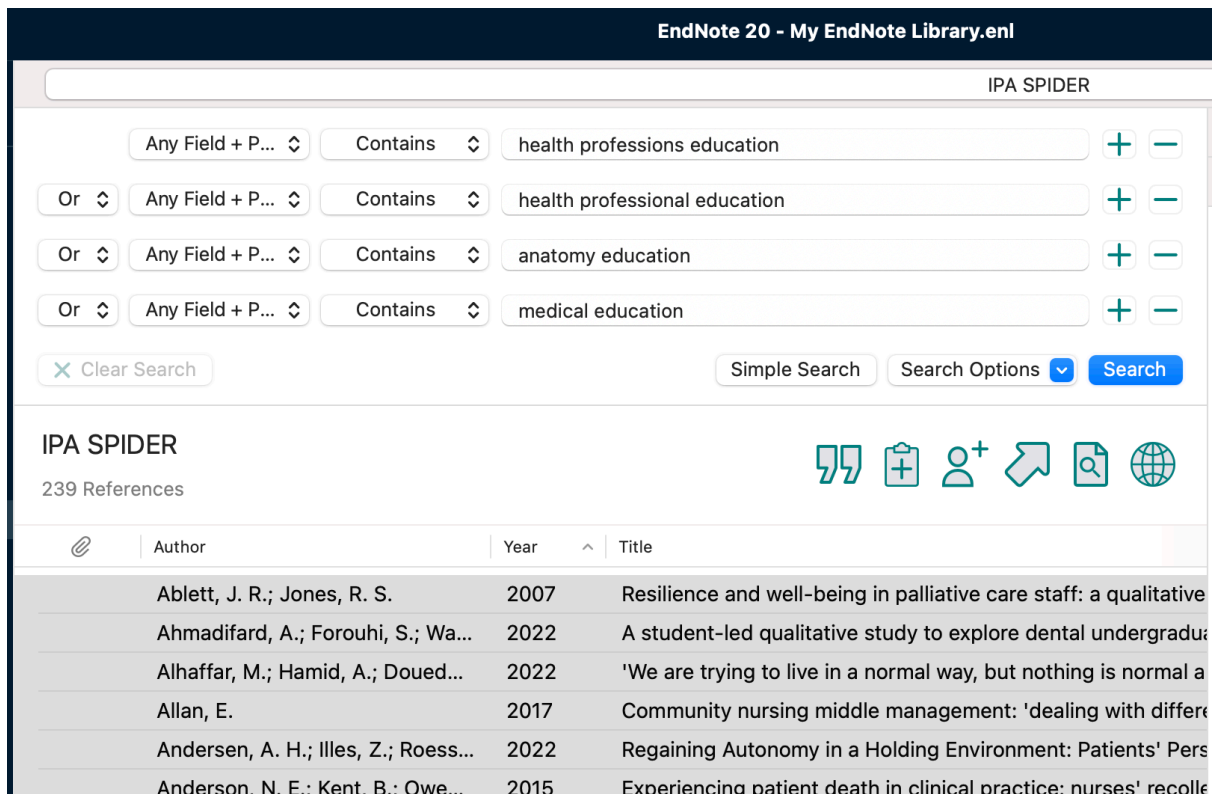


Figure 18: Endnote exclusion. Screenshot by the author.

From here, an assessment of the full text of all articles that met the inclusion criteria was carried out. The lead reviewer read all the included studies, extracting the following relevant information in addition to author, title, date, and journal:

- sample size
- voice usage (first or third person)
- pseudonym style
- meaningful specific event?
- philosophical rationale
- theoretical framework applied?
- aims/research question
- analysis / IPA analytic process citation if any

- results - theory or framework generated in the results?

6.4 Results

As in Cooke et al. (2012), I systematically reviewed the findings guided by two metrics; the number of returned articles generated and of these, the number relevant to the research constraints.

Search results ranged from database inception until 10th March 2023 (the present date at the time of writing). [Google sheets](#) was used to sort relevant aspects of each article, noting the main points of interest germane to the aim, specifically: the voice used in the manuscript, study aims, participant pseudonym stylings, theme conception, procedural referencing, how IPA might be mixed with theoretical frameworks, and to what depth the results were presented with interpretative work on the part of the author(s).

Click the linked text in the previous sentence or refer to Appendix C for a visual and link out to the coding sheet. We worked through the readings iteratively, and columns were modified as we continued noticing how IPA was used in the sample. For example, the column “PETs/GETs used” was deleted because only one study used them. From these observations and analyses, a set of five categories developed to characterise the N=33 sample:

- Educators' experiences (n= 3)
- Student/Trainees' experiences (n= 10)
- Clinicians' experiences (n= 8)
- Patients' experiences (n= 7)
- Composite (n= 5)

Drawing on the work of Starr & Smith (2023), the aim of this study was to build a critical narrative overview from the studies selected as illustrative of each category, representing how IPA is used in the field of HPE. The following sections present each category with

selected studies used to discuss how IPA has been utilised and adapted from its roots in health psychology.

6.4.1 Educators' experiences (n=3)

I reviewed three studies pertaining exclusively to the experiences of educators. All three studies looking at educator experiences showed relatively high sample sizes: 35, 11, and 34. The ideal sample size, "if one is trying to publish an IPA study" says Smith & Nizza (2021), "10 – 12 is a good number." In addition to small sample sizes, IPA calls for homogeneity. The overall sampling strategy aims for a closely defined set of people for whom the experience in question has been particularly meaningful (Smith et al., 2009).

The idea that an IPA study should look at the lived experiences of a small, purposively sampled group with respect to a particularly meaningful experience is one that warrants further consideration. For example, the study of anatomy educators by Kirkness, et al. (2023) may have the most appropriate sample size of this group (n=11), but the group was not strategically recruited to reflect on a particularly meaningful experience. The inclusion criteria for their study were simply that participants currently teach anatomy in a UK medical school and be willing to share their experiences. Similarly, the other two studies of educators (Sabel & Archer, 2014; Edirippulige et al., 2018) hinged around questions seeking broadly phenomenological insight about how anatomy educators cope with aspects of their job in relation to a certain theory or topic of interest.

IPA maintains a focus on the interpretations of the individual, through the interpretative lens of the researcher with a priority on that 'fusion of horizons.' In the process, the researcher may get to know more about the phenomena/issue used to catalyse the fusion. It is important to acknowledge that the knowledge gleaned about

the phenomena/issue is gained obliquely as a secondary focus. Theory or topical insight is thus a side effect of the main focus, which for IPA is always on the “things themselves” – the double hermeneutic comprised of our interpretations of the interpretations of our participants regarding specific, meaningful experiences.

Most of the literature reviewed used IPA to investigate phenomena about a sample of participants reflecting on some aspect of their long-term role in education with a focus on an *a priori* theory or concept. In the studies of educators’ experiences, Kirkness et al (2023) were focussed on the curriculum/learning environment complexity, Edirippulige et al. (2018) on exploring the progress of eHealth E&T in the Australian medical curriculum, and Sabel & Archer’s (2014) study was front-loaded with the Tajfel framework (social identity theory). That doesn’t discount these as IPA studies, as these articles show that IPA can be used to shed light on the importance of student experiences. However, considering how these studies have adapted IPA does raise the opportunity for HPE authors to carefully craft research questions that harness the ‘purposive’ sample of individuals best suited to IPA.

The studies looking at educator experiences illustrate the importance of formulating research questions that relate to meaningful experiences of a small, purposive group rather than serving an *a priori* theoretical or topical agenda. One may end up with links to theory and contemporary topics relevant to the field of HPE, but the priority of IPA is to inform our understanding of other people’s relationship to the world (Smith et al., 2021, p. 17), not to corroborate or contradict theory.

6.4.2 Student/Trainees’ experiences (n=10)

The preponderance of studies reviewed here used samples of medical students reflecting on aspects of their role as related to a

Chapter 6: IPA in the Literature – A Qualitative Evidence Synthesis

research topic (Bagri & Tiberius, 2010; Stockley & Forbes, 2014; Nortje & De Jongh, 2017; Witheridge et al., 2019) as previously noted with the anatomy educators. In the articles reporting on studies of student/trainee experiences, some studies used purposive sampling aimed at a group within the population of medical students, making the sample more homogeneous. For example, in Lane & Roberts' (2020) study of medical interns, sampling was purposive and criterion-based, for interns (PGY1 doctors) working within Western Sydney Local Health District (LHD), aiming to recruit not just interns as participants, but those who had experienced disclosure. This study is particularly suited to IPA because the event in question is one that would be meaningful to the participants and likely to elicit deeply felt reflections. The study by Fox et al. (2011) investigating the experiences of junior doctors who had 'experienced significant illness' since starting medical training is another example of a phenomenologically rich question aimed at a homogeneous group with respect to a meaningful experience.

In the articles exploring student experiences, there was expression of the crucial aspect of hermeneutic work. IPA studies ought to contain results that are co-created based on interpretative work made evident by the researcher. This work forms the data, where the quotes from participants are the raw materials that the researcher uses to co-create their results. Thus, the results are presented showing this process, making explicit the researcher's involvement as Tamachi et al. (2018) demonstrate in their focus on individual students' lived experiences in peer-assisted learning (PAL). From their paper, You understand that whole big situation they're in": interpretative phenomenological analysis of peer-assisted learning", the following is excerpted as an example of interpretative work:

The experience of informality was also central to the relationship between students and tutors. Here, there was a strong experience of joint purpose shared by tutors and students in sessions. Again, the oppositional nature of 'clinical teaching' provided a context for this experience.

"The idea of... a similar purpose in the sense that you're still students... you have the same goal, which is to pass medical school. Camaraderie is probably sort of the kind of word... you're on the same side you see. We're all learning together. I know what you're going through." Bob, tutor

"And that's such a unique thing for peer assisted learning because we naturally have that camaraderie, and we want to support each other and see each other excel..." Melody, tutor

This sense of camaraderie led students to experience the formation of deeper, more lasting relationships even after the PAL sessions were complete.

"I think there's definitely sort of the aspect of sort of friendship in terms... because I know that some people are now friends with some of the past tutors. So I think there's definitely that aspect to the relationship..." Scarlett, student

The intimacy of PAL sessions fostered a more personalised experience for students in comparison to the anonymity felt in a clinical setting as 'just one of the medical students'.

Tamachi et al.'s paper (2018) also reflects some of the conventions of IPA that we might do well to preserve in the field of HPE, i.e. the use of a quote in the title of their paper along with 'interpretative phenomenological analysis' being mentioned as part of the title. Tamachi et al. (2018) is also amongst only 4 to use names as pseudonyms – others were Bristow, Simmonds, Allen, & McLean

(2023) and Coakley (2019 and 2023) – out of all 33 articles we reviewed. Using names instead of numbers, i.e., “P8” or “ID19”, is another important convention of IPA that reflects its idiographic/idiosyncratic focus.

6.4.3 Clinicians' experiences (n=8)

Many of the articles reviewed contained reports of themes with quotes attributed to participants without robust interpretative work to demonstrate the researcher's process. In IPA, the results 'tell the story' linking personal experiential themes to the experiential themes of the group according to the researcher's informed interpretation. In the category of clinicians' experiences, most authors presented their data in the form of themes and subthemes, drawing on quotes from the data. This is done very well by Noya et al. (2022), for example:

3.2. Theme 1. Poor Governance

Participants were overwhelmingly scathing about aspects of the governance of the RR health system and provided detailed descriptions of poor governance at every level: District government, District Health Office (DHO), district hospitals or Puskesmas. With few exceptions, the implications of poor governance issues were raised in the focus group of post-internship physicians and continued to resonate through the individual interviews with more senior general practitioners (GPs) and specialists.

3.2.1. Favouritism

Predominantly, participants talked about relationship problems in leadership at various levels. Leaders of DHO and Puskesmas were reportedly appointed based on political affinity with the district's highest leadership and without consideration of their leadership abilities and supporting

qualifications. A junior physician described this situation in their district:

In general, the head of the Puskesmas graduated from SPK (Sekolah Perawat Kesehatan: Nursing School, high school level). The leader of the Puskesmas in this district has always been politically oriented. (JD2)

Participants provided examples of how the DHO and Puskesmas leaders' political appointments underpinned the misunderstanding of responsibilities and led to poor management:

. . . people with the unclear capacity to become the head of the Puskesmas were kept there . . . I don't know, maybe to let all the rotten things happen. (PI1)

The junior physicians raised favouritism as influencing the allocation of placement locations:

Usually, physicians whose families have direct access to the leadership there were assigned in the city. In the center of the district, on the main island. But, if you don't have anyone there, you will be automatically placed far away . . . (PI4)

Post-interns also identified favouritism occurring during their internship.

If there is a high-rank official's child in the internship group, everything will run smoothly, and incentives can also be suddenly provided or increased. (PI3)

Support being stopped if one offends the leadership was another example of unfair treatment:

Because the previous batch of interns caused problems, our batch had to bear the bitterness. The official house, car, and

Chapter 6: IPA in the Literature – A Qualitative Evidence Synthesis

all needs were immediately cut down. And the incentives were cut by more than half. (PI4)

In this example, the authors provide continuous narrative of their interpretative process grounded in quotes from their participants. As previously discussed, this interpretative work is central to the results of an IPA study. However, there are a few papers lacking that crucial next step of linking themes together with interpretative contextualisation. For example, in their paper, From professionalism to commercialism in healthcare: a phenomenological study, Malik & Mahboob (2021) provide their results in the form of a summary table (see Figure 24) without offering any written results detailing their interpretative work.

Table: Codes, categories and themes with representative quotes (in italics) from the participants.

S. No	Code/Category	Frequency	Sub-theme	Theme	Representative quote/s
1	Differential attitude.	10	1. Money as the main objective deteriorates attributes of professionalism.	1. Motives behind dual job holding & Public-private-sector interface	... difference in the attitude between Public and private sector is a bitter fact. ... Entire society is suffering from Attitude problems and doctors are part of it ... (Participant 4 and 6)
2	Deteriorating Professionalism & Generally Poor Attitude.	9	2. Probable cause and effect relation is: Money as main objective à Conflict of interests à Administrative issues à Poor attitude		... Main reason, "the human being is very hard in love for money" ... Money is one... "No definite referral and appointments system"... (Participants 3 and 9)
3	Financial reasons	14			
4	Administrative Issues.	13			
4	Faith in Almighty Allah & Sense of accountability before Him.	12	3. Faith in Allah & His system of reward and punishment gives:	2. Roles of: A. Faith & internal motivation	... our each act is a being monitored by the God, ... accountability in AAKHIRAH (at the day of judgment), (Participants 3, 6)
5	Role of Medical Education.	14	§ internal motivation § Self- Accountability § Self-regulation.	B. Medical education 3. Potential benefits in regulated dual job and role of Regulatory Authorities	...role of medical education; Faculty members have to be role models. Feedback in assessment from multiple sources... (Participant 5)
6	Potential Benefits in Regulated Dual Job & private sectors.	6	4. Medical education in a framework of virtuous professionalism potentially has a very strong role in building up professionalism.		... Dual practice is a necessary evil. Government institutions can and should play role to regulate dual jobs... (Participant 1, 2 and 3)
7	Important Role of Healthcare Regulatory Authorities.	7	5. Internal Motivation based on a strong faith remains the primary driving force and a strong regulatory system gives only an additional support		

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Figure 19: See the far-right column: Representative quote/s, screenshot from Malik & Mahboob (2021)

Other studies were more ambiguous about the relationship between their sample and the phenomena in question, for example, Foster et al.'s (2008) study looking at the opinions of GPRs with regard to using poetry sessions within a general practice vocational training scheme (GPVTS). This shaped the research question: 'How do general practice registrars (GPRs) experience the inclusion of poetry-based sessions within the curriculum of their vocational training scheme?' The study also sought to compare sessions utilizing facilitator-selected poems, with sessions based on learner-selected poems. In this study, the researchers are essentially using their study to test a hypothesis, that poetry sessions would have some effect on GPRs. As such, the researchers' focus could be characterised as aiming to understand the common structure of poetry in GPVTS as an experience. As in Smith et al. (2021), this focus might be more suited to a descriptive phenomenological approach (seeking to understand common structures of experiences), or discursive psychology (concerned with the use of available cultural resources, such as poetry, "to achieve interactive ends" (p. 38).

6.4.4 Patients' experiences (n=7)

As previously mentioned, IPA is normally used to design interpretative studies investigating how the individuals in a small, purposive group make sense of their experiences with respect to a particularly meaningful event in their life world. We have seen articles reporting on studies of educators, students, and clinicians where authors aimed to investigate *a priori* theory or topic relevant to education. In the case of this category, articles pertaining to the experiences of patients, we discovered that patient-centred studies inherently lend themselves to more meaningful experiences.

For example, in the study by Zhu et al. (2020) exploring the experiences of amputees, we found a strong phenomenological aim

with a corresponding sample of individuals having undergone amputation. Only participants who had undergone at least one episode of major or minor amputation due to diabetes in the last 12 months and underwent post-amputation wound care in polyclinics were recruited for the study (Zhu et al., 2020). Studies using IPA to generate data from a more heterogeneous sample within education in service to a particular issue, for example professionalism, focus on a phenomenon that is arguably less meaningful to participants than something like losing a limb.

Findings suggest that patient-centred phenomena are thus naturally more suited to IPA than educational-focused phenomena. This is not to say that IPA cannot be used to explore HPE problems from the point of view of its educators, students, and clinicians. However, the data indicates that the studies involving patients with a shared clinical condition are inherently more meaningful. These be used instructively for how to craft IPA studies in other areas of HPE where phenomena are subjectively less personal. For example, Lane & Roberts' (2020) study of interns who had experienced the disclosure process represents an HPE phenomenon that would be very meaningful to interns – maybe not as meaningful as losing a limb, but it is clear from their data that the participating interns were deeply affected by their experience. This quote from Lane & Roberts (2020) clearly conveys the sentiments of a person who is reflecting on a phenomenon that has been personally meaningful to them:

Interview 5: I would say I'm sorry this has happened; I didn't say I'm sorry during that time. But if I say I'm sorry that this has happened, but I wouldn't say I'm sorry. I wouldn't take ownership for the mistake that wasn't mine.

Phenomena such as these, affecting people deeply, seem to characterise patient experience even where there is a lack of any particular event. For instance, the IPA study of the Illness Journeys of People Living With Fibromyalgia, (Chen, 2016) takes a long-term view of the phenomena of 'having fibromyalgia'. It is worth asking – is simply living with a clinical condition more meaningful than being a fifth-year medical student? An even more potent angle better suited to the tenets of IPA might be a study of people living with fibromyalgia, for example, reflecting on their experiences of receiving incorrect diagnoses.

6.4.5 Composite (n=5)

An article was deemed composite if it sampled from more than one of the previous four categories. Wang et al.'s (2016) study reported on the results to their question, 'what are students' and tutors' experiences and perspectives of PBL coaching in the context of undergraduate medical education?' This study highlights the previous point about the importance of meaningful events as a focus for IPA studies. Although experiences of PBL might arguably not be particularly meaningful for the participants, the authors chose to explore it from two perspectives: students' and tutors'. Using one study to explore two sets of perspectives gives rise to a higher fidelity picture of experience, and it suits the parameters often found in HPE settings. This kind of adaptation to IPA will be raised in the discussion section, with an reasoned argument that certain stylistic adaptations are necessary to make IPA fit for purpose for each discipline.

According to Smith et al. (2021), there is at least one aspect that must not be compromised where IPA is concerned: the demonstration of interpretative work on the part of the researcher. Tamachi's results were raised as an example of how this is done well in the articles that we reviewed that explored the experiences

of students. In the composite category, we raise the article from Nortje's et al. (2017), which only contained two quotes, and these were not explicitly attributed to any participant, nor were they woven into a demonstrably interpretative section of results. For a study with 56 participants, this also represents a comparatively enormous sample size. For only two quotes to arise from a sample of 56 participants is not typical of IPA results:

Clinical Competence (training)

Many participants refer to the theme as having the necessary training and exposure to deliver a service which is within the scope of the qualification; evidence based; and what society expects of a suitably qualified person. Effectiveness and positive results are seen as positive outcomes of clinical competence. Being clinically competent also means to many that one has the ability to discern what therapeutic interventions work and what interventions will not contribute positively to a client, hence taking calculated risks. As one participant noted:

"Providing the most updated treatment and always ensuring your client understands the treatment you will be providing, both the positive and negative effects".

Client-centred Practice

Respecting clients for opposing views and not to be judgmental is seen as an important client-centred ability. Many responses allude to the fact that one needs to be transparent in your decisions and ask the client to participate in the treatment. As one participant noted:

"Considering your client's cultural and religious background when planning treatment by building good interpersonal

relationships. Always considering your client's context as it can have an effect on the outcome of the treatment".

Considering their aims: 1) To examine the understanding of both professionally registered occupational therapists as well as student occupational therapists as to the concept of professionalism; 2) To examine what could contribute to the development of professionalism amongst the aforementioned two groups; and 3) To elicit perceptions of attributes which contribute to professionalism, as described by the two groups; it is clear that this robust qualitative study was focussed on professionalism as a topic. We raise their study as an example of one whose sample size and research aims make it ripe for a methodology that focuses less on the experiences of individual cases and interpretative data.

Projects aiming to understand important transitions in professional lives of individuals form a potentially rich area of study for IPA. For example, the studies by Coakley et al. exploring the transition of medical students into clinical practice (2019) and following the experiences of the same cohort into their first year of clinical practice (2023) comprise a larger composite project exploring meaningful transitions of a group over time. Where Wang et al. (2016) aimed to explore two perspectives in one study as in their paper exploring perspectives of students and tutors involved in PAL as previously mentioned, Coakley explored a composite sample using two separate studies. This allows Coakley to stick with a small, homogeneous group for each study, whereas Wang had to bend the IPA rules to allow for two distinct categories of participant (student and educator) to participate in the same study.

We raise this comparison as it may be helpful for HPE authors to see precedents for how to approach questions rooted in composite groups or over longer time periods, as these types of questions are

germane to understanding lived experiences. In the most recent edition of Smith, Flowers, and Larkin's influential book Interpretative Phenomenological Analysis: Theory, Method and Research (2nd Edition) (2021), they highlight the centrality of identity themes in IPA studies, in particular, "identity changes associated with major life transitions" (p. 183). Coakley's project provides a sustained longitudinal interpretative account of such a major life transition, highlighting the fact that most physicians will be students, educators, and clinicians at some point in their careers, and sometimes all three at once.

6.5 Discussion

Our findings point to the wide range of interest and potential applications of IPA in studies looking at phenomena in health professional education, medical education, and anatomy education. We found that IPA can be used to explore lived experiences of educators, students, clinicians, and patients, as well as exploring complex phenomena arising from the interplay of these categories.

Amongst the strengths of the articles reviewed, we note that authors broadly considered the lived experiences of their participants and more than half of them (n=20) used citations to support their use of IPA with a specific source in their analytic process. Of these, 10 papers cited the influential book, Interpretative Phenomenological Analysis: Theory, Method and Research by Smith, Flowers & Larkin (2009), with only one paper (Kirkness et al., 2023) citing the 2nd edition of this book published in 2021. The 2nd edition contains important updates to the analytic process, and we advocate that authors wishing to use IPA in their research do so armed with the latest guidance.

Our findings identified a pervasive underutilisation of interpretative work in the preponderance of HPE studies analysed. The articles

reviewed appear to be at cross-purposes in serving two masters. As we established in the introduction, HPE is a field positioned at the confluence of two opposite intellectual horizons: social sciences and its constructivist paradigm, and the STEM disciplines situated in the positivist tradition of reductionist science. In a manner of speaking, the articles could be characterised by a tendency to objectify participants rather than highlight their personhood. This tendency is borne out in the data where authors present their results without sufficient interpretative work, quoting participants with numbers (n= 29) instead of everyday names as pseudonyms.

If the STEM community is to avail itself of the empirical richness offered by IPA, it needs to stop throwing the baby out with the bathwater. By this, we mean that IPA operates around the hermeneutic circle and its data is co-created. If journals require authors to dispose of the first-person ownership of their results and apply the conventions of third-person objectivity, then the value of the data itself is at stake.

Each discipline will have its own unique set of influences, especially in multidisciplinary fields such as HPE. Of course, the research questions posed in HPE settings require consideration from a multiplicity of perspectives with respect to paradigm. Certain health professional questions will lean into a classically realist lens and an objective, third person writing style. Other questions, those that are germane to health professional *education*, will require a constructivist paradigm and invite interpretivist methodology. Nortje et al.'s aims to explore professionalism amongst clinicians, justify a constructivist paradigm and invite subjective exploration. However, since they are using a massive sample size relative to IPA and have not demonstrative an interest in the interpretative process (evidenced by their use of only two quotes and no interpretative

work), these authors might have considered a thematic analysis or grounded theory methodology instead of IPA.

That is not to say that complex studies such as those facing many HPE researchers cannot be approached via IPA. We found that many of the articles we reviewed used IPA to explore participants' views on a certain topic relevant to the field. It is our contention that HPE researchers can increase their confidence using IPA to explore topics by maintaining integrity by way of robust interpretative work. For example, the phenomenon of experiencing PBL coaching is not as personally meaningful as, say, losing a limb. However, Wang et al.'s study (2016) using two cohorts (students and tutors) provided sufficient interpretative work and a robust philosophical rationale to demonstrate why their choice of IPA was appropriate for their enquiry.

Based on our findings, it is our contention that studies embracing IPA as a methodology will necessarily adapt it to suit the conventions of their field. HPE is no exception. However, where researchers wish to explore qualitative questions using IPA as a named methodology, there is a need for understanding the full context of what that means for their paradigm overall. Based on the critical evaluation of our findings, we offer the following ten top tips as recommendations to the HPE community for fostering an appropriate use of IPA in the literature:

6.5.1 Top Tips for using IPA in HPE

1) **Familiarise yourself with the latest IPA guidance.**

There are a few different approaches to IPA. Whichever you choose, find the most up-to-date guidance. For example, *Interpretative Phenomenological Analysis: Theory, Method and Research* by Smith, Flowers & Larkin (2021) is current at the time of this writing. Choose an appropriate source, and if using Smith et al.'s most

current edition (2021), then conduct your analysis using the tabular format with personal experiential themes (PETs) and group experiential themes (GETs) as advocated in their book.

2) Design studies of small samples around meaningful phenomena.

Even when the aim of the study is to generate data around a particular topic, try to craft the question around an event or meaningful experience in their lives. For example, you are interested in understanding the lived experiences of fifth-year medical students dealing with clinical placement. Your topic of interest is burnout. Instead of interviewing fifty fifth year medical students and asking them their perspective on burnout, you might craft the study design to recruit fifth year students who have utilised counselling for burnout within the last 12 months, which is likely to constrain sample sizes to $n < 10$.

3) Focus on providing evidence of your interpretative work.

When writing up your study, dedicate as much time and word count as reasonably possible toward crafting researcher interpretation. Use the analytic process to derive tables of data with quotes to support each theme. Instead of tallying themes quantitatively or attending to objective goals such as theme saturation, the IPA approach prioritises how you as the researcher weave the raw materials – participant quotes – into a well-integrated hermeneutic narrative. One needs to feel reasonably confident telling the story of the participants, owning the process and using the first-person voice where stylistic conventions permit.

4) Maintain the first-person voice where possible.

Many journals require third person scientific writing in the passive voice. Try justifying use of the first person in your introduction and see if your journals of choice allow you to maintain it throughout the sections of your manuscript. You might aim to at least keep the Results section in the first person, as this is where the interpretative work is most heavily concentrated.

5) Apply names as pseudonyms.

It is widely accepted that the use of pseudonyms is crucial for anonymisation of the qualitative data. In IPA, it is preferential to apply names to participants as a way of maintaining their personhood, whereas other methodologies may use conventions such as "P1" or "Participant 1".

6) Provide a philosophical rationale for using IPA.

IPA as a rich philosophical tradition that ought to be recognised as part of justifying your rationale for using it. With phenomenological roots in the work of Husserl (1900), where the researcher attains to the state of 'presuppositionlessness' (Reed-Downing, 1990), some authors may deploy their study as a *tabula rasa* aiming to ascertain the nature of 'objective reality' achieved through epoché by means of researcher bracketing. The interpretive approach (Heideggerian) is more contemporary, building on the work of Husserl, who was Heidegger's teacher. IPA, by definition both interpretative and phenomenological, argues that it is impossible to eliminate the researcher bias. Harnessing this philosophical rationale prioritises the interaction between the researcher and the subject. This 'intersubjectivity' provides the basis for validity in the context of interpretation of experiences (Shaw & Anderson, 2018) drawn forth by the researcher in continuous reflexive practice.

7) Acknowledge coming to the project with a *priori* theory.

Where possible, leave *a priori* theory behind. If your intention is to constrain your study with a theoretical framework, you might be better served with an analytic process that harmonises with the theory. If you are coming to the study with fore-structures such as theoretical frameworks, acknowledge these explicitly and explain how your process aims to focus on what comes out of the data. While IPA accepts the fore-structures that researchers bring to their work, it maintains an idiographic focus on what people have to say about their experiences, the so-called “things themselves”. Consider whether your theory-driven qualitative project might require another methodology.

8) Put the discussion into the Results.

Most journals require an IMRDC format (introduction, methods, results, discussion, conclusions), within which the thematic structure would be presented in the Results section followed by interpretation in the Discussion. In IPA, it isn't enough to provide the themes without weaving them into an integrative interpretative discussion. As mentioned in tip number three, the most important part of reporting on your IPA study is doing the interpretative work and demonstrating that process is the central achievement of the Results section.

9) Use the Discussion to link with existing literature and to draw connections with theory.

Once you have told the story of your participants using quotes to justify your interpretation, the Discussion section of your manuscript can provide you with a suitable place for taking your interpretative work to the next level. You have demonstrated a sustained commitment to “the things themselves” in the Results, as per the IPA tradition. If you have also noticed links with existing

literature or theories that would make for useful discussion, use your Discussion section to do this.

10) **Avoid slippage into positivism**

Remember that IPA is not just a method of analysis, it is a way of approaching research from study conception through to writing up stages. Sampling is purposive with an exclusive focus on the verticality of idiosyncratic experiences. This means that IPA studies make limited claims of generalisability, and the topic of researcher bias is moot as the researcher intentionally co-creates the data as per the double hermeneutic. In writing up an IPA study, the strengths of IPA can be turned into weaknesses when authors address the lack of randomised controls, generalisability, or validation as limitations.

6.5.2 Limitations, Future Directions

This study is necessarily limited in its scope due to the resources available. The SPIDER tool to vigorously constrain this search to very specific returns matching the requirements of the aim: to assess how IPA is being (and abused) in the HPE literature since 2000. The reality of researcher resources, i.e., time and expertise, is explicitly named and factored into the design of this study. The research team would benefit from more time as well a library scientist to consult on the search protocol and procedural aspects of sorting returns. Future endeavours to review the use of IPA in HPE could include more relevant databases to increase the number of search terms.

6.6 Conclusions

The aim of this study was to assess how IPA is being used in the HPE literature. We reviewed the literature (n=33) with selected articles illustrating an overview of five categories, the experiences of: educators, students, clinicians, patients, and composite studies.

In summary, we found the preponderance of articles to reflect a significant degree of adaptation of the IPA style to suit the conventions of scientific writing in the STEM community. Our findings demonstrate that adaptation of the IPA methodology is to be expected, as it was born in the field of philosophy and nurtured in health psychology. While adapting it to suit the needs of HPE is only natural, we raise concerns about the centrality of maintaining a high degree of interpretative integrity overall. To this end, we offer ten top tips to allow HPE authors to keep the hermeneutic spirit of IPA alive while also satisfying the requirements of STEM-rooted journals.

If HPE authors are to make full use of IPA without compromising its power, then academic journals ought to adapt their criteria for accepting IPA manuscripts. There is no point forcing round pegs into square holes. This is a plea to journals with a focus on health professions, anatomy, and medical education: allow IPA manuscripts to retain their interpretative spirit by accepting them in the IPA style. It reflects well on the remit of editors who demonstrate their commitment to evolving standards that remain sympathetic to the operative styles of submissions and their respective methodologies.

We also found that the SPIDER tool is useful for time-constrained researchers to craft their search criteria to a degree that allows them to cast the net wide enough (comprehensively) with a degree of specificity that returns only the articles relevant to their question. We found that SPIDER was the right tool for our study, which aimed to honour the 'fusion of horizons' concept. In conclusion, we advocate for more SPIDER studies looking at how qualitative methodologies such as IPA are being used in health professional education with tips on how to compassionately adapt them for use in answering the pertinent questions of our time.

6.7 Chapter Summary

This chapter provided a qualitative evidence synthesis with a critical overview of how IPA is used in the field of HPE. The review and subsequent interpretative overview gave rise to ten top tips to help HPE authors wishing to use IPA in their research. The results of this study served my developing understanding of just how challenging it is for a researcher in the STEM disciplines to get a grip of IPA in its “purest” possible form while also producing a manuscript with a chance of making it through peer review. The conclusions are useful as a primer for the empirical IPA chapters that follow, as the reader benefits from the introduction to IPA as well as understanding some of its key challenges

Chapter 7: “Preparing them for the profession”: an IPA study of anatomy educators coping with complexity in the UK curriculum

7.1 Chapter Introduction

The previous chapter provided literature review of IPA and how it is currently used in medical education and HPE research at the time of this writing. The current chapter forms the primary empirical contribution of this doctoral thesis and can be considered the lynchpin of the project. This study (Kirkness et al., 2023) was accepted for publication in *Anatomical Sciences Education* in September 2022.

7.2 Background

Anatomy is widely considered the foundation of clinical studies (Sugand et al., 2010). This explains why, conventionally, medical students are taught anatomy and basic sciences in the early years before moving into the so-called “clinical years” of their training. This polar distinction divided the curriculum and stratified the linear timescale used in medical education since the historic 1910 reforms of Abraham Flexner (Flexner, 1910; Duffy, 2011). Curriculum research over the last several decades has been aiming for integration, despite the routine variation of applications and definitions of the term as pointed out by Matinho et al. (2022) in their recent systematic review of integrated learning definitions. Without unified definitions, the term ‘integration’ has become more of a buzzword (Brauer & Ferguson, 2015). Despite calls for clarification (Gale, 1984; Patel et al., 2002; Buja, 2019), the intensity of this paradigm shift toward an “integrated” medical curriculum reflects the widely held view that learning anatomy and understanding how to apply it in practice go hand in glove (Daniel et al., 2021).

Curricular integration is normally achieved by one of three forms: (1) horizontal (between disciplines taught in parallel within the same time); (2) vertical (between disciplines that are taught at different times); and (3) spiral (combination of both horizontal and vertical axes, integrating across disciplines and time). Brauer and Ferguson (2015) define an “integrated curriculum” based on the spiral model (Bruner, 1960) as the ideal standard: “a fully synchronous, trans- disciplinary delivery of information between the foundational sciences and the applied sciences throughout all years of a medical school curriculum.” A key goal of curricular development is cognitive integration, which is achieved when individual learners understand the relationships between basic sciences and clinical practice (Haudek et al., 2022). Conceptual competence or “coherence” arises as learners develop the ability to apply these principles to clinical decision- making (Patel et al., 2009).

There are several key concepts related to integration. These concepts will be explained in the following subsections to connect the phenomenological study that follows, specifically: curriculum, reflective practice, complexity, learning environment, competency-based medical education (CBME), professional identity formation, and the HC.

7.2.1 The curriculum

First, it is relevant and important to unpack what is meant by “the curriculum” and how that differs from “the learning environment.” The General Medical Council (GMC) defines the curriculum as “a statement of the intended outcomes, encompassing content, teaching, learning and assessment methods, feedback and supervision as part of the educational programme.” (GMC, 2017). In this study, the curriculum is understood to be a top- down

statement of intent that instructional designers use to shape the learning environment toward desired outcomes.

Following a living systems perspective (a general theory codified by Miller [1985] encompassing the behaviour of all living systems), Gruppen et al. (2019) have defined the learning environment as “a complex psycho- social- physical construct.” In this sense, the learning environment can be taken to mean all the current circumstances of any given medical program and how they shape learning. This distinction between “curriculum” as intentional (from top-down) and “learning environment” (in all its ambiguity and bottom- up implications on learning) is important for getting a sense of the complexity that stakeholders in HPE are dealing with. Complexity is necessarily integrated; referring to Rickles' (2007) definition: “complex systems are highly composite ones, built up from very large numbers of mutually interacting subunits (that are often composites themselves) whose repeated interactions result in rich, collective behaviour that feeds back into the behaviour of the individual parts.”

Integrated curricula first appeared in the general education literature as reviewed by Beane (1997), who recognized usage much earlier by progressive educationalist Levi Thomas Hopkins (1937). The integrated curriculum was introduced into the modern medical education literature with Harden's early work (1984) and subsequent “ladder of integration” (2000). One of the first to implement an integrated structure throughout its curriculum was McMaster University in Canada (Neufeld & Barrows, 1974). Known as the “McMaster approach”, this trans-disciplinary structure deviated directly from the prevailing “2 + 2” curriculum whereby 2 years of basic sciences are followed by 2 years of clinical science as prescribed by the historic Flexnerian reforms of the early twentieth century (Flexner, 1910). The innovative McMaster

approach expanded and gained traction globally in the decades since (Neufeld et al., 1989).

Now known as the “integrated curriculum,” this relatively new and continuously evolving endeavour has rapidly become the international gold standard for curriculum design in medical education (Bandaranayake et al., 2022). With frequent, low- stakes assessment and rapid remediation, the concept aims to break down barriers between the basic and clinical sciences. The rationale is that integration fosters interdisciplinary transference, aids knowledge retention, and improves the development of clinical skills (Brauer & Ferguson, 2015).

7.2.2 Reflective practice in anatomy

Anatomical proficiency (knowing the facts) and clinical reasoning (understanding how to apply them) are the twin pillars of continuous reflective practice (Mamede & Schmidt, 2004; Mann et al., 2009; Wittich et al., 2013; Naylor, 2020). There is little doubt that the anatomical sciences are fundamental to understanding pathology, conducting a physical examination, interpreting radiological images, and developing confidence in clinical procedures (McHanwell et al., 2021). This view holds that anatomy and clinical practice, far from mutually exclusive, are deeply invested in one another (Cassidy, 2015; Sbayeh et al., 2016). In fact, Kassirer (2010) made the case not to wait until after the student has memorized their anatomy before teaching clinical reasoning. Junior doctors are increasingly expected to demonstrate not just anatomy knowledge but also expertise in the imaging of anatomy (Sheikh et al., 2016). Indeed, a higher level of reflective understanding is required to differentiate amongst types of cross-sectional imaging data (Phillips et al., 2012; Phillips et al., 2013).

The expectation of both teachers and students to perform at multiple levels of proficiency is more than complicated; it is

complex. This complexity is true of human anatomy as a subject, medicine as a profession as well as the medium of the integrated curriculum. Indeed, integration is complex and hard to quantify, as it “... happens inside the head of the individual learner, through the combination of prior knowledge with new information and/or experiences” (Grant, 2018). The continuing reduction in hours of gross anatomy teaching in UK medical schools is well-documented (Smith et al., 2022); with the upshot being that anatomy educators are tasked with teaching essentially more content in less time to students who are increasingly expected to do more with a vast amount of interdisciplinary information across the whole of their training and beyond.

How instructional designers adapt their pedagogical model to account for this time-constrained spiralling complexity is a key question for the HPE community. For their part, educators are necessarily given the practical responsibility of reconciling their learning environment with the top- down directives of integration. This often means having to superimpose curricular interventions onto the “old” model of teaching anatomy via exposure to cadaveric study (Papa & Vaccarezza, 2013; Patra et al., 2022) or dispense with dissection altogether, as most institutions internationally have already done (Sugand et al., 2010).

The topic of cadaverless medical education has received sustained attention in the literature (Azer & Eizenberg, 2007; Papa et al., 2022; Taylor et al., 2022), most notably in response to the Covid-19 pandemic (Singal, 2022; Zarcone & Saverino, 2022). Reducing anatomy hours represents a significant challenge to the remit of anatomy educators for two reasons explicitly relevant to this study. First, anatomy educators are increasingly expected to learn, deploy, and participate in a dizzying array of innovative teaching activities (Owolabi & Bekele, 2021) as well as engage with curricular practices

imposed by their institution, having to do more with considerably less in the way of time and training resources. Matinho et al. (2022) report that a total of 43 distinct practices designed to achieve integrated learning, education, curriculum, or teaching were identified in 77% of the articles they reviewed.

7.2.3 From content to competency to complexity

This growing arsenal of practices is emerging as part of the push toward integrating medical training into a curriculum bent on moving from “content” to “competency” as if these terms are mutually exclusive. The focus on competency is intended to bring a more holistic approach to learning outcomes, embracing knowledge, skills, and attitudes toward their delivery in practice (Maudsley & Strivens, 2000b). Competency-based education (CBE) is rooted in an approach to K-12 education growing in popularity in the United States, whereby progression is based on the pace of learning rather than conventional temporal structures such as the semester (Evans et al., 2020). This systems-change approach is reshaping how students are encouraged to demonstrate academic content knowledge and skills (Casey & Sturgis, 2018) toward a normative practice influenced by Muller's “powerful knowledge” (Hordern, 2022).

A shift like that of the K-12 CBE movement has become the reigning directive in the integrated curriculum of today, known as competency-based medical education (CBME) (Brydges et al., 2021). The CBME is an outcomes-led approach to the design, implementation, assessment, and evaluation of physicians and training programs (Frank et al., 2010). Although widespread in medical programs throughout the United Kingdom, the CBME approach remains controversial (Quraishi et al., 2019). It has been particularly confrontational to anatomy departments which are conventionally characterized by delivering anatomy as a subject.

The relationship between subject- based, integrated, and CBME medical education was distinguished as early as 1978 by McGaghie in three distinctions where, firstly, CBME “is organized around functions (or competencies). Secondly, it is grounded in the empirically validated principle that students of the intellectual quality found in medical schools, when given appropriate instruction, can all master the prescribed basic performance objectives. Thirdly, it views education as an experiment where both the processes of student learning and the techniques used to produce learning are regarded as hypotheses subject to testing” (McGaghie et al., 1978).

This early rationale for competency took it for granted that medical students should, under the “appropriate instruction,” come out with all the aspects of professionalism required to practice medicine. Before CBME became explicitly operationalized, competencies under the umbrella of medical professionalism were normally categorized as “hidden curriculum” (Bandini et al., 2017) and left students to experience and consolidate experiences independently. This connects to the second major challenge for anatomy educators grappling with the advent of integration as dealt with in this study as related to the HC.

The challenge for most educators is that in the “hidden curriculum” (Hafferty, 1998), the learning process and its impact on professional identity formation cannot be directly scripted. Hafferty (1998) defines the HC as “the commonly held ‘understandings,’ customs, rituals, and taken- for- granted aspects of what goes on in the life- space we call medical education.” Bandini equates the HC with the learned socialization process and self- reflection during medical training (2017). The HC has been discussed in terms of constraints by Cribb as a “necessary tension between the scientific and the personal dimensions of medicine” (Cribb & Bignold, 1999). Thus,

the definition of curriculum is then divided into the explicit or formal curriculum and the implicit or “hidden” curriculum that remains relevant in the literature for its role in shaping stakeholder experiences (Glicken & Merenstein, 2007; Brown et al., 2020a; Brown et al., 2020b; Finn & Hafferty, 2020; MacNeil et al., 2022).

Shiozawa and colleagues point out that anatomy educators have a unique advantage in the HC (Shiozawa et al., 2020) because of its intrinsic potency as a learning environment, especially in the use of cadaver- based settings. Pawlina (2019) points out that Netterstrøm (2007) was among the first to raise awareness that the basic sciences have a much more potent role to play in professional identity formation than was recognized at the time. This awareness was echoed in the work of Escobar-Poni et al. (2006) and continues today (Day et al., 2022), emphasizing the point that the anatomy class learning environment constrains for the learning of professional behaviour regardless of whether such behaviour is explicitly taught (Netterstrøm & Kayser 2008). Learners absorb competencies associated with the HC and synthesize them through role modelling (Warner & Rizzolo, 2006; Brainard & Brislen, 2007; Goldie et al., 2007). For many students, anatomy represents their first encounter with a “medical” discipline (Pabst & Rothkötter, 1997), especially in cadaveric dissection. Anatomy pedagogy comes equipped with a “tremendously powerful environment” (Shiozawa et al., 2020) for conveying professional identity formation in the classical dissection setting (Lachman & Pawlina, 2006; Swartz, 2006; Kumar & Kumar, 2019; Darici et al., 2022).

That first cadaveric experience can inspire students to seriously consider their future role as physicians as they reflect on their experiences in anatomy. This reflective process allows them a safe space to further process the realities of human vulnerability, death, and dying in the medical profession, as well as accountability (Hilton

& Slotnick, 2005; Slotnick & Hilton, 2006; Warner & Rizzolo, 2006). Consequently, the movement toward fostering professional identity formation through teaching interventions such as reflective practices is on the rise (Shiozawa et al., 2020; Abrams et al., 2021; Zumwalt, 2021).

Harnessing the “tremendous power” of the basic sciences via the HC through reflective practice allows students to process their experiences and become consciously proactive in their professional identity formation. The American College of Physicians (ACP) position paper put it succinctly, “Making the hidden visible and the implicit explicit helps to create a culture reflecting medicine's core values” (Lehmann et al., 2018). Indeed, professional identity formation is a “crucial psychological milestone” for aspirants in any profession (Pawlina, 2019), whether the student becomes a professional doctor or a professional educator, or both. It has been shown that the basic sciences, particularly anatomy, offer a learning environment that delivers intrinsic opportunities to harness reflective practices and boost the development of professional identity formation in students.

It is generally accepted that self-reflection is an appropriate way to teach professionalism (Maudsley & Strivens, 2000a; Mann et al., 2009), touching back on Grant's notion that integration happens “inside the head” (Grant, 2018) of learners. Considering that orchestrating integration for learners is a complex task, to say the least, what must be happening inside the head of educators making sense of so many competing vectors on behalf of their learners? The focus of the present study is to provide phenomenological insight into how that complexity comes together for key stakeholders, namely, the anatomy educators partly responsible for its navigation.

7.2.4 The Gap

This introduction has shown that there are an increasing number of studies looking at medical students' experiences in the era of the integrated curriculum, and there is a recent effort to understand professional identity formation in clinician educators (Sternszus et al., 2020; Triemstra et al., 2021; Byram et al., 2022) as well as teachers in HPE (van Lankveld et al., 2021; Hu et al., 2022). In short, the experiences of medical students and clinical educators are well- represented in the literature. However, there is a paucity of research exploring the lived experience of anatomy educators negotiating the top- down demands of a changing curriculum within their unique learning environments. This study aims to shine a light on this gap in the research, to make “the hidden visible and the implicit explicit” by seeking phenomenological insight as to what it's like to be an anatomy educator teaching in an MBBS program in the United Kingdom and Northern Ireland.

7.2.5 Rationale for using IPA

Interpretative phenomenological analysis (IPA) was chosen as the most suitable methodology to empirically investigate the experiences of anatomy educators dealing with the phenomena in question. Interpretative phenomenological analysis is an experiential approach that fosters a detailed examination of the experiences of a relatively small group to interpret phenomena via the sense- making of the individuals within that group. This methodology draws inspiration from phenomenological psychology (Eatough & Smith, 2017) and hermeneutic (interpretative) theory (Smith, 1996).

Hermeneutic phenomenology accepts theory as informative in creating knowledge and developing methodologies to get at the “things.” However, as Brocki explains (2006), “authors do not always explicitly recognise either the theoretical preconceptions

they bring to the data.” Lopez goes further to say that where bias becomes problematic is not on the researcher's part but rather when theoretical frameworks may “have a biasing effect on the narratives of the participants” (Lopez & Willis, 2004). Bendassolli (2014) makes the case that “theoretical naïveté presupposes a simplistic dichotomy between theory and empirical data,” suggesting that theory is, essentially, indigenous to qualitative research and that phenomenology cannot simply deny its influence while accepting other aspects of the researcher's background.

In hermeneutic phenomenology researchers own their stance explicitly as part of the data. Analysis is carried out via iterative reflexivity as researchers continuously “go back to the things themselves” (Husserl, 1900). In the previous chapter I drew on the invitation extended by Tomkins and Eatough (2013), calling for experiential investigation that suspends the “organizational attitude” obscuring access to “the things themselves” (Husserl, 1900). This invitation is especially apt in studies such as this one exploring the work/life context.

Engaged in this lively conversation amongst theory, phenomena, data, the researcher, and the timing of the narratives arising from their interplay, the present study is situated in the methodological currency of IPA. Considering that IPA is classified as an “experiential method” by its protagonists (Smith & Nizza, 2021), the authors used the most up-to-date terminology (Smith et al., 2021) to carry out a systematic set of interpretative processes that form the analytic audit trail (Smith & Nizza, 2021).

Carrying out IPA involves a vertical analysis (narrow but deep) from smaller samples of idiographic (a focus on the individual) data to interpret the variation amongst individuals making sense of different contexts (Yardley, 2000; Larkin et al., 2011; Nizza et al., 2021). This conceptual generalization is central to IPA; as Yin

(2018) succinctly explains, the goal is an analytic, not statistical, generalisation that gives rise to a coherent narrative in the cross-case analysis.

This study aims to provide that narrative, telling the story of anatomy educators through interpretation of their sense-making. Van Manen (2017) has been critical of the IPA approach to phenomenology, “Smith focuses on the “person” and on the personal experience of a participant and on his or her views and understandings, rather than on the phenomenon itself.” The present study utilizes IPA precisely for this reason, for its commitment to the value of individual experiences and its roots in reflexive practice (Smith, 1994), where the latter has previously been discussed as germane to professional identity formation. This multidisciplinary project brings together researchers from medical education, anatomy pedagogy, and psychology backgrounds, embracing the health psychology roots of IPA. The goal is to answer the phenomenological research question: what is it like to be an anatomy educator grappling from the bottom up with the rapidly changing top-down forces that shape their experiences?

7.3 Methods

7.3.1 Design

A semi-structured interview guide was designed to interview stakeholders in anatomy education in the United Kingdom (see Table 15 for a summary). The interview questions were formulated by the lead researcher (K.B.K.), a Ph.D. student in HPE, in supervision with co-authors. As a statement of reflexivity, the lead researcher acknowledges identifying as a white, cisgender female, non-medic PhD student with an anatomy pedagogy background. Questions were intended to stimulate participants to openly discuss and reflect on their experiences, teaching practice, and views on the current curriculum at their institution. The objective of the

interviews was to gain experiential data from participants interpreting their unique experiences within their LE.

Table 15: Semi-structured interview guide

Area of interest	Sample question(s)
Background	<ul style="list-style-type: none"> • How did you learn the basic sciences, specifically anatomy?
Understanding their role in anatomy education	<ul style="list-style-type: none"> • What best describes your professional practice as an educator? • Do you teach basic sciences/anatomy and if so, how often do you teach?
Understanding their curriculum	<ul style="list-style-type: none"> • What qualifications do your learners receive? • Are you involved in planning the curriculum? • Do you offer a cadaveric module/year?
What methods are they using and how is it going?	<ul style="list-style-type: none"> • What is your personal approach to teaching basic sciences/anatomy, e.g., your favorite method of teaching • Do you think there should there be more representation of the basic sciences within the clinical years?
“Blue Sky”	<ul style="list-style-type: none"> • Can you tell me more about the success you have had with your teaching methods?

	<ul style="list-style-type: none"> • Do you feel your method is supported by your colleagues and your institution?
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The study was given ethical approval by the Hull York Medical School Ethics Committee (approval number 1837) and is in compliance with the Helsinki Declaration. Participants were guaranteed anonymity, and their informed, written consent was obtained upon recruitment before the interviews. Recruitment of anatomy educators took place in 2019 via social media (Twitter) and virtual snowball sampling (retweeting), as well as recruitment initiated by email invitation using the research team's contacts. Since qualitative research does not typically privilege the response rate, it was not necessary to contact non-respondents. Educators teaching anatomy in an MBBS program in the United Kingdom and Northern Ireland at any level in their career were invited to participate. Participants included lecturers, professors, department heads, and one MBBS program director (see Table 16). Descriptive analysis revealed various anatomy experiences and demographic data from medical school educators with various levels of influence within their institution.

Table 16: Participant roles as anatomy educators

Participant code	Role at the time of interview
P1	Teaching Fellow in Anatomy
P2	Teaching Fellow in Anatomy
P3	MBBS Programme Director and Clinical Educator
P4	Deputy Programme Lead for BSc (Hons) Diagnostic Radiography

	Lead in Anatomy (BMBS)
P5	Lecturer in Human Anatomy
P6	Lecturer (Anatomy and Clinical Skills)
P7	Senior Lecturer
P8	Lecturer
P9	Anatomy Lecturer
P10	Teaching Associate
P11	Head of Anatomy

7.3.2 Data collection and analysis

The initial interview guide (Table 15) was refined following two pilot interviews, after which 11 semi-structured interviews were carried out over Skype by K.K. over 6 months in 2019. Data were audio-recorded and transcribed verbatim by K.K. The audio files were reviewed to refine transcripts which were further edited for accuracy. Responses were anonymized, and participants were assigned a code as the researchers began closely reading the data as part of their cyclical analysis. An experienced IPA researcher (IN) previously cited in the Introduction collaborated on the analytic process.

Transcripts were formatted in a tabular structure for each participant according to the most up-to-date IPA conventions. The first author (K.K.) commenced with a close analysis of each case, maintaining an audit trail of analytic discussions and decisions taken in conjunction with co-authors. The team utilised an iterative (going back repeatedly) and reflective (taking pause to consider interpretation) approach to analysis as per the IPA praxis. Between 50 and 100 experiential statements were interpreted for each case. These statements were used to develop a thematic structure using clustering, whereby the statements were manually cut out of the paper and clustered into higher-order themes (see Appendix F). In

this way, each case was analysed on its own in a vertical approach producing a table of Personal Experiential Themes (PETs) based on an iterative interpretation for each of the selected 11 participants. See Appendices E & F for details on this extremely time-consuming process. Working in close collaboration with I.N., the team then used these 11 tables of PETs to produce a higher-order piece of interpretative data: the table of Group Experiential Themes (GETs) in a further process of inductive iteration. This process is the most current protocol for carrying out IPA analysis as per Smith et al. (2021).

7.4 Results

7.4.1 Theme one: Awareness and empowerment as a stakeholder in the medical curriculum

Participants interpreted their teaching practice in relation to their feelings of empowerment within the curriculum, with some wearing many hats: *“I’m an anatomy lecturer ... and I’m also the course lead for anatomy in the medical school”* (P9, 1.20).

How connected they felt to the medical program and the degree of support they received from their colleagues were influential in their sense of agency, with some demonstrating a high level of empowerment, *“I know I’m in a fortunate position— we’re not under scrutiny for what we do”* (P11, 10.85). One case was interesting for its divergence, where P6 is senior in her role, *“I am also the interprofessional education lead on the MBBS”* (5.109); she is so apparently frustrated with the changing demands that she reflected *“from the educator’s view, that is clearly not supportive,”* (23.575). Anatomy educators contracted from other departments outside medicine felt less empowered to comment on the medical program as a whole: *“I just show up and give a lab when I’m asked”* (P8, 4.85). Self-deprecating humour was a way of almost

apologizing for being there, *"I'm not quite sure what happens to them. It's probably better that way [laughter] ..."* (P10, 6.123).

All participants discussed their experiences dealing with unknown aspects in their role, with longitudinal blind spots apparent. For example, the anatomy teacher, whose role is limited to the preclinical years, was reluctant to comment and showed a low level of confidence throughout her reflection: *"I haven't seen the exams in the clinical years, so sorry I couldn't comment properly on that"* (P2, 9.207). Whereas the clinical educator who also happened to be MBBS Director was much more confident and even derisive of the anatomy teachers while admitting his blind spot:

"So I think that's largely what they're doing. I mean, to be honest with you, occasionally, I think they sit there and let the students just wander around and look at stuff ..." (P3 7.167).

While P9 was confident about what's happening in his anatomy department, he was also unclear about the next steps for students, *"Eh, but I don't think, and I should check this, but I don't think they're getting any basic science questions after year two"* (P9, 9.221). Those who tended to strongly defend the integration approach were reticent about acknowledging blind spots, *"I think that they do. Although probably not in every single ..."* (P4, 12.287).

Reckoning with uncertainty shut down participants' efforts to speak confidently about outcomes, *"... really difficult to say what they're coming out with as a whole"* (P6, 23.567) and even the most confident of educators were concerned about the unknown toll of rising student numbers would have on her ability to maintain valued relationships with students, *"... worried that we will lose the personal element"* (P11, 10.234). The less experienced and least connected educators used the unknown to ringfence their island of

security, “*So all I know is ...*” (P1, 5.97); and in anticipation of impending curricular changes, they reflected cautiously on the unknowns about which they felt anxious knowing, as admitting to knowing them was strictly above their paygrade— “*I do know, but I don't want to say*” (P8, 4.95).

In addition to grappling with the unknown, participants also showed evidence of meeting with and interpreting the limitations on their involvement and decision- making in the curriculum, all of which the authors interpreted as evidence of the HC, “*I have no idea what we're going to be doing in future years*” (P6, 9.206). Participants seemed to accept the uncertainty they are faced with, “*I'm not quite sure how to answer that one [how anatomy is assessed longitudinally]*” (P7, 18.462); and demonstrated varying levels of confidence regarding their apparent limitations when it came to involvement and decision- making in the overall medical curriculum, from the junior, “*In the sort of grand hierarchy of things, like I'm very junior*” (P10, 11.265), to the more senior educator resigned to her feelings of frustration, “*I can't argue with the powers that be*” (P6, 18.453).

This theme underscores that confidence is required for educators to perform within a continuously changing complex system full of uncertainty and incongruencies and that this confidence leads to empowerment when it is fed by feelings of support and connectedness. Confidence can also come from years of experience and seniority, but such seniority was not necessarily required even for relatively junior educators to experience growing confidence. It makes sense that those with fewer years in their role would be expected to have less confidence, but what seems to matter most is the experience of feeling supported by one's colleagues. Participant P5, who has no problem acknowledging the limitations of his role as both ancillary and relatively new, “*... we're basic sciences, really,*

hired by the school to come out to teach” (4.74), also demonstrated a high level of personal confidence in his teaching methods, “I’m starting to roll out body painting in a big way” (7.148), and when asked if he has the support of his boss, he says “Oh, 100%” (13.308). He talked about how much support he received from his boss and equated this to a kind of mandate to develop his anatomy teaching style despite not being involved in curricular decision-making.

7.4.2 Theme two: Variations in discussing curricular integration

Further tensional vectors appeared in the various ways in which these participants discussed curricular integration. Conventionally, the medical curriculum starts with basic sciences, followed by the patient-centred clinical years. As previously discussed, the paradigm shift from a polar curriculum to an “integrated” curriculum is well underway in the United Kingdom and is evident in the data here.

Crucially, this study points to the experience of educators who were tasked with making that practical shift to integration while simultaneously having to work with the “polar” toolbox they have inherited vis- a- vis their role as a teacher of anatomy.

Participants in this study took pride in their investment as anatomists and background in dissection, *“I genuinely think that’s one of the reasons they come onto the course, the anatomy course,” (P9, 7.148)* and derived confidence from their years of study, *“I did dissection ... I was definitely probably quite nerdy” (P1, 1.5)*, necessarily siloed to achieve the required depth of knowledge. It gets complicated for those anatomy teachers who were also cognizant that this discipline-specificity, required to be expert in their field, simultaneously others them from the integrated medical program— *“I would love to do short dissection sessions with them,*

but you know, no, I'm just going to say no, it's not supported” (P6, 23.577– 579).

This is typical of the paradoxical situations related further in Theme Three. It is worth mentioning the divergent attitude of the MBBS Director and clinical educator who reflected on his dissection experience as a student, “... *just a social event, to be honest, in a dissecting room” (P3, 18.448),* which shows again the HC in action as well as the high degree of confidence in clinical educators versus those more junior who were perhaps clinging to their dissection experience as validation, “*I'm a bit biased toward being in the cadaver” (P2, 6.140),* and “*that's how I learnt it, and that's how I now teach it” (P10, 1.5).*

Some participants felt more comfortable couched in their “anatomy silo”, responding from their base of expertise as anatomy teachers while making it clear that the rest of the medical program was not in their purview, “*because I'm not [professionally based in the medical school], like, my input to that is very minimal” (P10, 12.273).* Other participants, especially those whose role was more integrated with the overall medical program, discussed aspects of their curriculum in terms of integration “*We try not to put artificial separation in between different disciplines” (P4, 7.162),* with the more forthcoming participants acquiescing “*It's challenging doing that vertical integration or that true spiral at times” (P6, 12.740).* These participants, experienced senior educators with more oversight within the medical program where they taught, shared a range of attitudes toward the efficacy of their program's integration. Participant P5, a champion of her program's use of progress testing, “*it's the ethos that works well for us” (9.211)* was consistently using language to emphasize that clinical skills are introduced in the early years with clinically relevant anatomy (a key basic science) appearing in the later years of the training: “*They do still get*

anatomy teaching later on, but it's not the whole group in a lecture theatre ..." (12.297). She confidently declared, *"... what we're aiming to do is produce very good quality foundation year doctors"* (7.164). Still, she could not resist showing her true colors as an anatomist; it did not take much prodding for her to admit she would like to see more representation of the basic sciences in the clinical years, *"always, Yes!"* (13.299) and *"If I had my way ... I would probably introduce more spotters"* (18.447). She recognized that the integration outcomes were not always reflected back to anatomy educators via student performance with their clinical educators, *"... the clinician is going ... Well, what ... What do they teach you? [laughter] ..."* (13.309); her high level of confidence equipped her identity to withstand the insult.

Other participants were possibly more cynical, not denying the ideals of integration but revealing the practical issues they were dealing with in making it so, *"We're giving them really broad outcomes, and we're dumbing down the anatomy"* (P6, 13.357). Nine participants talked directly about their curriculum as aiming to be integrated or discussed an impending shift toward integration as an explicit curriculum style. For example, *"So they're hoping to integrate all the subjects a bit better with the new, what is it called, em ... [progress testing]"* (P8, 13.302). For those participants who did not feel connected to the medical program or reported not feeling supported by their colleagues in some way, this shift toward an integrated curriculum generated more trepidation. For example, P6, previously quoted as feeling unsupported, reveals: *"I think a lot of the anatomists are struggling now because we've got ... This new curriculum that we have ..."* (17.417). She went on to express her concern for students, *"So it's very variable what the end product is and what students get overall"* (22.564). This imposed, top-down curricular change increased the pressure of the unknowns and

foregrounded the limitations those educators expressed in relation to their involvement in decision- making, "... *we'll go with that and trust their judgement and see how it works out*" (P10, 12.283).

As was seen in Theme One, it took confidence for educators to sit with unknown aspects of the curriculum. These impending and seemingly unending changes, "*I think we've had about a million curriculum reviews*" (P9, 8.187) to the spatiotemporal structure of the working environment threaten the stability of one's role and, thus, one's confidence. Theme Two talks about how these educators interpreted that system at the time of the interview. How they described and referred to the curriculum, whether it was integrated, supposedly integrated, or something else, offered a rich insight into their experiences of sitting with uncertainty and maintaining their confidence.

7.4.3 Theme three: Managing expectations to perform within paradoxical situations

The vectors of complexity exposed in Theme Two are defined here as lines of tension evident where participants were pulled in a minimum of two different directions. Theme Three unpacks the nested paradoxical alignment that participants talked about in their experiences as anatomy educators; as P6 says of her supposedly integrated program, "... *there does not seem to be any, em, vertical integration of the anatomy and I would love that.*" (19.477). With the advent of progress testing and other curricular interventions designed to integrate the medical program, these anatomy educators were caught in the proverbial crossfire: "*But you will always get clinicians saying, 'Well, I saw them this week, and they knew nothing ...' And it's like, 'Well, they did when they left us!'*" (P7, 19.476). They talked about having to teach anatomy according to short- term goals (anatomy assessments) while also being aware of the increasing pressure to take on the long- term educational

goals of the integrated curriculum being implemented by their institution. For example, P10 experienced the responsibility of her role, that she wasn't just there to teach and assess her students' knowledge but also to prepare them for their professional journey as doctors, *“Because it's not just assessing their knowledge, it's preparing them for the profession”* (12.295). Participant P6 went further in her feelings of responsibility to her students, *“I do feel kind of morally responsible to show them the links [between anatomy knowledge and clinical practice]”* (22.560).

The pressure to quickly develop, test and deploy teaching activities that satisfy both timescales was tolerated amidst the uncertainty of what might be expected of the educator in subsequent years, *“we don't know the shape of this new MLA, eh, the Medical Licensing Assessment, that's coming in ... if that wants any basic science, you know, it's guaranteed the med school ...”* (P9, 11.252). All this uncertainty boiled under an atmosphere of reduced emphasis on anatomy as a subject in the medical curriculum, a reduction acutely borne by educators: *“We're failing them in the anatomy education”* (P6, 15.350); *“because there's no time now ...”* (P6, 12.277); *“They've cut down on all our face- to- face time but increased repetitions”* (P6, 23.573). This paradox in alignment arose further in the data as participants discussed their interpretation of how students prepare for sessions and study for assessments.

“It sounds pretty brutal, but ... I've got very little sympathy for those struggling in session. We're not going down to the lowest common denominator ... That they've just chosen to forget it or ignore it [their anatomy knowledge]” (P4, 13.311– 14.330).

The mismatch continued as participants ran into incongruencies between the imposed curriculum and the HC, for example, where students were still having to use rote memorization to pass assessments, as P8 related; *“... almost as if we're teaching*

anatomists rather than clinicians” (P8, 13.321). Students pass their anatomy assessments only to forget the information, *“It does disappoint you a little bit”* (P8, 13.299). The disappointment underscored discrepancies between timescales, as these participants were caught in another current of tension— between the “old” polar curriculum and the “new” integrated curriculum, *“Like the progress testing, I suppose, they are trying to counteract that issue but ...”* (P8, 13.312). This further nesting of tension showed that polar origins are hard to kill despite the good intentions of imposed integration.

Participant P11 showed a sustained level of high confidence in her identity and reflected on her journey toward realizing that perhaps anatomy was integrated after all, *“I was always looking for, you know, anatomy to be branded later on ... But then when you go through an OSCE ... it's clearly there ...”* (P11, 11.248– 260). She explained, *“... my job role, em, is to ensure that anatomy is represented and appropriately covered in the assessment”* (7.146– 147). It is impossible to know the extent to which her involvement as an anatomist in the overall design of the program influenced the clinical assessments to contain more anatomy or if her level of mastery makes the anatomy obvious to her, but it does beg the question.

7.4.4 Theme four: Emergence of innovative teaching within curricular constraints

As is known from Theme One that acknowledging uncertain and unknown aspects of the job was a universal experience for these participants. For those new in their role or dealing with lower confidence, uncertainty seemed to push them further into their silo, *“They just sort of use us to teach their basic sciences”* (P10, 5.118); while for those with relatively high confidence, talking about the unknowns often acted as a catalyst for them to open up about how they met the challenges they were facing, *“We're anatomists ... So,*

the only way to get proficient in it is to practice it yourself
(P1,16.405).

Participant P1 was divergent in her views about whether basic sciences should be further represented and assessed in the clinical years, “*Yeah, I mean I don't know how much I would kind of push that, but it might be useful*” (P1, 18.451). She talked about the successful use of ultrasound in her teaching practice, how students loved it, “*... the moment that you say ultrasound ...*” (P1, 9.200), and reflected that while most of her colleagues were supportive, “*probably one of my colleagues would prefer to leave it to the experts.*” Educators who developed an innovative technique and experienced its success in practice seemed to enjoy a boost in their confidence. This allowed them to withstand a level of pushback and remain undeterred by the method not being operationalized in the formal curriculum, accepting that students default to a focus on what will be assessed, “*... that will probably last for about ten minutes and then the students will start to ask ... 'So, what do we need to know for the exam?'*” (P1, 11.259).

This emergence of innovation and confidence was also evident in P5. He was previously quoted as feeling supported by colleagues in using the body painting technique, and that translated into confidence, “*I intend to try and make it definitely part of the first two years of the programme ...*” (11.248) and showed an interest in persevering with it regardless of it not being assessed, “*I don't think it needs to be assessed in order to be successful*” (14.337). Other participants discussed how their teaching practice had been influenced by constraints, with convergence around positive adaptations, “*... that structure has forced me to be innovative*” (P4, 16.404), learning completely on the fly— “*I've never been trained in how to use ultrasound ...*” (P11, 9.172). Time constraints produced a

notable divergence, where P6 reflected on having to teach the same content repeatedly to increasingly large numbers of students:

“Obviously, I do it ... But it just kills all my enthusiasm” (P6, 20.516). What came across is that these educators are managing to balance and even thrive in the tension between fulfilling immediate learning outcomes while also modeling longer- term professionalism, however they do that.

These findings indicate that these anatomy educators were constantly hustling to adapt their strategies since they were on the receiving end of a top- down structural model (curriculum) superimposed onto the reality of the structure in the wild (learning environment). These data show a “productive tension” (Thackeray & Eatough, 2015) between convergence and divergence in the sample, as the challenge of teaching to conflicting timescales can both frustrate and inspire innovation. Such tension illustrated the sense- making strategies of each educator coping with the unique push- pull of factors at play in their experience. They managed while sharing a lasting passion for integrating basic sciences as a matter of professionalism even as they recognized a reduction in the time resources available for them to do so.

7.5 Discussion

This empirical study provides an incremental contribution to the field, offering phenomenological insight where medical, health professions, and anatomy education intersect. Four key themes are presented in relation to one another: (1) Awareness and empowerment as stakeholders, (2) Variations in discussing curricular integration, (3) Managing expectations to perform in paradoxical situations, and (4) Emergence of innovative teaching within curricular constraints. Participants demonstrated varying levels of connectedness to the medical program where they were teaching, interpreting their role as an educator in relationship with

Chapter 7: IPA Study | “Preparing them for the profession”

the unique vectors of influence particular to their circumstances of experience, inclusion, seniority, and perceived support from colleagues.

How much support they received impacted how they talked about the HC, that is, the unknowns and incongruencies apparent in their learning environment. Participants managed to strike a balance within their role where they felt more support from colleagues, doing their job despite paradoxical demands. In some cases, with adequate confidence and institutional support, the paradoxical pressures were key to participants' empowerment and creativity in developing innovative teaching activities, highlighting the complexity of their lived experiences. The findings of this study show that the working lives of anatomy educators are profoundly affected by the complexity of their network.

Participants all talked about their feelings of support at various levels by their colleagues and seemed to generate their confidence in large part from that support. There was a sense of pride in that they managed to deliver what was asked of them despite a great deal of uncertainty around how that fit into the bigger picture or how and when their role and associated deliverables would be changing in line with the “powers that be.” The levels of uncertainty, tension amidst timescales, and vectors of demands pulling in different directions, coupled with emergent strategies arising based on individual responses all point toward the spatiotemporal model of complex systems. While the authors leaned into Tomkins and Eatough's (2013) encouragement, aiming to suspend organizational attitudes and keep theoretically agnostic, they noticed that the language coming up in the data bears resemblance to complexity theory (CT).

7.5.1.1 The Complexity Turn

The significance of shifting the language from “complexity” to complex systems theory (ST), a.k.a. CT, systems theory, CS, in terms of the health professions learning environment considering hermeneutic research is compelling. That the data in question arise from the experiences of anatomy educators is of significant interest because it is a rare and yet deeply relevant perspective from which to consider how complexity feels in the learning environment.

Complexity in healthcare and education is not a new notion (Waldman, 2007), and this study resonates with literature exploring ST in HPE over the last two decades (Knight, 2001; Castellani & Hafferty, 2006; Mennin, 2007; Hafferty & Levinson, 2008; Mennin, 2010; Smolle, 2016), and more recently, (van Schaik et al., 2019; Woodruff, 2019; Khanna et al., 2021; Woodruff, 2021).

This study suggests that hermeneutic inquiry of the health professions learning environment is compatible with the CS literature. Van Schaik et al. (2019) highlight their vision for exemplary LEs, based on CASs, in which “everyone involved in HPE and health care collaborates toward optimal health for individuals, populations, and communities.” Complexity and chaos have become buzzwords in recent decades, with enormous implications on science and contemporary society.

That the social sciences and by extension, HPE, have come to embrace a systems perspective is well established (Hammond 2003). Castellani points out that in sociology, for example, the advent of systems thinking can be linked to “the founding of the discipline, as in Spencer’s evolutionary theory; Marx’s dialectic; Durkheim’s social fact; Pareto’s 80/20 rule; and Comte or Quetelet’s social physics” (Castellani & Hafferty 2009). The relationships within HPE as a discipline owe much to sociology and its embrace of systems thinking. Mennin points out that “Becoming a health

professional is necessarily relational and dynamical.” (Mennin, 2013).

In 1992, Tarlov predicted that:

“Medical education will change from within in response to continued advances in biological sciences and technology, but changes that are occurring outside the natural sciences can have greater impact, especially (1) the reconceptualization of the meaning of health, (2) the increase in the number and range of different health improvement strategies, (3) the growing awareness of the paradox of the relatively low health status of the U.S. population and high per-capita and national health care expenditures, and (4) shifts in the causes of illness and death. These changes make it necessary for medical students to be given a foundation in both the natural and the social sciences.” (Tarlov, 1992)

A ‘foundation in the natural and the social sciences’ is an apt characterisation of HPE in theory and practice. Accepting that the social sciences have been shaped by research in the critical realism paradigm as well as systems thinking, it makes sense to look critically at what ‘systems thinking’ really is. Networks, CASs, CS/CT, computational modelling, hive mind, swarm intelligence, data, ecological ST, neural networks, global network society, post-humanism, social physics, to name a few, all have in common the so-called “complexity turn” coined by British sociologist, John Urry (2005).

Although systems language shares common ground with complexity, the two are distinct as theories (Turner & Baker, 2019). General Systems Theory (GST) approaches systems problems using overwhelmingly linear relationships (Yawson, 2013) within stated boundaries, which becomes increasingly problematic when applied to social systems: “It is hard to define such a boundary to an

organization” (Wang, 2005, p. 397). ST is often considered too mechanistic as an approach for understanding the learning environment.

As von Bertalanffy states, “systems theory is indeed the ultimate step toward the mechanization and devaluation of man and toward technocratic society” (1972, p. 423–424). From a critical realist point of view, the concern is that social systems are human constructs, which invites the hermeneutic dialectic of agency-structure (Kast & Rosenzweig, 1972) more suited to CT (emergence focus) than ST (linear outcomes focus). In the next chapter I will argue for the position of multiplicity, on the basis that #complexity features in the HPE literature in such a confusing and confused array of usages. The multiplicity stance allows HPE researchers to operate from a position of acknowledgement with regard to this ambiguity, recognising that complexity is a can of worms.

What engenders something that is merely complicated with the heightened status of Complexity? Sturmberg et al. (2017) highlights the importance of disambiguating what is simply difficult from what is ‘complex’ – a trendy term that has become a catch-all for situations that defy control. The Latin term *complex* refers to structural characteristics, meaning 'entwined/interwoven' – the geometry of a system and its internal relationships. Indeed, “complexity arises from the interactions between structurally connected entities - a functional characteristic of a system.” (Sturmberg et al., 2017).

Once we are clear that complexity is a geometric quality of structural relationships, then it is useful to be clear on what is meant by a complex adaptive system (CAS). In his ground-breaking book, Complexity: The Emerging Science at the Edge of Order and Chaos, Mitchell Waldrop (1993) defines the CAS as “a dynamic network of many diverse agents ... constantly acting and reacting to

what the other agents are doing. Control tends to be highly dispersed and decentralized. Coherent behaviour arises from competition and cooperation among the agents themselves. The overall behaviour of the system is the result of a huge number of decisions made every moment by many individual agents.” (1993). From this definition, this thesis continues with ‘CAS’ understood as a behavioural description – a complex system demonstrating ‘coherent behaviour’.

CS offers a plurality of definitions and tools along with what may be a new perspective for HPE researchers contending with globalisation and its itinerant set of complex and overlapping issues (Castellani & Hafferty, 2006; Beutement & Broenner, 2012; Capra & Luisi, 2012; Byrne & Callaghan, 2013; Sturmborg & Lanham, 2014). We have seen that the learning environment contains a significant degree of complexity, taken together it forms a dynamical (ever-changing) system.

In such a system, new properties and behaviours will emerge. These emerging properties are different from those of the constituent elements and are not necessarily predictable from the initial conditions. According to Mason, “These concepts of emergent phenomena from a critical mass, associated with notions of lock-in, path dependence, and inertial momentum, suggest that it is in the dynamic interactions and adaptive orientation of a system that new phenomena, new properties and behaviours, emerge.” (Mason, 2008b). CAS behaviour can be seen all around us in nature, from the viscoelastic murmuration of starlings to the electrifying performance of shoals of fish, to the self-organising properties of human tissue (Kollmannsberger et al., 2011), as well as consciousness (Seth & Edelman, 2009; Theise, 2023).

The allure of such an elegant solution, derived from observations of the natural world and applied to all the people problems, is hard to

resist. This is an important moment for scepticism, as Sturmborg reminds us “the basis of scientific rigor is a clear understanding of a discipline's epistemology” (Sturmborg et al., 2017). The danger of attractive, fashionable theories is that they may be more vulnerable to the epistemic fallacy (Bhaskar, 1975; Bryant, 2011). The epistemic fallacy is associated with the conflation of ontology and epistemology – “confusing the nature of an underlying reality with knowledge of it” (Galbraith, 2015). In this doctoral project, geometric modelling is used to understand ‘underlying reality’ of the LE as a means of real-world problem solving. In the next chapters of this thesis, I will present a deeper investigation of the epistemic fallacy regarding the use of complexity-informed models in HPE.

Proponents of complexity, a science that concerns itself with eschewing reductionism, might be doing it a disservice by way of ‘reducing’ social issues to the buzzword of complexity. As Nowotny (2005) argues convincingly, “we are engaged in a contradictory process when encountering, analysing and dealing with complexity. We face opposite tendencies that indicate an inbuilt dynamic, if not a race, between the increase of complexity and its reduction (Löfgren, 1987).” This thesis will further explore the need for understanding discipline-specific usage of complexity, particularly in section 9.6 with the discussion of a Multiplicity perspective.

Although the collective result of CT permeating the social sciences has been variously hailed as a revolution in thinking, this innovative ‘paradigm shift’ is not actually new. As previously mentioned, Urry (2005) coined this move toward complexity in the social sciences the ‘*complexity turn*’ at a time when he was also active in the formation throes of critical realism, but the concept was gaining traction in the mid-20th Century.

In his Complexity Theory and the Philosophy of Education, Mason notes the importance that CT places on interpretive perspectives

that are transphenomenal, transdisciplinary and transdiscursive (Mason, 2008a). Further, Morrison offers that with respect to educational research, CT highlights the need for case study methodology, qualitative research, and participatory ...collaborative (self-organised) partnership-based forms of research, premised on interactionist, interpretative accounts. As such, CT points to pluralism in methodological, theoretical, and paradigmatic approaches.

Although embracing the term rigorously in HPE is going to take some focussed disambiguation, there is no doubt that complexity is here to stay. In the era of integration, competency development and identity formation within one's professional network relate intimately with personal feelings of connectedness, support, and involvement in that ever-evolving system. On this score, the distinction between student, teacher, doctor, and patient is collapsible. As Tsouroufli et al. (2011) remind us, our personal and professional identities are not separate. In a world increasingly waking up to its interconnectedness (Finn et al., 2021; Rabin et al., 2021), fostering confidence as part of identity formation can only happen in relationships with others and in acknowledgement and acceptance of uncertainty.

7.5.1.2 Uncertainty

Navigating uncertainty is a key finding in this study that foregrounds the importance of professional identity and confidence development. This result agrees with the widely held view that uncertainty tolerance (UT) is key to the optimal functioning of health professionals. Low tolerance of uncertainty is reported in connection with negative healthcare outcomes, such as burnout in both medical students and practicing doctors (Hancock & Mattick, 2020; Patel et al., 2022).

Research suggests that reduced UT in clinicians is associated with an increased experience of unnecessary investigations, distress and harm to patients (Lysdahl & Hofmann, 2009; Hall, 2002). More recently, Brun et al report that intolerance of uncertainty (IU) may have a strong negative impact on clinical reasoning, potentially resulting in diagnostic errors and could lead to over prescribing unnecessary or dangerous tests (Brun et al., 2023). The upshot is that further research in how to proactively engage with UT as a clinical skill, shifting it from HC to explicit, is warranted.

Hillen et al. (2017) provided the first qualitative contribution to the literature on uncertainty in HPE with their interpretive conceptual analysis, which factors the primary authors’ conceptualisations of tolerance of uncertainty scales. They define tolerance of uncertainty as a construct describing how individuals respond to their perception of uncertainty (see Table 17 for related definitions). Prior to 2017, most studies dealing with the tolerance of uncertainty in medical education were quantitative and cross-sectional; (Geller, et al., 1990; DeForge & Sobal, 1991; Merrill et al., 1994; (Weissenstein et al., 2014; Hancock et al., 2015). These studies focus on measuring students’ UT, comparing data with their stage of education to produce “inconsistent findings” (Stephens et al. , 2021a).

Table 17: Glossary of Uncertainty Definitions (Stephens et al. 2021)

Term	Definition
Tolerance of uncertainty	“The set of negative and positive psychological responses—cognitive, emotional and behavioral—provoked by the conscious awareness of ignorance about particular aspects of the world” (Hillen et al. 2017)

Tolerance of ambiguity	“The tendency to perceive ambiguous situations as desirable” (Budner, 1962)
Uncertainty	The “conscious awareness” (i.e., the perception) of “ignorance about particular aspects of the world” (Hillen et al. 2017)
Ambiguity	A source of uncertainty; a property of information pertaining to its lack of “reliability, credibility or adequacy” (Han et al. 2009; Hillen et al.)
Grey cases	Clinical anatomy case-based learning with purposeful integration of ambiguity (see appendix for example case)

Quantitative approaches to understanding UT yield limited insight into the specific mechanisms by which education may influence participant experiences of uncertainty. Stephens et al. (2021a & 2021b) have advocated for the potential of qualitative methodology for exploring the role of education in supporting medical students’ exposure to and subsequent tolerance of uncertainty. They have pointed out that anatomy education represents a particularly suitable vector for leveraging insight into medical student tolerance of uncertainty. If there is value in understanding the experiences of medical students, as their study shows, then surely the experiences of anatomy educators with regards to UT can provide yet another valuable angle of understanding.

What is compelling here is that Stephens et al. (2021a & 2021b) have also pointed to “the relationship” as established in Chapter 3 of this thesis. The relationship between anatomy as a subject and medicine presents a complex entanglement of vectors in terms of alignment. Anatomy assessments are normally characterised by lack of ambiguity, where MCQs and spotter tests conspire to elicit

correct and incorrect answers. In that sense, students are not encouraged to develop their tolerance of uncertainty despite anatomy being very much a discipline abounding with anomalies and variation.

Findings from the present study show that anatomy educators are grappling with this same concept from another angle, as they are tasked with teaching very broad learning outcomes in a decreasing timescale, so the ambiguity is bound up in LOs such as “Know the region of the axilla” – students are increasingly responsible for learning a poorly defined domain of correct answers that may be on their exams. Educators are thus given the impossible task of using less time to teach an ambiguous domain of practically endless “facts”.

“Such contradictions between disciplinary know-how (i.e. that anatomy is ambiguous) and anatomy education (e.g. that all anatomy is known and absolute) could serve to affect tolerance of uncertainty in unknown ways and with unknown (and possibly negative) professional impacts. For example, a lack of awareness of anatomical variation in clinicians is associated with negative outcomes, including medical errors and unnecessary procedures (Royer, 2018). In this way, the anatomy learning environment provides a potentially rich environment for exploring the impacts of education on students’ tolerance of uncertainty development.” (Stephens et al., 2021).

If we accept that human anatomy is inherently ambiguous and that lack of awareness of anatomical variation in clinicians is potentially dangerous, how has anatomy assessment remained an exercise in rote memorisation? Students may be deprived of opportunities to develop their tolerance of uncertainty with exams that focus on anatomy as a set of indisputable facts with minimal emphasis on its

variation. However, we have seen that students and educators alike are challenged to build their uncertainty tolerance in relation to the vagaries of pedagogical alignment whereby it’s anyone’s guess what might be asked on the exam.

Apart from Stephens et al., there are a few other qualitative studies that explore medical students’ experiences, suggesting that education may positively influence UT development. Nevalainen et al. (2010) carried out a longitudinal study involving medical students and found that students’ tolerance of uncertainty improved throughout their first year of clinical placements through the practice of using reflective diaries. Their findings suggest that reflective writing may facilitate the processing of uncertainty in medical students. Gowda et al. (2018) completed a mixed methods study involving first-year medical students engaged in a museum-based visual arts elective, wherein one course objective was based on the identification and exploration of uncertainty. The authors concluded that arts-based courses may facilitate medical student development of UT.

These two studies use interventions (reflective writing and creative practice) highlight the potential role for education in moderating students’ tolerance of uncertainty. Findings from these studies are limited due to the lack of an interpretative framework of applied comprehensive theoretical models of UT such as that of Hillen et al. (2017). These studies are also scaled down to the impact of electives on student experience.

The work of Stephens et al as previously mentioned has provided a substantial contribution toward understanding the role of education in moderating tolerance of uncertainty. Their longitudinal study showed how education can impact emotional and behaviour responses to uncertainty. Their novel findings suggest that “student cognitive appraisals of uncertainty improved over time and with

exposure to uncertainty stimuli in the context of anatomy education”. They conclude that further research toward the development of our theoretical understandings of UT in medical students is warranted, perhaps involving “purposefully exploring tolerance of uncertainty in the clinical learning environment”. In light of this call for further qualitative research to develop our theoretical understandings of UT, together with the like-minded findings from our study of anatomy educators, the next chapter in this thesis will lean into a new model of the learning environment.

It takes confidence to thrive and innovate in the face of many unknowns. As Rees and Monrouxe (2018) state, “we advocate that curricula explicitly aim to develop professional identities, not by forcing people to go through stages of development, passing (or failing) assessments, but through the promotion of individuals' sense making around who they are and who they want to be.” Van Woezik et al. (2020) have shown that assessment in the conventional sense does not evidently drive long-term learning, a complexity that calls for new didactic approaches to support “a lifelong learner.”

At present, there still exists no universal consensus on the UK undergraduate medical curriculum (Sharma et al., 2019), but perhaps this uncertainty can be harnessed for the benefit of all stakeholders toward professional identity development. As part of the Winter 2022 webinar series of the International Association of Medical Science Educators (IAMSE), Dr. Michelle Lazarus shared her view that the appropriate build- in of professional identity development in the basic science curriculum has the following advantages: (1) It prepares students better for the realities of their future careers, (2) By creating a classroom fostering uncertainty tolerance, it helps students manage future transitions to work. (3) Uncertainty tolerance will increase students' ability to detect novelty

and promote professional identity development (Haudek, 2022). Uncertainty is undoubtedly here to stay; whether it is made explicit in the curriculum will have lasting impacts on all stakeholders (Stephens et al., 2022).

This study highlights the need for open discussions about what can be done to support the anatomy education community through uncertain times and timescales. Balmer et al. (2021) have called for an appreciation of timescales, a trend that is on the rise in the longitudinal qualitative health professions literature (Reale et al., 2018; de Cates et al., 2019; Gordon, 2021; Balmer & Richards, 2022). This study has the potential to expand longitudinally to interpret further the experiences of educators emerging from the pandemic to redefine anatomy pedagogy. Looking at how anatomy educators deal with “dynamic lived experiences as they unfold through time,” (Balmer et al., 2021), especially through the lens of IPA, is an exciting next step.

The authors are keenly interested in the sense-making of anatomy educators experiencing a steady erosion of their learning environment as the number of anatomy hours continues to decline and shift to asynchronous formats (Stone et al., 2022), changes accelerated in the wake of Covid- 19 (de Carvalho Filho et al., 2021; Evans & Pawlina, 2021; Harrell et al., 2021). It is worth reiterating that the raw data from this present study was collected just before the pandemic, while the bulk of the analytic process was carried out during and after lockdown. Thus, the authors decided to treat the Covid topic as another set of vectors, now endemic, profoundly influencing the unfolding complexity of the learning environment but beyond the scope of this study *sensu stricto*.

Hermeneutic practice may allow the field to describe other related examples of complex pedagogical phenomena ‘endemic’ to the co-created education experience. Smith and Osborne characterize IPA

as “especially useful when one is concerned with complexity, process or novelty” (Smith, 2015). Further, IPA as a methodology is emerging as an approach for the health professions research to develop phenomena that may otherwise remain hidden in the obvious. As a field with roots privileging deductive analysis and theory- driven qualitative inquiry, anatomy education has an unmined seam of potential for phenomenological (Neubauer et al., 2019) and constructionist (Rees et al., 2020) research. The IPA approach is particularly suitable for health professions researchers seeking a flexible yet systematic method that fosters the “internal coherence” called for in qualitative methods (Palermo et al., 2021). This approach harmonizes with complexity and allows a unique interpretative analysis of phenomena considered *terra nullius* in the horizontal generalization normally used in medical sciences. The researchers refer to Varpio and colleagues' recent article (2021) for encouraging HPE scholars to apply appropriate standards of rigor that align with the nature of the research undertaken.

7.5.2 Limitations of the study

Normally, IPA is used to get insight into how a group of people make sense of a significant experience or event in their lives. The authors acknowledge that being an anatomy educator coping with a changing curriculum is not particularly exciting for non- anatomists. However slow the change or perhaps dull this shift may seem to the wider academic community, it is the authors' view that IPA works well for giving voice to the sense-making of the participants for whom these phenomena are very significant.

Interpretative phenomenological analysis is also constrained by its verticality. Its narrow focus on single cases provides a unique view whereby individual experience is considered in context and on its own grounds. Researchers co- create knowledge by interpreting their participants' interpretations of their experiences. However

vivid and valuable for developing perspective to examine phenomena, this insight is by its nature limited in its generalizability and reproducibility. The strengths of the interpretive approach lie in the very same constraints that narrow its focus. The authors call for these constraints to be embraced as wholly appropriate and worth the trade-off.

7.6 Conclusions

1. Teaching the basic sciences as part of a medical program takes confidence and a strong commitment to identity development for all concerned. The learning environment is messy and fraught with uncertainties, continuously challenging all who seek to navigate its complexity. The authors advocate building uncertainty tolerance into the curriculum for all stakeholders. Acknowledging that unknowns, hidden in the obvious, are often the most potent teachers— facing uncertainty is as much a part of educators' professional life as it is for students. When anatomy educators develop confidence in the face of impossible demands, they model what it is to be engaged in professionalism. Institutions can foster this by promoting kindness and transparency and acknowledging the “elephant in the room” that the curriculum will never be a known quantity.

2. People perform better and can build uncertainty tolerance when they feel involved. If the goal is an integrated curriculum, decision-makers will do well to further integrate the people delivering all aspects of that curriculum.

3. Interpretative phenomenological analysis allows medical education researchers a fresh, bottom-up approach to understanding experientially the people making sense of what is normally a top-down world. Encouraging phenomenological research would demonstrate an interest in how people are overcoming, or at

least engaging with, their struggles to deliver the impossible in a constantly changing entanglement of vectors. When anatomy educators feel they are being heard, they are more likely to feel valued and involved, empowering a feedback loop where everyone can contribute despite the curriculum remaining ever a work-in-progress.

4. This research points to the need for more hermeneutic insight into how stakeholders in medical education are making sense of the rapidly shifting goalposts in their complex working lives.

Complexity as a spatiotemporal model offers a rich picture of the health professions learning environment. This model has the potential to aid further inquiry into the intrinsic behaviour of the learning environment as a complex adaptive system. Listening to and interpreting the sense-making of individuals who live and work there can allow instructional designers to better serve them and, ultimately, the patients who inherit its consequences.

7.7 Acknowledgements

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7.8 Chapter Summary

This chapter forms the main empirical contribution of this doctoral thesis. As a result of working and reworking the manuscript, I came to understand the intrinsic conflict that exists in writing up a truly phenomenological study for a STEM-based journal. This experience provided me with key insights that I was able to use in writing the qualitative evidence synthesis of IPA literature in HPE that forms the previous chapter.

Chapter 7: IPA Study | “Preparing them for the profession”

This chapter represents what I would consider to be the primary empirical contribution of my doctoral work. Getting published as first author for the first time filled me with the enthusiasm I needed to keep going. It also gave me confidence to embark on another study and to “stick with my IPA guns” in the writing up process. This study aimed to reveal through interpretation the lived experiences of its participants. Any links with theory are secondary to the emergent phenomenological data, and yet we as the authors must own the theoretical impetus for undertaking the study.

The next chapter explores how the findings of this study are the lynchpin results of this doctoral project.

Chapter 8: Authenticity, Uncertainty, Complexity, Multiplicity: Proposing Authentic Alignment Theory

8.1 Chapter Introduction

This chapter pauses to reflect on the previous four results chapters. It is time to see what is emerging from the data and how this emergent logic links to the aims established at the outset of this thesis. What are the findings of this doctoral work so far? How has abductive reasoning led us into earshot of the intransitive structures, and what transitive knowledge do we have to show for it?

8.1.1 Chapter Purpose

This chapter leads into the key hermeneutic dialectic of this doctoral work: the agency-structure dialectic. It presents the philosophical and analytical rationale for a novel spatiotemporal model of alignment. So far, this thesis has demonstrated that Biggs' static CA triangle ought to be updated to a mutable structure in order to be more authentic as a model of alignment. This chapter drives home that update with the proposal of Authentic Alignment Theory.

The theoretical framework used in this thesis, abduction, was introduced in Chapter 3. This chapter reiterates and develops that theory, going much deeper into the 2 vectors at play:

1. the top-down forces of agency applied by curriculum designers, and
2. the bottom-up forces of existing structure found in the LE

The upshot is that where Constructivism collapses these two vectors into a single mechanism, Critical Realism encourages that agency and structure be considered as at least analytically distinct as per Margaret Archer's analytic dualism. This, the dialectic, is a key

Chapter 8: Proposing Authentic Alignment Theory

means by which CR accomplishes its emancipatory axiology. In other words, this chapter provides original, doctoral-level discourse justifying the new theory proposed.

Additionally, this chapter strongly advocates for the position of Multiplicity for HPE researchers seeking a complexity stance on asking and answering their questions. Complexity science (CS) is complicated and points to complementarity, where relationships are nonlinear and often displaying seemingly opposite qualities simultaneously. The task of authors wishing to embrace CS and its models of systems is to sort out which type of complexity one is working with. This chapter provides further background on CS and urges authors to develop clarity around which type best suits their intentions and questions.

“Constructionism thus impoverishes humanity, by subtracting from our human powers and accrediting all of them - selfhood, reflexivity, thought, memory and emotionality - to society's discourse.”

— Margaret S. Archer (2000), Being Human: The Problem of Agency

8.2 Summary of Findings, Rationale for Progression

This chapter begins with a reflection on the empirical chapters to summarise how the findings from one study relate to that of the next one. Linear progressions can be comforting and clarifying presented inside such a nonlinear hive of interconnectedness. After the summary of findings, this chapter provides three threads of discourse: conceptual models, educational philosophies, leading into a discussion of the curriculum as a problem space.

After establishing these as a rationale for reimagining a more authentic geometry for Biggs' (1996) model of CA, I will then provide a comprehensive philosophical framework seated in the hermeneutic dialectic of CR. The dialectic pertaining to this doctoral

Chapter 8: Proposing Authentic Alignment Theory

work harkens to the agency-structure debate epitomised in the conversation between Anthony Giddens' Structuration Theory (1985) and the Morphogenetic/Morphostatic approach of Margaret Archer (1995).

8.2.1 From Chapter 3 & 4

The relationship between the remit of anatomy educators and the network of the wider medical curriculum is not adequately or authentically modelled by a simple two-dimensional triangle as per Biggs' model of CA. This study showed that further investigation was needed to gain an immersive entry into the 'transitive realm' where it may be possible to theorise further about the spatiotemporal nature of alignment in HPE learning environments. Results pointed to a fundamental disconnect between what people were living with versus what the prevailing model dictates. These findings inspired the question that inspired the next chapter: "How are stakeholders coping with the disconnect in real terms?"

8.2.2 From Chapter 5

The use of humour in anatomy labs points to coping mechanisms humans use to mitigate the effects of personal overwhelm in the face of challenging circumstances. Our study confirmed the significant influence of the HC and the need for further humanistic studies to investigate the lived experiences of stakeholders in HPE. The findings showed that continued empirical insight using hermeneutics and phenomenology was the next logical step according to the tenets of critical realism.

8.2.3 From Chapter 6

Toward gaining that truly hermeneutic insight, I needed to understand how associated methodologies are being used in the field of HPE. I chose Interpretative Phenomenological Analysis (IPA) because it is a dominant qualitative methodology, well established

Chapter 8: Proposing Authentic Alignment Theory

in psychology and emerging in health sciences. The findings of the qualitative evidence synthesis provided in Chapter 6 form the methodological rationale for using IPA in the next study. The results, consolidated after I carried out the IPA study in Chapter 7, offer a set of top tips for HPE researchers interested in the potential of IPA as a research methodology.

8.2.4 From Chapter 7

The findings from Chapter 7 point to the intrinsic uncertainty that anatomy educators face in their working lives. The results highlight that it is time to focus not on modelling the curriculum as such, but on the learning environment (LE) in all its complexity. Complexity as a spatiotemporal model offers a rich picture of the HPE environment, replete with emergence and uncertainty. This model has the potential to aid further inquiry into the intrinsic behaviour of the learning environment as a complex adaptive system (CAS). At this point, the aims of my thesis had been achieved so I chose to bring empirical work to a close to focus on building the case to justify the new model of the LE.

8.2.5 Integrated overview of findings with interpretative discussion

Anatomy educators in HPE are tasked with supporting their students to become independent, competent clinicians-in-practice while simultaneously grappling with significant uncertainty on the receiving end of rapid changes and information overload. Efforts from “the powers that be” to control the overall stakeholder experience, “the curriculum”, are effectively top-down vectors thrust upon / experienced by anatomy educators. The educators are often not involved in the decision making around if and when changes to curricula become implemented and must necessarily pass on the randomness to their students, who are tasked with learning a vast amount of anatomy knowledge with no idea if, how

Chapter 8: Proposing Authentic Alignment Theory

or when it will be required of them to maintain for future assessment.

The reality of the experience in the wild, including the bottom-up effects of all past, present, and future vectors, is referred to as the “learning environment”. Stakeholders in the LE report that the terrain is becoming increasingly complex, with more aspects (such as the humour required to cope) being relegated to the “Hidden Curriculum” – what is known as ‘noise’ in CT. The parts-whole relationships, e.g., between anatomy and the wider curriculum, is proving contradictory and often unreasonably challenging to navigate in large part because the uncertainty/ambiguity is still treated as the elephant in the room, something everyone knows is there but has yet to become operationalised or even formally acknowledged.

In the obsession with documenting learning outcomes of any given curriculum within sophisticated blueprints establishing intended competencies, there persists a demonstrable lack of key competencies amongst newly qualified medical students (Monrouxe et al., 2018). This has understandably led to an increasing call for reform in education (Jorm & Roberts, 2018). As described in the introduction to Chapter 7, medical curricula continue evolving over time, leading to contemporary models that primarily focus on achieving, on the one hand, integration (longitudinal, horizontal, and spiral). On the other hand, curriculum design is also under pressure to prioritise the competencies required for safe and effective clinical practice and to demonstrate this priority to the public, e.g., the MLA.

One apt metaphor here is that a hammer sees everything as a nail. Since organised medicine has most control over top-down vectors, the result is that efforts to reform student experience have remained prescriptive and concentrated on curriculum design. In

Chapter 8: Proposing Authentic Alignment Theory

undergraduate and postgraduate settings alike, contemporary curricular reforms cluster as poised around the individual elements of a programme.

As an anatomist, I am sympathetic to this call for the vertical integration of basic sciences such as anatomy and embryology. We can understand the recent focus on competency-based learning outcomes, the value of task-based, programmatic, “authentic” approaches to assessments. But are we so focussed on hammering away at the blueprint that we have forgotten to look at the essential nature of the learning environment? What emergent properties might the natural structure of the LE and its internal relationships reveal to us?

Curricular reforms are undoubtedly based on well-intended educational innovations targeted at nurturing and assessing graduate competencies. However, continuously pushing directives from the top down to receiving actors below without giving the LE and its peoples enough time to self-regulate is inherently problematic. As previously demonstrated, anatomy educators are already overstretched in their efforts to reconcile what *is* happening (descriptive) with what is *meant* to happen (prescriptive). The relationship between anatomy (part) and the learning environment (whole) is a complex, multidimensional, *mutable* peg being forced into a static hole.

The findings presented in this thesis represent an opportunity to embrace the HC, the elephant of uncertainty, and the parts-whole relationship all in one fell swoop. By making explicit reference to these features not as noise, but as key properties of normal alignment (simply complex), we may see the LE as an authentic representation of the professional life that awaits students upon graduation. If the HPE model of alignment remains situated in the static triangle where nothing adapts and the curriculum is

Chapter 8: Proposing Authentic Alignment Theory

prescriptively dosed upon the learning environment, as Khanna et al. (2021) put it, “learners will continue to struggle with sense-making in relation to their learning trajectory (Lomis et al., 2017; Storrar, et al., 2019).

8.3 An Authentic Model of the LE

To consider an authentic spatiotemporal model of complexity in the LE as justified by the findings presented, we need to include two further threads of discourse: (1) conceptual models, and (2) educational philosophies. These threads lead to an understanding of the LE as a social science problem space. I will clarify that the new model I’m proposing is not a *replacement* for Bigg’s (1996) model of CA as applied to the HPE curriculum. Instead, I will propose the T-icosa as a geometric, complexity-friendly upgrade to the conceptual model of the learning environment that is more authentic than the historic triangle model and aligns with the stratified reality of critical realism.

8.3.1 Conceptual Models: realism, fidelity, authenticity, uncertainty

This discussion of conceptual models is couched in the simulation literature as it provides robust definitions for contextualising the notion of authenticity in terms relevant to HPE. As previously discussed, authenticity is a subjective topic that lends itself to interpretation and invites empirical consideration via subjective, interpretative analysis. If authenticity in HPE may be understood as a function of its alignment, what would that alignment look like as a model? Considering that a model is a simulation of the real thing, it is useful to borrow the language of simulation to factor authenticity in relevant terms.

The notion of “authenticity” is conceptually adjacent with the concept of “fidelity”. However, the two terms are distinct in usage, and the tension between them becomes important upon reflection.

Chapter 8: Proposing Authentic Alignment Theory

Fidelity refers to the extent to which an aspect of reality is precisely reproduced. Authenticity is more subjective, as it applies to the learner's interpretation of situational veracity, their experience of interacting within a context, with other learners, and a simulator (Bland et al., 2014).

The difference between fidelity and authenticity is crucial for educators tasked with delivering HP curricula fit for purpose. Toward deploying increasingly relevant and engaging educational methods, educators rely on simulation. The concept of simulation as a tool is most often associated with technology, manikins, and other simulated realities. However, here we are making use of simulation in the broad sense, defining it as the practice of replacing real experiences “in the wild” with guided activities that replicate *aspects* of the real world using interactive functionality (Gaba, 2004). The definitions used here are depicted in Table 18 from Lavoie et al (2009) and their sources.

Table 18: Definitions of Realism, Fidelity, and Authenticity (Lavoie et al., 2020)

Concept	Definition
Realism	The quality or fact of representing a person, thing, or situation accurately in a way true to life; this enables participants to act “as if” the situation or problem was real (Lopreiato, 2016, p. 39).
Fidelity	The degree to which the simulation replicates the real event and/or workplace; this includes physical, psychological, and environmental elements. The ability of the simulation to reproduce the reactions, interactions, and responses of the real-world counterpart (Lopreiato, 2016, p. 18).

Chapter 8: Proposing Authentic Alignment Theory

Authenticity	<p>An authentic learning environment provides a context that reflects the way knowledge and skills will be used in real life. This includes a physical or virtual environment that resembles the real-world complexity and limitations (Gulikers et al., 2005, p. 509).</p> <p>Interpretation of authenticity is individual (Bland, et al., 2014, p. 1113). Authenticity in the context of simulated learning is associated with realism of which fidelity is a potential attribute. Authenticity, however, may bring realism even if the learning environment is unrealistic and fidelity is low (p. 1115).</p>
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The advantage simulation affords is the element of control, allowing educators to constrain what learners will experience. This opportunity to preferentially constrain the learning environment is a power that comes with responsibility: to provide learners the most realistic experience possible. The act of constraining, to make realistic, is a top-down intervention that seeks to improve the simulation's fidelity, the success of which can be measured purely to understand the simulation's short-term success as "realistic" or not. Such interventions are part of the explicit curriculum.

Authenticity describes how that simulation and, by extension, the associated curriculum, play out in the LE and beyond. Where fidelity is a concept lent for objective, positivist discourse; authenticity is a subjective quality constructed according to its users in a more long-term sense. Proponents of authentic learning contend that learning is optimized when it occurs not only in activities that reflect accurate knowledge, but in authentic settings akin to those that will

Chapter 8: Proposing Authentic Alignment Theory

be experienced in real life (Brown et al., 1989; Herrington & Oliver, 2000).

Authentic knowledge development is a measure of an activity's fidelity, whereas embedding such knowledge within the wider field of unconstrained circumstances, i.e., the "real world" is the realm of authenticity. As Lavoie explains (2020), "a high-fidelity simulation can be perceived as predictable (poor authenticity), whereas a low-fidelity simulation can be experienced as highly relevant to clinical practice (high authenticity)."

A key difference between fidelity and authenticity appears to be predictability, where authentic learning aims to develop uncertainty tolerance in learners for greater competence in "real" practice. Ahn (2018) points out succinctly that "Assumptions of the superiority of high-fidelity simulators can be seen as a myth." The preoccupation of STEM disciplines with objective "realism" and technology in general has galvanized critics such as Smallman et al. (2007), who has developed the "naïve realism" theory to account for the misplaced faith in slick, hi-fi tech.

The advent of "Authentic Learning" has called for the operationalizing of authentic contexts not to make more realistic simulations, but because cognition is coupled to the situation in which it happens (Onda, 2012). Taken a step further, the characteristics of fidelity, realism, and authenticity may be considered as a blended whole emerging from a given simulation experience where learners are engaged with the material world (Rystedt & Sjöblom, 2012; Ahn & Rimpiläinen, 2018). Reflecting on the perspective that authenticity is an emergent property of the learner's experience, we'll take as the segue into the second thread of this chapter: educational philosophy.

Chapter 8: Proposing Authentic Alignment Theory

8.3.2 Educational Theory—Practice—Philosophies

Over the course of this project, I have shifted away from using the term 'pedagogy' because of its association with early learning and education of children. In his theory of adult learning, Malcolm Knowles (1988) pointed out that adults learn differently than children do, introducing the term "andragogy" to differentiate adult learning. From my perspective in elucidating a spatiotemporal model of curricular alignment, the distinction between adult and child learning is not important. As with many binary relationships, the contrast between child and adult learning is probably best reframed as a continuum that reaches across a lifetime of learning.

There is a wide range of explanations in the literature exploring andragogy, how adults learn (Merriam et al. 2007). Taylor notes that individual theories fall short in explaining "what is happening when an aspiring health professional is engaged in learning" (Taylor & Hamdy, 2013). Modern educational theories broadly emerge from Constructivist roots, especially via Vygotsky (1997). Their view holds that learning is the process of constructing new knowledge on the foundations of what you already know.

It is important to consider that in HPE, including medical programmes and the gateway years that may precede them, learners are coming from a range of backgrounds. Some will have a university degree; others begin their journey into health professions straight from secondary school. HPE also encompasses the considerations of postgraduate and continuing learners. All involved in the educational process will bring their own circumstances, individual constraints, personalities, and experiences. It is the educator's task to understand the nature of the learning environment to best meet the needs of each learner.

In the subsections that follow, four major educational philosophies are described in tandem with some discussion of current

Chapter 8: Proposing Authentic Alignment Theory

applications. These philosophies are classically studied in support of early years education (Noddings, 2018); however, their influence is pervasive as they underpin our collective understanding of learning. Kirch and Sadosfsky (2021) have proposed using the term 'Theory—Practice—Philosophies' to highlight the dynamic, interconnected, and inseparable relationship amongst them.

8.3.2.1 Nativist Approach

Also known as the Innate or Maturational approach, Nativists claim that intelligence is essentially inherited. The founder of eugenics, Francis Dalton, popularised the 19th Century notion that we derive learning capacity from our genes. This view proposes that human experiences are organised developmentally through underlying structures in the brain, such as behavioral genetic studies of intelligence (Plomin & Von Stumm, 2018), and linguistics (Chomsky, 2008; Chomsky, 2014). Nativism is widely considered the oldest educational view, with ideas currently at work in the educational system, such as IQ testing and early tracking of students using norm-reference testing (NRT) that grades students on a bell curve assuming that inherent fixed capacities are predictable.

Jerry Fodor, a contemporary nativist, suggested that the preponderance of our actual knowledge and skills are inborn (Cowie, 1999). This reflects the pervasive nativist principle that heredity determines development, encapsulated in the computer analogy that states that knowledge and particular abilities are hardwired from birth. This intrinsic hardware is required for any learning to take place, just as hardware is required to install software. In practical terms, researchers using empirical methods to study mental activities in the brain using medical imaging (such as fMRI) will often they use the rationale that the software relies on the hardware (Elliott et al., 2020).

Chapter 8: Proposing Authentic Alignment Theory

8.3.2.2 Behaviorist Approach

Behaviorists are also known as environmentalists, as they assert that developmental outcomes emerge from environmental conditioning. This is popularly known as the *tabula rasa* “blank slate” theory which can be traced back to Aristotle’s *De Anima* (1984). Burrhus Frederic Skinner and Edward Thorndike influenced early development of this side of the “nature (genes) versus nurture (environment)” debate, a conversation that continues to evolve. Behaviorists such as Skinner experimented on animals to demonstrate learning through conditioning (Skinner, 1935). Learning was observed in test organisms as new associations between stimuli and responses arose from practice (trial and error) and reinforcement (immediate reward). Behaviorist thought purports that neither agency nor free will, nor even inheritance, determine a child’s development. Rather, it is environment impacting upon the child that determines development.

Watters describes the birth of programmed instruction as a behaviorist tool widely used in medical education today. (Watters & Skinner, 2019). According to Skinner (1945), learning environments should be designed to instill the desired stimulus-response chains, involving the presentation of lessons (instructional stimuli) in small, manageable, pieces. This should be followed by the completion of a related task with immediate feedback of performance provided along with continuous encouragement. Skinner referred to this as programmed instruction, aka the “teaching machine,” a process which is repeated until the students are conditioned to give the right answers (Watters, 2023). Critics of modern conditioning practices that have evolved out of Skinner’s teaching machine refer to them as “drill and kill methods” because as the learner repeatedly drills, so their interest in learning is duly killed (Peterson, 2014). Skinner’s Behaviorism fell out of favour after challengers demonstrated

Chapter 8: Proposing Authentic Alignment Theory

convincingly that conditioning could not explain all of learning (Simonton, 1994).

Despite losing its original popularity, Skinner's solution would ultimately influence all educational settings, which is perhaps why Watters (2019) has referred to him as the most important theorist of the 20th Century. Behaviorist ideas are fundamental to what could be considered today's 'normal' instruction: fact recollection, conceptualisation, analysing explanations, rote memorization, drill and practice routines, utilising learner management strategies and employing token economics.

8.3.2.3 Constructivist (aka Interactional) Approach

Constructivism is sometimes referred to as interactionism. Jean Piaget and his colleagues developed their constructivist ideas in response to older views of the learner as a passive recipient of constraints. Piaget was influenced by his observations of Maria Montessori's classrooms (Mooney, 2013). Montessori is well known for her belief that children ought to self-educate and this process is best supported by an expert teacher who can provide them with a rich educational environment (Montessori, 1959; Montessori et al., 2017).

Constructivism is an umbrella term representing a diverse corpus of theoretical approaches. According to Piaget, development and education are not controlled by internal (nativist) or external (behaviorist/environmentalist) forces. Rather, Piaget proposed that children are in fact inherently curious young research scientists compelled to explore the external world (Piers, 1972, p. 27). As argued by Montessori, children absorb what they encounter as a natural consequence of their explorations. They do so, armed with their pre-existing construct of reality, known as *schemas*.

Chapter 8: Proposing Authentic Alignment Theory

As learners are regularly faced with new environmental phenomena, they instinctively assimilate them into their schema. During this process, an uncomfortable disequilibrium arises between children's schemas and the external world, because the new phenomena doesn't quite fit within the old schema. It is this pressure, arising from a complex system pushed beyond its equilibrium state, that stimulates learning and development. Consequently, a new and temporary equilibrium arises as the child sits comfortably between her newly developed schemas and the external world. This equilibrium continues until the learners come across new environmental phenomena that stimulates another state of disequilibrium. Learning is thus constructed by the learner interacting with their environment and requiring little intervention (Piaget, 2015).

Piaget and Montessori's constructivist theories were a challenge to nativism, yet their educational implications resonate with nativist directives to abandon intervention. Both philosophies advocate the provision of opportunities for exploration, but neither nativists nor constructivists believed it was possible to accelerate a child's development or to directly promote learning. Piaget and Montessori both proposed universal cognitive development stages fixed to a strict timetable (he later retracted these) (Piaget, 1972). His proposed stages appear in accordance with a timetable universally applicable to all children regardless of their background. Although learners may construct their cognition, neither they themselves nor their parents or teachers can influence the rate of their development.

Detractors of constructivism point to its inefficiency, since its process demands that learners sit with the struggle of their disequilibrium for as long as it takes to resolve. A related challenge arises in the potential for misconceptions to develop in the lag time,

Chapter 8: Proposing Authentic Alignment Theory

errors that are never corrected for the lack of feedback in the moment. Another concern is that young learners are biologically and chronologically fixed to each stage and have no other recourse for progression. Constructivism in early education is widespread and is also pervasive in medical education via problem-based learning (PBL), self-directed learning (SDL), and independent learning.

The continuing evolution and amalgamation of theories has found particularly fertile soil in educational psychology, contributing to metacognition of learning (Colthorpe et al., 2018) and self-awareness. The umbrella of HPE appropriates constructivism from the theoretical foundations of the Piagetian psychogenetic approach, the theory of cognitive schemas, the Ausubeline theory of assimilation (Daley et al., 2010) and meaningful learning, and Vygotskian sociocultural psychology (Nalliah & Idris, 2014).

According to Rillo et al. (2020), contemporary medical education assumes the following principles:

1. The student is ultimately responsible for their own learning
2. The student's constructivist mental activity is applied to content that already has a considerable degree of elaboration, and
3. the teaching function is to integrate the student's construction processes with collective knowledge (Arab et al., 2015)

8.3.2.4 Vygotskian Approaches

The Vygotskian approach calls for some intervention in the learning process. Introduced by Lev Vygotsky and his students in 1930s Stalinist Russia and by Jerome Bruner and Michael Cole among others in the 1970s West (Vianna & Stetsenko, 2006), it falls under the umbrella including (among others) socio-culturalism and social constructivism (Gergen, 1994).

Chapter 8: Proposing Authentic Alignment Theory

Vygotsky had a divergent epistemological stance: learning and development are a function of mediation (Karpov, 2014). Whereas nativists hold that learning and development are predetermined by heredity, behaviorists hold that it is determined by conditioning, and constructivists hold that it is created through learner's independent explorations, Vygotsky's revolutionary idea was that learning can itself lead development.

Contrary to fixed developmental stages, learners do not simply wait until they're biologically ready for a new period of development. Rather, teachers have a more active role in the form of "scaffold teaching-learning" within which the learner is supported to master symbolic, cultural mediators through their "appropriat(ion) and internalization...of inner psychological tools." (Kozulin, 2003, p. 24). Vygotsky's term, the zone of proximal development (ZPD), describes how the teacher sets up, or scaffolds, the next outcome for learning (Wood et al., 1976; Vygotsky & Cole, 1978). Since its introduction and through the development of related socio-cultural-historical theories, Vygotsky's approach has permeated all fields of education.

8.3.2.5 Curriculum as a problem space

Although the previous section provided a brief background of educational philosophy from a historical perspective, it is important to clarify that this project is not fundamentally concerned with educational philosophies or theories of learning. I chose to include this section to provide some needed context on CA as a pedagogical model of alignment, one that I contend remains valuable. This project is essentially concerned with justifying why modelling aspects of education are important and suggesting an update to Biggs' model of CA. Where evaluating authenticity may be a fundamentally intersubjective question, this thesis draws alignment

Chapter 8: Proposing Authentic Alignment Theory

of the LE into the problem space of Margaret Archer's critical realism.

Biggs expresses ideas about approaching the notion of alignment using phenomenology and comes at the issue from a systems perspective as early as 1993: "Theories of learning and teaching have tended in the past to have been derived top-down, from existing theory. It is increasingly recognised today that such a strategy oversimplifies a complex reality, in which there is a great deal of mutual interaction. One way of handling the situation is to derive contextualised theories, such as phenomenography. Such theories are however part of a more general model based on ST, in which all parts of the teaching-learning context are seen as seeking equilibrium. A "system" may exist at several levels: The student, the classroom, the institution, the community. The task of teacher and of staff developer is to achieve those good teaching practices that are viable within the existing matrix of systems and subsystems." (Biggs, 1993).

8.4 From Curriculum to Learning Environment

The use of a constructivist framework in teaching the sciences has been criticised by Jervis et al. (2005) for reasons around its epistemological validity as compared to realism. Nevertheless, Biggs' conceptual model of CA, borne out of the constructivist education discourse, was a monumental contribution to the field of education and remains relevant in curriculum design (Biggs, 2014; Thian et al., 2018; Stamov Roßnagel et al., 2021). The paradigm of critical realism has provided me a suitable framework for boldly reimagining constructivist pedagogical models, namely Biggs' CA, for use in HPE environments.

To shift from constructivism to critical realism is not to throw away constructivist roots, the baby out with the bathwater so to speak.

Chapter 8: Proposing Authentic Alignment Theory

Rather, we are entering the intransitive realm via dialectics, conversations between tensioned poles. For shifts like this to happen, the poles have to remain as such, polarised.

Moving from the traditional curriculum front-loaded with transmission style instruction toward a complex, integrated curriculum embracing timescales has been discussed previously in this thesis. At this point, it is time to make the critical transition suggested in the IPA study presented in Chapter 7: the curriculum is complex, but more importantly, so is the learning environment. The curriculum as a complex problem space is a view supported by McKimm and Jones (2018), who describe it as “a dynamic, complex process which is continually being constructed and mediated through the interaction between teachers, students, the external world, and knowledge,” citing (Knight, 2001) and (Kelly, 2009). Development and implementation of proposed changes to a curriculum are largely influenced by the perception of the stakeholders, with a range of unintended consequences characteristic of nonlinear, complex systems. The shift from “curriculum” (top-down constraints) to a focus on modelling the emergent “learning environment” requires an upgraded spatiotemporal model.

8.4.1 Describing the LE – toward authentic alignment

A pervasive disconnect in curriculum design perspectives frustrates the synthesis of relationships amongst the constituent elements of the LE. Khanna et al. (2021) highlight that this lack of connectedness blocks the curriculum from lending “coherence and meaningfulness to all stakeholders.” They point out that the absence of “synthetic and overarching curricular perspectives” is inferred from the literature that “broadly suggests two key models that underpin medical program curricula: prescriptive and descriptive models” (Prideaux, 2003).

Chapter 8: Proposing Authentic Alignment Theory

8.4.1.1 Prescriptive models such as competency based medical education

Prescriptive models include the LO-driven curricula normally dominant in UK medical schools. Even contemporary attempts to integrate curricula are primarily outcomes-based emphasising the competencies that graduates are expected to demonstrate at the end of their medical training (Hall et al., 2021). The competency-based education (CBE) approach, based on the prescriptive model, has been criticized as an exercise in box-ticking (Black, 2016) where the large number of competencies needing “signed off” and misunderstood assessment scenarios in the workplace resulted in high anxiety (Talbot, 2004; Depelteau et al., 2010). Advocates of prescriptive curricular models such as CBE claim them to be relevant to supporting learners in developing transferrable skills. As described by Ross, et al. (2022, p. 528), “this educational framework focuses on defining specific outcomes of training (competencies), and then designing curricula and assessment to ensure that the necessary competencies can be learned and demonstrated throughout training (Ten Cate, 2014).”

CBME – competency based medical education – is defined by Frank et al. as an ‘outcomes-based approach to the design, implementation, assessment, and evaluation of medical education programs, using an organizing framework of competencies’ (2010, p. 641). According to Frank et al. (2010), the goals of CBME are to prepare physicians for practice by focusing on outcomes, “emphasising abilities, deemphasizing time-based training, and promoting learner centeredness”. Advocates of CBME promote it as a means of fostering continuous self-assessment, facilitating life-long learning skills and reflective professionalism (Miser & Haynes, 2019).

Critics of CBME and the prescriptive approach to curriculum design have pointed to the risks of outcome-based designs at the

Chapter 8: Proposing Authentic Alignment Theory

conceptual, assessment, and practical levels (Touchie & Cate, 2016). Risks include “tendencies to reductionism and oversimplification of complex capabilities and critical skills such as professional judgement” (Lee et al., 2013) as highlighted by Khanna et al. (2021). For reasons previously mentioned (hammer and nail), prescriptive models tend to dominate approaches to curriculum development. However, attempts towards more descriptive models have come to attention in the literature over the last three decades. For example, Skilbeck’s situational model (Soliman, et al., 1980) and Pinar et al.’s curriculum reconceptualization theory (Green, 2018), and more recently, the symbiotic curricular model (Depelteau et al., 2010).

The PRISMS model (product focused’; ‘relevant’; ‘inter-professional’; ‘shorter, smaller’; ‘multi-site’; and ‘symbiotic’), has developed as a symbiotic design aiming to guide designs that build and nurture relationships between medical schools and healthcare services (David Prideaux, 2007). Ultimately, even these more descriptive designs do not speak to the importance of galvanising the various curricular elements toward optimising the “learning trajectory” of students navigating the complexities of their journey toward the evolving realm of professional practice in order to practise in evolving healthcare models and practices (Bleakley, 2012).

The ‘3P-6Cs’ “thinking toolkit” proposed by Khanna et al. represents a systems-oriented, complexity-friendly framework for engaging with a descriptive approach to influencing the LE. It “illustrates a student’s journey through interactions and intersections of various curricular elements at the personal (P_1), program (P_2 with 6Cs), and practice (P_3) levels. The *personal* describes core considerations of learning at the level of an individual learner; the *program* describes the features or elements of a curriculum, both the explicit and

Chapter 8: Proposing Authentic Alignment Theory

hidden, that a learner navigates through; and the *practice* describes the wider context for learning within the clinical workforce” (Khanna et al., 2021).

8.4.1.2 Seeking a descriptive model for the LE

It follows that designs can either be prescriptive or descriptive, and that the prescriptive approach can be said to dominate curriculum design. I contend that descriptive approaches to modelling the LE that can embrace its inherent uncertainty are aligned with a complexity perspective and are more authentic. The remainder of this chapter works through the ontological rationale for taking up a descriptive approach to modelling alignment, understanding the LE through Archer’s analytic dualism (1995).

8.5 Embracing uncertainty using analytic dualism

Toward clarifying where my contribution sits in the schema of curriculum theory, I’ll go back to Macdonald’s early 1970’s work that provides three categories: knowledge oriented, reality oriented, and value oriented. What he said about curriculum theorising fifty years ago holds true today: it “is one of the least understood activities in the total profession, yet it has a fundamental meaning inasmuch as it can be thought of as the essence of educational theory since it is the study of how to have a learning environment.” (Macdonald, 1971).

Over five decades ago, Macdonald (1971) defined knowledge-oriented work around the curriculum as that which makes epistemological questions the primary value. Further, he described reality-oriented work as that which makes an essentially ontological priority commitment. He characterised value-oriented theorists as basically curriculum designers, those tasked with making and implementing the named designs we are familiar with in the field, such as CBME, PBL, Integrated, and others. Considering these

Chapter 8: Proposing Authentic Alignment Theory

distinctions, I consider this project to be reality-oriented work as it is couched in the critical realist paradigm. This doctoral project proposes a model of the learning environment. In the sense that critical realism is always seeking an understanding of the intransitive aspects of real via theorising within the transitive realm, and it does so by way explanation, I believe this model to be explanatory of the learning environment.

Further, the ontology-oriented work presented here can be considered within CR's analytic dualism. This approach to realist work was first championed by Margaret Archer, recognising that while structure and agency remain interdependent, they operate on different timescales (Archer, 1995). The morphogenetic model, an approach situated in the language of critical realism, refers to emergence in its ontological account of the way that structure relates to agency. The analytical dualism at the heart of her morphogenetic approach allows Archer's (1995) perspective to provide insight into the "conditional and generative mechanisms operating *between* structure and agency (p. 16). In the next section, agency and structure are explored as distinct. I will discuss why this distinction is important in the consideration of a model of the learning environment.

8.5.1 Agency-structure relationship in terms of CR

In RTS, Bhaskar (1975) offers a justification for utility of scientific experiment based on the three domains of reality as per critical realism. In this argument, experiments are important because of the possibility for alignment of the three domains whereby they become "in-phase". He goes on to philosophically assign distinction between agency causality:

"Now an experiment is necessary precisely to the extent that the pattern of events forthcoming under experimental conditions would not be forthcoming without it. Thus, in an experiment we are a

Chapter 8: Proposing Authentic Alignment Theory

causal agent of the sequence of events, but not of the causal law which the sequence of events, because it has been produced under experimental conditions, enables us to identify.” (Bhaskar, 1975, p. 23). Here, Bhaskar provides a philosophical distinction between agency and structure. Critical realism “grew up” in the era of the postmodern turn, characterised by a limitation of agency... “seeing the human as the patient of History rather than its agent.” (Fitzhugh & Leckie, 2001). This could be described as a pendulum swing away from the Humean centrality of causation whereby the Enlightenment woke up to the power of reason and human agency (Kocsis et al., 2021). So, although there is no problem differentiating structure and agency, there is a well-established precedent of one subsuming the other.

This tendency for agents to collapse into structures is one of the enduring problems of social science and one that beats with the heart of CT as well. In this consideration of the LE as a social structure that has intrinsic complexity properties ripe for modelling through geometry, so too rises the age-old question of relationships between people and structure. Complexity theorists model systems after murmurations of starlings and shoals of fish, which are physical systems with complex geometric relationships demonstrating adaptive behaviour. The issue at hand in applying CT to social structure is such structures are abstractions of relationships, models of concepts rather than physical systems of birds and fish in direct relationships. Emergence becomes a problematic quality without a clear framework for distinguishing the geometric behaviour of the model from the agency of users *over time*.

8.5.1.1 Disambiguating Reduction

A key challenge in applying complexity to social structures is the confusion of [at least] two kinds of reduction. This section will focus

Chapter 8: Proposing Authentic Alignment Theory

on disambiguating epistemic reduction from the usage of “reductionism” commonly attached to traditional positivist science. The epistemic reduction rests in the assumption that knowledge from one scientific domain can be reduced to another, which is essentially what is happening when one applies CT to the social sciences.

Reduction is especially important in multidisciplinary frameworks seeking common ground for the hard and soft sciences, because the philosophy of science abounds with all kinds of different reductions (Dupré, 1993). Reduction in its broad sense is about reasoning out relationships. Where HPE (a social science) is coming to terms with the learning environment in terms of CS, reduction is a key concept.

The verb ‘reduce’ is not a value judgement. It derives from the Latin ‘*reducere*’, meaning ‘to bring back’, pointing to the process of interchange cycles in philosophy. In terms of biology, where CT finds many of its most compelling illustrations, a scientist confidently assumes that heat reduces to molecular (kinetic) energy. In this sense, heat can be *brought back* to molecular energy.

In terms of social science, reducing one theory to another – e.g., hidden curriculum theory (x) to complexity (y) – means that the reduced theory x (HC) can be brought back to the reducing theory y (CT). In philosophy, the term ‘reduction’ expresses the evolutionary relationship of entity x to entity y. If x *reduces* to y, then y is *prior to x*, is *more basic than x*. Saying x reduces to y conventionally implies that x is *nothing more than y*. That is to say, x is constituted by and *fully depends upon y*. When we say that *curriculum theory* reduces to CT, we are saying that it is brought back to complexity. And by *complexity*, what exactly do we mean?

Chapter 8: Proposing Authentic Alignment Theory

8.5.1.2 Reducing for Complexity

Recall that in the previous chapter, I presented Sturmburg's (2017) definition of complexity as "a functional characteristic of a system". CS has been recognised as the "new science" (Man Joe Ma & Osulaz, 2011, p. 94) that considers organisations as complex systems that defy traditional linear approaches toward understanding and predicting their behaviour (deMattos et al., 2012). deMattos et al. (2012) have identified three trends contributing to the rising popularity of CS: rapid change, information proliferation, and the dissolution of organisations. HPE is no doubt grappling with the first trend, reflecting the pace of dramatic changes due to "globalization, intensive local and global competition, process re-engineering, workforce diversity, quality improvement, and continual innovation" (deMattos et al., 2012, p. 154). The second, the rapid proliferation of information overload, is rampant in health professions (Kumar & Maskara, 2015).

As previously mentioned, CT is often represented in the realm of biologic, dynamical systems and computational models such as algorithms, chaos and fractality. These systems are conventionally understood in terms of their behaviour, as a *function* of their geometry. Such systems are not typically subjected to the agency-structure scrutiny because of their intrinsic heter-archy – "internal ruling principle" – where agency is something of a moot point. Behaviour emerges from such systems as an adaptation to their ongoing functionality in response to the world of constraints.

That there is risk for reductionism here is ironic and testament to the complication and conflation of words and concepts, since CT is hailed for "exceeding the limitations of reductionism" in its transdisciplinary application (Mazzocchi, 2008). In this sense, authors talk about scientific reductionism – and associated realism – as the foil for complexity (Turner & Baker, 2019). Proponents of

Chapter 8: Proposing Authentic Alignment Theory

complexity point to the conventional use of reductionist frameworks and realist philosophy in science (Westhorp, 2012) to reduce entity x to its *smaller parts*.

This contrasts with the epistemic reduction described previously, where we assume x can be reduced to y . Reductionism in the popular CT sense is referring to the parts-whole relationship. In the so-called “reductionist science” as it is popularly now known, the whole entity can be understood more comprehensively by understanding its constituent parts, a view that dominated the Cartesian era and ushered along the Industrial Revolution (deMattos et al., 2012).

In the words of Turner et al. “Complexity science expands on the reductionistic framework by not only understanding the parts that contribute to the whole but by understanding how each part interacts with all the other parts and emerges into a new entity, thus having a more comprehensive and complete understanding of the whole.” (Turner & Baker, 2019).

Chapter 8: Proposing Authentic Alignment Theory

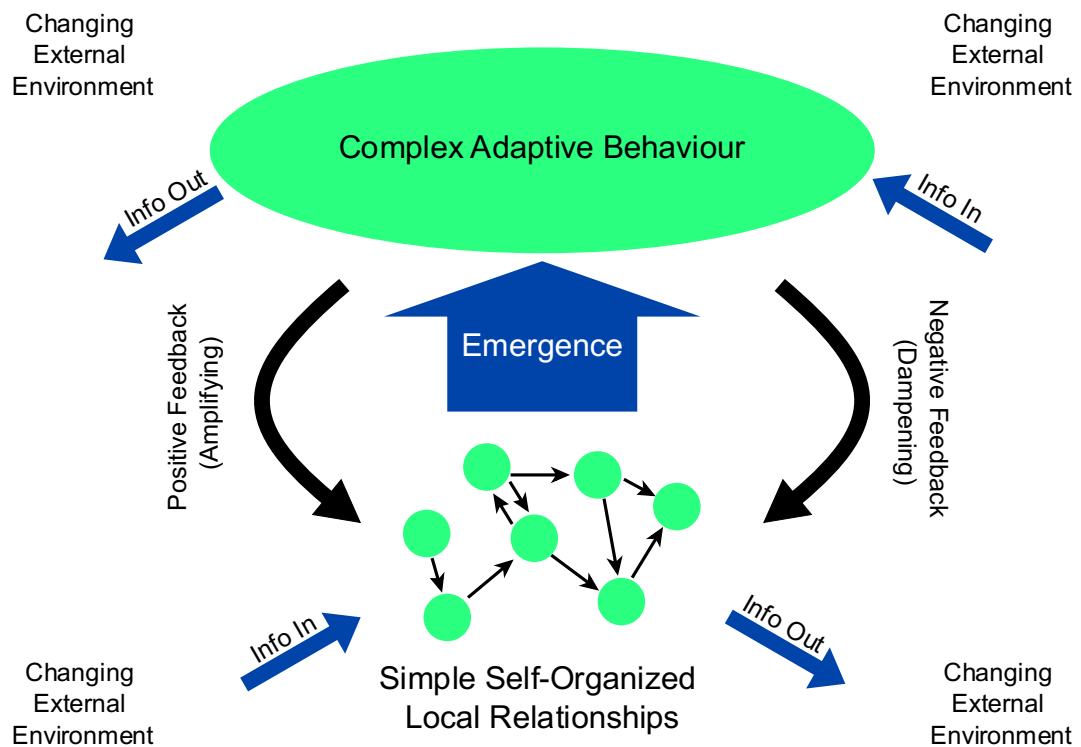


Figure 20: Diagram of a CAS. Image designed by the author using Canva.

For authors such as Turner advocating CT and its CAS as a framework for enquiry in social sciences, causal research around individual linear relationships represent the fatal flaw that renders reduction-to-parts methods inadequate for the “wicked problems” of today. They call for a comprehensive approach to reckon with the unpredictability and uncertainty found in complex systems (Westhorp, 2012). To better understand the “real-life complexity” (Haslberger, 2005, p. 162) of systems we experience in social sciences, CS casts the CAS as “a framework for understanding these systems” (deMattos et al., 2012, p. 1550). See Figure 20. This reinforces the idea of complexity as a structural quality (x) – and adaptation as the behaviour (y) – of such a system, where we can “bring back” x from y by way of reduction.

Fully availing HPE to the models of complexity requires HPE researchers to become *au fait* with reduction insofar as to

Chapter 8: Proposing Authentic Alignment Theory

distinguish these two basic forms. There is the reduction often used as a generalisation about traditional science reducing entities to their smaller parts and focusing on linear relationships between those parts, often forgetting the whole, or trying in vain to understand the whole merely via investigation of parts. This is normally what is meant by “reductionist science” when pitted against CS as “new science”. Then there are the many other types of reduction used in the philosophy of science to talk about relationships, for example relationships between a structure (e.g., complexity) and its behaviour (e.g., adaptation).

8.5.2 Multiplicity: a confluence of complexity

The general line for proponents of CT is that while reductionist science has historically served humanity well, it simply cannot fathom the complexities of globalisation. This section aims to describe how HPE research has drawn on CS in response to these challenges. The unavoidable pendulum swing has ushered in a consideration of simplicity alongside and in useful opposition to complexity (Berlin et al., 2017; Wolkenhauer, 2014).

Within the discourse, across disciplines, there is a conversation about complexity in terms of simplicity considering Ashby’s law as adapted by Pina et al. (2010): “only simple organization provides enough space for individual agency to match environmental turbulence in the form of complex organizational responses.” The simplicity-complexity dialectic is rising to prominence in the literature in health (Peterson & Fraser, 2001; Pearce & Merletti, 2006; Weinberg, 2014) and organisational sciences (Paola & Leeder, 2011; Collinson & Jay, 2012), with evidence of the tension present from much earlier (Barron, 1953).

In response to this tension between simplicity and complexity, a third stance has arisen in the form of *multiplicity* (Carter et al., 2021; Troccoli et al., 2022). For example, Troccoli et al. (2022)

Chapter 8: Proposing Authentic Alignment Theory

have described the multiplicity of ways in which participants in their study of refugees manage their health, reporting on “highly varied” usage of various combinations of NHS and private sector services. In addition, their study incorporated the time factor in our analytical framework to categorise engagements with health services “as linear, nonlinear and singular depending on how access to services for specific health needs occurred in time”, arguing that their results demonstrate how service access is multilinear (Troccoli et al., 2022).

In conclusion to their evidence synthesis, Cristancho et al. (2019) advocate for medical education shift away from complexity to the multiplicity stance. Their suggestion is evidently based on the revelation that CS is not adequately understood, reflected in their reports of four problematic patterns in how CS is used in medical education research. Their results are summed up in that CS is described in a variety of ways with multiple combinatory approaches to complexity in single papers where the type of CS use tends to be left implicit, with references using secondary rather than primary sources (Cristancho et al. 2019). Complexity is so appealing as a concept it has come to enjoy ‘god status’ in various disciplines (Richmond, 2007). However, it appears that it is suffering from misapprehension and confusion in its practical applications, not least in the field of HPE.

8.5.2.1 Mitchell, Castellani, and Manson: relevant overviews of complexity

As Cristancho et al. (2019) provide a cogent synthesis of complexity usage in medical education, I will draw on their presentation of three scholarly perspectives on CS as they pertain to complexity in HPE, starting with Melanie Mitchell’s multidisciplinary history of CS. This section will also look at Brian Castellani’s temporal description evolution of CS in terms of its evolution, followed by a summary outlook of CS as pertaining to three main orientations according to

Chapter 8: Proposing Authentic Alignment Theory

Steven Manson. Mitchell's history describes the quest for common governing principles regarding complex systems gained momentum in the 1940s in response to the crises in the natural sciences (Mitchell, 2009). As conventional science could not explain phenomena such as the adaptive and nonlinear behaviour of living organisms and the unpredictability of weather events, scientists began exploring the relation between physics and life sciences beyond the reductionist approach (Beyler, 1996).

Castellani and Gerrits (2018) have built an evolutionary timeline that maps the advent of CS from the mid-twentieth century to the present (see Figure 21). Their map portrays CS as the evolving corpus arising from a network of interdisciplinary scholars whose synergistic enterprise has resulted in a progressive resource of complexity-minded applications. Over the decades, CT has arisen as the result of many authors' overviews and interpretations of intersecting theories, concepts, and methods used in different fields.

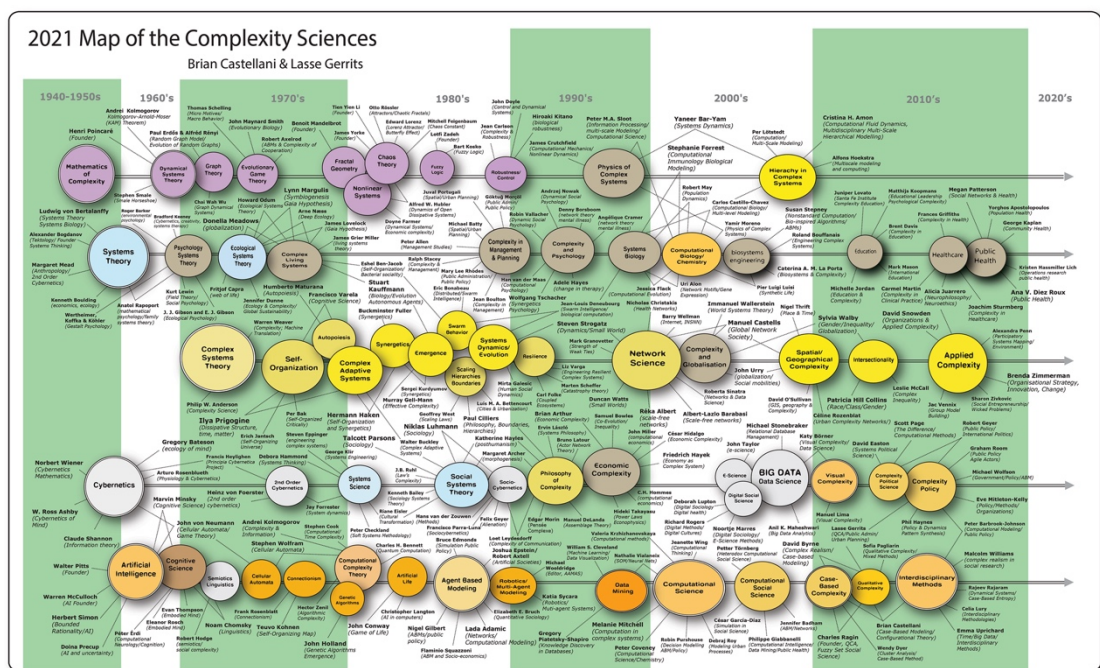


Figure 21: Map of the Complexity Sciences by Brian Castellani and Lasse Gerrits (2018).

Chapter 8: Proposing Authentic Alignment Theory

Reckoning with this diversity is Richardson et al. (2001) who have suggested that complexity has three modes in its usage, the first two they refer to as 'hard' CS and 'soft' CS. The area in-between represents the third mode, what might be called 'complexity thinking'. Complexity thinking is a path for the HPE researcher concerned with what they describe as the 'middle way', where "equal attention paid to qualitative as well as quantitative approaches to analysis." (Richardson et al., 2004).

8.5.2.2 Flavours of complexity in Manson's conceptual framework: algorithmic, deterministic, and aggregate

The third perspective relevant to an HPE-focussed understanding of complexity usage is Manson's framework (2001). Cristancho et al. (2019) distinguish Manson's framework as it "offers explicit attention to disciplinary origins that will be valuable to the interdisciplinary endeavour of the medical education community." For a doctoral thesis operating conceptual within a hermeneutic fusion of horizons, Manson's framework is particularly resonant as it is driven by the assumption that applications of CS will always be shaped by the approach of the respective discipline. CS approaches are thus categorised in terms of disciplinary motivations, patterns in definitional terms and epistemological assumptions (Manson, 2001). Cristancho et al. (2019) point out that this framework allows an understanding of "high-level patterns across the diversity of approaches narrated by Mitchell (2009) and visually depicted by Castellani [& Gerrits] (2018)".

Manson's framework elucidates three approaches to CS, each concerned with how the nature of a system may be understood in non-reductionist reflection to its constituent parts. These approaches arise from mathematics in the form of algorithmic complexity, from physics in the deterministic form, and from biology in the form of the aggregate approach (Manson, 2001). For

Chapter 8: Proposing Authentic Alignment Theory

disciplines seeking a mathematical or computational reproduction of a system's behaviour, algorithmic complexity is the operative mode. Algorithmic complexity is concerned with abstract representations of physical phenomena such as the capacity of the nervous system for information processing. However, where the goal is to predict a system's identity or dynamics quantitatively, deterministic complexity is the appropriate choice.

Where environmental or mechanical problems are concerned, deterministic complexity factors in feedback, nesting, attractors, and deterministic equations for integrating the relevant phenomena in a positivist perspective. An example rests in the global approach governments took to managing the COVID-19 pandemic, where analyses of data were modelled systematically attempting to delineate the underlying pathogenesis and project outcomes. Deterministic mathematical models of disease progression were designed to predict the clinical outcome, factoring in causal factors known to contribute to COVID-19 pathology. Age, comorbidities, together with certain viral and immunological parameters were used by Chirmule et al. (2021) to show the influence of each of the parameters on the outcome, where positive values correlate positively towards disease severity, and negative values towards asymptomatic disease. Deterministic complexity hinges on the assumption that a system can be described by the interaction of a few key variables in a small set of equations. However, where social phenomena are concerned, deterministic equations are typically inadequate because of the unpredictability that characterises human behaviour.

Between algorithmic and deterministic complexity there is aggregate complexity, which aims for more comprehensive models. Like algorithmic and deterministic complexities, it uses feedback and non-linearity. The difference is that aggregate complexity

Chapter 8: Proposing Authentic Alignment Theory

incorporates relationships for a holistic representation of a system in relationship with its setting. Aggregate complexity aims to understand how systems are created by interactions, with less focus on measuring variables between the internal components. It takes into consideration relationships between internal structure and the surrounding environment, as well as learning and emerging behaviour in an ecological embrace. In this sense, aggregate complexity is often associated with a constructivist perspective (Doolittle, 2014; Wilkinson et al., 2020) with respect to its interest in a system's adaptive behaviours, and the learning process that results from constituent interactions. Aggregate complexity foregrounds the importance of self-organisation, a quality that refers to elements within a system constantly adjusting to better serve the whole.

In studies seeking to understand the development of humility in interpersonal clinical relationships (Frie & Timm, 2023), for example, aggregate complexity is the natural approach. For subjective qualitative questions that are defined by individuals and their relationships, aggregate complexity takes into consideration the relationship amongst the individuals and their context. In the study referenced above, Frie et al. (2023) present an interprofessional clinical education model using student-led, faculty-guided clinics interacting with rural Midwest American communities lacking health care access. In their report, all aspects of the internal and anchoring relationship are taken into consideration.

8.5.2.3 The multiplicity of complexity

These three orientations to complexity as described by Manson (2001) are an opportunity for working with a multiplicity of complexity ideas. Cristancho et al. (2019) make a compelling case for the multiplicity stance in consideration of how medical education ought to approach complexity given the high degree of confusion

Chapter 8: Proposing Authentic Alignment Theory

and disagreement in its usage. They point to Manson's orientations as a sound compass, as his framework accommodates "a range of epistemological perspectives which suggest that understanding complex systems requires triangulation among approaches and viewpoints" (Cristancho et al. 2019).

Manson's conceptual framework allows HPE researchers a lens for critically appraising relevant problems from the appropriate orientation. Together with Mitchell's narrative history (2009) and Castellani & Gerrit's visual timeline (2018), Manson's three orientations have strongly informed my interpretation of CS as a multiplex. Complexity has a multiplicity of meanings and calls for informed usage. This understanding of the 'multiplicity of complexity' challenges researchers in HPE to apply due rigour while interpreting their findings in relation to the field of CS.

8.5.3 Dialectic of Structure-Agency in the pursuit of Complexity Theory for HPE
This chapter will now continue with a discussion of what reduction means for models of social science structures such as that of Biggs' (1996) CA. Critical realism considers entry into hermeneutic dialectics as a key phase of doing science. For this project, it is the dialectic of agency and structure that form the operative poles of tension. For the purposes of this enquiry, I am considering the triangle of Biggs' (1996) CA as an entity enmeshed into the larger entity of the learning environment as a social system.

The dialectic of agency and structure forms a central volley for social theorists in accounting for the development of social systems. This chapter now presents the polarity of Giddensian versus Archerian views on structure-agency and will subsequently focus on Margaret Archer's Morphogenetic approach as compatible with CT as a lens for examining alignment of curriculum with the LE. Anthony Giddens' (1984) theory of structuration operates via the integration of agency and structure. For Giddens, structure and agency are two

Chapter 8: Proposing Authentic Alignment Theory

sides of the same coin. As Morrison (2005) describes structuration, “such ‘duality of structure’ is not external to individuals and groups but internal to their lifeworlds.” See Figure 22 for a visual depiction of structure and agency as two aspect of a single, integrated entity.

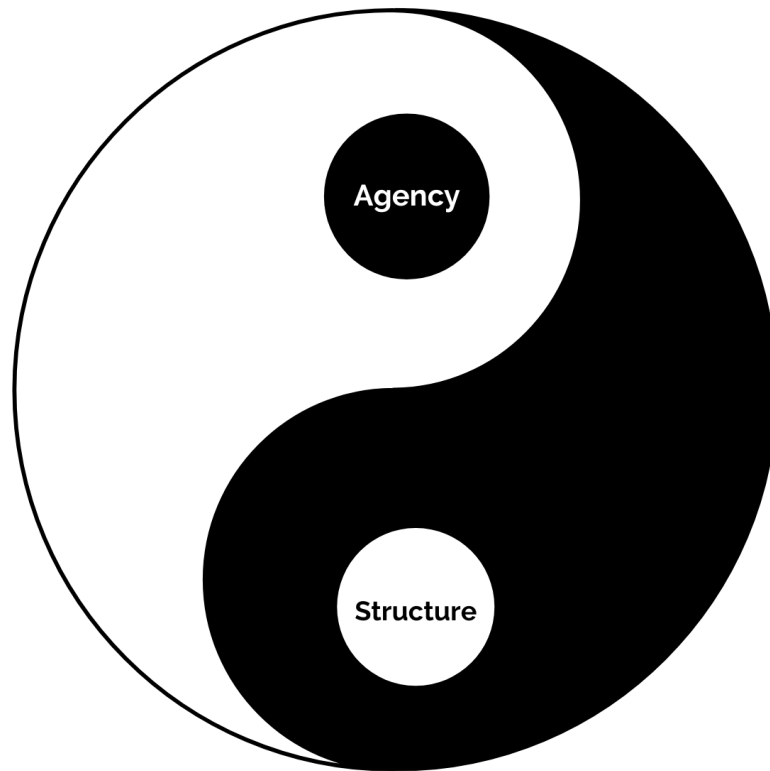


Figure 22: Structuration sees the system as a unification of agency and structure. Image designed by the author using Canva.

To illustrate the practicalities of the Giddensian agency-structure construction, let’s take the example of anatomy educators under pressure from all sides to deliver a set of unreasonably broad learning outcomes. In the study of anatomy educators presented in Chapter 5, educators bemoaned such “broad LOs” because expecting students to effectively focus their limited time in pursuit of such amorphous, ill-defined umbrella outcomes is unfair. The uncertainty foisted on the educators, and by extension onto the students, was implicit and remained hidden in the obvious.

Chapter 8: Proposing Authentic Alignment Theory

These educators were forced into pushing a virtually endless set of facts about a region into didactic lectures, without knowing with any certainty which 'anatomical facts' might be assessed, sometimes repeating such lectures to several student groups in one day. Such pedagogical practice runs counter to their directives toward an "authentic, student-centred" approach, but the educators persisted in using these methods. Some repeat the didactic methods out of choice, others are forced into it by the circumstances of the role, but the outcome is the same: repetition of the status quo.

8.5.3.1 Structuration and the persistent collapse of agency

Giddens' (1984) structuration theory provides the rationale for how people create, reproduce, and reinforce social practices. His ideas are prefaced with the famous dictum about people making their own history, "but they do not make it under circumstances of their own choosing" (Marx, 1852, p. 115). Through our own agency, we produce and reproduce systems as a construction of our everyday interactions. In turn, these systems constrain our behaviour – not unlike the way the complex geometry of a system constrains and influences adaptive behaviour. It follows, 'all human action is carried on by knowledgeable agents who both construct the social world through their action, but yet whose action is also conditioned and constrained by the very world of their creation' (Giddens, 1981, p. 54).

Structuration contends that anatomy educators, in their normal interactions and everyday working lives, make choices that both constrain and enable the social structures that define their role, which are both the medium and outcome of social production and reproduction (Giddens, 1976). In structuration, moments of agency can also be the moment of social reproduction where "history repeats itself". Giddens contends that in our actions, we reproduce the conditions of reproduction, 'the conditions that make these

Chapter 8: Proposing Authentic Alignment Theory

activities possible' (Giddens, 1984, p. 2), which may shed some light on why so many anatomy educators cling to dissection as the one 'gold standard', hanging onto the spotter tests as a kind of rite of passage. According to Layder (1994, p. 133), 'as ciphers of structural demands, people are condemned to repeat and reinforce the very conditions that restrict their freedom in the first place'. Whether unknowingly or otherwise, we as humans perpetuate our social constraints in the form of resources, rules, models, and norms. See Figure 23.

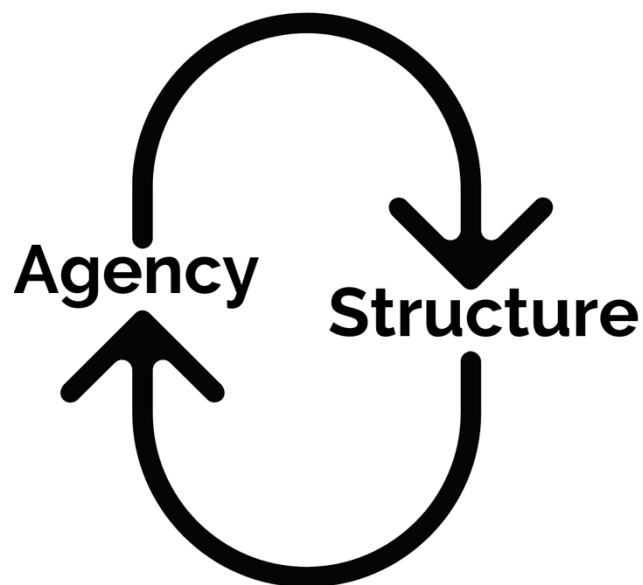


Figure 23: Agency-Structure feedback loop. Image designed by the author using Canva.

Whether a system stagnates or innovates to adapt the alignment of its internal relationships, is a key question for HPE. For Giddens, routinisation begets inertia instead of change; as he contends (1984, p. 2), 'human social activities, like some self-reproducing items in nature, are recursive. That is to say, they are not brought into being by social actors but continually recreated by them via the very means whereby they express themselves as actors'. This view reflects the broadly constructivist, postmodern tendency to banish

Chapter 8: Proposing Authentic Alignment Theory

agency, or at least to collapse it into the overarching behaviour of social systems.

HPE is only too aware of the STEM tendencies to perpetuate classically reductionist (to parts) curricula seated in the positivist paradigm of realism. In response, we have seen the turn toward Authenticity in HPE and related disciplines. This project anchors the aims of its enquiry in a decidedly post-positive, critical realist stratified ontology seeking an understanding of casual mechanisms.

Critical realists are looking for the emergent properties of phenomena to better understand and influence future outcomes. This axiology is tantamount to an alliance with the aims of sociology, to understand and foster change in our systems. In particular, this HPE project seeks an understanding of the relationship between structure and behaviour as a function of alignment for the purpose of increasing 'authenticity'. Where Giddensian structuration (anchored in constructivism) does not allow for objects and subjects to be considered as discrete entities for the purpose of analysis, there is an approach to critical realism that treats structure and agency as separate, yet interdependent, entities. Reflecting on the advent of CT in HPE, there is a need to reconcile, from an analytical standpoint, the nature of social structures such as the learning environment with agency available to its denizens.

8.5.4 The Freedom of Separation: Archerian Morphogenesis

Margaret Archer's (1995) Morphogenetic/Morphostatic (M/M) approach has risen to primacy championing analytic dualism, the recognition of agency and structure as distinct entities. The following sections will explore how M/M is compatible with CT and best suited to approach the 'micro to macro' structure-agency problem that concerns "our capacity to explain the relationship between the constitutive elements of social systems (people) and

Chapter 8: Proposing Authentic Alignment Theory

emergent phenomena resulting from their interaction (i.e., organizations, societies, economies)” (Goldspink & Kay, 2004). This dialectic speaks to the need for a “meso-theory” to analyse the real-world complexities facing HPE (Cleland et al., 2020).

Yang (2021) has recently articulated the need for researchers to “avoid the empirical applications of CT that often collapse larger systematic outcomes into micro individual actions by appreciating the value of time sequence analysis in assessing the separate existence and interactions of structural determinism and entrepreneurial individualism.” My position aligns with Yang (2021), that a more effective CT analytical framework is served by understanding and embracing the distinction between systems and individuals. The lynchpin of the morphogenetic approach – analytical dualism – provides a framework that glides around the fulcrum, “conditional and generative mechanisms operating *between* structure and agency” (Archer, 1995, p. 16).

Structuration theory, although aligning with the complexity idea that structure and behaviour are co-generative, suffers analytically from the generic defect of conflation (Sibeon, 2004). See Figure 24. Conflation is the stumbling block that trips up efforts to theorise emergent relationships between social phenomena. As a result, causal autonomy is denied to one side of the relationship (Knio, 2018), which hamstring the hunt for causal mechanisms via emergence. Archer, prioritising emergence as analytic oxygen, identifies conflation as stifling to analysis in directional terms:

- 1) *Downwards conflation*, where autonomy is denied to agency with causal efficacy only granted to structure,
- 2) *Upwards conflation*, where autonomy is denied to structure with causal efficacy only granted to agency,
- 3) *Central conflation* such as in Giddens’ structuration theory, where agency and structure as considered as being co-

Chapter 8: Proposing Authentic Alignment Theory

constitutive, precluding analysis of the relationship between them.

Archer's critical realist view considers agents and systems as interrelated yet distinct, as they operate on different timescales. She coined her approach as "morphogenetic", where emergence does not deny systematic structural conditions that can transcend the agency of individuals. Rather, it fosters consideration of the unpredictable and complex aspects of HPE as emergent outcomes of individual choices vis-a-vis the status quo.

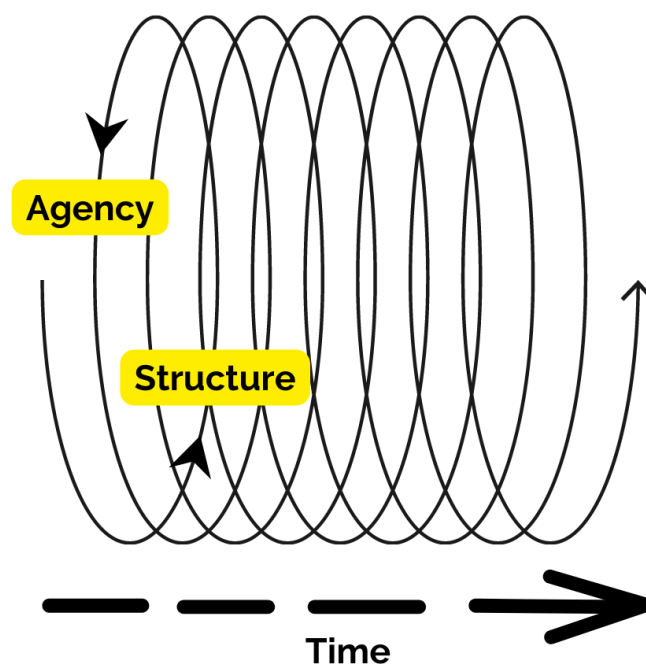


Figure 24: Agency-Structure feedback loop over time. Image designed by the author using Canva.

8.5.4.1 Emergence

Emergence in the social sciences is defined by Sayer (2000) as the "situations in which the conjunction of two or more features or aspects gives rise to new phenomena, which have properties

Chapter 8: Proposing Authentic Alignment Theory

irreducible to those of their constituents, even though the latter are necessary for their existence.” Archer’s view of emergence follows as a phenomenon that heralds a stratification of social reality whereby “different strata possess different emergent properties and powers” (Archer, 1995, p. 9). She argues that any theory about the social order, which includes conceptual models of alignment in education, must necessarily “come in a SAC: it must incorporate Structure, Agency, and Culture” (Archer, 2020).

Emergence has invited various accounts, notably here is that of Dave Elder-Vass who differentiated between two types of emergence: temporal (diachronic) and synchronic emergence (Coutrot, 2011). According to Elder-Vass (2010), the former ‘lay usage’ of emergence refers to the “first appearance or initial development of some new phenomenon,” while the latter is concerned with “the relationship between the properties and powers of a whole and its parts at any single instant in time” (p. 16). According to Knio (2018), Elder-Vass adopts the view that a (weak) relational version of emergence is inherently synchronic in nature and bases his understanding of emergence on the relationship between “properties and powers of a whole and its parts at any single instant in time” (Vass, 2010).

Knio points out (2018) that Archer's usage of emergence is not merely synchronic, but “inherently diachronic in nature” (Archer & Elder-Vass, 2012). Contrary to Elder-Vass, Archer claims that emergence applies to interactions between the parts and the whole at specific moments *in time as well as over time*, “acknowledging the heritage of ideas and culture left behind by previous rounds of socio-cultural interaction” (Archer & Elder-Vass, 2012, p. 95–6). Archer demonstrates (1995, p. 183) commitment to both a diachronic and synchronic understanding of emergence in her

Chapter 8: Proposing Authentic Alignment Theory

treatment of the 'parts' and the 'people' – the relationship between system and social integration.

Time in terms of scale and sequence inform Archer's analytic approach. She argues that people act within and as a result of structural circumstances, which their actions subsequently either revise or sustain. For her, the sequence of events in time is germane to functionality (Figure 25)— Time 1 (Structural conditioning) begins, with antecedent systematic circumstances as people respond, acting to sustain or alter those circumstances (T3 Structural elaboration) during the T2 (Social interaction) process. The results at T3 represents the affected circumstances, systematically unpredictable (emergent) outcomes and settings for future actions at T4 (Porpora, 2013, p. 28).

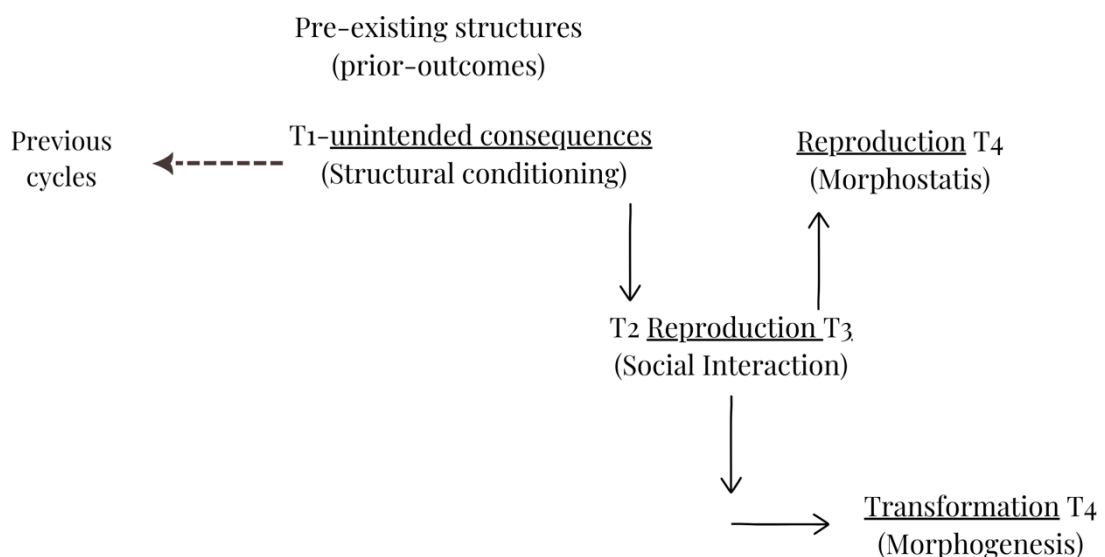


Figure 25: Adapted from Archer (1998)'s MST model of social action (p.376).

On these terms, morphogenetic (shape making) implies the potential of the morphostatic (shape maintenance). Since systematic features predate and condition (T1) the action(s) that may either disrupt, maintain, or reproduce them (T3) during agent-

Chapter 8: Proposing Authentic Alignment Theory

system interactive processes (T2) and then that structural elaboration (T3) necessarily post-dates those actions (T4). This model is thus couched in a multidimensional vector space, where time allows for the system to change states.

As such, an initial systematic pattern can be disrupted by external events or internal individual and group processes. This time-sequential update of CT for HPE allows the possibility of emergent group-level properties and subsequent downward influence on individual actors. It accounts for the decussation of forces through analysis as it considers “the micro-foundations and agentic consequences of individual actions” (Coutrot, 2011).

8.5.4.2 Meta-philosophical interpretation of the structure-agency dialectic

This thesis has raised the hermeneutic dialectic of structure-agency, presented in the conversation between Giddens' synchronic and Archer's morphogenetic models of the interaction between structure and agency. Superficially, I am taking Yang's (2021) interpretation of the difference between the two models, summed up “as an Archerian refinement of Giddens' “duality of structure” with the incorporation of a “time sequence” dimension that makes systems and agents analytically distinct.

Giddens' camp can be thought of as holding the pole for the structuration of agency in the constructivist tradition, where social structures are reproduced through the routinisation of behaviour. For instance, students from an historically deprived post code will normally recapitulate the deprivation and demonstrate the associated behaviour, predictably, generation after generation. Archer, on the other hand, holds the pole for emergentism as a distinct orientation toward prioritising the non-deterministic interaction between two discrete entities. Piironen (2014) explains that the crucial distinction between the two camps of theorists is

Chapter 8: Proposing Authentic Alignment Theory

characterised by the extent to which they value the mutual dependency of systems and their agents.

This chapter offers a meta-philosophical interpretation of the Giddensian constructivist and Archerian critical realist approaches to social sciences, and HPE, research. Previously, I explained that most HPE enquiries relating to complexity will be with its aggregate orientation. Such explorations of aggregate complexity lean into constructivist tradition as well as early expressions of Bhaskar's critical realism. In *The Possibility of Naturalism* (1979, p. 35), Bhaskar argues for his transformational model of social action, proposing that "society forms the individuals who create society; society, in other words, produces the individuals, who produce society, in a continuous dialectic."

In Bhaskar's early writings, as interpreted by Baert (2005, p. 97) society is a precondition for, not an impediment to, people's agency; agency which then reproduces and transforms society. Bhaskar's early transformational model echoes fundamental aspects of Giddens' structuration theory, namely, treating the social system as simultaneously the means and result of agency. Later, Bhaskar's philosophy would come around to what critical realists now consider, in the words of Porpora (2015, p. 29), "a more analytically robust conception of social structure."

In *Reclaiming Reality*, Bhaskar (1989, p. 9) emphasises the importance of distinguishing between human action and social systems, "because the properties possessed by social forms may be very different from those possessed by the individuals upon whose activity they depend." In *the Dialectic*, Bhaskar (1993, p. 160) argues that social reality "must be differentiated into analytically discrete moments...as rhythmically processual and plastic to the core. This is a feature which . . . distinguishes it from structuration, or more generally any 'central conflation' theory". That Bhaskar

Chapter 8: Proposing Authentic Alignment Theory

came to categorically endorse “analytically discrete” entities represents the fundamental break with his earlier conceptualisations of the constructivist-leaning transformational model.

Critical Realism: Essential Readings (1998) is an early volume on critical realism in the social sciences. Coedited by Bhaskar, Archer, Collier, and Lawson, it demonstrates a consensus of CR protagonists regarding the agency-structure dialectic. In it, Archer insists that critical realists urge the distinction between systems and agents on methodological grounds, that only as distinct entities is it possible to examine, analyse and interpret their interplay. Archer (1998, p. 203) argued further that the critical realist ontology “warrants our speaking about ‘pre-existence,’ ‘relative autonomy,’ and ‘causal influence’ in relation to these two distinct strata by virtue of their emergent properties and powers.”

Archer has called her approach ‘analytical dualism’ in recognition of the importance of separation between structure and agency for the analytic process. It has become orthodoxy in critical realism (Porpora, 2013), and provides a lively counterpoint for the constructivist-oriented interpretation of aggregate complexity. The upshot is that critical realism and the structure-agency dialectic remain compelling as a tool for applications of complexity in HPE questions that demand multiple considerations. Such multiplicity may require a constructive lens for exploring subjective aspects, as in the case of my exploration of authenticity. The same project might also require simultaneous consideration of aggregate complexity issues better served by critical realism’s stratified ontology and analytic dualism in the same way I have reckoned with curriculum interventions (agency) in relationship with, yet analytical separate from, the learning environment (structure).

Chapter 8: Proposing Authentic Alignment Theory

8.5.4.3 Authentic Alignment: embracing uncertainty

It is clear from the 'Authenticity turn' that HPE is broadly engaged with operating as a system of experiences that can best serve with and adapt to the needs of each learner (Mennin, 2007; Hamdy, 2015) and ultimately the health services (Greenhalgh & Papoutsis, 2018). This movement toward the student-centric experience runs counter to the traditional model that casts individuals as component parts of the whole, who are controlled by "hierarchy, jurisdictions, and exhaustive written rules" (Forrester, 1969). The complex dynamics of life navigating the vagaries of institutional behaviour necessarily constitutes chaos, uncertainty, and widespread rule breaking, all of which can be considered as individual responses to "the exercise of domination by structural forces" (Hodson & Sullivan, 2012).

In practice, HPE appears to have already accepted that the whole (the learning environment) is more than the sum of the parts (the individual stakeholders) as evidenced by increasing efforts toward concepts like integration and authenticity as previously discussed. Human behaviour in organizations remains indeterminant, with various interpretations of rationality of behaviour across timescales. As there is no ruling structural principle as found in linear systems, there is no overall control on vectors of behaviour. Agency is therefore multidirectional, multidimensional, and can be characterised as contradictory, chimerical, and unpredictable.

Taking up the Archerian approach to CR means considering the LE in its SAC (Structure, Agency, Culture), thus equipped to consider how a complex HPE learning environment emerges from the interplay of discrete entities. There is always a process unfolding in time, as the "powers that be" are rule makers learning to control through trial and error against structurally unpredictable contributions from the ruled (junior educators and students), who

Chapter 8: Proposing Authentic Alignment Theory

are both conditioned to and shaped by the rules but also predisposed to breaking them. Such structural modifications preface future activity which remains fixed in uncertainty.

This unpredictability, the certain uncertainty of HPE, is always and everywhere the non-deterministic result of agency–system interactions playing out at their own pace in time. As Yang (2021) describes the emergent situation for effective government analysis, “it is impossible to predict emergence on the systematic and organization level from the behaviours of the pre-existing components of lower levels such as individual actions.” This resonates with the findings of HPE scholars such as Lazarus who point to uncertainty as an element of special interest (Reuter, 2018; Lazarus et al., 2022; Stephens et al., 2022a; Stephens et al., 2022b; Rozario et al., 2023). Normally relegated to the HC, it is time to embrace and operationalise uncertainty as an explicit feature in models of the complex HPE learning environment.

8.6 Authentic Alignment Theory

This doctoral thesis will continue exploring the Giddensian and Archerian orientations to the agency-structure dialectic, where both are reimagined as relevant perspectives for considering the complex questions of HPE. This co-existence of theories, at first appearing mutually exclusive, is germane to the shifting of HPE to a stance aligned with multiplicity. Authentic Alignment Theory holds that an authentic model of the learning environment ought to be fit for purpose.

Recall that this doctoral thesis uses the retrodution of CR to rationalise its findings. Sayer (1992, p. 107) defines retrodution as “the mode of inference in which events are explained by postulating mechanisms which are capable of producing them”. This chapter

Chapter 8: Proposing Authentic Alignment Theory

offers the explanation for empirical findings presented in chapters 4 through 7: Authentic Alignment theory.

To meet the criteria for authentic in the context described in this chapter, the model should 1) account for the multiplicity of perspectives on complexity with regards to agency-structure, 2) consist of triangulated structural geometry, 3) demonstrate responsive behaviour, 4) embrace uncertainty. The next chapter introduces a practical example of such a model (see Figure 31). It is multidimensional, triangulated, and simple enough to make and hold with your own hands.

8.7 Chapter Summary

This chapter provided a summary of findings from the results chapters presented in chapters 4 - 7. I offered an integrated discussion of the findings as a rationale for progressing the project toward an authentic, complexity-friendly model of the HPE learning environment. The next stage in this chapter provided context for the updated model, situating the notion of authenticity in the conceptual model literature of simulation in HPE. To provide philosophical context, I presented an account of Educational Theory—Practice—Philosophies as related to constructivism and the advent of Biggs' (1996) CA as a model of the alignment of ILA curricular components (instruction-learning-assessment, introduced in Chapter 1). I disambiguated ST from CT for these purposes where the former is concerned with mechanistic, linear descriptions of systems, whereas the latter prioritises emergence.

This chapter continued investigating “the curriculum” as a problem space, making the shift from an interest in the curriculum (ST, constructivist context) to the Learning Environment (CT, critical realist context). As a key to making the shift to modelling the LE on realist terms without losing the constructivist interest in

Chapter 8: Proposing Authentic Alignment Theory

authenticity, I clarified that prescriptive approaches push curricula onto environments whilst a descriptive approach seeks to understand uncertainty and emergent properties of the LE. We In the process of distinguishing between prescriptive and descriptive approaches to the problem space, this chapter provided an example of prescriptive models: CBME (competency based medical education), including its strengths and weaknesses.

In seeking a descriptive model for the LE, this chapter is responding to increasing integration of CT qualities such as uncertainty and emergence in HPE research. Here, I distinguish my enquiry as ontology-oriented work in that is situated in the stratified reality of critical realism. To maximise clarity, I presented a disambiguation of reduction whereby CT eschews “scientific reductionism” in the sense of positivism’s trend of reducing the whole to its parts but embraces other iterations of reduction in terms of describing relationships and qualities emerging from those ever-changing interactions.

This chapter presented a discussion of Multiplicity according to a close reading of Cristancho’s (2019) influential paper. Multiplicity accounts for the wide-ranging and often confused usage of complexity in the medical education literature. These sections outline the three orientations of complexity according to Manson’s conceptual framework (2001), highlighting that among these, aggregate complexity is normally most relevant to qualitative research in HPE. Aggregate complexity is normally constructivist-aligned as it considers a system and its global interactions with the environment as definitive.

This chapter called for embracing complexity using the analytic dualism of critical realist, Margaret Archer (1995), in contrast to Giddens’ (1985) constructivism-couched structuration theory. I presented this agency-structure relationship (hermeneutic dialectic) as applied to CT particularly suitable in HPE settings where the LE is

Chapter 8: Proposing Authentic Alignment Theory

changing in relationship to its agents *over time*. These sections characterised structuration and the persistent collapse of agency into structure, contrasting it to the Archerian Morphogenetic approach that sees structure and agency as discrete entities for the purpose of analysing the emergent properties that arise from their interplay. I offered a meta-philosophical interpretation of the agency-structure dialectic as a tool for HPE researchers aiming to refine approaches to complexity in their work.

As readers in complexity and multiplicity refine their usage of the terms, a paradox arises. Although aggregate complexity aligns with constructivism, the Archerian approach to analytic dualism is situated in a realist paradigm (CR). This paradox will be further explored in my interpretative discussion of integrated thesis findings presented in Chapter 8.

This chapter underscores the link between emergence and authenticity, that all the components of social structures, educational and professional, play into a multidimensional, ever-changing, and unpredictable result. I highlighted that uncertainty (normally relegated to the HC) is an explicit characteristic of complex systems such as the LE. This chapter concludes that only through embracing uncertainty can HPE avail itself of the rewards: increased authenticity.

Chapter 9: Tensegrity Icosahedron: Authentically Aligned

9.1 Chapter Introduction

The previous chapter provided a thorough examination of the empirical findings presented in this thesis, culminating in a rationale for proposing an upgraded model of alignment. This chapter goes further into the practicalities of what that model looks and feels like. Let's take this opportunity to reflect on what has been established so far:

- 1) Robust empirical evidence justifying the rationale for an upgrade to existing theory in the form of a model of the LE
- 2) A presentation of discourse relevant for considering the model in terms of conceptual models, educational philosophy, and curriculum design

Equipped with the above, this chapter will introduce the tensegrity icosahedron (T-icosa) and present its geometry as a suitable model for authentic alignment of the HPE learning environment. See Figure 26 for a model of the T-icosa. I am proposing the T-icosa as an upgrade to Biggs' triangle and other related two- and three-dimensional models of CASs. This chapter first appeared as sections in the appendices of my book (Kirkness, 2021), [Spiral Bound: Integrated Anatomy for Yoga](#), in which I treat the body as a CAS arising from the interplay of two forces: tension and compression. Here, I use the body as a metaphor for the learning environment and a tool for enriching the case for both as tensioned systems that are best modelled using the tensegrity principle.

This chapter repurposes the original text to suit the aims of my doctoral thesis, one of which is to propose a model of alignment of the complex HPE learning environment. The book from which it is excerpted and modified was written for the semi-academic market

and intended to be accessible for professional movement teachers. As such, the tone shifts markedly from the formal academic voice (albeit softened by the first-person perspective) of the previous chapter.

In this chapter, I greet you in my role as a yoga educator. Here I make use of the fruits of critical realism: interpretation and creativity. Reflecting on the heteroglossic nature of this doctoral thesis, I fully own the transition to more informal language here, that it will serve its readability and foster the interdisciplinary spirit. The chapter eases into a narrative concerned with morphology, tissue architecture, and continues to incorporate a full account of the T-icosa. My aim is to show that the tensegrity-based model is suitable for modelling CASs, whether they are biologic or social in their nature.

9.2 Geometric Models

“All models are wrong, some are useful.” George Box (1979), the British statistician, coined this popular aphorism, effectively reminding us about the limitations of all types of models. How can we fathom the nature of complex systems such as social structures that show all their features, including but not limited to adaptation and emergence? As we saw in the previous chapter, models are essentially simulations of reality but can never encompass the real domain of causal mechanisms. We rely on our best guesses, models that emulate those aspects of the real that are comprehensible via the behaviour of their geometry.

In the case of modelling the complex alignment of the HPE LE, our starting point is the triangle. Biggs’ model uses its lines to connect the vertices, with a node at each vertex assigned to a pedagogical unit: instruction, learning, assessment. The triangle does not move

Chapter 9: A Novel Spatiotemporal Model of CA

or change or permit the juxtaposition of other nodes. It does not allow for intersectionality of concepts, or the flux of nodal interchange (for example assessment changing to instruction and vice versa). On a very practical level, the triangle is held together by linear geometry in two dimensions. You can hold it in your hands, but you can't feel it move.

9.2.1 Icosahedron

The first thing we need to do, then, is give our model access to three dimensions. Then we can hold it in our hands as representative of a system that moves and changes. The icosahedron is a regular polyhedron – a 'many faced shape' – in which each face is a triangle. See Figure 27. We do still need to triangulate the activities of instruction, learning and assessment. It is only with the utmost respect to the triangle that I propose the icosahedron as a shape more befitting the complex interplay of relationships in the LE. This is an important moment to clarify that in this proposal of a novel model for CA, I aim to preserve the functionality of 'constructive alignment' in the sense that it is authentic. Henceforth, I will refer to the T-icosa (see Figures 26 and 31) as a novel model for *Authentic Alignment*.

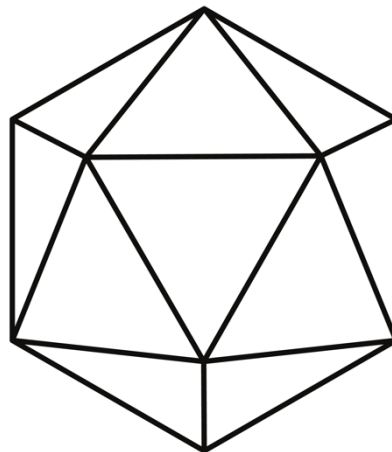


Figure 26: Icosahedron. Image by the author using Canva elements.

Chapter 9: A Novel Spatiotemporal Model of CA

Icosa is from the Greek for 20 – the icosahedron has 20 triangular faces and 12 vertices. As one of the five regular polyhedra (a.k.a. Platonic solids), it is a 20-faced shape that happens to enclose the greatest volume within a minimum of surface area when compared to any other structure other than a sphere. As it most closely approximates the sphere, it contains a host of emergent properties preferred by Nature. See Figure 28. Most viruses prefer the icosahedral shape, (Louten, 2016). As shown by Zhou, the regular icosahedron is the most likely conformation of nature to optimize self-assembled structure (Zhou & Ou-Yang, 2011). Self-assembly is a hallmark of complexity. The icosahedron is a triangulated sphere, a compact geodesic shape endowed with minimal-energy characteristics that make it preferential in Nature.

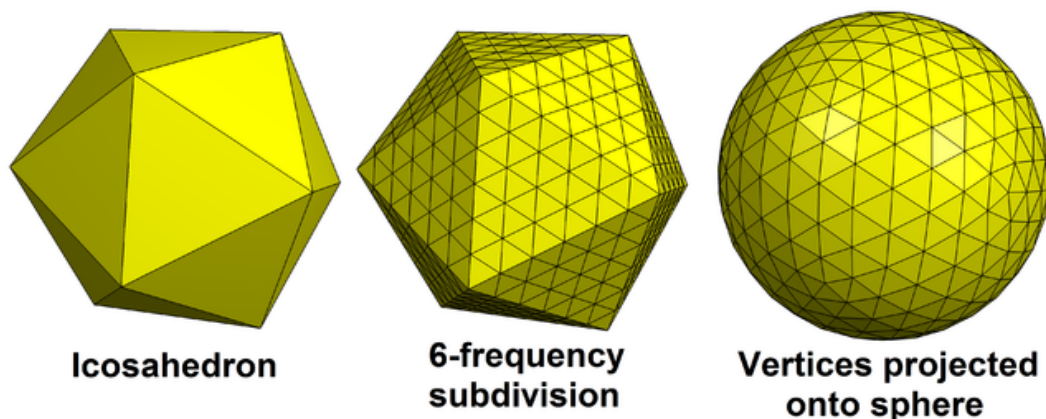


Figure 27: Image credit Tomruen Attribution-ShareAlike 4.0 International

Now imagine that each one of those triangles is home to the I-L-A from Biggs' iconic model of CA. Recall that Instruction/Teaching & Learning Activities is "I", Learning Outcomes are "L", and Assessment is "A". The conditions are that any I, L, and A readily change states to another of the three in constant flux. See Figure 29.

In practice, for example, formative assessments are a learning activity. Instruction can take the form of learning. The distinction

between what is instruction, what is learning, and what is assessment collapses into the form of the icosahedron. We have now mapped Biggs' items from two dimensions onto a three-dimensional frame that brings its own emergent qualities to bear on the relationships amongst the items.

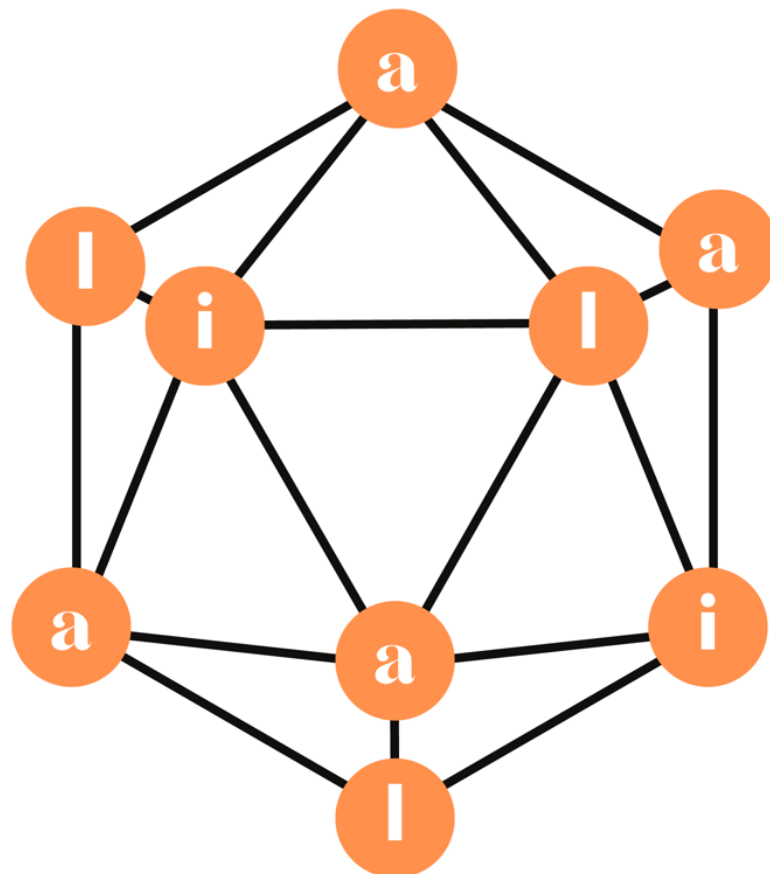


Figure 28: Authentic Alignment: ILAs mapped onto the vertices of the icosahedron. Image designed by the author using Canva elements.

This move has allowed us to pull the constructivist model from its 2D limitations into a higher order vector space that is volumetric – now we have a shape in three dimensions. This is the *spatio* aspect of the upgraded spatiotemporal model. In a sense, my proposal to upgrade Biggs' model is a move to give it new life in the form of a more complete conceptual model. Not only two or even three dimensions is enough to provide a high-fidelity model of the

Chapter 9: A Novel Spatiotemporal Model of CA

learning environment. We have the *spatio-*, now we need the *temporal* aspect of our new model. So, how are we going to get this shape moving? That is where the *tensegrity* aspect of the T-icosa comes in.

9.2.2 Tensegrity

Tensegrity is a portmanteau, joining the terms “tension” with “integrity”. It is composed of six struts and twenty-four cables that connect twelve vertices. The term ‘tensegrity’ was coined by Buckminster Fuller, who was inspired by a novel 20th Century architectural principle originating in the work of the sculptor, Kenneth Snelson, one of his students. Snelson first referred to the principle as “floating compression” (Snelson, 1965), whereas Fuller created a syntactic of ‘tension’ and ‘integrity’ (or, *tensegrity*). See Figure 30. The term tensegrity stuck. Structurally, tensegrity is a celebrated arrangement emerging from nature; the embodiment of natural forces interacting with a biologic form.



Figure 29: Needle Tower, 1968. This influential floating compression artwork by American sculptor Kenneth Snelson stands outside of the

Chapter 9: A Novel Spatiotemporal Model of CA

Hirshhorn Museum and Sculpture Garden in Washington, DC, United States. Photograph by the author.

Tensegrity refers to a configuration system, a structural relationship that endows continuous tension throughout the system. The entity is formed by this continuous tension applied to compression members whose “outward push” maintains the tension. Loaded with this comprehensive tension, the system self-adjusts to factors that can negatively or positively impact the structure and the compressional members (Fuller & Kuromiya, 1981). Such systems are volumetric and triangulated and thus approximate the sphere, qualities they share with organisms.

Structural designs in architecture conventionally focus on gradually constructing buildings that rely on compression and do not harness continuous tension as a strategy. By contrast, tensile structures are those in which whole system works in concert and are necessarily deployed as a single unit (Pugh, 1976; Skelton et al., 2001). These architectural systems are dynamical in their ecology, as they interact within themselves and within their settings through a structural–environmental relationship.

Conventional architectural methods used in construction are largely based on compression models, wherein the units of design stabilise themselves via gravity relationships. For instance, stacking bricks to make a house uses a progressive “one on top of the other” approach. “Tensegrities” stabilize via the balance of forces independent of gravity, whereby tensional relationships “spring to life” like a pop-up tent. Unlike a tent, however, true tensegrities are independent of fixtures to a substrate. They hold up and function, ‘structurally integrated’, because of their balanced force vectors independent of gravity and substrate.

The tensegrity principle rests in the quality of structural integrity, “influencing natural, built, or social structures” (Primus, 2022).

Chapter 9: A Novel Spatiotemporal Model of CA

Tensioned structures in balance are naturally flexible and stiffen under load, an adaptive behaviour that engenders the system with durability and resilience. Where the compression members intersect with lines of tension there are nodes, or anchoring points. This nodal intersection of tension and compression is a key concept as we move toward thinking about tensegrity as a structural basis for considering authentic alignment the learning environment.

The tensegrity concept is shown in the literature to have widespread applications in computational models of the cytoskeleton (Luo et al., 2008; Ingber & Landau, 2012; Kardas et al., 2013; Bansod & Burša, 2014; Aloui et al., 2019; Jiang et al., 2023), biomechanical models of anatomy such as the elbow (Scarr, 2012) and cranial vault (Scarr, 2008), as a medium for haptic perception (Turvey & Fonseca, 2014), mechanotherapeutics (D. E. Ingber, 2023), health and wellness (Ching et al., 2023), applied mathematics (Xu et al., 2023), robotics (Liu et al., 2022; Woods & Vikas, 2023), engineering (Motro, 2012), biomimetics and architecture (Pohl et al., 2015).

In the world of social structures, tensegrity is appearing in the literature as a means of understanding phenomena in family systems (Tateo, 2018; Primus, 2022), psychology (Marsico & Tateo, 2017), and organisations (Turnbull, 2022). In light of the comprehensive discussion presented in the previous chapter detailing the rationale for reimagining the alignment of the HPE LE, I propose that tensegrity is a compelling aspect of a novel structural model, the tensegrity icosahedron.

In short, this authentic alignment theory, based on tensegrity, comes in the Archerian SAC (structure, agency, and culture) (Archer, 2020). The structure of tensegrity illustrates the basic principles of CASs and allows us to consider how agency (i.e., curricular interventions) interacts with the structure to create

Chapter 9: A Novel Spatiotemporal Model of CA

emergent qualities in the context of wider cultural norms in HPE and beyond. However, tensegrity as a structural principle is still a little fuzzy on a practical level.

The use of triangulation to connect nodes is universal in conceptual maps and models. Biggs' triangle makes it easy to see the relationships between I – L – A as each of these nodes gets a single, static representation at each of the 3 vertices in the triangle. However, this collapse of the curriculum onto the structure in two dimensions fails to account for all the flux we know to be true of the LE as it responds to and constrains the prescriptive actions of its agents in a dynamic reciprocity.

Authentic Alignment theory calls for applying the I – L – A to the nodes of a tensegrity icosahedron, with the conditions that each one is predisposed to changing states in-the-moment. See Figure 31, where the author has photographed a multicolour Manhattan Toy 200970 Skwish Classic Wooden Baby Rattle and Motor Skill Activity Toy for Infants and Toddlers with the classic I – L – A triangle superimposed into the structure. The result is a model the sufficiently carries out its aims. The benefits of using the icosahedron are related to its relative simplicity as a shape. It is manageable, discrete, and its simplicity contains qualities that are much more than the sum of its parts. We can hold it in our hands.

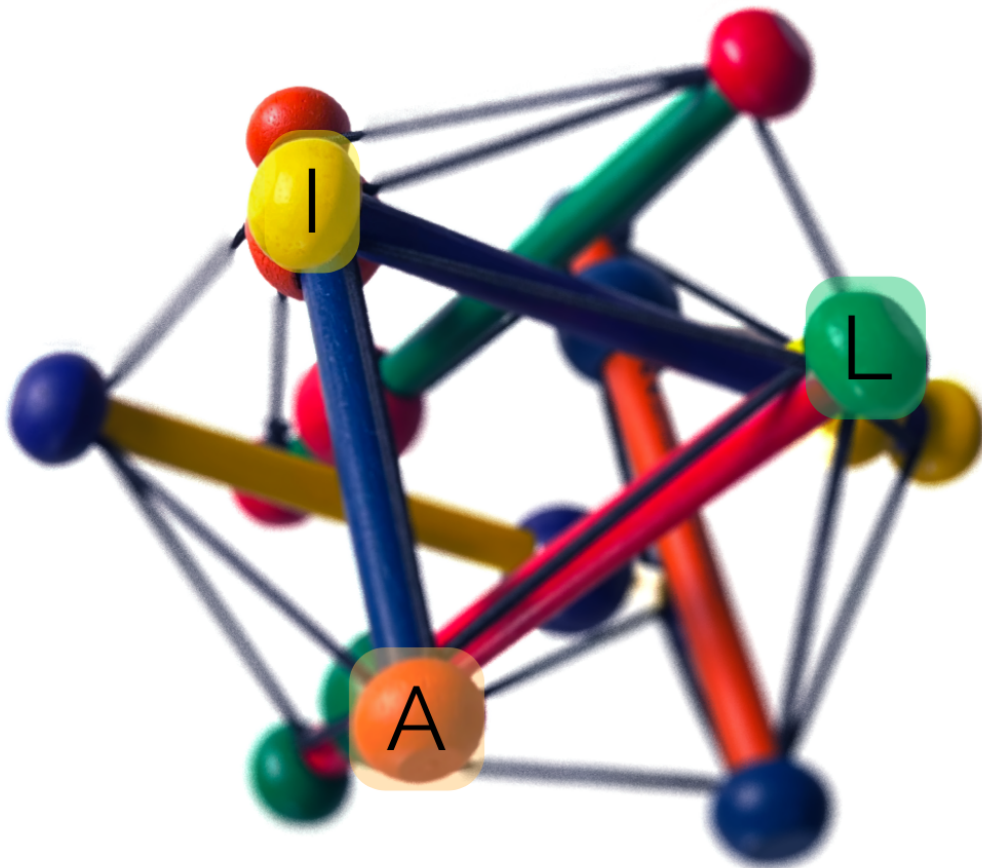


Figure 30: Authentic Alignment of ILA - instruction, learning, assessment triangulated in a T-icosa. Image created by the author using a photograph of the Skwish toy with Canva text overlay.

9.3 The Tensegrity icosahedron (T-icosa)

The T-icosa model has become popular in the media as an icon for physical culture. It is tempting to reduce it to the explanation that the struts are bones and strings represent muscles and tendons. This oversimplification is a good start, but it comes at the cost of seeing wholeness in motion. The T-icosa is ultimately a symbol of balance. Its “perfect” regularity illustrates the state of equilibrium in flux.

Chapter 9: A Novel Spatiotemporal Model of CA

The T-icosa features spherical symmetry and regularity in its equilibrium state. However, it is important to recall that the LE, like the human body, is in a constant state of flux and contains a high degree of uncertainty. In life, a T-icosa demonstrates its responsiveness to stress. When a particular LE is balanced, it benefits from its high strength to mass ratio. It is resilient under stress, dynamical, and multistable.

In a complex system, where things are always in flux, the T-icosa would be hustling as part of a symphony in time with the rest of its network. The elemental polyhedra are never found in their pure state as uniform in nature; they're always oscillating around that perfect state of equilibrium. T-icosa is a tensioned, heterarchical module of interlinked sub-units, ever-changing and adapting within themselves. It is an ideal visualization for how nodes relate to one another in the conceptual model, where instruction-learning-assessment is always changing.

The T-icosa is a model for helping us to understand how the nodes of ILA connect and animate the volumetric learning environment. The entire system gets stiffer as it is loaded. Loading causes the tensegrity to spiral down into itself; unloading allows the structure to spiral back out. Now is an excellent time to have one in your hands.

9.3.1 Embodied complexity

The T-icosa is a diagram of tension and compression force vectors that shows up everywhere in nature, including our bodies. As Guimberteau has shared with his endoscopic exploration of living tissue, the gooey polyhedral fibrils of the fascia world are continually lengthening, dividing, and migrating (Guimberteau, 2017). See figure 32 for an image of the tensioned vacuolar system. The visual evidence he provided with fluoroscopic imaging showed what he calls a vacuolar system capable of supporting blood

vessels within the fascia. These vacuoles, microscopic fluid interspersed channels, glide adaptively and independently of muscle contraction.



Figure 31: Vacuolar system. Image courtesy of Guimberteau & Armstrong (2015).

The continuous adaptation of fibrils along energy-minimising paths (geodesics) gives rise to the fractal-like nature of cellular structure and secretions, evident even from the outside texture visible on the surface of the skin. (Sharkey, 2008) It is well known that living beings embody fractal geometry (Paar et al., 2001) and this factors into the essence of anatomy. Fractals explain self-similar structures and also have applications in the dynamic processes fluctuating over multiple time scales such as those found in physiology (Goldberger & West, 1987).

Moving further into the web, observers meet with the seemingly chaotic entanglement of filamentous fibres that define, connect, differentiate, and permeate the fabric of our inner world. This network of threads is tied into the milieu of embryonic tissue arising

from the mesoderm, intrinsically linked through the intra and extracellular matrices of tissue. This fractal inner world is home of the T-icosa.

It is at this level we can observe the network of an interconnected, dynamic, fractal-like architecture of fibres in constant communication. These relationships and their adaptive consequences preserve our shape without rupture by moving responsively according to tensegral architecture. This architectural activity can be approximately modelled in a state of stillness using the sticks-and-string or elastic band method. The best way to study it functionally is still to feel it for yourself.

9.4 Tensegrity in living systems

A tensegrity structure is one in which tension and compression balance through a particular arrangement. This arrangement is unique in part because it can handle being turned upside down, on its side and “thrown into” any of an infinite number of relationships to the ground. It can expand omnidirectionally and retract into itself, its movement is self-limiting, and it spirals.

Can your house do that? Have you seen a column that breathes or a post-box that squeezes? Pause here and have a play with your model. As Susan reminds us, the best way to explore tensegrity is to have it in your actual hands, to appreciate the *qualitative nature* of its resistance to deformation and agency towards balance, from the co-creative forces of tension and compression.

Tensegrity in biology refers to a living system; a wet, breathing organisation of multiple types of tissue expressions. Considering how living things might work as tensegrity structures offers powerful insight into morphology, pathology, behaviour and evolution of living systems. In the next sections, we'll get a bit more

Chapter 9: A Novel Spatiotemporal Model of CA

perspective on living tensegrity and look at the features of heterarchy, modularity, and a bit of vector space.

The word *biotensegrity* originated in the work of American orthopaedic surgeon, Dr Stephen M. Levin (1981). He proposed a structural model for living organisms that incorporates the same physical laws that also relate to triangulated structural forms, 'closest packing', and foams (Levin, 1981). In a tensegrity, when you move one element, all the other components are affected. When you adjust a student by pulling their hand skyward in *Trikonasana*, the response can be felt not just in their hand, but globally throughout their body as well as integrated with your own. The asana visualisation becomes a metaphor for the LE. When one aspect of the curriculum is modified, ie, the introduction of progress testing into a medical programme, the quality of the entire LE is affected. In CASs, local interventions have consequences that felt globally.

We have previously looked at structure through the lens of hierarchy. Now, the lens of *heterarchy* puts a soft focus on the picture of anatomy so we can see that everything blends into the whole; both *hier-* and *hetero-* are evident ruling principles in the study of living anatomy. CASs give rise to the merger of ruling principles in the form of the holarchy.

9.5 Ruling principle: Simultaneity & Circularity

A heterarchy is a flexible organisational structure. The term heterarchy comes from *heteros* (another or other) and *archai* (ruling principle) and represents a flexible structure composed of unranked, modular units "ruled" by an intrinsic self-order. In a heterarchy, all components are of influential significance to the whole system, regardless of size. This is in contrast to a hierarchy, from the Greek 'sacred ruler.' Functionally, a hierarchy is a top-

Chapter 9: A Novel Spatiotemporal Model of CA

down organisation based on importance, in which an arrangement is “ruled” by a prominent entity *independent of feedback*.

“Heterarchy addresses the diversity of relationships among elements in a system and offers a way to think about a change in spatial, temporal, and cognitive dimensions.” (Crumley, 2015).

Systems science literature points to the *heterarchical embeddedness* (Luis Emilio Bruni & Franco Giorgi, 2015) of layered causal links in something that device communication people call the “3 C’s”: consistent, continuous complementarity (M. Levin, 2014).

Like a set of Russian dolls, a collection of things can *look* like a hierarchy from the outside due to the noticeable size difference. Still, living systems are characterised by the importance of feedback. They can thus also be considered as *structurally hierarchical* while embedded communication is *organised heterarchically* (Bruni & Giorgi, 2015). A CAS is multistable and works simultaneously in both modes – it is stabilised while in constant flux.

9.5.1 Holarchy

Reconciling our experience of top-down authority (which we can feel and therefore know to be true) with the heterarchical nature of the CAS (which can also feel and know to be true) is the next step.

CASs such as the body and the LE can be described as holarchies, a concept introduced by Arthur Koestler (1967, 1969, 1978).

According to Koestler, a holarchy is “a tree-like hierarchy where the nodes of the tree - the components of the hierarchy - are autonomous intelligent acting I/O systems” (Kay et al., 1999).

These nodes he coined *holons*, a model-component with a “Janus face” – with one side looking down (representing an autonomous system) instructing “lower” holons. See Figure 33. The other side of the Janus face is looking “up” to receive and serve directives from a “higher” holon. Holarchies provide according to Koestler the

appropriate conceptual framework for modelling and simulation of self-organising open hierarchical systems as they can be found in biology, medicine, sociology, and management science.



Figure 32: The Janus face metaphor for holons. Image created by the author using Canva elements.

Such an arrangement of nested directional loops amounts to continuity, in that the body itself is a continuum, a complex adaptive system (CAS). CASs are characterised by the property of emergence, which means that qualities arising from the network are not qualities of any single component of that system (Ridder et al., 2017). Device designers talk about designing the user experience as an ecosystem within which the user is embedded. The successful design of user experience creates a sort of “auto-regulating” influence space that provides users with a sense of familiarity (Liao, 2016). The dynamics of circularity pervade top-down, bottom-up, and peer-to-peer relationships (Cumming, 2016).

Chapter 9: A Novel Spatiotemporal Model of CA

This kind of interconnectedness fails when there is a fault in simultaneity and circularity, like when you've just taken a video on your iPhone and expect it to load in your photo cloud for instant viewing on your desktop. When it doesn't load due to a fault somewhere (forgot password?), cue frustration. When immediate availability is blocked, either in our device-based experience or in our personal experience of movement, there is a disruption in the ecosystem. A CAS is a system that finds workarounds for these disruptions toward the ultimate immediacy. This behaviour is evident in the LE, notably in how it adapts to reductions in resources for anatomy education.

In this era of neural networks and complexity, the old understanding of hierarchical "top-down" power arrangement is rapidly evolving into something more like a blend of hierarchy and heterarchy – the *holarchy*. This paradigm shift is happening across disciplines in contemporary cultural and scientific discourse. Self-organisation in biological systems is well documented as a means of understanding the "robustness and evolvability" of natural systems (Gunji et al., 2008; Bruni & Giorgi, 2015).

The balance of forces in anatomy is not controlled exclusively by large-scale structures such as the trunk, arms, and legs. Everything within the body is linked to everything else. The nervous system is an excellent example of simultaneity, whereby the holarchy is in continuous coordination with itself via voluntary movement, autonomic function, and reflex arcs nested within the sensorimotor matrix; the largest organ of which is the fascia (Garofolini & Svanera, 2019).

The way we experience our bodies is a balancing act from the macro end scaled to the molecules and everything in between. Ingber has demonstrated that the contribution of the cytoskeleton is as relevant as postural alignment in the anatomical heterarchy of a

living organism (Ingber, 1993). The global information exchange within individual bodies and between individuals within a community arises from a heterarchy and hierarchy in balance. The point is that a CAS is not one or the other, it is both: a *holarchy*.

9.6 Cellular Tensegrity

As previously mentioned, the principles of intrinsic stress (tensional prestress) are modelled in our anatomy through the balance of push and pull with regions of density (compression members) held in a matrix of continuous tension. The constant low level of muscle activity and tension generated by the cytoskeleton creates this inherent tension. The same tensegral arrangement appears in cells and molecules. This biologic tensegrity is a way to “get a feel” for the concept in CASs for the purpose of better understanding how it can be applied to the learning environment.

The molecular structural framework of the cell, its cytoskeleton, mechanically stabilises the cell through tensegrity. Cell biologist Donald Ingber has published his research on tensegrity in the cell, his work appearing extensively in the literature (Ingber, 1993; Ingber, 1998; Ingber, 2003; Ingber, 2004; Ingber, 2023). This section offers a tip-of-the-iceberg glimpse at cellular tensegrity, which of course follows the same principles as the rest of the body architecture.

Cytoskeleton (CSK)

The CSK rigidity gives cells their structural integrity. It allows cell migration, communication, regulation, and just about every other functional attribute that brings the cell to life. The cytoskeleton of almost every cell (apart from mature erythrocytes) consists of three basic types of proteins (biopolymers):

- microfilaments

Chapter 9: A Novel Spatiotemporal Model of CA

- microtubules
- intermediate filaments (thinnest)

Adhesions in the ECM are where transmembranous proteins such as integrins, cadherins etc., cross the cell membrane and link the inner CSK with the outer ECM. This means that tensional forces can be transferred between them (Ingber, 1997). Consider these transmembranous proteins within a more extensive network: body, fascia, ECM, cell, CSK and nucleus. Both the CSK and ECM can generate tension and influence each other.

The intermediate filaments (IFs) are tensional; they integrate the cytoskeleton and hold it in place. The IFs connect the microfilaments, microtubules, the cell membrane, and the cell nucleus to one another. This dynamic molecular network of nano-scale struts and cables is continuously adapting the balance of tension and compression throughout the cell. Without this intrinsic force attenuation, cellular function would be impossible. Cells have to move, adapt, respond, manufacture, regenerate, and communicate, in addition to withstanding the imposition of outside forces, none of which would be possible with a nonadaptive, rigid structure. See Figure 34.

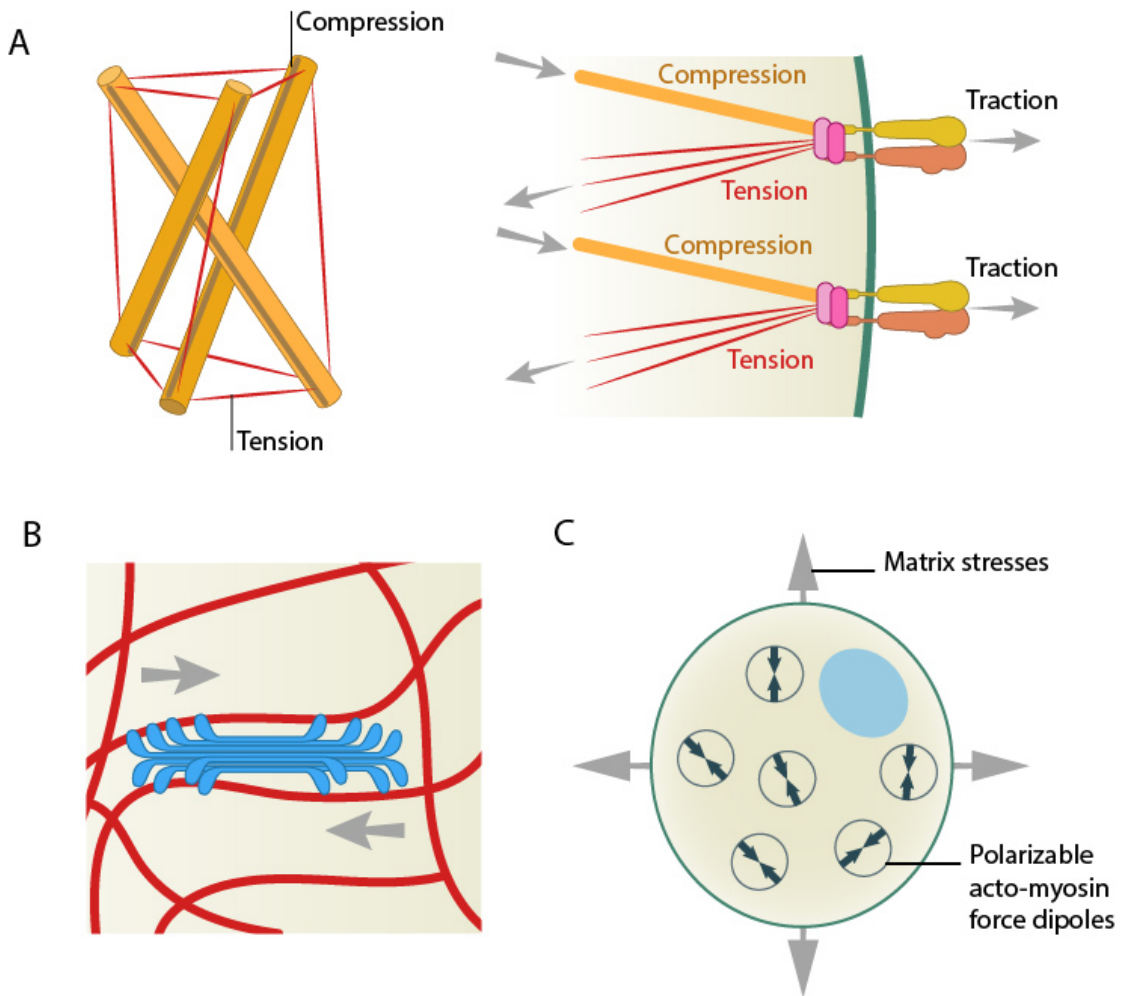


Figure 33: Cellular tensegrity model introduced by Stamenović & Ingber (2009): (a) Tensegrity model: Top left- A simplified version with compression struts and tensioned cables exemplifying that stress levels regulate cytoskeletal rigidity. Top right- In the cellular context, microtubules (gold rod) apply compression on cell-matrix adhesions (represented by actin linking modules in pink and integrin dimers) while the actin filaments (red) experience the cellular tension and hence stiffen accordingly. (b) Semiflexible chain model is represented by the flexible actin cables (red) that locally rigidify at points of stress application i.e., myosin (blue bundle) contraction. (c) Dipole polarization model: Formation of contractile actomyosin dipoles is represented by the arrow pairs. According to this model, they freely orient in response to applied stress as experienced at a particular point. Image source: <https://www.mechanobio.info/what-is-mechanobiology/what-are-some-common-themes-in-mechanobiology/> <https://creativecommons.org/licenses/by-nc/4.0/>

A central feature of tensegrity structures is that they stiffen when loaded. When cells are loaded, they behave just as the T-icosa

Chapter 9: A Novel Spatiotemporal Model of CA

model does: they “stiffen up” and preserve their original shape by self-limiting further deformation. This happens as an essential response to any loading, for instance, the interlinked proteins of the cell adjust their firmness in response to prodding (Ingber, 2004). See Figure 34 for a tensegrity model of force-induced modulation of cytoskeletal stiffness adapted from Stamenović & Ingber (2009).

Strictly speaking, the cellular tensegrity model is an example of prestressed, or “intrinsically stressed” variety of tensegrity (as opposed to geodesic). However, the same fundamental mathematical rules underpin the different geodesic forms as they do the closest packing of cells within the ECM (Ingber, 2003). The interplay of tension and compression is a motif that has many avatars on a molecular level in nature. Hexagonal arrangements (a hallmark of triangulated spheres), can be found in:

- basement membrane proteins
- polyhedral enzymes
- viral capsids
- lipid micelles
- RNA and DNA molecules

From molecules to cells, into tissues, through whole organ systems, and finally into the shapes the body makes, tensegrity describes the formation of living things as a diagram of forces. Tensegrity models and anatomical structures are visible representations of the invisible forces of tension and compression within them. Living tissues self-organise with the CKCs describing the underlying mechanics. The fibrous matrix moves responsively, and out of this vast sea of auto-tuning linkages, we find a sense of self.

9.7 Prestressed and nonlinear

The literature shows current efforts to reconcile traditional hierarchical assumptions about motor control in the body with updated models to incorporate the role of fascia and resting tonus (Profeta & Turvey, 2018). This is an exciting area of research, as the notion of motor control is revised to consolidate disparate levels that have been studied independently in the 70 years since Bernstein introduced his essay in Russian, *Levels of Construction of Movements*. The English translation of Bernstein's hierarchical neural model was published in 1996 (Latash, 1996), holding at its core a hierarchical neural model.

Considered by many to be the founder of biomechanics, motor control, and physiology of activity, Nicholai Aleksandrovich Bernstein shaped long-standing views of voluntary movements and dexterity. Bernstein's anatomical model addressed the coordination of neural levels to produce voluntary movement, where each level of the hierarchy evolved to solve a particular class of movement problems. This view did not consider the influence of connective tissue in the maintenance of basal tension in the body.

Basal tension has replaced the vague term 'tonus' in contemporary biomechanics. As hierarchical models morph into embedded heterarchies and then to holarchies to better explain biologic structure, the tensegrity model is rising to the forefront as an illustration of how basal tension works. As demonstrated by Souza, et al. (2009), this basal tension functions as *prestress*, or intrinsic tension, that accounts for the anticipatory characteristics of the body's default status (Turvey & Fonseca, 2014). Primed for movement, tissue densities exhibit the multifractality observed in fluctuation patterns across timescales (Cavanaugh et al., 2017). These fractal fluctuations integrate with sensory experience to produce coordination of haptic perception (Schleip et al., 2014).

Chapter 9: A Novel Spatiotemporal Model of CA

A tensional force flows along the length of a medium. The word *tendon* arises from tension, a force associated with flexible materials. Kenneth Snelson referred to the body as a “sea of tension.” In such a 3D arrangement, the tensional force draws body elements inwards. This ‘in-drawing’ comes from the state of intrinsic stress, as described by Kenneth Snelson (1965), “...Islands of compression floating in a sea of continuous tension.”

This chapter continues using tensegrity in the human body as a means of explaining how tensegrity can model the learning environment in HPE. The concept of tension is at the heart of tensegrity, and the last sections have discussed how basal tension is maintained through our cells and tissues. What holds the LE together?

I am going back to Archer’s SAC for a look at what provides the tension in our T-icosa model of the LE. In the Archerian perspective of this thesis, it is structure, agency, and culture that form the context of all social theories. The authentic alignment theory, which holds the T-icosa as its structural model, considers agency and culture as the tensioning members of the LE. Agency is applied in the form of curricular interventions (prescriptive), for example when LOs are modified and updated or when a programme changes from modular to integrated or adopts more PBL techniques.

All efforts to constrain the system will result in changing the vectors of tension within the system, like tuning the strings of an instrument. Culturally, HPE is caught in a vast network of vectors that come from government, society, tradition, and testing norms among many other cultural factors. Rule-makers continuously respond to cultural influences, tweaking curricula, ultimately changing the balance of forces at play in the LE which shapes stakeholder experience.

This social interaction between agents and structures is detailed in the previous chapter using Archer's M/M approach. Now that we have the basis of tension for the CAS as applied to the LE, how can we distinguish amongst the various modules of experience? The basic sciences, clinical skills, professionalism & ethics, placements, clerkships – all of these parts have important roles to play and each must have their own ILA (instruction-learning-assessment) balance.

9.8 Modularity

Modularity is a foundational principle of tensegrity, holarchy and CASs. Wagner suggested in 1996 that the body is composed of locally integrated, quasi-autonomous units (Wagner, 1996). A 'module' is like a 'part' in the sense that the integration of many modules creates a whole. But unlike a mere part, modules are self-contained and quasi-autonomous (they have intrinsic completeness, like a modular unit of storage) (Stewart & Wilson-Kanamori, 2011).

Tensegrity models exhibit modularity, composed of units that are complete within themselves into assemblies of higher order complexity that can be disassembled without disrupting the inherent balance. These movements are powered by relatively autonomous, interconnected components. Plants and animals are anatomically modular in the sense that they are organised in developmentally and anatomically distinct units. These units are often repeating in body segments such as petals, fingers, and compartments. (Rosslénbroich, 2014). Modularity has applications in mathematics, design, biochemistry, behavioural science and neuroscience and social science (Wagner et al., 2007).

Modularity in organisms is observed during the development of the embryo (ontogeny) and is thought to facilitate evolutionary development (phylogeny) (Schlosser & Wagner, 2004). In so-called "evo-devo" the emergence of modularity in the developing organism

refers to sets of traits that are closely linked. From these, patterns of anatomical modularity in adult forms are better understood (Kavanagh, 2016).

Human beings can experience the loss of a module and still function perfectly well. Although losing a limb is unquestionably more than a little disruptive, it is common for amputees to develop workarounds for lost modules like arms and legs. There is a profound built-in predisposition to adaptability and auto-responding workarounds at play in a CAS.

Complexity in human movement arises from the coupled interplay of balanced opposing forces. These combinations of push and pull, attraction and repulsion, tension and compression create *dynamic reciprocity*; from which a third state emerges – “throupled”. As we have seen in previous chapters, higher order properties emerge, transcending the sum of the individual qualities and structures at play.

9.9 Reciprocity

In the study of tissue, “dynamic reciprocity” refers to a continuous and bidirectional relationship between cells and the matrix (Gjorevski & Nelson, 2009; Schultz, et al., 2011). The literature on the extracellular matrix (ECM) abounds with the critical importance of *dynamic reciprocity*. This is because it describes the relationship that gives living tissue the properties required for essential life functions such as structure, balance, healing, reproduction, communication, and coordinated movement (Kaul & Ventikos, 2015; Thorne et al., 2015).

By playing with tensegrity in the models of tension and compression, we can get a feel for aspects of this directionality in our hands. Models and bodies both show how the dynamic reciprocity of the two critical forces of push and pull (structurally

experienced as tension and compression) unite in co-creative force transmission. The tension makes the compression compress. The compression struts make the tension tensioned. Together they make the constraints of multi-dimensional, volumetric shape-change.

9.10 Vectors in the round

Like all CASs, the body is a playground of vectors. Put simply; a vector is a force (think of an arrow: it has magnitude and direction). In linear algebra, vector *fields* allow us to visualise the magnitude and direction of forces. The human body itself is a vector field. As a biologic organism, the human body obeys the same physical laws of triangulation and closest packing that also govern space-filling spherical vector spaces such dandelions, seafoam, bee larvae, chia seed pudding, and caviar (Levin, 2006).

In traditional anatomy, the student works toward memorising origins and insertions, etc. concerning length, width, and depth as the Anatomical Planes. The classical anatomical terms of movement and position came out of this three-dimensional, planar orientation that puts everything at ninety degrees to everything else. In the conventional Cartesian vector space of the anatomical planes, we can talk about points in the same three dimensions to find locations of parts in cubic relationships.

In the geometry of organic form, vector space starts in 90 degrees when we learn about the so-called anatomical planes. Flat planes are great for describing movement along a single axis like forward bends, backbends, side bends, and twists. However, 90 degrees fails to account for the in-and-out movement of breathing. There is no such thing as a cubic plane that can describe breathing. This leads to the question: what is the body geometry for movement

that breathes? How do we talk about CASs that move and self-regulate *in the round*?

Although it is not featured in traditional anatomy textbooks (yet), there is an alternative to the cubic vector space, one that describes the omnidirectional in-and-out of biologic movement. This alternative is expressed in the “synergetic” coordinates of Buckminster Fuller’s explorations (Fuller & Applewhite, 1975) in 60 degrees. This triangulating, sphere-based geometry is just as important as the planes (if not more so) for understanding anatomy because it allows for the consideration of movement within a mesh *in the round*. The sphere-based vector space offers a triangulated playing field, a perspective that makes sense of our physical experience of how CASs move.

9.11 **Nonlinear pedagogy**

From a grasp of tensegrity, we get a glimpse of the nonlinear behaviour that is characteristic of CASs. In such multistable systems, the boundary between hierarchy and heterarchy bends and blends. Instead of one or the other, we have both states at the same time as part of a holarchy. Nonlinear behaviour characterises not only our bodies but also our ways of learning about the body. We can break down linear systems analytically into direct relationships (Strogatz, 2014) In contrast, nonlinear systems (like you, your dog, the weather, a flock of seagulls, your family, the learning environment, etc.) describe networks that exist as complex expressions of their interconnectedness.

Nonlinearity is a keyword finding its way into many fields across the hard and soft sciences, including HPE (Eoyang & Mennin, 2019; Bleakley & Cleland, 2022). Research in biology points to the nonlinear nature of our tissues, showing that our bodies often defy account (Kahn et al., 2010; Andriotis et al., 2018). With having

Chapter 9: A Novel Spatiotemporal Model of CA

variable conditions of timing, duration, frequency, intensity, vector, attitude, neuroendocrine activity, genetics, epigenetics, privilege, and so many other factors. Accounting for all these factors calls for more than “linear” allows.

Here, we may come to experience the inscrutable *quality* of body habitation where the linear rules of biomechanics get *bent*. We can measure individual direct relationships in linear terms, and this data is valuable for its insight, but biologic organisms are inherently nonlinear. As CASs, the LE exhibits many of the same qualifiers.

Nonlinear pedagogy is a theory about how people learn and has been explored by Chow (Chow et al., 2006) and recently, Button et al. (2020) in physical education for its role in skill acquisition. In this section, we’ll look at the differences between linear and nonlinear systems, then check out Chow et al.’s (2011) four characteristics of nonlinear learning behaviour and finally explore how this relates to the body as a teaching and learning space.

Let’s take a look at what makes linear and nonlinear systems different. In linear dynamics, a substantial change in a system’s behaviour is initiated by a substantial shift in its cause(s). For example, linear systems are used to:

- convert currencies
- describe the data relationship between things (e.g., femur length and overall height), or
- calculate rates

Linear relationships are easily quantifiable, which makes for a desirable quantitative experiment. Everyone loves a tidy equation and problems that resolve under measurable controls. These are essentially linear systems.

In nonlinear dynamics, we are talking about the so-called “butterfly effect”. This effect describes how a tiny shift in the dynamics of a

Chapter 9: A Novel Spatiotemporal Model of CA

system or group of systems dynamics may also generate massive, essentially *qualitative* shifts in its behaviour, including unpredictable and disproportionate differences. The expression of a linear system is *always* proportional to its causes, whereas nonlinear systems often exhibit proportional and disproportionate sets of properties simultaneously. Stress-strain curves in human tissue are a perfect example.

Biological systems are nonlinear, and yet have been traditionally approached with the “linear lens” of positivist science. Indeed, in anatomy, things are a lot easier to study when we focus in on tiny bits and look at simple, direct (linear) relationships of cause-and-effect. Looking at anatomy linearly is the only way to memorise parts, so it’s the natural *starting point*. However, such cause-effect proportionality is the signet of linear behaviour, so its recipe only gets us as far as the ingredients list. Once we’ve got the ingredients measured, the nonlinear space accounts for everything that we know makes an actual loaf of bread *as such*. Likewise, CASs such as the human body and the LE require a nonlinear approach to get to grips with them (Jayasinghe, 2012).

9.11.1 Non-proportionality

Nonlinear systems are characterised by non-proportionality.

Continuing the cooking metaphor, consider bread making. A pinch of yeast makes the bread rise but adding two pinches won’t double the size of the loaf. In fact, adding too much yeast is likely to make the dough go flat by releasing the gas before the flour is ready to expand. Small changes lead to large differences or vice versa on an unquantifiable timescale. The implications are that tiny factors can conspire to produce significantly different outcomes.

In terms of living tissue, non-proportionality describes how biologic motion is hard to quantify with biomechanics. Systems scientists acknowledge that what makes something different from its parts-list

are the *non-proportional interactions amongst those parts* (Boogerd et al., 2007). Let's say you're in a forward bend applying a tensile load along the back body. If you were to double that load, for example, your hamstrings would not get twice as long! They do something very different from that as part of their evolved response to stress (constraints!).

Most processes in biology are understood to be non-proportional (Donze et al., 2010; Qian, 2012), and biomechanical models are only just recently innovating their methodologies to account for the non-proportionality of (for example) tendon concerning the wider problem of data analysis (Durandau et al., 2018; Jachno et al., 2019). Research in continuum biomechanics (CB) has been accumulating a literature base around non-proportionality (Epstein, 2012) in looking at non-Newtonian behaviour of tissue (Holmes & Mow, 1990; Almeida & Spilker, 1997; Ahmed et al., 2017; Atzeni et al., 2019).

Just when you think you've got a straightforward proportional outcome, (like thinking that the surgery you had on your knee was what fixed your knees), somebody publishes a study showing it might all be an artefact of expectation. In 2013, Finnish researchers demonstrated that outcomes after arthroscopic partial meniscectomy were not any better than those following a sham procedure (Sihvonen et al., 2013).

Their trial involved patients with symptoms of a degenerative medial meniscus tear. Out of a total of 146 randomised patients, seventy underwent arthroscopic partial meniscus removal. Seventy-six had a sham surgery. Although both groups reported a remarkable improvement up to 12 months after the procedures, the researchers found no significant differences between the groups in the change from baseline to 12 months in any of their outcome measurements.

Sihvonen's well-known (2013) study raises plenty of relevant discussion points. I think it is enough to see their results as an example of the nonlinearity in our experience of pathology. In another study, Moseley et al. administered arthroscopic lavage (washing out of the interior of the knee with saline) or debridement (lavage with the removal of bits of loose tissue) to patients with established knee osteoarthritis (Moseley et al., 2002). The treatment did not result in better outcomes than a sham procedure involving skin incisions only.

Out of all the curricular interventions that have been implemented in HPE in the last decade, how many of them might have disproportionate, unpredictable, contradictory results? Non-proportionality in the HPE LE is important to take into consideration for stakeholders seeking authenticity.

9.11.2 Multi-stability

That brings us to a second difference between linear and nonlinear systems; multistability. Systems can be many things all at once; see Figure 35. We can see multi-stability is applied naturally everywhere – both literally (in molecular arrangements of living things) and symbolically (in the meanings of words and images) (Kruse & Stadler, 2012). We could consider our entire nervous system as an example of “co-ordination dynamics of multistable states”, (Kelso, 2012a) in terms of both action, response, and perception. Linear systems can be *mono*-stable. CASs are “multistable” because they are nonlinear, or perhaps they are nonlinear, so they are multistable. The crux is that systems do not display one behaviour as a result of one cause. As multistable systems, both the human body and the learning LE may have multiple performance effects from a cause (Ribeiro et al., 2019).

Nonlinear systems (such as living organisms) can be both *mono*- and multistable (Laurent & Kellersohn, 1999). Multi-stability is a

Chapter 9: A Novel Spatiotemporal Model of CA

generic, default phenomenon of dynamical systems like our bodies. In systems biology, scientists are interested in fluctuating states (oscillations) being an intrinsic part of that system's overall integrity. Take, for example, a school of fish, moving collectively in response to stimuli without the need for a "central command". These individual fish are all agents, collaborating as a unified force (Pratt, 2010); much in the way of the integrated elements of our bodies and learning environments.

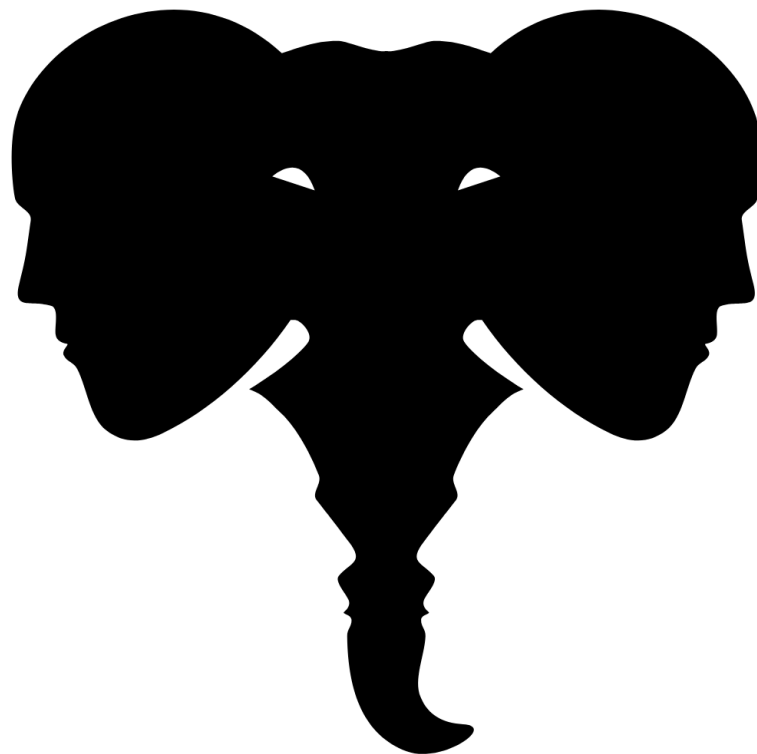


Figure 34: Multistability in graphical representation. Image created by the author using Canva elements.

Multi-stability is also a way of understanding the "asymptomatic" experience of those whose tissues are clinically damaged. Imaging revealed that in 1,211 adults between the ages of 20-70 years, 87.6% had bulging discs; and for those in their 20s, the incidence of disc pathology was 37% (Nakashima et al., 2015). Mitchell (2018) reviews the literature in her book and makes the point on

page 145 that this is “good news” because people can function pain-free despite the large-scale prevalence of so-called abnormalities.

A 2003 study found that asymptomatic damaged knees are as common as symptomatic ones (Smith, 2003). A more recent study by Horga (2020) shows that “nearly all” (97%) of the 230 knees of the 115 uninjured, sedentary, “asymptomatic adults showed abnormalities in at least one knee structure.” Multi-stability appears to offer multiple options for damaged tissue as the rest of the body figures out how to get on with the show.

Multistability is a conserved strategy in biology that also shows up in large-scale neural circuitry in humans (Kelso, 2012b).

Gracovetsky refers to it as “controlled instability” (Gracovetsky, 2007) when he describes the lumbosacral region. Within the tensioned body fabric, the sacrum is suspended as a hub within a bicycle wheel. During gait, the region is dynamically stable, or “manageably” (and rhythmically) unstable. The engine must turn if it is to drive the chariot.

Adaptive properties of our structure, such as the multi-stability of the lumbosacral region, are at work at all size and time scales (Etkin, 2016). As is any complex adaptive system (CAS), we are *stable in flux*. Like schools of fish or murmurations of starlings, our tensioned fascial matrix oscillates in various states as it attenuates forces in constant “fluxtability” (my term, or at least Google assures me it is as of this writing). This fluxtability is tissue-specific, and it operates on every scale from self-organising cell structures to the learning environment within which we operate. Our physical and learning environments are flexibly integrated via their fluxtability. The structural matrix can deform, spring back, and instantly relay positional information that contributes to the stability of the system over time. Stiffness and flexibility could be described as

Chapter 9: A Novel Spatiotemporal Model of CA

simultaneous states of this fluxtability, another way of expressing multi-stability.

9.11.3 Parametric controls - constraints

By changing specific learning outcomes, or parameters, educators can *intentionally* lead a learning session to foster or craft experiences of appropriate progression. Chow refers to “parametric controls”; which means “manipulating system parameters” the third of his four characteristics of nonlinear systems. Parameters such as clinical competencies situated in authentic settings give curriculum designers a way to constrain learning opportunities.

Regardless of what you’re trying to teach, parametric controls are how we can design teaching and learning activities with specific constraints that allow the task to evolve as a nested emerging property. Through trial and error, teachers and students can co-create constraints by agreeing on acceptable parametric controls. These are the features of a practice space within which we all have some agency. For example, there are lots of ways to lead a session on gastrulation: model building, drawing, didactic lecture to name a few. Choosing a set of parameters to suit the circumstances is how educators use their agency to influence the LE.

Balagué et al. (2019) discuss the relatedness and nestedness of constraints in skill acquisition based on four claims:

- (a) Task constraints are distributed between the person and the environment and hence are relational variables,
- (b) Being relational, task constraints are also emergent properties of the organism/environment system,
- (c) Constraints are nested in timescales, and
- (d) A vast set of constraints are correlated through circular causality.

Chapter 9: A Novel Spatiotemporal Model of CA

9.11.4 Noise & the Hidden Curriculum

The fourth characteristic of Chow's nonlinear pedagogy is the one I contend is most relevant to the HC: noise. Conventionally, "noise" represents the uncontrollable factors acting within system dynamics: ungovernable, unruly, and therefore, often unwanted (especially in linear system measurement). Linear systems often either ignore noise or make up new rules and exceptions to account for it. In multistable, nonlinear, dynamical systems, Chow indicates (2011) "noise can play a functional role by enhancing the probability of system transition between multiple states."

In HPE, teaching and learning in a complex LE means facing (and embracing) all the noise. Authors in HPE have brought many aspects of the HC to light in recent decades, as I have discussed previously in this thesis. My empirical chapters, particularly Chapter 4 presenting the study, *Uncovering Hidden Curricula*, are largely concerned with "making the implicit explicit" regarding noise. Authors like Lazarus have called for the field to embrace uncertainty by building our tolerance to it. My findings would broadly agree with building such tolerance, otherwise the noise becomes deafening. The LE is a hard process to navigate for all concerned, with so much uncertainty and so many vectors at play. However, the challenge of navigating the noise of its complexity comes with its rewards.

Vaughan et al., talk about how "creative moments, skill and more generally talent in sport, are not traits possessed by individuals alone, but rather can be conceived as properties of the athlete-environment system shaped by changing constraints." (Vaughan, et al., 2019) There is an exciting literature base emerging around creativity in nonlinear pedagogy (Coste et al., 2019; Hristovski et al., 2011), one that might guide our changing understanding as adapt to a compassionate curriculum.

Chapter 9: A Novel Spatiotemporal Model of CA

As teachers, we might all benefit from being tuned into all four factors of nonlinearity in the LE, and in particular, the element of noise. It isn't just the tentative medical student overwhelmed in year two who will be "noised up" with countless uncontrollable factors coming to bear simultaneously and on longer-term strata. Basic sciences teacher, clinical educators, administrators, and other individuals making sense of the LE are all contending with the complexity. There is an infinite number of psychosomatic cues at play on the systems of everyone sharing the LE, some contradictory, others unconscious, gross, subtle, and unquantifiable. This signal variability will be simultaneously creating challenges whilst contributing to the students' exploration of potential solutions. Noisy situations like these can enhance the flexibility of learning (Schöllhorn & Sechelmann, 2006) and offer spontaneous constraints (Newell, 1986).

To recap, these four significant characteristics of nonlinear pedagogy inform this study of applying a complexity model to the HPE LE:

1. non-proportionality
2. multi-stability (fluxtability)
3. parametric controls
4. the functional role of noise

The last section of this chapter has presented an adaption of the characteristics of nonlinear pedagogy according to Chow. This approach resonates with the T-icosa model of the LE, a structure that self-regulates and encourages emerging properties, constraints within which individuals can experience creativity in-the-moment. Stewart talks about knowledge co-creation as an "authentic recursive transactive process" that is inherently nonlinear (Mennin, 2010)

9.12 Creativity, authenticity & empowerment: the rewards

Constraints and creativity are a hot topic in cognition and skills acquisition literature (Torrents et al., 2020) and HPE (Hew & Lo, 2018). Orth et al., are talking about how innovation happens in moments of confusion. During times of uncertainty, people often discover creative solutions and apply them in nonlinear ways. Solutions can occur spontaneously in the face of fear with appropriate constraints. It appears that constraints foster spontaneity. In such moments, the practitioner allows solutions to emerge, rather than developing a solution first and subsequently “forcing” it or conforming to a received method and rigidly adhering to it (Orth et al., 2017).

9.12.1 Practical Considerations for using the T-icosa

Constraining the HPE to *embrace noise and operationalise the HC* not only increases authenticity, but it also fosters creativity and empowerment. Using the T-icosa as a designer of teaching & learning activities involves simply having one in your hands. Biggs was not the first nor the last to use the “holy trinity” of the triangle to connect ideas. The triangle is a fundamental shape that we have all drawn and doodled in the margins of notebooks – it comes naturally to anyone holding a pen.

Bringing that ease of use to the T-icosa represents the shift from two to three dimensions. It is simply an extension of drawing the triangle to connect ideas. The Skwish toy as pictured in Fig 31 is an inexpensive kinetic toy that feels satisfying just to hold. You can make one yourself as pictured in Fig 35. It is responsive to the forces moving through it, you can feel it jiggle and return to its integral shape. Educators and administrators may benefit by simply having a T-icosa in and around their workspace. Models that are also toys confer the benefit of kinaesthetic feedback, and the T-icosa can also remind educators:

Chapter 9: A Novel Spatiotemporal Model of CA

1. Structure and agency are always co-informing one another (your hands squeezing/stretching/stacking/throwing the structure).
2. The structure is multistable and can perform perfectly well even under stress.
3. The structure's behaviour is patterned yet **uncertain**.
4. Its behaviour is more than the sum of its individual parts.
5. Educators can influence the structure's behaviour, but they must also embrace the inbuilt behaviour

9.12.1.1 Make your own: DIY T-icosa

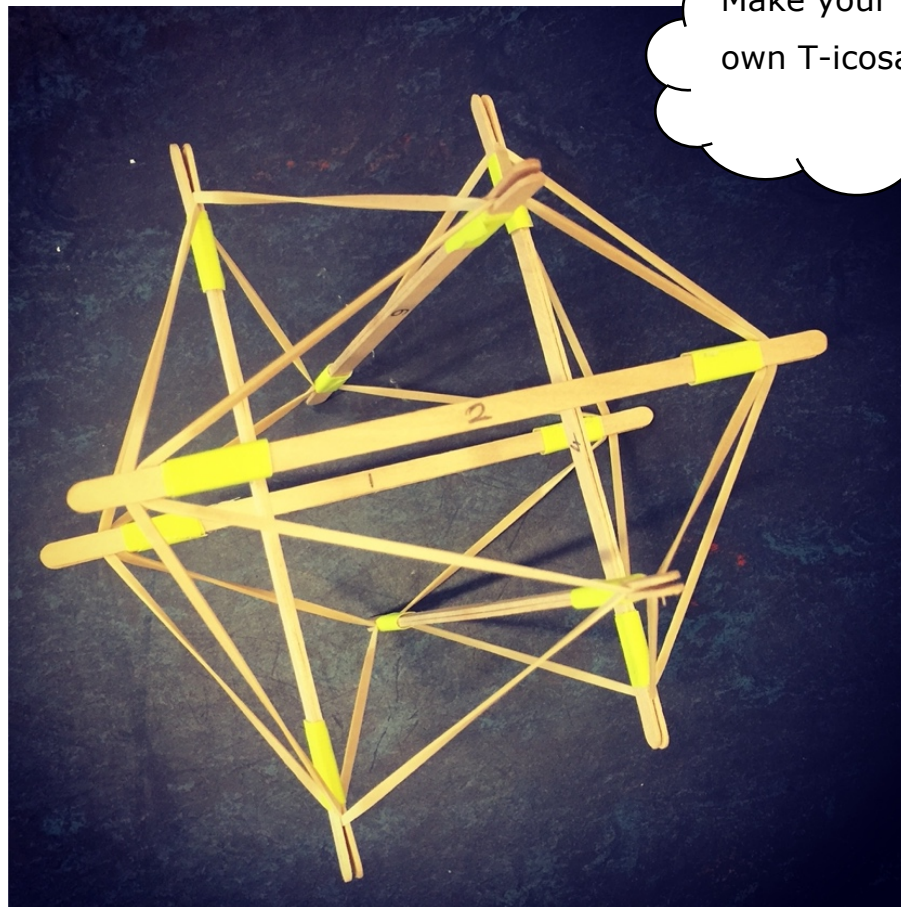


Figure 35: DIY T-icosa, designed and built by the author

Materials:

- 12 flat wooden coffee stirrers
- 6 rubber bands all the same size
- tape (moshi tape works best)

Process:

Step 1: Pair the wooden stirrers and tape them together near the ends, leaving one-thumb width free at the ends

Step 2: Now you have 6 struts – ensure the ends are open and each pair is consistently taped

Step 3: Number each strut from 1 through 6 as shown in Figure 35

Chapter 9: A Novel Spatiotemporal Model of CA

Step 4: Slip the ends of Struts 2 & 3 around the bands (mid-band level) of Strut 1, going from 1D to 2D – now you have the x and y axes.

Step 5: Slip Strut 4 into the bands of Struts 2 & 3 – now 2 & 3 are end-capped by 1 & 4.

Step 6: Now you will take the 2D structure and “open it up” into the third dimension by adding the z axis with Struts 5 & 6... get ready for the ping!

Step 7: Carefully slip the ends of Struts 5 & 6 over the bands of 2 & 3, in so doing you will be pulling 2 & 3 apart.

Step 8: Now pull the bands of Struts 1 & 4 down into the slots of Struts 2 & 3 – use the structure’s tensioned quality in relationship with the floor/table to help you navigate the forces!

Step 9: Et voila! Your T-icosa is ready – now adjust the bands to get the shape as regular as possible.

Step 10: Play – squeeze, throw, catch, delight in the responsive elasticity of the shape.

9.13 Chapter Summary

This chapter opened with a nod to the shift of focus from philosophical justification in Chapter 8 to the more informal tone of this chapter, which is concerned with presenting a complexity-friendly model of the learning environment. I then offered a discussion of geometric models, introducing the icosahedron shape and then progressing into an explanation of tensegrity and its applications in both living and non-living CASs. The living human body is an example of the former, while the LE is the operative example of the latter.

Chapter 9: A Novel Spatiotemporal Model of CA

This chapter moved next into a discussion of the tensegrity icosahedron (T-icosa) as a model of embodied complexity, where ILAs are mapped onto the nodes of the model and are always in flux. This developed into a discussion of tensegrity in living systems and then considered how such systems are governed, or ruled, as holarchies. This is compared to the same behaviour in the LE. Simultaneity & circularity are carried out via heterarchical arrangements in CASs, with hierarchical behaviour playing into the system via the “Janus face” of holons that can give and receive influence via higher and lower order units.

A key aspect presented in this chapter is that of cellular tensegrity, whereby complex living systems are prestressed, tensioned via their cytoskeletal architecture. This tensioned interconnectedness gives rise to nonlinear behaviour in the CAS. I discussed the tensioning properties of the LE, modelled as a T-icosa, as part of the Authentic Alignment theory that comes in an Archerian SAC (Archer, 2020) – structure, agency and culture. If the T-icosa represents its structure, then agency and culture are the tensioning forces.

Other important aspects of tensegrity applicable to CASs are modularity and reciprocity, important for making practical sense of the T-icosa as a model of Authentic Alignment. Modules are interconnected and tensioned and display reciprocity in and amongst the relationships. The curriculum (agency) and the LE (structure) are themselves engaged in dynamic reciprocity.

This chapter covered the relevance of considering tensional vectors in the round, moving from 90-degree cubic geometry to the geometry of round things in nature, the 60-degree “synergetic” vector space of spheres a la Buckminster Fuller. I presented this shift into spherical geometry as an essential step toward embracing nonlinear pedagogy.

Chapter 9: A Novel Spatiotemporal Model of CA

In the section on nonlinear pedagogy inspired by Chow (2006), I presented the four characteristics he proposed as part of NP: non-proportionality, multi-stability, parametric controls (constraints), plus the fourth and perhaps most important in this doctoral work: noise. I offered my view that noise accounts for the HC, which is where HPE puts all the uncertainty that it can't account for with traditional models. I proposed that creativity and authenticity are the potential rewards of embracing uncertainty with higher fidelity, complexity-friendly models such as the T-icosa.

"Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organization of the entire tapestry."

— **Richard P. Feynman**

Chapter 10: Toward Authenticity – Integrative Discussion

10.1 Chapter Introduction

This penultimate chapter contains a reflection on the aims of the thesis as set out in the Introduction presented in Chapter 1. The general findings are contextualised using the conceptual framework of critical realism. These findings will then be interpreted from an integrated perspective, presenting important considerations before closing with a short chapter summary.

10.2 Reflecting on Thesis aims

This doctoral thesis has presented empirical chapters with results that inform the trajectory of the project via abductive reasoning. Recall that abduction represents an alternative (from within) to the usual modes of coming to know about the world via deduction (top down) and induction (ground up). Via retroduction, this dissertation concludes that CAS modelling is authentic for the LE (see Table 20). Accordingly, the aims of this work hinged around understanding not only the alignment and authenticity of the learning environment, but that of this thesis itself and its original contribution to the fields of medical sciences and HPE.

The summary aims of this thesis were:

1. to understand the alignment of anatomy within the medical curriculum via its stakeholders.
2. to explore the apparent complexity of the learning environment (LE).
3. to generate a critical evaluation of the methodology, Interpretative Phenomenological Analysis (IPA) (Smith, 1996) as an approach appropriate for realist research in the complex fields of medical and HPE.

Chapter 10: Toward Authenticity – Integrative Discussion

4. to propose a functional, authentic model of the learning environment and provide a robust theoretical justification for it.

Here, I will provide a brief reflection of how this thesis responded to each of its original aims. The first three aims have been resolved throughout the thesis, reflecting the abductive style of critical realism.

10.2.1 Aim Number 1:

Chapter 4 set out to get familiar with the tools of critical realism in an exploration of anatomy educators' views on the alignment of their curriculum. From this study, I was able to glean key insights about how the educators fit within their wider environment. The empirical constraints of the study allowed me to reason abductively that the relationship between anatomy as a subject and medicine as a program of study, aka "the medical curriculum", is complex. The first aim was achieved at a basic level in this study, and further studies resonated with this finding.

10.2.2 Aim Number 2

After gaining access to the intransitive realm via the "Fit for purpose" study, I dove deeper into it with the study of anatomy students and teachers exploring the use of dark humour in anatomy labs presented in Chapter 5. This study provided key insights into how stakeholders use humour to cope with complexity, information overload, and exposure to morbidity during their routine educational life.

Two outcomes are particularly noteworthy from Chapter 5 in relation to Aim Number 2. First, the HC is evidently an important factor to consider when looking at HPE questions around modelling an authentic version of the LE. Secondly, this study pointed to the need for more "humanistic focussed" research in HPE. The second

Chapter 10: Toward Authenticity – Integrative Discussion

aim, to explore the complexity of the LE, began here as my later findings revealed that the dark humour/HC can be understood as 'noise' in terms of CAS behaviour – unpredictable, unruly, misunderstood effects of nonlinear systems. Aim Number 2 was also duly achieved in the IPA study of anatomy educators presented in Chapter 7.

10.2.3 Aim Number 3

Aim number 3 involved generating a critical evaluation of IPA for HPE. This aim is met in Chapter 6, constituting a qualitative evidence synthesis of IPA literature with a critical overview of selected articles. The evaluation of IPA for HPE research questions is provided in the discussion section of that chapter, encapsulated in the ten top tips for using IPA in HPE (See 6.6.1). Further insight regarding the appropriate use of IPA in larger mixed methods projects such as this one is presented in the next section, *10.3: Contextualising Findings in the Conceptual Framework*.

10.2.4 Aim Number 4

Aim number 4 was to propose a functional, authentic model of the LE. I have rationalised and proposed what amounts to a theory, Authentic Alignment, that claims roots in Archerian analytic dualism and argues for the use of complexity-friendly geometric models as most suitable for the representation of authentic learning environment in HPE. Chapter 9 provides background justification for tensegrity and the icosahedron as suitable elements for modelling, and the T-icosa brings together these aspects in a model with practical applications for influencing deeper understanding and modulation of HPE settings. The philosophical justification for Authentic Alignment theory is presented in Chapter 8, and the model itself is presented in Chapter 9.

10.3 Contextualising Findings in the Conceptual Framework – revisiting the thesis research questions

The previous chapter provided the fruit of a reasoning process using the abductive logic of critical realism. Considering the empirical chapters and the paradigmatic rationale for their results, I have proposed Authentic Alignment theory. This novel theory claims that it is appropriate to apply Bigg's (1996) ILA triangle to a spatiotemporal model that better explains complex HPE learning environments for all its users. This model, the T-icosa, is used frequently in the complexity thinking literature and has its roots in art and architectural discourse.

Original research questions with summary answers:

1. How can the curriculum be modelled?

With the benefit of experience, I now understand that the curriculum is only one part of the relational experience that defines using a medical programme. Upon reflection, I think that the basic curriculum alignment is still modelled with Bigg's (1996) ILA triangle. My findings show that the curriculum interacts with the learning environment in dynamic reciprocity. The curriculum is an avatar of agency, and the learning environment is the existing structure.

The top-down actions of users (agents) prescribed to and imposed upon the LE (structure) together form a complex adaptive system. Considering that the sum structure is ever-changing as an agency-informed LE, we may use the Authentic Alignment theory. This theory claims that the HPE LE can be modelled as a T-icosa.

2. Can the authenticity of a curriculum be understood through its model of alignment?

I have found that the simulation literature provides an apt set of constraints for defining authenticity. Models that are higher fidelity are said to be more realistic, but a higher level of realism does not guarantee greater authenticity. The key to making models with the highest degree of authenticity is evidently to incorporate a level of uncertainty. This dissertation concludes that CAS modelling is authentic for the LE (see Table 20).

Can we use models to understand complexity specifically for intended fields such as HPE? These findings suggest that, yes, we can adapt our dominant conceptual models to update them considering what we know about complexity. For example, I have suggested that it is useful to map Bigg's (1996) ILA triangle onto a T-icosa. This provides a higher fidelity model, truer to life, that embraces uncertainty and is thus more authentic in theory and practice.

3. What does an authentic learning environment feel like?

Based on my findings, my answer to this question is that an authentic LE feels much the same to all agents using it: complex, ever-changing, and characterised by uncertainties and contradictions with which everyone is tasked to manage in their own way. I interpreted that the more control educators felt they had with regard to decision making in the curriculum, the greater their sense of belonging and involvement, the more confident they felt.

4. Who decides what is authentic?

This is an important epistemological question as it underscores the intersubjective nature of this doctoral project. Authenticity enquiries defy objective approaches. As researchers in HPE, it is impossible to claim definitively that one setting is more authentic than another, as our findings show that authenticity is known only through subjective means. However, this thesis presents findings via CR that

point to a realist-informed conversation about authenticity in terms of fidelity and uncertainty. It is possible to design high-fidelity scenarios for learners and make uncertainty explicit rather than to prioritise realistic portrayals (i.e., more lifelike and expensive mannequins in OSCE stations, or moulage in simulations (Stokes-Parish et al., 2019)). The conclusion of this thesis rests on the centrality of increasing uncertainty tolerance and embracing the HC to produce more authentic settings in HPE. This understanding would provide reasonable justification for curriculum designers to decide what constraints may provide increasingly authentic experiences in practice.

10.4 Interpretation of Integrated Thesis Findings

Going back to the conceptual framework of this critical realist project means reiterating what is meant by abductive reasoning and what it aims to do. Recall the three modes of reasoning as I compare their trajectories as in Table 19. I set out to get inside my topic and enter the realm of the intransitive, which is to say I immersed myself in empirical studies and did my best to interpret the results in conversation with theories about the structure of Real. I did this in full acknowledgement that my theories, based on what I could observe about emergent effects, are temporal, transitive, subject to change and expressly fallible. Table 20 presents the major retroductive conclusion of this thesis.

Table 19: Comparison of modes of reasoning and their trajectories, designed by the author inspired by Garbuio (2019)

Reasoning	Point of Departure	Aim	Nature of Conclusions
Inductive	Empirical observation (theory neutral)	Developing theory	Generalisation/transferability of results

Chapter 10: Toward Authenticity – Integrative Discussion

Deductive	Theoretical framework	Testing/evaluating theory	Corroboration or falsification
Abductive	Empirical observations (unmatched by/deviating from theory)	Developing new explanations & understanding	Suggestions (for future directions, theory/paradigm/tool)

10.4.1 Hermeneutics

In essence, I have approached this project in the hermeneutic spirit, see Figure 36. From the Greek verb *hermeneuein*, which means to say or interpret; the noun *hermeneia*, refers to “the utterance or explication of thought” (Moules, 2002); and the name Hermeneus, which refers to the playful, mischievous, “trickster” Hermes (Grondin, 1994). The final chapter will take a deeper look at what my thesis contributes by way of this approach in terms of methodology, educational theory, HPE, and the wider field. Here, I will explore my interpretation of what the findings of this thesis contribute to the field of HPE overall.

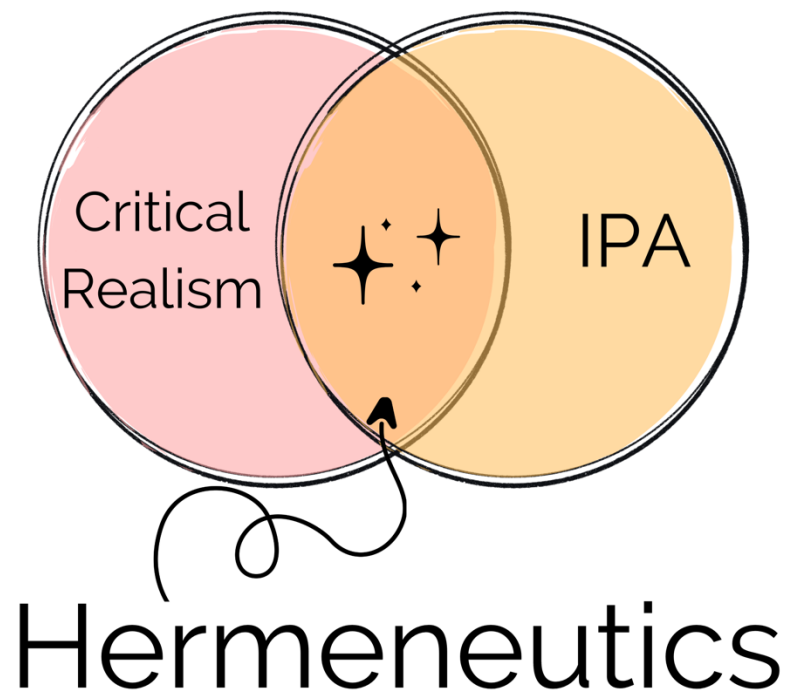


Figure 36: Hermeneutics, the link that connects critical realism & IPA. Image created by the author.

10.4.2 HPE: A suitable home for hermeneutics

Chapter 1 and 3 offer a background on Biggs' (1996) CA and Authentic Learning, leading into a Beginners Guide to critical realist perspective presented in Appendix A. I established the centrality of reflexivity and the importance of the 'emancipatory axiology' for CR projects – useful for many HPE research questions that are culturally tied into STEM realism but require a subjective epistemological approach to methodology. These chapters also reinforced the value of language and the sophistication of varied voices – heteroglossia – useful in communicating the integrative nuance of consolidating my doctoral work.

My intention was to provide a robust defence of changing voice and tone to give further precedent for other HPE projects whose readability would benefit from this writing technique. HPE researchers are normally grounded in STEM communities, i.e., medical schools, with strong roots in the positivist paradigm of

Chapter 10: Toward Authenticity – Integrative Discussion

reductive realism and objective third-person scientific writing conventions. As such, authors from this discipline need more justification than those coming from a purely social sciences community where heteroglossic, subjective enquiries are the norm. My thesis contributes a strong rationale for using the heteroglossic approach in HPE writing which is further explored in Appendix A.

The findings of this thesis were gathered and analysed in an increasingly hermeneutic approach made possibly by the heteroglossic technique. Hermeneutics involves a foray into language, and Gadamer advocated dialogue – the *conversation* – as its ideal vehicle. Gadamer asserts that “language is the universal horizon of hermeneutic experience” (Gadamer, 1985). The terms “conversation” and “dialogue” are indeed central to Hans-Georg Gadamer’s definition of understanding.

Principally concerned with the interpretation of historical texts, Gadamer believed that understanding is linguistically regulated via conversations with others. If my goal is to understand what might be meant by authentic alignment, then the way to do that is to enter conversation with key texts and stakeholders. In this way, in dialogue, a new understanding about reality is conjured that is relative to time, place and circumstance of the conversations, representing a new understanding of reality set in the milieu of its interpretation.

Gadamer’s Hermeneutics has been described as the practice and theory of interpretation and understanding in human contexts (Chesla, 1995). Grondin refers to it as the science, art, and philosophy of interpretation (Grondin, 1994) and the “discipline of thought that aims at (the) unsaid life of our discourses” (Grondin, 1995). In essence, the hermeneutic process involves reflective enquiry concerned with “our entire understanding of the world and thus...all the various forms in which this understanding manifests

itself" (Gadamer, 1977, p. 18). This process is classically mapped to a circle, the hermeneutic cycle of reading a text in continuous reference to its context.

10.4.2.1 The Hermeneutic Circle

The hermeneutic circle, as introduced in the IPA chapters of this thesis, has its roots in the cycle of faith and reason (*intellego ut credam*), introduced by St. Augustine of Hippo. Like the Janus face of the holons that form the systemic architecture of CASs, each giving and receiving instructive influence, the hermeneutic circle is a graphical representation of reflective behaviour. The iterative circle has many avatars, with another example in the snake eating its own tail, the ouroboros, ubiquitous in global iconography symbolising cyclic renewal and union of opposites:

"When Shakti is united with Shiva, she is a radiant, gentle goddess; but when she is separated from him, she turns into a terrible, destructive fury. She is the endless Ouroboros, the dragon biting its own tail, symbolizing the cycle of samsara." (Storl, 2004).

In modern hermeneutics, the circle refers to the continuous parts-whole reflection that authors carry out in their pursuit of greater understanding, about a subject through the interpretation of texts. Gadamer (1975) developed this concept into what would become the seminal usage for the contemporary hermeneutic tradition that followed. Previously, Heidegger treated the hermeneutic process as cycles of self-reference that couched our understanding in *a priori* preconceptions (Racevskis, 1994). "This circle of understanding is not an orbit in which any random kind of knowledge may move; it is the expression of the existential *fore-structure* of Dasein itself." (Heidegger, Stambaugh, & Schmidt, 2010) (p. 32, 295).

Chapter 10: Toward Authenticity – Integrative Discussion

Gadamer reimagined the hermeneutic circle as an iterative process. As we move around the circle, a new understanding of a whole reality is developed in exploration of its parts. Gadamer's understanding of the HC as, essentially, a conversation, is seen as a break with previous hermeneutic traditions. "As in play, it rests on a common willingness of the participants in conversation to lend themselves to the emergence of something else..." (Gadamer, 2013) TM p. xvii. Hermeneutic methodology allows us to dissect the underworld of language. As Moules describes, "it ventures into the contextual world of a word" (Moules, 2002), considering "what is said, what is uttered, but at the same time what is silenced" (Grondin, 1995).

This attention to the shadow implications of language makes hermeneutics especially cogent for exploring the HC. My findings over the course of this doctoral work are a result of continuous hermeneutic reflection. The philosophical apex of this thesis presents the hermeneutic dialectic of structure-agency as epitomised in the conversation between Giddensian Structuration theory and Archer's Morphogenetic/Morphostatic approach via analytic dualism as grounded in critical realism.

Overall, my integrated findings demonstrate that the need for a complexity-friendly model of authentic alignment for the HPE learning environment can be explained via analytic dualism. In conversation with Biggs' (1996) triangulated model of CA, I used this rational to reimagine Biggs' model in the practical form of the T-icosa. Thus, my contribution to HPE involves bringing hermeneutics in conversation with CT, uncertainty, the HC, and modelling the learning environment in reflection of emergent qualities.

Chapter 10: Toward Authenticity – Integrative Discussion

10.4.3 Integrating IPA findings with critical realism

I will now unpack what I consider to be the two main philosophical contributions to HPE research offered in this doctoral work, 1) reconciling critical realism as a paradigm with IPA as a methodology, and 2) presenting critical realism in conversation with CT.

10.4.3.1 Reconciling critical realism as a paradigm with IPA as a methodology

As previously mentioned, a paradigmatic stance in critical realism seeks knowledge via hermeneutic (interpretative) dialectics as we enter the intransitive realm. The interpretative tradition permeates a range of methodologies. The findings of the Uncovering Hidden Curricula study presented in Chapter 5 called for the need for more “humanistic focused” research. My quest for a methodology based on hermeneutics prioritising the lived experiences of humans led me to Interpretative Phenomenological Analysis.

IPA methodology is an explicitly hermeneutic means of accessing the CR path into knowledge, using transitive glimpses of lived human experiences to reflect with “more complete” understanding overall. Its main modus operandi is the Hermeneutic circle. In the process of moving around that circle, I have come to understand CR as an integrated paradigm for science, sitting between the normative forms of positivism characterised by an objective pursuit of universal laws and the postmodern turn that eschews causality to focus on interpretation (constructivism).

The former (positivism) represents the hegemony of quantitative research seeking reduction and regression-concerned variables models in STEM disciplines, closed off from the privilege of sustained abduction. The latter (constructivist interpretivism) encompasses the hermeneutic and constructivist qualitative research that has come to dominate the social sciences, robbing it of the hunt for causation. As an alternative view to this polarity,

Chapter 10: Toward Authenticity – Integrative Discussion

critical realism became an exciting perspective from which to think about the complexity, authenticity, and alignment of relationships.

IPA provided me with a surgical route for immersing myself into the inner space of participant life worlds, where I was able to find and co-create my data in conversation with them. I believe that other HPE researchers will benefit from situating their projects in the paradigm of critical realism where they may avail themselves of mixed methods to approach empirical practice. My contribution demonstrates that IPA methodology resonates deeply with the philosophical framework of CR as a powerful combination to equip future HPE researchers in their aims. I will now position CR as a meta theoretical position and discuss how it interfaces with CS.

10.4.3.2 Critical realism and complexity: a conversation

Critical realism, like the CT discourse, is an amalgam of applications, a kind of hashtag that brings together a ranging enquiry. As previously described, CR discourse includes a stratified realist ontology with subjective epistemological views on causation, with its findings expressed as explanation. As with the protagonists in complexity, critical realists are concerned with emergence, the parts-whole relationship, and self-regulation. Both conversations have their roots in the post-positivist crises in the natural and social sciences that begin in the mid to late 20th Century (Fischer, 1998). Critical realism and complexity represent a significant dialogue in the post-positivist conversation.

I have come to appreciate CR as a philosophical tapestry woven in conversation with Marxism, with Bourdieusian and Habermasian threads informing the weft. Critical realists often draw upon a wealth of influences, including but not limited to those referenced in this thesis (i.e., (Archer, 1982, 1995, 2000, 2003, 2020; Bhaskar, 1975 & 1979); Porpora, 2015; Sayer, 2000; Vandenberghe 2015; Vass, 2010). However, although Archer “would not object” to her

Chapter 10: Toward Authenticity – Integrative Discussion

Morphogenetic approach being considered a methodology (2020), there is still no standardised unifying methodology or framework that defines CR enquiry.

CR doesn't explain anything, so it cannot be considered a theory as such. There is agreement about CR as a meta-theoretical position (Owens, 2011) that supports the formulation of a coherent post-positivist philosophy. The meta-theoretical position of CR as a reflexive philosophical stance allows projects like this one to explore multidisciplinary questions, situating its findings in a philosophically informed account. As such, I present my findings as a multilevel report of my journey on three scores: my empirical data, the theories that I have drawn upon to explain my results, and the metatheories that provide the philosophical framework – the warp and weft, so to speak.

CR invites a continuously changing, reflective explanation of juxtaposed theories. The findings in this doctoral project detail a close investigation of relationships and emergent understandings that rise above the water line and sink again into the background. One set of relationships sheds light on another. What began as an examination of the relationship between anatomy education and the wider medical curriculum evolved into an investigation of the relationship between CT and CR.

I will now reflect on the inconsistent usage of CS in the medical education literature as shown by Cristancho et al. (2019), as I have explained in section 8.6.2 of this thesis. My appropriation of the term during my doctoral project began with the same problematic usage of complexity as can be found in the wider health sciences. Complexity is a buzzword that requires robust clarity if we are to use it correctly. In recognition of the woolly ways in which 'complexity' is used, further confused in medical education by the pervasive use of secondary rather than primary sources

Chapter 10: Toward Authenticity – Integrative Discussion

(Cristancho, Field, & Lingard, 2019), I have enlisted the support of Manson's conceptual framework to appropriately situate my project. Overall, I am dealing with aggregate complexity, the orientation sitting between algorithmic and deterministic complexities that invites consideration of the environmental factors within which a system interacts.

I have embraced my usage as 'complexity thinking', sitting in between hard complexity and soft complexity as per Richardson et al. (Richardson et al., 2001). I sometimes use the descriptive term, 'complexity-friendly', in acknowledgement that no nondeterministic model or framework can account for all aspects of how we come to appraise the nested systems at play in HPE. My alignment with usage of the term 'complexity' has become informed by 'multiplicity', the stance advocated by Cristancho et al. (2019) as being most appropriate for scholars in medical education.

Multiplicity acknowledges the wide-ranging applications of different complexity orientations in the relevant literature. My findings and wider research demonstrate the need for HPE scholars exploring complexity topics to ensure that their usage is clearly situated in Manson's framework and that they provide sufficient primary sources in their writing.

There are a number of projects in the social sciences that explore the relationship between complexity and critical realism, notably Yang's (2021) paper extolling Archer's analytic dualism approach to CR for reconciling CT in business governance. My thesis findings make the case for considering the HPE learning environment as a CAS, a complex adaptive system as defined in CT. CT has been on the radar of HPE researchers for some time, as I have previously detailed. I will now focus the conversation on how aggregate complexity, shown by Cristancho et al. (2019) to be aligned with

Chapter 10: Toward Authenticity – Integrative Discussion

the constructivist paradigm, will benefit from further unpacking to bring its usage in line with the constraints typical of HPE settings.

Advocates of CT describe it as a “critical scientific paradigm of the 21st Century” (Waldrop, 1993; Castellani & Hafferty, 2006; Byrne & Callaghan, 2013). CS represents a matrix of fields and associated theories concerned with non-linear systems, also known as CASs. (Sturmberg & Lanham, 2014). Complexity derives from *plexus*, Latin for inseparable. As such, CASs are typically nested within other CASs; for example, a learner is nested within their cohort and society; anatomy as a subject is nested within the wider curriculum, as part of what I have described as a holarchy. The relational focus of aggregate complexity, whereby the collective is understood to be more than the sum of its parts by virtue of their relationships, resonates with the stratified ontological position of CR. Interesting things emerge when entities interact, communicate, and adapt.

CS, especially the aggregate orientation, appropriates ecological models calling for the consideration of whole systems, espousing a multi-systems view where reality is formed of overlapping contexts (i.e., cultural, social) that shape experiences and are shaped by the people experiencing them (Clarkin, 2018). CS has been applied in many healthcare domains, such as personal health (J. P. Sturmberg, 2013), HPE (Mennin, 2013), medical education (Bleakley, 2010; Fenwick & Dahlgren, 2015) interprofessional education (Jorm et al., 2016) and nursing (Ebright, 2010; Bird & Strachan, 2020; Olsson et al., 2020).

Research into the core topics of complexity has been germane to significant advances in medicine over the last two decades. For example, complexity appears in the research on virus transmission (Domingo, 2015; Berge et al., 2018) and vaccine development (Therrien et al., 2017; Utamura, Koizumi, & Kirikami, 2022); in cancer research (Schwab & Pienta, 1996; Chin et al., 2020) in

Chapter 10: Toward Authenticity – Integrative Discussion

computational biology (Gusfield, 1997; Noble, 2002; Schuurman, 2023). Complexity has helped to better understand the dynamics of primary care (Litaker et al., 2006; Ellis, 2012; Sweeney, 2017; de Oliveira et al., 2023) and women’s health (Hoffman, 2000), with the National Institute for Health Care and Research quoted as stating the importance of addressing complexity as a barrier for women’s health issues – “We must address system complexity and break down barriers to inclusion” (NIHR, 2023).

In qualitative health research, complexity has catalysed novel methods (Agar, 2003; Castellani & Castellani, 2003; Anderson et al., 2005; Gummesson, 2006; Byrne & Callaghan, 2013; Gear et al., 2018), with increasing attention in cross-disciplinary research evident in new journals such as *Frontiers in Complex Systems* (San Miguel, 2023). There are calls for investigation into the structure and dynamics of the learning environment (Keeling et al., 2007) especially in health sciences (Mason, 2008; Dyrbye et al., 2009) (Vinichenko et al., 2016) (Gruppen et al., 2018). Complexity is a hot topic in higher education, evidenced by this quote from the Teaching and Learning Conference by AdvanceHE (2023):

“The complexity of the challenge and the recognition that no-one model suits all, means there is no better time to work together, to share practice, learn from our success and our failures to work together to shape the future of teaching in higher education.”

Indeed, it seems that every organisation concerned with health care is talking about how it plans to “tackle complexity”. It is no wonder, as national health in the United Kingdom today is overwhelmed by so-called “wicked problems.” The NHS England website now explicitly defines itself as a CAS, stating on its website (2023):

“The NHS and social care is a complex adaptive system. This means high levels of interdependence and connectivity,

Chapter 10: Toward Authenticity – Integrative Discussion

competing and changing demands, unpredictability, uncertainty, myriad relationships – as well as the need to work with emergence. Periods of very rapid change can occur but with constant often competing pressures the system, being a complex adaptive system, tends to inertia.”

Millions lack access to basic medical services as the NHS has become overwhelmed (Alderwick, 2022). Health expenditures consistently outpace growth (Rodriguez Santana, Aragón, Rice, & Mason, 2020) as medical school graduates abandon primary care in record numbers in a wave coined “Drexit” (Wilson, Abrams, & Simpkin Begin, 2021). Silveira et al. report, “As teachers “Speed up” the clinical encounters, acting as negative role models, students internalized behaviors without reflecting on their attitudes, which culminates in a state of dissonance between the physician they wanted to be and the professionals they actually are, triggering feelings of shame and guilt. Without feeling the rewards that a meaningful practice can provide, students struggled with the idea of sacrificing themselves to become physicians.” (Silveira et al., 2019). Temporality of the agents using the structure is distinct from the structure itself, highlighting the need for a model of the LE that takes timescales into account, such as the Morphogenetic approach does.

Amidst concerns for patient safety, stakeholders in medicine are facing a very real loss of public trust. Organised medicine responds to the crises in its professional ranks by calling for overhauls in education. Curricular interventions such as efforts toward a spiral and integrated curriculum ostensibly aim for authentic, student-centric experiences. Yet a contradictory move to implement the Medical Licensing Assessment (MLA) has shown that top-down interventions to cultivate professionalism may be at cross-purposes in theory and practice. In sum, medical and HPE currently struggle

Chapter 10: Toward Authenticity – Integrative Discussion

with identity as a core topic – medicine may be having an identity crisis as it doesn't have an authentic understanding of what it is as a discipline.

As researchers in education grapple with how to model the HP learning environment, doctoral work such as that presented in this thesis asks: could CT inform the structure and behaviour of educational models seeking authenticity? The answer to that question is one that is loved by critical realism: *maybe*. As previously discussed, one enduring obstacle tripping up efforts to operationalise CT in HPE is the lack of clear frameworks for analysing the complexity of systems within the field. Although complexity remains a buzzword, there has yet to form a consensus on the role of CT in theory and practice in HPE. Notable exceptions such as the CYNEFIN framework (Van Beurden et al., 2011) and CYNEFIN variants (Lane et al., 2021) in healthcare serve to point out that similar frameworks have yet to be operationalised for modelling the learning environment of HPE (See Figure 37). From the paper by van Beurden et al. (2011), the following resonates deeply with the CR stance on the centrality of relationships and emergence: "The Welsh *cynefin*, literally 'habitat', alludes to our myriad affiliations such as those of kinship, culture and location. We are never fully aware of them, but patterns of multiple experiences that emerge from them influence our every interaction (Kurtz & Snowden, 2003)."

The Cynefin Framework (CF) interfaces with the complexity of nested involvement. The CF has applications in the fields of policy making and leadership training, research, knowledge and strategy management, and IT (Mark & Snowden, 2006; Snowden & Boone, 2007). The framework operates via five domains: the Complex, Complicated, Chaos, Obvious and Disorder. Ultimately, the CF

facilitates stakeholders in making sense of relevant complex processes to ensure the most appropriate actions are taken.

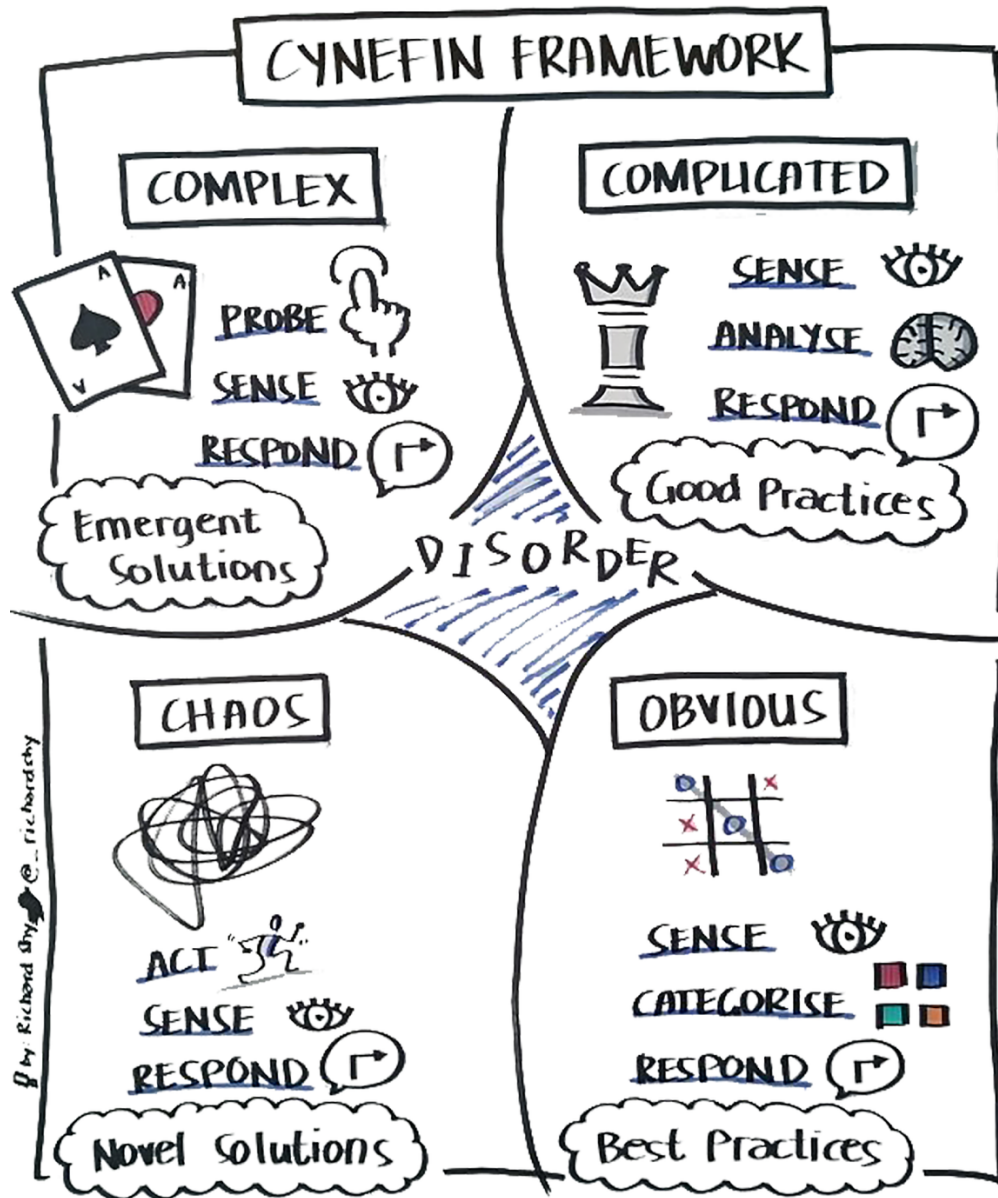


Figure 37: The Cynefin Framework [adapted from <https://itrevolution.com/articles/cynefin-four-frameworks-of-portfolio-management/>]

10.4.3.3 Separating agency and structure to serve the analytic process

The CF is essentially a conceptual guide for agents seeking to navigate complex scenarios. It is not a structural model of the learning environment, although it would aid stakeholders (agents)

Chapter 10: Toward Authenticity – Integrative Discussion

aiming to influence the LE (structure) via curricular interventions. Previously, I have mentioned that despite calls for operationalizing the HC, uncertainty, and other aspects of CASs evident in HPE, there is a persistent reluctance to adopt explicitly complexity-friendly frameworks.

My interpretation is that this lack of clear operational action is because complex scenarios buck the harness. In other words, it is hard to grapple with a hot mess. Most people come to their first understanding of complexity as the amalgam of agency and structure popularised in mainstream literature. This amounts to a constructivist philosophical position that fails to recognise that agents and systems are discrete entities, as presented in the hermeneutic dialectic of this chapter. Although structuralisation of agency is not philosophically problematic, as Archer (1995) points out, collapsing the two into one entity precludes them and their interplay from effective analysis.

“Full significance is accorded to the timescale through which structure, culture and agency themselves emerge, intertwine and redefine one another, since this is the bedrock of the explanatory format employed in accounting for any substantive change in social forms.” (Archer, 2020)

One of HPE’s chief concerns is how curriculum interventions affect the learning environment and its peoples. The context within which the relationship between agency and structure takes place defies simplistic, linear analyses. In this doctoral thesis, I have applied a critically reflective lens using Archer's framework for an immersive understand of this complex interaction. My overall findings confirm

Chapter 10: Toward Authenticity – Integrative Discussion

previous work in HPE, including the relevance of the HC and the importance of embracing uncertainty.

Adding to the difficulty in developing coherent frameworks for CT are the questions about authenticity and how it can be operationalised in practice. This sustained interest in promoting authentic learning in HPE amounts to “the achievement of some specific agential enterprise” (Archer, 2003, p. 5) which can only be analysed if agency exists as a discrete entity. My interpreted findings claim that authenticity can only be analysed subjectively, and only as an emergent quality amongst the interplay of structure and agency as discrete entities.

It is thus evident that rule makers in HPE seeking increased authenticity would benefit from recognising the uncertainty facing educators as well as students aiming to reconcile the dualities of a medical programme: anatomy and medicine, short term and long term, curriculum, and LE. Further, curriculum designers interested in authentic learning would do well to acknowledge what Archer as referred to as the ‘personal emergent properties’ (2000, p. 194) that people carry with them into HPE settings. My research revealed that although uncertainty, complexity and contradiction form real aspects of the LE, these qualities are not explicitly valued. These findings resonate with van Schalkwyk et al., whose work uses Archerian analytic dualism to explore perceptions of professional learning as part of quality teaching. In their words, such results need to be explored in “institutional conversations that might shift dominant discourses and encourage spaces where teaching can flourish.” (Van Schalkwyk et al., 2015).

10.4.4 Dynamics, self-organisation and coevolution

In this section, I will provide an interpretation of my findings that owes much to the work of Yang as previously mentioned. Their paper, *Critical realism and complexity theory: Building a*

nonconstructivist systems research framework for effective governance analysis (Yang, 2021) rings in key with my integrated interpretations of how this thesis demonstrates realist-informed conclusions for applying CT to HPE research. Inspired by Yang, I will start by recapitulating three major concepts of CT (dynamics, self-organisation, and coevolution), then discuss how efforts to operationalise CT in research typically stumble at coevolution. Klijn (2018) explains the application of CT in public management studies highlighting the same three CT concepts, sitting well with the description of CASs in Chapter 9. My interpretation of the constructivist-realist dialectic takes Yang's points on the side of embracing a realist approach to CT. I'll use this as a major steppingstone on the approach to Authentic Alignment, which sees both the constructivist (Giddensian) and realist (Archerian) views of CT as part of its multiplicity stance.

10.4.4.1 Dynamics & self-organisation

Dynamics, and *dynamical*, refer to the constancy of interaction amongst interconnected nodes of the system, always changing. The dynamical system is stabilised in constant flux and is therefore multistable and "fluxtable". Local developments will affect other elements and developments via nonlinear behaviour, with a high degree of unpredictability. Such dynamical systems are constantly moving between order and chaos, a shift that, according to Klijn (2008), keeps governance in balance.

Similarly, social life is characterised by a mutable array of the orderly and the disorderly (Kingdon, 1984) that endows the system with autonomy, or self-ruling tendencies, what I have compared to Koestler's *holarchy*, giving rise to unpredictable yet self-sustaining behaviour. This concept of self-organisation speaks to the origins of such uncertainty, as agents "do not (only) behave according to laws or principles, but they have self-organizing capacities" (Teisman &

Klijn, 2008, p. 288). Here lies the nondeterminism, as emergent properties arise at the macro level because their self-organising micro holons influence the shape and direction of the whole in apparent spontaneity.

According to da Rocha, “a non-deterministic social event is usually accredited to the free will of the actors, or even the complexity of the configurations of conditions associated with such event despite the hypothesis of its deterministic nature (da Rocha Braga, 2017).”

This definition becomes important in the agency-structure dialectic in relation to CT applications in HPE, especially where modelling is concerned. It presupposes that nondeterministic outcomes are unpredictable by virtue of free will (agency) *or* can be nondeterministic because of the event’s configuration (structure). Da Rocha is here acknowledging that the two, agency and structure, are separate entities, at least for analytic purposes. CR proposes that emergence arises in the interplay of these discrete entities.

It is well established in CS that such “emergence” is the fruit of complexity behaviour. In an educational context, the individual ‘local’ level catalyses educational effects at the macro ‘global’ level which cannot be reduced to the local. In this way, emergence occurs in systems with causal properties that are greater than the sum of its “lower level” parts (Vass, 2010). In such systems, properties of the collective are not reducible to the properties of the constituent parts.

This “irreducibility” notion speaks to the fact that you can’t unbake the cake, so to speak. Emergent phenomena defy determined prediction by prior knowledge and actions of the lower-level constituents (Greve, 2012). While recipes can constrain the processing of ingredients, so we end up with palatable confectionary in linear processes like baking, nonlinear CASs have no recipe. The “cake” arising from a dynamical system is nothing you could expect.

Chapter 10: Toward Authenticity – Integrative Discussion

10.4.4.2 Coevolution: conflation and the Agency-Structure dialectic

This last sub section moves into the last of the trio of CT qualities described here: co-evolution. What makes CT difficult to implement in social research (and by extension, education) harkens back to the agency-structure dialectic previously described. According to Yang, “most complexity theorists like Holland (1995) and Morçöl (2012) conflate individual actions and larger systems as they suggest that emergence provides mechanisms for understanding the macro/micro problems at the heart of public management process, via Giddens' structuration (1984).” Where the systems and agents are treated as interchangeable entities, they become conflated.

As discussed in 7.6.4., the analytic defect of conflation constitutes the central problem Archer takes with the constructivist perspective of social system behaviour. When autonomy is denied to agency, causal efficacy is granted only to the structure (downward conflation). Where autonomy is denied to the structure, causal efficacy is granted to agency (upward conflation). In the case of Giddensian structuration, and constructivist views generally, central conflation collapses system and agency into a co-constitutive and co-evolving determinist entanglement.

The trap is that applications of complexity most suitable for HPE questions would normally fall into the aggregate orientation, where the system is modelled in conversation with its environment. As such, the aggregate complexity orients with the constructivist tradition, which eschews realist ontology – and in this sense complexity questions would be incompatible with critical realism, rendering it ineffective for analysis of curricular interventions. In aggregate systems that are not considered within the structure-agency dialectic, emergence is overpowered by ambiguity. Yang (2021) puts it this way, “conflating structure (as rules–resources sets), systems (as products of structures), and agents (as

mediating producers) into mutual construction; Giddens collapses systems into agents as the former are reproduced through the latter who are simultaneously constrained and enabled by the former (Kaidesoja, 2009).”

Indeed, emergence is not just something we wish to observe. Critical realists embrace an emancipatory axiology that seeks appropriate action in the form of theorising the next level of completeness. Toward a more complete HPE understanding of how we can best embrace all that complexity thinking has to offer, we need to see clearly the paradox embodied in CASs. Teisman & Klijn (2008, p. 290) refer to the “the combined actions of individual agents in the system lead to the emergence of new features that solidify and form the system.” From this Giddensian perspective, models, systems, and culture are “all instances of structural traits that actors may draw on, choose to ignore, or counteract” (Bouchikhi, 1998, p. 229). Structuration, like constructivism, casts reality as a construct of agents engaging in an ever-flowing cascade of interaction.

The contradiction flares when we consider the situation as an instance of multiplicity. On one hand, we understand complex systems as collectives that change behaviour structurally. On the other hand, we know them socially to be a result of self-organising agents responding to environmental stimuli whilst navigating the unique circumstances of their temporality in the wild. The multiplicity approach is effectively a juggling act, as I contend with the multiple perspectives required to address mixed methods research projects.

From a constructivist perspective, reality is the consequence of interactive agents cocreating systematic adaptations. The system and agency relationship is characterised by the continuously co-construction of one another in a dynamic reciprocity. The problem

with this model, from an analytic perspective, is “the temporal conflation of the synchronic and diachronic dimensions” (Winch et al., 2023) that beats at the heart of structuration theory. In other words, there is a risk of confusing measurements of change taken at a certain point in time with the potential for measuring changes over a period of time.

If we accept that the agency-structure dialectic can become a tool for HPE researchers addressing multiple vectors of enquiry in mixed methods projects, then it is useful to appreciate both structuration and analytic dualism with regards to the concept of coevolution. Coevolution involves adaptive multilevel changes over time where systems and elements/agents influence one another. As all elements coevolve in a hive of decision-making with each other simultaneously within and amongst their broad environments, coevolution designates systems as nested. Recall the holarchy, where nested elements – the Janus faces – are poised hierarchically within larger systems that are, in turn, elemental agents in even larger systems. The holarchy concept, while useful for modelling structural relationships, is problematic when it comes to conceptualising the effects of agency on multiple timescales.

10.5 Multiplicity, authenticity, complementarity

Recall the nature of dynamic reciprocity, whereby the relationship of a polarity is self-sustaining. Two opposite understandings can maintain useful tension. Boulton et al. (2015, p. 29) offer what they consider to be the crux of complexity, “sandwiched between a view that the world works like a machine and a view that the world is chaotic, unpredictable, and without structure.”

Appreciating that patterns are often disrupted by the unforeseen, our educational world is indeed co-evolving in relationship with pre-existing structure. The hermeneutic spirit of this doctoral project

illustrates the power of conversation as a vehicle for such co-evolution. The complexity literature in HPE broadly recognises the nonlinear multiplicity of its interacting systems and demonstrates a sustained interest in engaging with CS to produce strategies that embrace its central concerns.

My findings have shown that for a consideration of authentic alignment, it is worth considering the coevolution of the curriculum (agency) and the learning environment (structure) as not temporally fused. We can observe emergent properties arising on their own time as a function of how curricular interventions play out in the field of structure on multiple timescales. Also, we may utilise the conceptual union of a structure and its behaviour in the case of making complexity-friendly models of the learning environment.

Importantly, HPE authors ought to be clear about their orientation with complexity. One way of doing this is to apply Manson's conceptual framework to disambiguate complexity. Where authors are clear on their orientation and usage of the term, it is possible to clarify which perspective (Giddensian or Archerian) serves their enquiry.

Via retroduction, this dissertation concludes that CAS modelling is authentic for the LE (see Table 20). I have offered a comprehensive interpretation of how Bigg's (1996) CA can be updated to embrace aggregate complexity in consideration of both constructivist-leaning and critical realist perspectives. In this way, multiplicity allows for an authentic conceptual embrace of both determinism and voluntarism, constructivism, and realism. As our world stumbles daily under the weight of its wickedness, there is an urgency to balance the interplay of powerful forces that may otherwise reign mutually destructive.

10.6 Limitations, Considerations, Future directions

This section will focus on what I believe to be the major limitations of this doctoral project. Each empirical chapter contains a section discussing perceived limitations of the respective study. Here, I focus on a retrospective of the journey at large, with a focus on paradigmatic and methodological choices. Overall, I have endeavoured to present reasonably balanced arguments, framing these as the central explanatory tool of critical realism. For example, as I found my project wading further into the murky waters of complexity, I chose to include a close reading of Cristancho et al.'s critical evidence synthesis that clarified how not to fall unwittingly into the buzzword trap.

10.6.1 Limitations of critical realism

The overarching criticism of CR relates to its 'between seats' positionality. Constructivists favouring interpretivism would fault critical realists for being too realist-oriented, while quantitative researchers see it as not realistic enough. As I reflect on the evolution of my project, I see the integrative thread has revealed itself as an emergent quality: the authenticity of alignment. Not all examiners will place the same value on results that are gleaned via emergence and abductive reasoning.

Critics of Margaret Archer's morphogenetic approach have offered counterarguments. According to Anthony King, "the shortcoming in Archer's approach is that by generalising the position of her opponents, there is a risk that she will misrepresent them, building her own position, in opposition to what is, in the end, a straw man." (King, 1999, p. 204). King's criticism here relates to his complaint about Archer misrepresenting the interpretative tradition, for which he provides compelling evidence. However, regardless of Archer's treatment of "her opponents", the way in which I have applied her analytic dualism is about matching it with Giddensian structuration.

Chapter 10: Toward Authenticity – Integrative Discussion

I do not throw the whole interpretive tradition under the bus, on the contrary. King raises several other criticisms of Archer's approach that are beyond the scope of this project. My findings reflect an appreciation for different perspectives depending on the question, as per the multiplicity stance that I have suggested for HPE research where complexity is concerned.

Cruickshank et al. argue that critical realism suffers from a "slippage in meaning" where its "ontology is defined as both a fallible interpretation of reality and as a definitive definition of a reality beyond our knowledge claims (Cruickshank, 2004)." I have accepted the definition of reality as stratified, and also that knowledge claims about reality are fallible. This ontological position has served me in exploring the central aims of my project, which do not include a categorical defence of critical realist tenets.

There has been a sustained critique of CR ontology also amongst realist theorists, such as Harré and Varela (1996), who have a fundamental problem with analytic dualism (Lewis, 2000) vis-à-vis the agency-structure dialectic. Their perspective contends that social structure is inherent to the agents involved and their practices, whereas critical realists approach agents and structures as distinct entities. Realists such as Harré & Varela (1996) consider social structure to be embodied within agents, as Lewis (2000) states, "structure is so intimately bound up with agency that to accord the former a distinct ontological status would be to reify it." Reification—essentially, the practice of giving real status to something that is not demonstrably real—is a central concern for realist theorists who oppose the stratified ontology of critical realism. I have chosen CR as its agency-structure dialectic represents a conversation where both sides of the tension have something valuable to contribute. Model-making, one could argue,

Chapter 10: Toward Authenticity – Integrative Discussion

is the process of reifying something for the purpose of better understanding it.

My questions aimed to understand the nature of the relationship between anatomy education and medical programmes, and how this understanding might aid in modelling the learning environment. CR gave me the tools for interpreting my results, presenting relationships between and amongst concepts in a balanced way. For example, seeing the curriculum (agency) and the learning environment (structure) as separate structures allowed me to consider a more nuanced interpretation of their interaction. Considering the temporal aspects of agency-structure was an important consideration for embracing authenticity in alignment. Although reification is a valid concern, I lean toward the Box caveat, that all models are wrong, but some are useful. I contend that a useful model is worth the reification trade-off.

10.6.2 Considerations for multi-methods

This doctoral thesis has qualitative aims culminating in a spatiotemporal model of the learning environment. Such a model is necessarily characterised by geometry and holds promise for further investigation both qualitatively and quantitatively. However, this project has not stress tested the model. My focus has remained on the robust conceptualisation to develop a meta philosophical context for the T-icosa as an authentic model. As such, this project is limited in its ability to report on the efficacy of the model in practice to determine which aspects should be further explored. However, I have provided a deeply considered theoretical rationale based on multi-methods results chapters as presented in chapters 4 through 7. This theoretical framework for Authentic Alignment theory led to the proposal of the associated model which I hope will have applications in curriculum design.

Chapter 10: Toward Authenticity – Integrative Discussion

Future work could involve a similar approach, whereby a series of studies such as those used in this thesis are used to understand how Authentic Alignment may be used in practice. For example, the use of IPA in the experiences of anatomy educators (Chapter 7) was a crucial step toward embracing the complexity conversation in terms of modelling the HPE learning environment. A similar methodology could be applied to understanding how students make sense of their first experience of dissection. If I had this doctoral project to do all over again, I'd approach it using Mukumbang's (2023) CR framework for mixed methods research.

A key feature of IPA is that the research prioritises what comes out of the data with a focus on the sense-making of the participants, rather than to test a hypothesis or work with a theoretical framework from the outset. Thus, constraining the homogeneity of the participants to reflect upon their dissection experience would be an interesting way to see what comes up, if any themes resonate with the threads of conversation woven through this thesis. For explicitly testing the utility of the T-icosa as a model of the LE, future directions might utilise more survey type methods, or other empirical studies that investigate educator opinions. Further methodological contributions of this doctoral work are outlined in the next chapter.

1.1.1 Meeting the challenge of using trending keywords correctly

Disambiguation is a major concern for any author taking up a loaded term like complexity. In the due course of my doctoral work, my understanding of complexity matured until I realised the depth of my misunderstanding. Justifying my usage of the term has been a key consideration for me, as the #complexity matrix of usage is so wide and deep across disciplines. Authors with a background in hard sciences will tend to focus on the applications associated with those disciplines, i.e., 'hard complexity'. In the soft sciences, such

Chapter 10: Toward Authenticity – Integrative Discussion

as education, there is an understandable shift toward 'soft complexity'.

In HPE, we stand with a foot in each of these camps, which I believe comes with the expectation to embrace the conventions of the hard and soft sciences. For a topic as technically challenging as complexity can be, this represents a considerable intellectual challenge. The other concern that looms large is the appropriation of #complexity in popular science culture, where the concept is vulnerable to oversimplification and general abuse. My approach has been to meet these challenges head on and to be explicit about how my understanding and usage has matured because of contending with them.

Finally, I think it is important to reflect on my choice to include a reconfigured text from the semi-academic book that I wrote during my doctoral journey. This book, being only *semi* academic, is expressed in a tone that aims to be accessible to a diverse readership. My choice to include this as a chapter in my doctoral thesis aimed to serve two purposes. Firstly, I believe that the chapter does present a robust argument for the T-icosa as a model of authentic alignment, and the text I excerpted from my book only serves to better explain the relevant tenets of complexity and tensegrity in context.

Secondly, there is a reflexive element here, as my doctoral thesis is intended to encapsulate my journey as a researcher. Including these excerpts from my book demonstrates that my progress over the last five years has involved empirical research, co-authorship of studies in scholarly journals, first named authorship of a study, as well as the publication of a book all germane to the golden thread of this thesis: alignment, complexity, and authenticity.

Chapter 10: Toward Authenticity – Integrative Discussion

1.1.2 Future directions

I have previously mentioned that the constraints of time and word count precluded the final appearance of my ongoing IPA studies in this doctoral thesis. Naturally, I will continue analysing my data and write it up into manuscript format for submission to peer reviewed journals. My studies and research into philosophy has also led me to a deeper understanding of authenticity with a broad and scholarly literature base. I intend to further explore the authenticity literature as it relates to philosophy and contemporary social discourse with the aim to contribute to its literature in due course.

10.7 Chapter Summary

This penultimate chapter opened with a reflection on its original aims and questions. My conclusion is that CAS modelling is authentic for the LE. I used this opportunity to contextualise my findings in the conceptual framework, abductive reasoning, before moving into the main text of this chapter, the Interpretation of Integrated Thesis Findings. This section revisited the tradition of Hermeneutics and identified HPE as a “suitable home for hermeneutics”, where researchers can make use of the Hermeneutic Circle for doctoral work embracing multi methods.

I described the process of Integrating IPA findings with critical realism, identifying the overlap between IPA and critical realism in the realm of hermeneutic methodology. This Reconciliation of critical realism as a paradigm with IPA as a methodology will be continued in the next chapter where I outline my contribution to methodology in HPE research. My interpretative discussion continued into a conversation between critical realism and complexity.

I reflected on the central hermeneutic dialectic of this doctoral work: agency-structure, where HPE research is served by having a

Chapter 10: Toward Authenticity – Integrative Discussion

nuanced understanding of the polarised conversation between Giddensian/constructivist/interpretivist/aggregate CT structuration theory (collapsing agency and structure into union, essentially deterministic) and Archerian/critical realist morphogenetic analytical dualism (separating agency and structure to embrace voluntarism). This understanding owes much to Yang's work (2021) applying nonconstructivist CT thinking to governance.

My integrated interpretation of thesis findings continues into a section outlining three main tenets of CS: dynamics, self-organisation and coevolution. Aligning with Cristancho et al., I advocate for HPE to align with a multiplicity stance. This perspective reframes conflation through the lens of multiplicity, where I contend that HPE researchers benefit from the availability of the two camps (Giddensian, Archerian) for considering various aspects of complexity as per Manson's conceptual framework (20) in their research questions. My interpretation suggests that the world is so fraught with wicked problems, no single model –or paradigm – can account for the multiplicity of challenges.

This chapter closes by raising a number of important limitations, considerations, and future directions. This includes key concerns and limitations of critical realism, considerations for multi-methods projects such as this one, and meeting the challenge of using trending keywords correctly.

Chapter 10: Toward Authenticity – Integrative Discussion

Table 20: Example of the syllogistic structure used by the retroductive argument as applied to this project.

Major Premise	Only if Q, then P.	Only if the world has ontological properties X, Y and Z, then scientific experiment is possible.	Only if the LE has properties uncertainty and nonlinearity, then it is a CAS.	Only if the LE can be modelled as a CAS, then performing within the LE requires UT.	Only if CAS modelling is authentic, then the HC has an impact on experiences of the LE.
Minor Premise	P.	Scientific experiment is possible.	The LE is a CAS.	Performing within the LE requires UT.	The HC has an impact on experiences of the LE.
Conclusion	Therefore, Q.	Therefore, the world has properties X, Y and Z.	Therefore, the LE has properties of uncertainty and nonlinearity.	Therefore, the LE can be modelled as a CAS.	CAS modelling is authentic for the LE.

CAS = Complex Adaptive System HC = Hidden Curriculum LE = Learning Environment

UT = Uncertainty Tolerance

Chapter 11: Thesis Conclusion

11.1 Chapter Introduction

As this is the final chapter of this thesis, it brings together the findings in context of their originality and significance to the field of knowledge. I will present my summary understanding of how my doctoral work represents original contributions to methodology, to educational theory, to HPE research, and the wider field. Finally, the chapter closes with some concluding personal remarks before leading into the References and Appendices.

11.2 Thesis Conclusion Summary

Via retroduction, this dissertation concludes that CAS modelling is authentic for the LE (see Table 20). The main findings of this thesis in relation to its original aims are: 1) the alignment of anatomy within the medical curriculum is complex and forms a multiplicity of perspectives; 2) this complexity is ripe for phenomenological exploration; 3) IPA is particularly suitable for realist research exploring complexity in HPE; 4) Authentic Alignment theory offers a spatiotemporal model of the complex HPE learning environment: the T-icosa (see Figure 31).

This doctoral project explores how authenticity of the learning environment can be modelled as a function of its alignment in HPE. This project uses hermeneutic phenomenological studies as the basis of its empirical chapters and contends that the Interpretative Phenomenological Analysis (IPA) methodology is particularly powerful when it is harnessed within the abductive paradigm of CR.

11.3 Original Contributions

This doctoral project has resulted in several original insights, some of which are contained within the chapter structure and other contributions that happened in dialogue with the thesis but were not woven into the final thesis. Still others have yet to be formally

stated. The following sections are intended to bring together what I believe to be the major outcomes of my doctoral project.

11.3.1 To Methodology

Critical realism is a dominant paradigm used throughout soft sciences such as education. However, it is not recognised as a single theory or methodology. As such, the onus for developing a robust methodological approach for the empirical states of this doctoral project sat squarely on my shoulders. Through a deeply considered reading of philosophical literature, I came to a position that reconciled Interpretative Phenomenological Analysis as a methodology with critical realism as a paradigm. The joining link is found in their shared value of hermeneutics, the interpretative tradition.

Moules has pointed out (2002) that modern applications of hermeneutics have had trouble in developing a corresponding philosophical paradigm (Johnson & Gray, 2010). This is an important concern for authors asking social enquiry questions such as those pertaining to HPE, because the philosophical assumptions galvanised in paradigmatic choices guide the direction of research. In effect, I found that my critical realist paradigmatic approach needed a corresponding methodology. Serendipitously, the methodology of IPA that I was using in my study of anatomy educators needed a paradigm. They both love hermeneutics, so the match was made, see Figure 36.

This thesis contributes a qualitative evidence synthesis of IPA usage in HPE questions, aiming to provide a framework for authors interested in applying IPA methodology in their research. This study is presented in Chapter 6 along with its discussion that includes top tips for HPE authors embarking on IPA projects. The IPA study of anatomy educators presented in Chapter 7, published in *Anatomical*

Sciences Education (Kirkness et al., 2023), contributes to a further development of IPA methodology in the field of HPE.

Research choices must be made responsively, opportunistically, and contingently. In my experience, this is especially true of the body of work encompassed by a doctoral project, which can be assessed as much by what it leaves out as what it includes. Hermes, that mischievous messenger, is connected to the shaping of borders. The boundaries of my thesis shifted as my understandings progressed, which meant that aspects of my original plan disappeared whilst others materialised spontaneously.

For example, my original intention was to explore anatomy pedagogy, particularly the use of kinaesthetic and art-based methods of teaching anatomy. However, my first foray into empirical research revealed that any efforts to study anatomy pedagogy would be constrained by linear questionnaire and survey designs. Participant responses reflected that anatomy educators were in complicated relationships with the wider medical programmes where they were teaching.

The complicatedness I was seeing in relationships quickly turned to complexity. It caught my attention, as it was clear to me that inadequate modelling of CA needed to be investigated as it relates fundamentally to questions of authenticity in anatomy pedagogy and beyond. As such, my lines of enquiry shifted from strictly pedagogical to more philosophical, increasingly hermeneutic and dialectical. At some point, I came to understand that Complexity was going to take on a prime seat of importance in my enquiry, upshifting from the lowercase 'c'.

As the COVID-19 pandemic hit, I witnessed the demise of my opportunities to carry out in-person studies of learning techniques such as anatomy body painting. I realised that my access to

empirical studies would be limited to remote options, and such would henceforth be the defining constraints of my PhD. I could either accept these the limitations and roll with them or quit my studies. Serendipitously, the Complexity topic became my focus as a movement educator, and I gratefully received the gift of resonance as my research on all fronts was finally serving a single 'golden thread'.

Prior to the time when I married IPA with critical realism, my approach to research was methodologically promiscuous. In short, I was taking all opportunities. Because the nature of my project brief was so amorphous, essentially to "explore authentic assessment", I had almost too much freedom. My interests were and still are very much based in the potential for anatomy and the basic sciences to continuously inform the trajectory of medical and HPE. I guess you could say that the traditional positivist-leaning methods of evaluating educational interventions (i.e., survey, questionnaire, post-test crossover studies) have always left me cold.

As I got to know my way around critical realism, it occurred to me that CR projects hinge around abductive reasoning. I could and should use my early scoping data as part of the abductive conceptual framework, as it would lead me to lines of reasoning that I could triangulate with my IPA studies. Ultimately, this relationship between conceptual framework (abduction) and my chosen methodology (IPA) converged into a meta-methodology unique to my project.

A summary of my integrated methodological contribution: HPE projects are often challenging for many reasons, particularly in the overlap of quantitative and qualitative traditions represented in health sciences and education respectively. The critical realist paradigm invites empirical activities that prioritise emergence, whatever that looks like, and uses abductive reasoning to arrive at

hypotheses and novel theories as a result of the empirical journey. HPE researchers embarking on doctoral work might consider a plurality of methodological approaches to their studies that may be abductively analysed with the aim to move relevant theoretical conversations forward. My project constitutes an example of how CR's conceptual framework formed a meta-methodology linking the various approaches into one forward-moving theory: Authentic Alignment.

It's true, Hermes has a lot to answer for. As a patron saint of travel and messaging between the divine and humankind, the hermeneutic approach urged me to listen to what the gods were telling me. I had pastoral issues such as my pregnancy leave of absence, extending into further leave on grounds that COVID was wrecking my business. From maternity and parenthood issues to moments of crushing self-doubt when I was sure this project would wreck my head, there were many times when I was in crisis. At these times, my supervisors were always supportive and urged me to get back to that golden thread of alignment.

11.3.2 To Educational Theory

My main contribution to educational theory in this doctoral work is the novel theory of Authentic Alignment. My concern with authenticity draws philosophically from the early Heideggerian notion of authenticity [*Eigentlichkeit*] in conversation with his later writings on the concept of dwelling [*wohnen*] (Burgess & Rentmeester, 2015). Malpas writes about how authenticity and dwelling are immanent in architectural discourse (Malpas, 2014), as they relate to place and space. This architectural context remains interesting for a model incorporating the architectural principle of tensegrity. What does it feel like for stakeholders to navigate the architecture of a complex, mutable, multi-stable learning environment?

Authentic Alignment reframes Biggs' CA (1996), bringing it into the complexity conversation. Where CA does not explicitly distinguish between agency (curriculum) and structure (learning environment) in its ILA triangulation, Authentic Alignment draws on a multiplicity of complexity perspectives in its modelling of alignment. This novel theory uses the tensegrity icosahedron as its structural basis, mapping Biggs' ILAs onto the nodes of the mutable, volumetric frame. Consequently, this theory maintains a conversation with constructivism as per the hermeneutic tradition.

Educational theory is well established as a constructivist-oriented discipline, whereas modelling has deep roots in STEM disciplines as well in the soft sciences. Using critical realism to shift the conversation forward from having to choose one flavour of complexity (determinist or voluntarist? Structuration or analytical dualism?) in favour of another, my contribution embraces the dialectical facets in proposing a model based on multiplicity. For the increasing number of enquiries into complexity-flavoured problems in HPE, the Authentic Alignment theory provides a sound meta-philosophical position.

11.3.3 To HPE research

This thesis includes a Beginners Guide for novice researchers (see Appendix A) coming to HPE doctoral work for the first time. It provides a clear overview of philosophy relevant to understanding paradigm in general. It also gives a more detailed explanation of critical realism as my preferred option for the complex research questions typical of HPE doctoral projects. I am currently in the process of formatting this monograph piece for submission to a relevant journal, *Health Professions Education*.

The chapters contained in this thesis offer several original graphical representations of concepts germane to HPE research situated in any paradigm. As my paradigm of choice here is critical realism,

many of the images contained in this thesis are relevant to CR and its stratified ontology. Many of these images are unique and represent a significant contribution to HPE as they can be used to advance collective understanding of philosophical frameworks most suited to the multi-disciplinary questions at the heart of HPE projects.

11.3.4 To the wider field

In addition to the work contained within this thesis, I have also engaged with the wider field. I have presented multi-media lectures with original content to an international audience via The Fascia Hub, with a special focus on CS in the context of human anatomy and movement. My semi-academic book (Kirkness, 2021), Spiral Bound: Integrated Anatomy for Yoga, written with special input from my mentor, Joanne Avison, has reached a global audience of allied health professionals. I have co-authored an abstract for a new pedagogical model for teaching gastrulation in embryology, and a paper exploring tensional models of anatomy as an update to pedagogical techniques.

I have collaborated with movement educators in Brazil and Switzerland on programmes of study that incorporate complexity thinking in our approach to movement as therapy. My approach to teaching biomechanical principles involves a motion rubric I have coined as the Five Filaments. This heuristic model is informed by my ongoing study of tensegrity and complexity in biology. Since the pandemic, I have created online course content based on the Five Filaments and other pedagogical tools and have brought these courses to market where I am currently engaged with an international cohort of clients and fellow learners.

Over the last three years, my research has brought me into correspondence with the anatomist, John Sharkey, who organises dissection experiences for the private sector of allied health. I have

assisted him as guest faculty dissector and presenter at several of these events internationally. My sustained interest in anatomy and embryology has found applications in a wide range of private sector anatomy webinars and virtual dissections delivered remotely.

My yoga teacher training courses have evolved significantly over the course of my doctoral project as I refine my understanding of curriculum in relationship with the learning environment. I continue to offer anatomy body painting to all my trainees as standard in their training as I see this approach as unparalleled for its impacts on deep learning. My ongoing yoga and movement workshops draw on all the experience I have gained as a PhD researcher and allow me to contribute to the professional yoga world at a much higher level than before.

I have contributed a section to the current canonical biotensegrity book, Everything Moves, by Susan Lowell de Solorzano (Lowell, 2020). Since 2022, I have joined the Gateway Year teaching team as a graduate teaching assistant with a focus on embryology, for which I have produced a series of recorded lectures and drawing/sculpture workshops. I see my career moving into a blend of academic and private sector contributions all informed and utterly transformed by experience as a PhD researcher.

11.4 Concluding Personal Remarks

A tolerant wisdom.

This journey into philosophy has resonated with me on many levels. As a lifelong student of yoga, I have come to appreciate the philosophical underpinnings of the discipline as an enquiry into the real. The *Sāṅkhya – the enumerated* – school of Indian philosophy that is normally associated with the practice of yoga brings with it a dualist perspective whereby reality is composed of two principles:

puruṣa (energy, 'consciousness', or spirit); and *prakṛti*, (matter, or Nature, which includes the human mind and emotions).

Coming to critical realism for the first time has lit up my interest in philosophy as a matter of spiritual enquiry. As I sit with the analytic dualism of Margaret Archer, my understanding of yoga philosophy is enriched. Conceptually separating matter from energy allows us to consider the emergence of their interplay on a cosmological level. In yoga, we find a host of practices designed to put us in touch with the collective consciousness through developing awareness via interventions carried out in the physical space. But this separation is not Cartesian, on the contrary, separation of opposites is an analytic technique for coming around to wholeness. Because agency (*puruṣa*) and structure (*prakṛti*) reflect the quantum conversation, that reality is composed of waves and particles that are both separate, unified, and subject to swap.

“Shiva is static; Shakti is dynamic and creative. Shiva is being and Shakti is becoming. He is one; she is many; he is infinite, and she renders the infinite into finite; he is formless and she renders the formless into myriad forms; but both are one.” (Raveesh, 2013)

Reflecting on Hermes, the playful trickster sporting winged sandals, I am reminded of one who delights in his work. For me, there have been moments of inexplicably ecstatic realisation where I have been able to clearly see the conceptually connected relationships in all the disparate pieces of my project. These joyful junctures were hard won and have come at the cost of many hours, frustration, and personal sacrifice.

Doll et al. (2010) have written about humility, sharing their view that to show vulnerability is to demonstrate strength. They draw on the work of French philosopher, Michel Serres, and his reflections on

teaching and living. Serres articulates that wisdom begins when we develop what he calls a 'fear of a unitary solution' (1997, p. 122).

In my experience as a seeker, it is easy to become naively enchanted by the grand unifying ideas espoused by charismatic advocates of complexity. Latterly, I have become increasingly aware of my tendency to reduce the merely complicated to Complexity. Such reflexivity is only possible where humility allows us to contend with the previous iterations of our understanding. It is not easy to look back with kindness on earlier versions of ourselves of which we may be less proud.

But reflect I do, as is the practice of critical realists and, as far as I can tell, the basic requirement of being a good human. As I look back at my initial understanding of my project, I recognised HPE as a place of contradictions. Research in HPE now has a strong qualitative base. However, it remains rooted also in the STEM disciplines, dealing with questions that assume reality to be a set of closed, deterministic systems. The aims are often couched in abstract mathematical models, as Doll puts it, "congruent essentially with themselves." Complexity thinking aligned with determinism is a place where projects can be deployed without much disruption from the researcher's humanity. Containing problems as closed systems is a convenient approach.

Here I will note the constant tension of writing a subjectivist dissertation knowing it will be submitted into a largely objectivist methodological community. HPE and medical sciences are traditionally positivist. Although qualitative research is now broadly normalised, the conventions of positivist writing still dominate how formal manuscripts are received. I'll admit this gives me the fear as the deadline for submitting this dissertation is nigh! But this tension has been worth the phenomenological upgrade I have undergone in the process of writing it.

My obsession (I'll call it what it is) with the behaviour of geometries began in my yoga practice. I have always been interested in making shapes with the body. With maturity, I became more interested in making shapes that have a therapeutic effect. In essence, I believe that there is an inherent geometric orientation in our species-specific morphology, our natural shape as humans. This geometry predisposes our tissues to "like" certain ways of bending and to "break" when we try to bend them contrary to the natural grain. My view on the system has been deterministic, in the sense that the human body is a biomechanically closed system. Biomechanically speaking, a few key inputs give rise to predictable outputs.

As a result of my PhD enquiry, I am coming to the open view. In terms of biology, our bodies are thermodynamically open systems that are continuously reacting with our surroundings. We not only consume, metabolise, and excrete; we also react chemically with our surroundings, socially with our relations, gravitationally with our planet, and iteratively with the material of our circadian rhythms. There is just no way to predict what could emerge from all those interactions.

Here lies the tension, that our models of learning broadly reflect our models of self and, by extension, reality. In Tantric tradition, Shiva (Purusha) and Shakti (Prakriti) represent the two fundamental forces that cocreate the universe; reality emerges as an interplay of these forces. Agency and structure – I have considered them as separate entities, as unified entities giving rise to emergent reality, and finally as not mutually exclusive but existing in complementarity. Although I am coming around to Serres' suspicion of unifying solutions. What will I do now that my dissertation is finished? With humility I go back to the work of living day to day wondering who or what might be in charge.

In the words of Michel Serres (1997, p. 122):

"Wisdom provides the yardstick of moderation. The fear of a unitary solution makes for the beginning of wisdom. No solution constitutes the only solution: neither a particular religion, nor a particular politics, nor a particular science. The only hope remains that science can learn a tolerant wisdom that the other instances of power were never really able to learn and prevent a united, madly logical, rationally tragic world."

Chapter 12: List of References

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Chapter 13: Appendix A: Anatomy of Wholeness – Considering Narrative and Paradigmatic Alignment

Introduction

The Introductory Chapter set the stage and aligned the players involved in this story, so to speak, establishing the heteroglossic approach. This Appendix continues with a descriptive explanation of the paradigm that provides the logical substrate of the narrative as it has developed over time. The story of my project gets started around the development of its characters: me, my supervisors, co-authors, colleagues, study participants, the authors who have so deeply influenced the trajectory of my journey, and YOU, the reader.

This chapter addresses the narrative relationships within which the acts of this thesis play out. The researcher is both the narrator and the main character, a personality that evolves significantly over the course of this tale. This chapter is thus set as an instructive letter written by the accomplished² doctoral candidate (me) to the naïve candidate, a new PhD student working on a health professions education (HPE) doctoral project. The intention is to create a *Beginners Guide to Philosophy* as relevant to novice researchers in HPE. The point of view shifts between first and second person as it is well documented that these perspectives are more direct, easier to read, and convey more nuance than the third person objective.

Reflexivity Statement

As I got familiar with my research cohort in HPE, it became clear that many of us experienced feeling way out of our depth when it came to grappling with the philosophical nature of doctoral work.

² By accomplished, I mean I published two of my chapters prior to submitting this thesis. And if you are reading this, I also submitted this thesis.

The expectation to demonstrate a high level of engagement with philosophical frameworks in HPE is now well documented (Brown et al., 2020c; Kumar et al., 2022). Cue frenzied search for resources to help digest the new terminology, such as ontology and epistemology. I have crafted this monograph piece to demonstrate my process as a researcher and to describe the paradigm within which that process has evolved: critical realism (henceforth, CR). The intended readership is new to doctoral research and the piece is applicable to any burgeoning PhD student coming to philosophy for the first time.

The letter that follows is designed to go beyond a regurgitated explanation of key terms, situating descriptive details within the evaluation of my research framework. I'm sharing my truth here for a dual purpose. Firstly, using varying voice is more engaging for the reader, providing narrative interest while also "ticking the box" of explaining the philosophical rationale of this project in an authentic style (see Chapter 1, section 1.10.2, for further rationale based on the concept of *heteroglossia*).

Secondly, this text is a manuscript, a tool providing guidance and encouragement for the struggling PhD student – and anyone else coming from a science background who may be new to social sciences research and its jungle of philosophical terms. It takes inspiration from Fryer's (2020) *A short guide to ontology and epistemology: Why everyone should be a critical realist*, sponsored by the Bhaskar Memorial Fund. His PDF is written in the first and second person informal and uses humour to engage his readership. It is a bold move for me to include such a piece in this doctoral thesis, even as an appendix. I made the choice to include it as part of my dissertation because it represents my strong commitment to the heteroglossic approach as described in Chapter 1.

While it is all very progressive to align one's work conceptually with innovative and contemporary approaches, there does come a point where the risk has to be taken to actually do it. This appendix represents my commitment to authenticity. My aims are to convince the reader that confusion and uncertainty are part of the process, and to explain why I chose CR for framing the various research endeavours that invariably crop up as part of the research journey.

Dear PhD student new to Health Professions Education,

Congratulations and welcome to the twin peaks of doctoral work! You're overwhelmed, excited, and intimidated all at the same time. It's no wonder you've got so many mixed emotions as you get started with your project, because getting started is suddenly the hardest part. I hope this guide will explain the basics of philosophical frameworks as applied to doctoral work and leave you feeling more confident as you prepare for the next 3 to 5 years of your life (if you're lucky). My main aim is to convince you that critical realism is about to be your best friend.

If you're coming from a STEM background, that likely means you're accustomed to measurements and results that can largely speak for themselves. You're maybe thinking that this PhD equates to a big project based on more measurements and more results (Muller et al., 2019). Stop the record. I'm here to tell you that your data is the easy part in comparison to contextualising your finds in the vast field of philosophical rationales out there.

You knew going into this PhD that you'd be facing up to a mountain of work, but how could you have known that you'd also be reckoning with the contents of your soul as part of the project? Here you are, realising with mounting anxiety that you have yourself a double mountain: the rugged terrain of your explicit project brief AND the perilous peak of philosophy. This manuscript is intended as

a guide to make the philosophy more approachable and to introduce you to something called *critical realism*. I'll mostly use the acronym CR to talk about critical realism and HPE in reference to health professions education.

Oh, you still think you're here for the results of your studies (data). Time to think again! I know you came to nerd out on the topic of _____, and that you anticipated *some* philosophy would obviously be involved in a Doctor of Philosophy. Ah, but it's not just *some* philosophy – you will not merely be decorating your topic in flowery philosophical language. Results topped and tailed with contextualising theory does not a PhD make.

You need to get your head around the idea that you are “growing” a philosophical dissertation, a plant with many winding tendrils. In a sense, your topic is the food for the plant. Another way to look at it is that your project is the plant, the data is the food, and the DNA is your philosophy. Or you could think about your project as a car – the philosophy is the chassis *and* the engine, and your topic is the fuel. Whatever the metaphor, the point is: you'll never pass Go if you haven't got behind the wheel of your paradigm yet.

What do you need to know if you want to survive this degree and maybe even contribute to the field of knowledge? You can start by accepting that the next several years are about your paradigm, your adaptation, and your community as much as they are about your data. You need to get to know yourself and your paradigm.

Wait, *what?*

That's right, your *paradigm*. Let's start with paradigm: your philosophical position.

Paradigm

Your paradigm is basically *your mind*, the sum of your experiences and beliefs that come to bear on all research choices you're likely to

make. Your research paradigm is “the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed” (Kuhn, 1962). Paradigm can include axiology, the study of the nature of values, or description of the things that hold value in a particular setting (Deane, 2018). We’ll get into axiology (what holds value) after we look closely at what it means to have a research paradigm and why I chose critical realism. I have woven my reflexivity (reflecting on my values in terms of social position) into the fabric of this piece as a choice to make it easier on you as reader to get a feel for who I am and why you might take my advice on board.

The Oxford Reference defines paradigm as a model: “a large-scale and generalized model that provides a viewpoint from which the real world may be investigated. It differs from most other models, which are abstractions based on data derived from the real world.”

This becomes relevant and useful when you think about your PhD as a kind of model of your investigation with its own built-in logical structure. The etymology of ‘paradigm’ (from the Online Etymology Dictionary) is via late Latin from Greek *paradeigma*, for pattern, from *paradeiknunai*, to ‘show side by side’, from *para-* ‘beside’ + *deiknunai* ‘to show’ (2022). For simplicity, let’s say that in our paradigm, we’ve got a pattern that shows two aspects “side by side”. The two aspects needed to make the philosophical position of your paradigm are *ontology* and *epistemology*.

Ontology – the “What”

Ontology boils down to *stuff*. It is the ‘what’, the stuff of what you’re studying. Each paradigm has its own idea of what can be known; this is its *ontology*, its stance on the nature of *what* it is possible to know. Is reality a thing? Can we even know it?

As you first enter the world of research, it seems that what can be known is a kind of given – why would we bother differentiating what it's possible to know from what we can't know? Surely if we can't know it, it can't be worth worrying about. Why would my supervisor have me off on a fantasy trip chasing my tail – if reality can't be known, then why have I dedicated the next three years tracking its every move? I hear you. Ontology is a can of worms!

But don't despair, there are essentially two flavours of ontology to get you started: *realism* and *irrealism*. *Realists* believe there are actual worms in the can, that my choice not to eat the worms is informed by real social and environmental structures. *Irrealists* believe that there are multiple possible wormish realities and the can itself defies objective labelling. We might think of the *realist-irrealist* dichotomy as a kind of gradient with lots of potential variations. To get started, you can think of it as two discrete (meaning separate), opposite positions: those who think there is one reality (realists), and those that dispute the possibility of one reality (irrealists).

Epistemology – the “How”

Now we're looking at the can of worms and wondering, how can we get to know these little guys? Should we weigh them on a scale, measure their length, interview them, or conduct a focus group on lived worm experiences? Questions about kinds of worm knowledge and how it can be generated are part of your epistemological stance.

Let's shift from worms to the medical curriculum: how can we know more about what it's like to learn anatomy using 3D apps? There is another polarity here. On one end, the nature of knowledge is *objective* and on the other, it is *subjective*. This polarity of knowing comes from the object-subject syntax of language. Whether a particular language follows the subject-verb-object (SVO) order or

the subject–object–verb (SOV) is apparently an example of how language co-evolves with communities to best serve the needs of their cultural priorities (Hahn & Xu, 2022).

Approximately 40% of the world’s languages are categorised as following (SVO) order (as in English: “dogs bite people”), and 40% are classified as following (SOV) order (as in Japanese: *inu-wa hito-o kamimasu* [“dogs people bite”]) (Dryer & Haspelmath, 2013). In this example, *dog* is the subject and *people* constitute the object of the verb. Let’s shift our SVO to “students use 3D anatomy apps” – a study investigating students’ experiences of using 3D anatomy apps. Now, the SVO shifts. You as the researcher are the subject, while your study of student experiences is object of your enquiry.

An objectivist position assumes that it is possible to derive knowledge about such student experiences simply by observing and recording them. From this perspective, all you need to do to understand what it is like for a student to learn anatomy from a 3D app is conduct randomised crossover studies of students, analyse the data and there you have it: Knowledge. Reasoning is deductive. From such an objective view, knowledge production is straightforward. Facts are apparent, verifiable, and generalisable.

At the other end of the epistemological spectrum there is the more sceptical *subjective* perspective. Subjectivists deny that it is possible for observers to gaze upon the medical curriculum and end up with the same results. The SVO is more focussed on how you, the researcher, co-construct your knowledge in conversation with the circumstances of your enquiry – including theory. Subjectivists contend that all observations are *theory dependent*. Theory-dependency is a critical feature of your epistemological position, for example:

Let's say that your project is exploring how medical students are learning anatomy in the UK. If you're coming from an objectivist stance, you would simply go into a medical school, observe how students are learning anatomy, maybe devise a crossover trial to compare learning techniques and write up your findings. This is in stark contrast to the subjectivist, who would see that as a major oversimplification.

Why would a subjectivist be so darn particular? Firstly, what we consider 'learning' versus what is being taught is far from cut and dry. Learning, as a focus of study, is theory dependent. Educational theories distinguish between simple knowledge acquisition and clinical competency, for example. The definition of learning *changes* depending on the context, the consequences of which will impact medical education and ultimately, patient care. So, it is not enough to observe, record, analyse "students learning from apps" and call the results "new knowledge". The subjectivist wants context, reflexivity, and theory to justify, guide the design and ratify the results of a study.

So far, we've got two pairs of opposites to deal with, one from each aspect of our paradigm as pictured in Figure 4. Where arrows in blue point to the left and become increasingly constructivist and arrows in yellow point to the right as they become increasingly positivist.

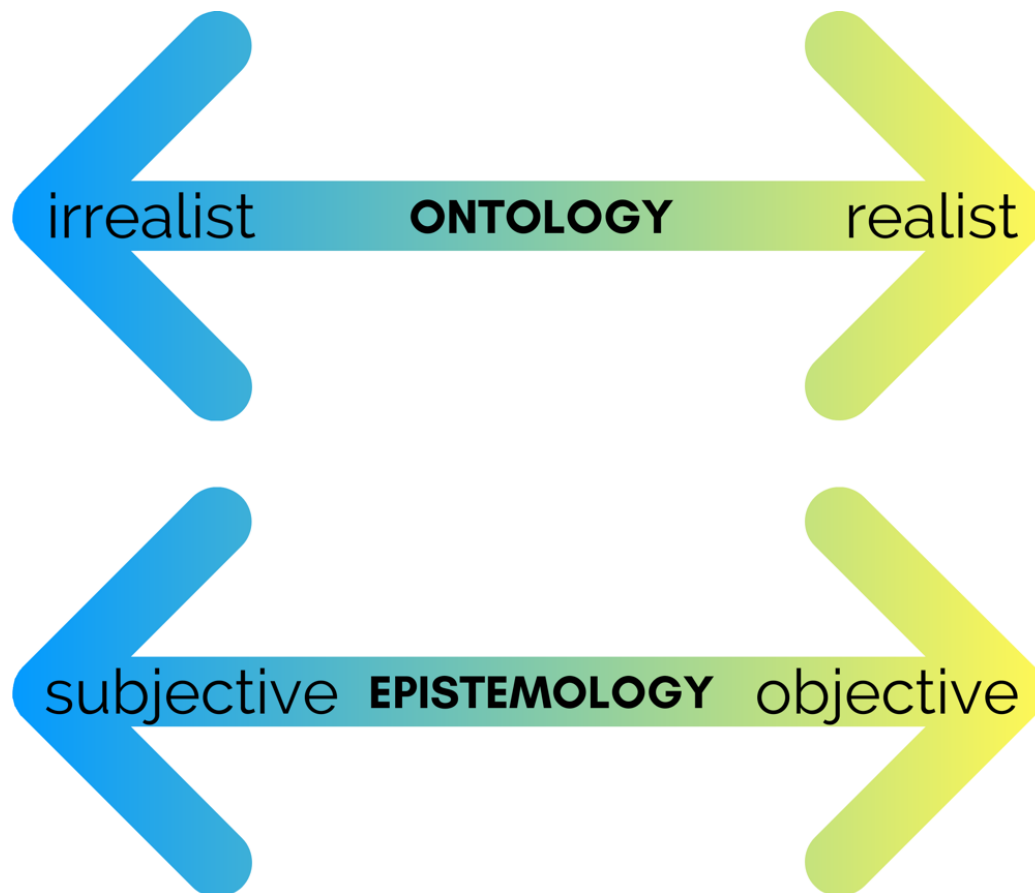


Figure 38: Paradigm as a gradient

I mentioned previously that your paradigm is basically made up of two aspects. If we go with the binary approach³, you can select either *realism* or *irrealism* as your ontology and either *objectivism* or *subjectivism* as your epistemology. Together, these form your philosophical position, or paradigm, and function as a framework to unpack all other possible paradigms (there are more than I can discuss here). Varpio et al. (2020a) have identified two approaches to research commonly used in HPE: the objectivist deductive approach and the subjectivist inductive approach. Tom Fryer (2020) boils down paradigm identification as a process. When looking at research positions, ask first:

³ The binary approach to ontology, *real vs irreal*, gives us a “get started” perspective – be prepared for the binary to dissolve into a continuum of realness

Is it *realist* or *irrealist*?

Is it *objectivist* or *subjectivist*?

By this line of thinking, you are left with four possible combinations:

1. Realist/Objectivist (Positivism)
2. Realist/Subjectivist (Critical Realism)
3. Irrealist/Objectivist (Impossible – How could one aim to generate objective knowledge about a world they don't believe exists?)
4. Irrealist/Subjectivist (Constructivism)

What about Phenomenology?

I'm so glad you asked. While it comes as good news that we can discount Number 3 in the rubric above, you may be wondering where Phenomenology sits in the bigger picture of paradigms. Interpretive phenomenology is on the rise in the health sciences literature. I used it as a primary methodology in the empirical chapters of my thesis as it reconciles with the broad aims of CR.

Interpretative phenomenology is generally considered both a philosophy and a research methodology but not a paradigm as such. It has its origins in the work of the phenomenological philosophers Husserl and Heidegger (Dowling, 2007; Munhall, 1994). To really get a handle on your paradigm and move with dexterity in the literature, I recommend you go after a deeper understanding of two popular methodologies you will encounter in the health sciences: Constructivist Grounded Theory (CGT) and various flavours of interpretive phenomenology such as the one used in my doctoral thesis – Interpretative Phenomenological Analysis (IPA). We'll compare them later in the Methodology section of this guide. For now, it is enough to acknowledge that phenomenological methodologies have paradigmatic roots in constructivism (irrealist, subjective).

Methods vs Methodology

One of the early questions I had when getting to grips with the philosophical framework of my project had to do with the difference between Methodology and Methods. Eh, could we come up with another word for one of them to make things a little less confusing? Unfortunately, these are the terms that have stuck. In this short section, I hope to contextualise methods by giving you a brief on what I used in my project.

Methods are the processes and tools you can use to carry out your empirical studies. Any doctoral project, whether leaning into qualitative or quantitative methodologies, will be carrying the burden of proof. The methods you use in generating empirical data should align with your methodology. However, complex research questions will usually involve a complex approach involving various methods from different methodological communities.

For example, my thesis contains a series of studies that were all sort of happening simultaneously, or at least overlapping in time, and all of them influenced one another to some degree. Chapter 3 of my thesis contains what I would consider my first study and is one of three empirical chapters to have a quantitative element. The remaining chapters contain studies of an increasingly qualitative nature, going from theory-laden to theory agnostic (phenomenological) and back again (as per the abductive framework I'll get into later in this guide).

Your methods are your tools for gathering data. For example, Interpretative Phenomenological Analysis (IPA) is a methodology that comes with a set of research tools that resonate with its philosophical interest in lived experiences. I used the methods of semi-structured interviews and iterative data analysis with the tabular structure advised by contemporary IPA protagonists (Smith & Nizza, 2021). I also used Grounded Theory as part of one of my

empirical chapters. As such, I would describe my project as both mixed methods research and multimethod research. Yes, there is a difference, which we'll go into next.

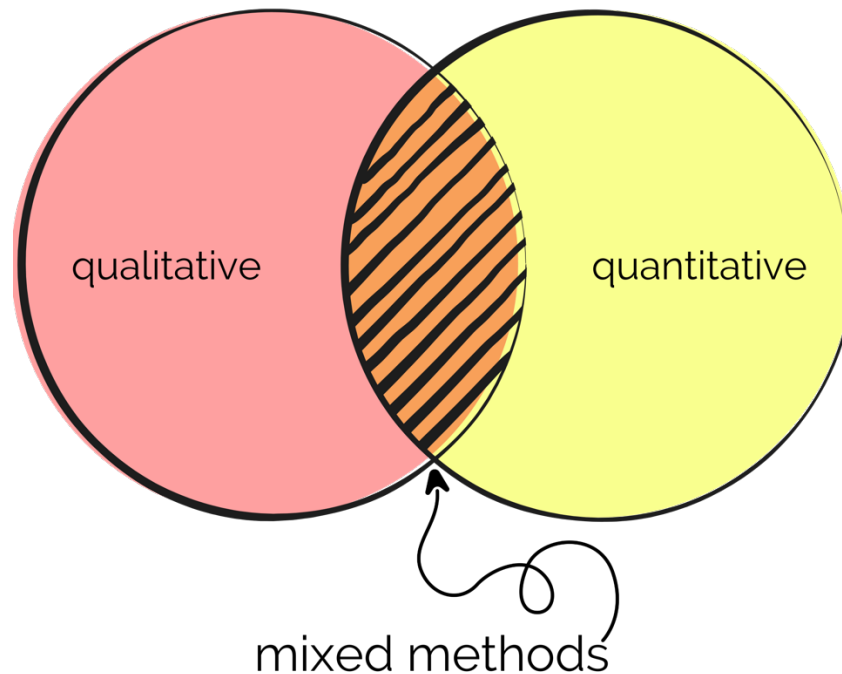


Figure 39: Mixed methods research

Mixed methods research is widely regarded as the third methodological community – after quantitative and qualitative research communities (O’Cathain, 2009). As distinguished by Hunter & Brewer (2015), ‘multimethod’ describes the integration of any different methods, whereas ‘mixed methods’ combines qualitative and quantitative methods. Many social scientists (as you will be if you’re asking HPE questions) draw from the literature on mixed methods research (MMR) as much of the insight is applicable to multimethod studies (MS) as well.

I would describe my empirical chapters as progressing on a gradient from quantitative to increasingly qualitative, utilising a variety of methods. As such, my doctoral project is both mixed methods and multimethod. I go from a study using thematic analysis (TA) to another using grounded theory (GT) with findings that span some

quantitative analysis to a qualitative evidence synthesis (a.k.a., literature review) to an IPA study using tabular analysis. Some might see this as a kind of dog's dinner, and I would be the first to acknowledge the plurality of methods my research has embraced. However, I hope that once you have read the remaining sections of this guide you will see this variety as a strength. Ultimately, you need confidence to experiment with methods, tapping the wisdom across methodological communities to orchestrate robust argumentation in your project.

Before we move into methodologies, let's sum up what we've established so far, that a paradigm gives structure to the researcher's basic belief system. As per Guba & Lincoln (1994, p. 104), a paradigm "guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways." This means that when I state that my research is situated within CR, I am describing how my research aligns with my worldview at this stage of my practice. Because I have taken the view of a critical realist for this project, readers may assume consistently that my entire project is seeking to understand real aspects of the world (the what) through a subjective interpretation (the how). My approach to doing all that, including the many and various methods I may choose, can be summed up as *methodology*.

Methodology

In a doctoral project that spans several years, developing a clear understanding of your methodology sometimes happens after you've already started with your methods. According to Varpio (2020b), "Methodology generates knowledge reflective of the ontological and epistemological foundations of the paradigm." You need to speak your methodology as fluently as you would hope to speak any language. If you've ever tried to learn a language, however, you know that the only way to really get fluent is to speak

it before you're ready. So, if you've already started with your studies (methods) but you're still not confident in how the methods align with your methodology and paradigm, I would say don't be discouraged.

In the examples of CGT and IPA previously mentioned, we have two research methodologies that have evolved from distinct intellectual traditions (Starks & Brown Trinidad, 2007) but have much in common. As a qualitative researcher, you'll need to be well-versed in their commonalities as well as their differences, avatars, and the variation of descriptions used by different references. It is generally agreed that both methodologies extend beyond the description of phenomena to propose meanings. Lincoln et al. contend that both aim to interpret the nature of experiences and that this understanding makes them useful to inform the health sciences (2018). As researchers in HPE, we will thus be seeing a lot of these two qualitative approaches.

Both CGT and IPA draw from multidisciplinary roots including health, medicine, education, and psychology (Smith, 1996; Charmaz & Thornberg, 2020). Table 21, adapted from Burns (2022), offers an overview of these methodologies featuring their evolutionary development from a common ancestor and a surprising flip to the opposite end of the paradigm spectrum (from Positivist to Constructivist in a single century). This plurality of disciplines endows these methodologies with the inherent capability of bringing together the otherwise disparate paradigms that so often characterise the multidisciplinary research aims of HPE.

Table 21: Evolutionary Overview of Grounded Theory & Phenomenology, adapted from Burns et al. (2022)

	Grounded Theory	Phenomenology
Creator(s)	(Glaser & Strauss, 2017)	Husserl (early 20 th century)
Paradigm	Post-positivist	Positivist
philosophical underpinnings	Pragmatism & Symbolic interactionism	Philosophy of phenomenology; Human experience is the root of knowledge
Researcher stance	Neutral, objective	Neutral, objective
Author of evolutionary turn of methodology	Charmaz (2000): Constructivist grounded theory	Heidegger (1960s): Interpretive phenomenology
Paradigm	Constructivism	Constructivism Understanding through <i>being-in-the-world</i>
philosophical underpinnings	Pragmatism & Symbolic interactionism & World is <i>interpreted</i>	Life-worlds Heidegger (1960s): Interpretive phenomenology
Researcher stance	Subjective, co-creator of knowledge	Subjective, co-creator of knowledge

As pointed out by Charmaz et al. (2018), CGT emerged from the influences of Glaserian and Straussian grounded theory lineages. Although both methodologies arise most recently from the constructivist paradigm (Burns, 2022), their aims are distinctive in several ways. The main difference explored here is that CGT seeks to generate theory in its findings whereas IPA operates remaining theory agnostic, meaning that the findings of an IPA study tend to focus on the intrinsic value of participant lifeworld.

Whereas CGT hinges on the application of a top-down theoretical framework and seeks to generate results discussed in light of the theory, IPA can be considered as bottom-up. Like a plant drawing water up through its roots, IPA methodology interprets phenomena up through the sense-making reflections of its participants (roots and stem, if you like). Top-down and bottom-up is another useful binary frame to help make the relationship more digestible, but bear in mind that in discourse, binaries are often reframed on the loom of a continuum. For example, a CGT study might privilege the interpretative reflections of its participants with a phenomenological focus, just as a lot of IPA studies, particularly in STEM disciplines, are carried with an applied theoretical framework.

This distinction between the two methodologies is crucial for novice researchers, especially those coming from a sciences background into HPE. I came to my doctoral work in HPE from an anatomical sciences background. My experience writing up my master's dissertation prepared me for the referencing and reporting aspects of PhD research, couched as it was in the use of 3D printing in the anatomical sciences.

Why am I telling you this? I hope that my hindsight can inspire you to look closely at your own background and embrace your roots. What I didn't know then was that my research practice was totally aligned with a positivist paradigm where it was taken for granted

that the entire manuscript is written in the third person objective. At that time, in my experience, it was not expected that master's degree students working in a STEM discipline have a reaching measure of meta cognition concerning their research framework.

Rising to the level of PhD research was like being born into another dimension where strange chimerical creatures spoke an impenetrable language. HPE seemed a field where the medically trained could depart from their clinical educational pathway to explore contemporary issues including social and educational theory. You could also expect to find methodologists in the mix, coming to HPE in the interest of exploring psychometrics and epidemiology. Sociologists, psychologists, education specialists, information scientists, nurses, midwives, and others could all find a reasonable foothold in the field of HPE. If you are coming into HPE from any background, it is likely that you will be collaborating with someone from a different background than your own, perhaps paradigmatically opposite.

The intersectional nature of health studies is so broad that no single methodological community can address all the questions emerging under its umbrella. Methodologies are the languages spoken by your colleagues, each coming from a different community with its own accent. It makes sense to know what language you speak, learn the variations of your native tongue, and appreciate the rules of other languages you're hearing in the field. Being multilingual is the best way to maximise the significant potential for collaboration that HPE has to offer.

Your Project, X-rayed

Let's say you're on board with methodologies and ready to practice your fluency. Now what? Well, the bad news is that qualitatively inclined projects rooted in the constructivist lineage don't usually offer the step-by-step recipes for research that can make positivist-

leaning research more appealing in some ways. I'm in no way saying that researchers in the hard sciences like mathematics and engineering are getting off lightly in their quantitative research. In fact, I bow in reverence to the commitment it takes for the STEMmers to do what they do, fortifying vaccines, conjuring ghostly neutrinos and suchlike. In fact, Bhaskar highlights (2008, p. 33 - 35) that scientific experiments have a primary role in the production of knowledge because they allow us a lens through which we may come to understand how causal mechanisms operate. Controlled experiment provides a 'closed environment' in which a single causal mechanism is thought to bring about an event, giving scientists a way of isolating and testing the nature of the causal mechanism under investigation.

What I'm pointing to is the conundrum facing qualitative researchers, as we pay for our freedom with the concomitant requirement to justify, iterate, contextualise, adapt, and generally agonise over how our conceptual framework produces its findings. We must show how and why the results are worthwhile, and what new methodological tools might be added to the largesse of discourse. Lest your enquiry falls apart like uncontained jelly, your conceptual framework is the binding that can bring it all together. Figure 40 shows a visualisation of a project's potential structure. Like an X-ray, drawing the structure of your project goes a long way to understanding how the components can be arranged in a nested hierarchy of functional relationships: its endoskeleton.

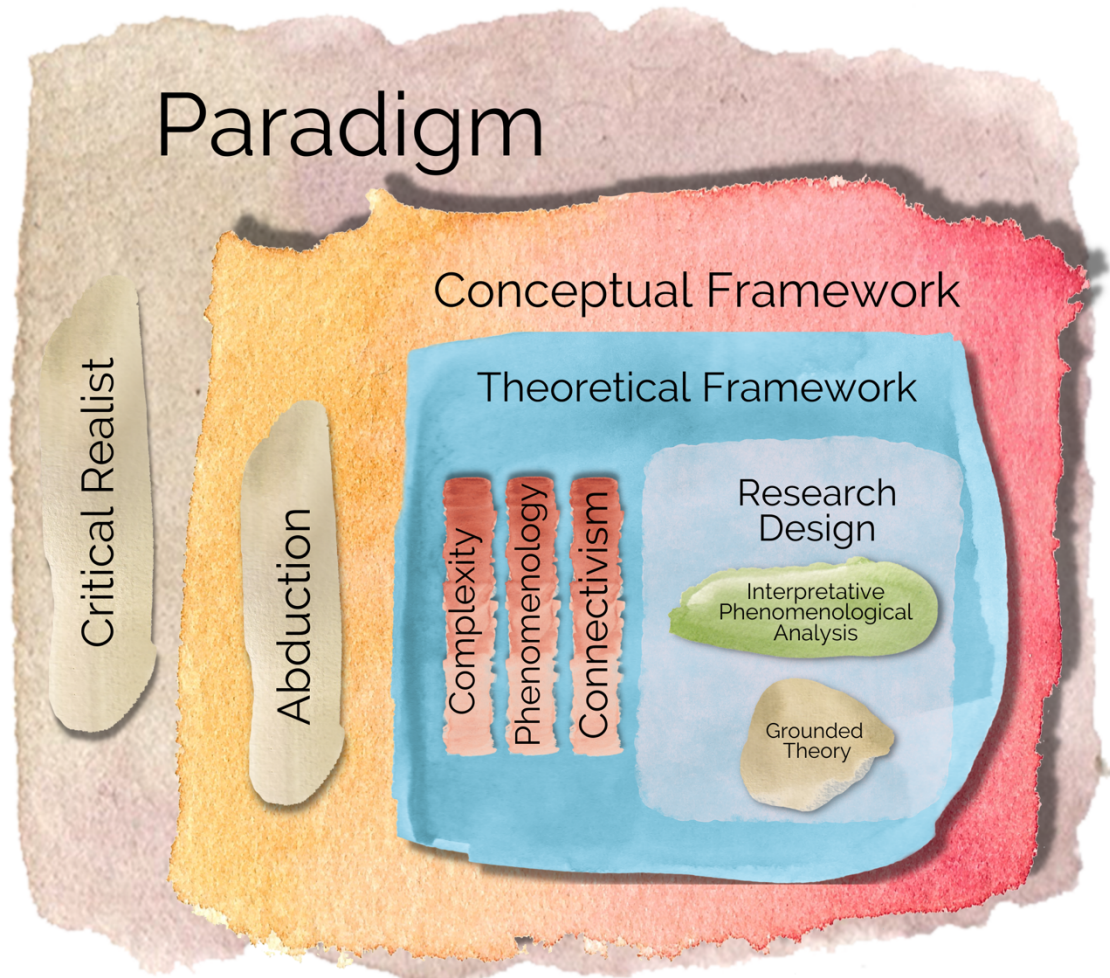


Figure 40: "Project X-ray" - a visualisation of my thesis framework. Image designed by the author using Canva elements.

The way you set up your studies, including all the methods involved, is your research design. How these studies are carried out depends on the prevailing conventions of their respective methodologies. How that process interfaces with theories at the fore of your enquiry can be described as your theoretical framework. Your theoretical framework considers how theory may intentionally/unintentionally, directly/indirectly influence your methodology.

Going back to the variety of methods I used in my thesis, let's take pause to reflect on the value of uncertainty. Big projects are necessarily chaotic at times as they are often behaving as complex

adaptive systems. The studies you're working on right now may seem disjointed, with tenuous connections to your initial brief. Recognise this for the opportunity that it is: casting a broad net gives you more options from which to gain experience and whittle your reasoning process.

If you persevere and develop your framework, your work to date might reveal to you a "golden thread" that emerges as hidden in the obvious. Drawing out your "Project X-ray" can help you see how your various studies are potentially influenced by theories you've had in mind but weren't sure how they fit together. I'm only saying that because there is a 98% chance that you'll be feeling more than confused at any point during your journey, as well as overwhelmed with worry and riddled with self-doubt. Please, don't despair – get yourself some markers and set to work drawing your Project X-ray.

In this section so far, we've made our way up to the level of the Theoretical Framework. We've got a series of studies in the works and a basic understanding of the relevant theories around them, the methodologies working through them. Now, how do we tell the story of how these studies *relate* to one another? I must describe the process of reasoning I used in making decisions around what to include and what to omit. The thesis is where I contextualise my findings as a journey, even though it likely didn't happen in a straight line. In my experience, the way to tell that story is through the Conceptual Framework. In CR, this reasoning is carried out via a process called abduction (more on abduction in 2.3.6).

In presenting our findings, we as HPE researchers must again reckon with the framework we devised at the outset of the project, a framework that is mutable – it *wants* to evolve, as it is a living extension and reflection of the researcher's mind. As most qualitative research is both theory dependent and, at PhD level, theory generative, the overall result is that the literature base

continues undergoing exponential growth. Critical realism advocates both emergence and mutability – reality is emergent, and our theories about it are both changeable and fallible.

It does appear that the positivist researcher can get on with their measurements in the relative peace of a known conceptual framework. In contrast, the qualitative researcher is tasked with producing new theory and linking it with that of every other researcher – project after project, year after year. Not to discourage you, dear reader, but to inspire you: whatever the paradigm, your work will become a unique link in a vast, evolving web!

OK, so that was the bad news – once you've got your paradigm set, you have some work to do on setting up your theoretical framework. In my experience, sometimes that process can unfold back to front, as you might well have inherited the theoretical framework from your project brief so from there you can work back through your Project X-ray to get familiar with the structural relationships of your project. So, the bad news isn't all that horrendous, right?

Why choose critical realism?

The good news is now upon us. You are a qualitative researcher who has accepted that there is no easy roadmap or recipe to justify your conceptual framework. There are qualitative approaches that offer what Chamberlain has dubbed "off-the-shelf" methodologies, such as CGT and narrative analysis (2012). IPA, similarly, could be considered as formulaic as it represents a standardised set of philosophical assumptions with sanctioned analytic techniques used in the interpretation of a constrained breed of research questions. Braun and Clarke (2022) contend that TA demands higher level conceptual and design engagement from researchers compared to the use of off-the-shelf methodologies, with other qualitative researchers in agreement (Willig, 2013; McLeod, 2011). The terrain

becomes more complex when you remember that we're working with multimethod projects containing a plurality of studies: not just one approach.

Gulp. I did say that the good news is coming! You know it is up to you to develop a rationale that may well be unique to your project. The good news is that there is critical realism.

CR first appealed to me because it recognises the apparent realness of shared experience. Let me share a key example. My roots in the anatomical sciences mean many things, but chiefly it means that I'm geared for working with the collective pattern of bilateral symmetry. Where arms and legs are concerned, I am totally on board.

Bilateral symmetry is real, it must be, because everyone I know has arms and legs! All the cadavers I have ever dissected have been ostensibly symmetrical, and upon entering the visceral cavities we discover the internal asymmetry. You can ask any orthopaedic surgeon: typically, how many *patellae* does one human have? The answer, across all cultural divides, will be "Two."

Critical realism argues that it would be stupid to question the realness of this shared experience. So, CR shares an *ontological* position with the positivist paradigm, which is great for those of us working in the HPE field since we're sharing common ground with STEM researchers who might be described as primarily working in the positivist paradigm (taking Real for granted as such).

Positivism assumes that the world consists of real stuff, an assumption with which CR agrees. The similarities kind of end there, though. As previously mentioned, Positivist methodology operates via an objective epistemological stance. Our positivist friends are gunning for universal laws of correlation to arise from linear ontological relationships.

A universal law is a statement about how two events are related to each other. This is essentially a linear relationship that may be true under certain circumstances. For example, some hypothetical linear relationships in anatomy:

- Age is a significant predictor of the likelihood of joint degenerative syndrome, with an effect size of 18.34764% ($p < 0.03$)
- Gender predicts 19.117% of the variation in patella presentation at age 25 in Scotland ($p < 0.03$).
- Activity levels predict 34.3458% of the variation in ACL repair ($p < 0.2$).

Critical realists don't doubt that these correlations exist. However, we might consider them as part of a rather superficial approach to causation if our research question seeks to understand the real causes of the patient experience of knee pain. The problem here is that universal laws between the events proposed in the bullet points above can't exist, and that trying to establish causation from these bullet points alone is ridiculous.

For example, the idea that "activity levels" can sum up the broad and various ways people move is beyond an oversimplification: it is a dangerous manipulation of facts. One participant's "activity" might be cage fighting, another could as well be swimming or Pilates or potato farming. The point is that correlation tells you about how A and B are related to each other in a vacuum.

CR does not refute that linear relationships between events exist. The problem it has with correlation is that there is no objective way to sum up the *context* or account for the unknown unknowns, such as the confounding variables of such linear relationships. CR disputes the epistemological position (objectivist) of the positivist

paradigm and offers a subjective route into exploring the reality of shared experience.

The practical challenges of critical realism

Don't get too excited! We've still got a long way to go, and you haven't even finished any studies. A subjective epistemological stance is not a free ticket to doing whatever you want. In fact, dear reader, you should now be buckling up in advance of the bumpy ride ahead along the winding road of subjectivity. My first practical piece of advice at this point is to get yourself ready for that dog's dinner. It's time to start speaking the language before you're ready.

This brings us to an important point of reflection: a qualitative PhD in the health sciences is not going to comprise one study. You're looking at starting a journey involving several studies that will span different methodologies. You are casting the net of your enquiry widely according to the luck of your reflexive circumstances: who is among your cohort, what are the projects your supervisor can offer you, and how can you harness your wider circle for data? How much time do you have left on the clock? Is there a pandemic waiting to happen? What levels of access do you have to participants? How familiar are you with questionnaire design? Data analysis software?

Critical realism offers a container of time, space, and context to qualitative projects that may begin as nebulous generalities. For example, my project started as an enquiry into Authentic Assessment. As a novice researcher, I threw myself into any opportunity that presented itself. Some studies ended up as part of my thesis and others became ancillary, still others just sort of petered out. All of them had a part to play in my abductive process, the underlying logic of this thesis, whether they appear in final chapter form or not. In my experience, both the challenge and delight of applying CR has been suspending the disbelief I had that my dog's dinner would come together as cohesive in the end.

Embracing the Real

How it ended is happening now, as I write this guide, which happens to sit toward the beginning of my thesis. You might wonder, how did this story begin chronologically? From a CR perspective, the powers that be assumed that Authenticity is real because it had risen to attention in the literature. They decided it was worth directing resources to exploring it via a PhD studentship. I applied, interviewed, and somehow got accepted for the role. Boom, the clock on my project started ticking.

Let's get to the main question: Why did I choose CR as a paradigm, and would I recommend that students embarking on a PhD in HPE consider the same? I would recommend HPE researchers consider that CR offers common ground with the questions rising in most health sciences, concerned as they are with realist-oriented enquiry. It does so while simultaneously affording us the tools of qualitative methodologies to go about investigating the real via subjective enquiry.

By accepting a studentship, I am essentially saying that, yes, I agree that _____ is a thing and we should know more about it. In that sense, I haven't been asked to question whether X is real, I have been asked to make up a project that will contribute not only to what is known about that topic, but also to philosophically rationalise the project in contemporary discourse. This is challenging for many HPE researchers who are similarly front-loaded with a realist ontological position and then go about investigating their topic via qualitative methodologies that are inherently irrealist (i.e., CGT).

My project centres around Authenticity in the medical curriculum, which is about as subjective a concept as one can get. On the observation that many HPE topics have a similarly subjective element and are often extremely vague, your project will struggle

methodologically unless you have a means of justifying on what basis the topic is real. I didn't just write this guide for your benefit, dear reader. I am using it to demonstrate sustained engagement with the philosophical rationale of my own project.

CR has allowed me to contextualise my enquiry into realness as relevant, unpacking worthwhile results about the topic without having to feign any Universal Laws. For a project concerned with Authenticity, this is no trivial revelation. For Roy Bhaskar, the father of Critical Realism (Bhaskar, 2010), it is worth distinguishing between the 'real' world and the 'observable' world in what I have come to consider to be the pursuit of authenticity.

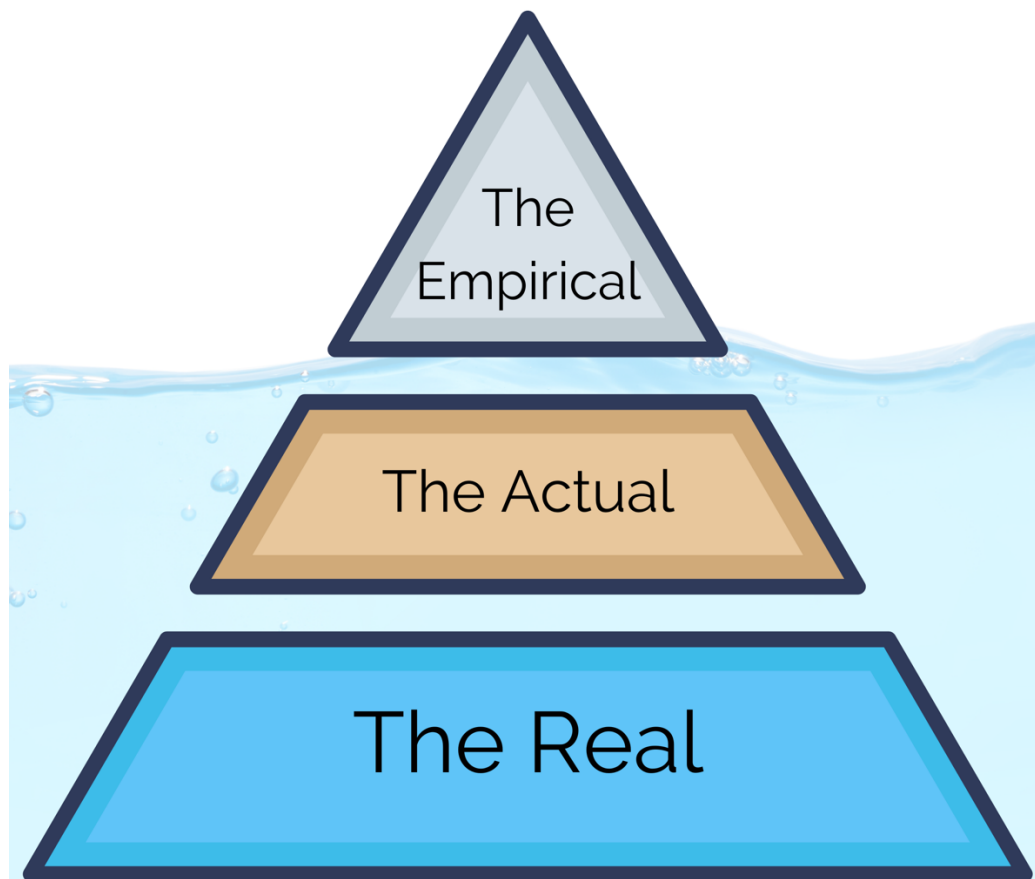


Figure 41: The domains of reality as per critical realism. Image designed by the author using Canva elements.

CR operates on the presumption of reality as a continuum. See Figure 41 for the domains of reality according to CR. There is the domain of the Real, containing the mechanisms of Nature that act to produce events – the domain of the Actual – and the domain of the Empirical which includes measurable experiences. For example, in a sample of ultra-marathon runners, excessive running predicts 34.3458% of the presentation of patella maltracking ($p < 0.2$). The experience of knee pain that ultra-runners suffer represents the Empirical domain (events and experiences we can measure). The suboptimal adaptation of the knee joints in response to the specific activity of ultra-marathon running is the Actual (mechanisms that constrain the Empirical domain). The Real domain may include the fact that the extracellular matrix of living tissue is constantly adapting to mechanical forces (structures of Nature).

Working from the real domain, we are talking about the structure and nature of mechanisms and their causal powers. The 'actual' refers to the functionality of these causal tendencies. The 'empirical' is the subset of the real + actual that is experienced by participants. Changes in the domain of the actual (i.e., gait modification) may influence the nature of the real (i.e., tissue behaviour). However, the latter are not reducible to the former, any more than the anatomy of the knee joint can be reduced to its physiology.

Applied to Authenticity in the curriculum, CR can offer HPE researchers a set of similarly practical constraints. We accept that there is empirical evidence of authenticity being real. There is $n=x$ number of hits of the keywords #authenticlearning #authenticassessment #authenticity in the relevant databases and a medical school has used this as a justification for the realness of the topic. Working back from the empirical evidence, how do we qualify the Actual and Real domains of Authenticity? CR gives us the process of abductive logic to reason out a best guess. That is, in

essence, the framework of my PhD dissertation: *abduction*. You can use abduction to work back to the Real from your own topic. How exactly you go about doing that will become your unique contribution to knowledge.

Abduction: how critical realism works its magic

I know, it was very sneaky of me to introduce another big term, **abduction**, into the mix. If you can hold on for two more sections, I promise this text will wrap up soon and you will have your complete Beginners Guide to framing your PhD. There are a few more “-uctions” coming up, then a summary, and then we’re done.

I mentioned previously that Positivist projects may be characterised by their somewhat prescriptive methodologies. On the other hand, projects based in qualitative research can suffer from a lack of logical structure. In terms of cooking, “quants” follow a recipe to the letter, whereas “quals” are known for their somewhat imaginative and spontaneous creations. CR has its own built-in reasoning system that reconciles structure with spontaneity and can provide needed internal scaffolding to qualitative projects in the form of abduction.

Abductive argument is the technical term for a really good guess. Abduction is a type of reasoning that can be considered alongside the usual suspects of *deduction* and *induction*. Where deductive reasoning proceeds from general to specific, and inductive reasoning works back the other way from special cases to a general principle, abduction is a way of embracing both directionalities whilst moving iteratively through the research process. See Figure 42 for a visual of this process.

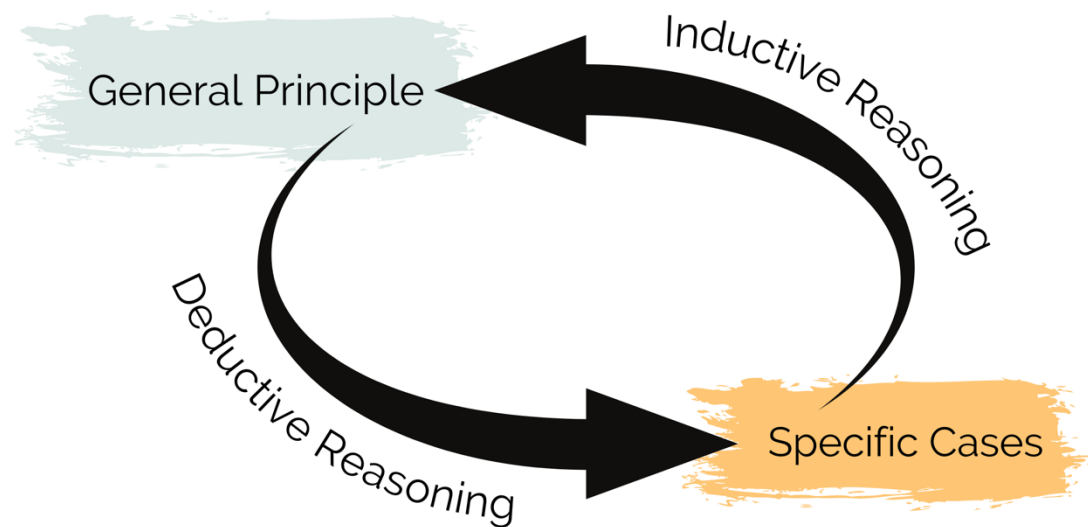


Figure 42: The bi-directional flow of reasoning. Image designed by the author using Canva elements.

Abductive arguments are based on an inference to the best explanation. From the online etymology dictionary, 'abduction' arises from the 1620s, "a leading away," from the Latin, "a forcible carrying off, ravishing, robbing." Ravishing or otherwise, the process of abduction is used universally to develop theories or models and can be thought of as germane to the scientific method. Scientists use data from their observations to generate ideas (hypotheses) about how the world works. There are different kinds of abduction; here we're drawing from the logic-based abduction that deals with the inference of hypotheses. See Table 22 for a comparison of reasoning methods.

Table 22: Deductive, Inductive, and Abductive reasoning

Deductive	Inductive	Abductive
All runners will eventually have sore knees;	Allan is a runner;	All runners will have sore knees;

Allan is a runner;	Allan has sore knees;	Allan has sore knees;
Allan will have sore knees.	All runners will have sore knees.	Allan might be a runner.

Logic-based abductive reasoning differs from deductive reasoning, in that abduction does not require that all logical consequences of a hypothesis be known at the outset of a project. This is a crucial allowance for researchers coming to an undefined topic, as many of us starting our HPE project have literally no idea where we're going with it! OK, there, I said it.

Abduction involves looking for patterns in observations and uses them to propose hypotheses that best explain those patterns. The researcher then evaluates the hypotheses to see if they are consistent with their observations – the data – and are then reiterated to ask the next level of questions and predict new data. The abductive conclusion is not a conclusion, it is a best guess. Critical realists make no bones about their best guesses, they use them to do what they do best: hypothesise.

A hypothesis in the Positivist sense undergoes much the same cycle – starting out as a best guess that the scientist arrived at via their common sense, a.k.a. intuitive thinking – a “hunch” that told them X is likely to be true. Equipped with this idea, the scientist devises an experiment to test their hypothesis to see if it can be supported in other scenarios. If the data arising from controlled experiment does not support their hypothesis, it gets scrapped or modified. You are no doubt familiar with this process of testing and modifying ideas as the scientific method. In the positivist tradition, scientists normally use deductions to prove their abductions and call it good.

Critical realists use abduction to essentially extend the scientific method beyond testing the validity of simple, linear relationships. Again, reader, I am not discounting the importance of correlation. However, the type of research questions with which we are confronted in the social sciences are often based on complex, multidisciplinary concepts that require a complex, multidisciplinary approach to research that looks not just for correlations, but for *causal tendencies*. Critical realists want to know: what is most likely to be the cause of the phenomena in question? How can we talk about it?

Toward working back to the most likely causes (causal tendencies, aka 'mechanisms' or 'powers'), CR provides us with **retroduction**, a mechanism for internal coherence that gives the researcher a system of accounting in their work. Meyer (2013) distinguishes *abduction* as involving the analysis of data that falls outside of an initial premise or theoretical frame. *Retroduction* is a specific method of conceptualization, a syllogism, which requires the researcher to identify the circumstances without which something (the concept) cannot exist. Table 23 shows how retroductive syllogisms can justify the reasoning that if you had not run that ultra-marathon, your knees probably would not be sore today.

Table 23: Retroductive process

Number	Premise	Terms
rule	You arrive home and are surprised that your knee hurts.	(X)
result	But if you had just completed an ultra-marathon, this would be unsurprising.	(If Y, then unsurprisingly, X)

case (hypothesis)	Therefore, it is reasonable to conclude that your knee hurts because you ran an ultra-marathon.	(therefore, presumably Z)
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Abduction: confidence in Maybe

Positivism seeks universal laws to justify its results, privileging the correlation of data. Qualitative projects rooted in Constructivism, at the other end of the spectrum, often prioritise the stories of individuals and do not aim or claim to establish causation. CR, on the other hand, is looking for causation and models in its tiered domain of reality. Its use of retroduction shows the state of balance to map studies relatively into to the literature base and within the project itself.

In their review of relevant literature, Mukumbang et al. (2021) found that the level of application of retroductive theorising in realist-informed studies is largely inadequate. I want to be really clear here, because retroduction can sound unnecessarily obtuse and antithetical to the qualitative spirit, but in retroduction we have a kind of internal scaffolding to aid in organising the empirical journey. It is my contention that using retroduction as a narrative tool goes a long way toward making our research choices more explicit, easier for writers to describe and readers to understand.

OK, so we are not dealing with the patella or any other neat little aspect of anatomy. By the time we get to PhD level, we must shift our attention and interest from anatomical parts to the subjective experiences of stakeholders in health education. We can move from the made-up case presented in Table 23 to another made-up syllogism relevant to HPE as presented in Table 24.

Table 24: Example of a retrodution with Peirce's (1878) three steps applied to the HPE context

Number	Premise	Terms
rule	You enter the medical profession and are surprised that you are overwhelmed with uncertainty.	(X)
result	But if you have just completed a standard medical programme, this would be unsurprising.	(If Y, then unsurprisingly, X)
case (hypothesis)	Therefore, it is reasonable to conclude that you are overwhelmed with uncertainty because you have just completed a standard medical programme.	(therefore, presumably Z)

The philosophies of science and social science formed a dichotomy in the mind of Bhaskar, inspiring the development of Critical Realism. This 'meta theoretical perspective' (Owens, 2011) originated in what Bhaskar called 'Transcendental Realism' in *A Realist Theory of Science* (1975), which he pulled through the social sciences as 'Critical Naturalism' in *The Possibility of Naturalism* (1978). The result would eventually become known as 'Critical Realism,' an elision of Transcendental Realism and Critical Naturalism. Proposed by others, Bhaskar accepted the nomenclature, and it has risen as such to encompass a means of bringing together two ostensibly opposite philosophical camps.

The role of CR in fusing the horizons of social sciences and science into a common paradigm is particularly suitable for health

professions education research. Since many HPE researchers are exploring questions originating from medicine, there is a strong compulsion to situate results in the corresponding positivist-leaning paradigm of medical education. As researchers, one of our “paradigmatic parents” is the STEM literature. The other parent is indelibly of qualitative heritage, inductive, heuristic, iterative and phenomenologically aligned. It’s like having a surgeon for a father and a poet as your mother. See Figure 43 for a visual designed by the author to express the holism of reasoning.

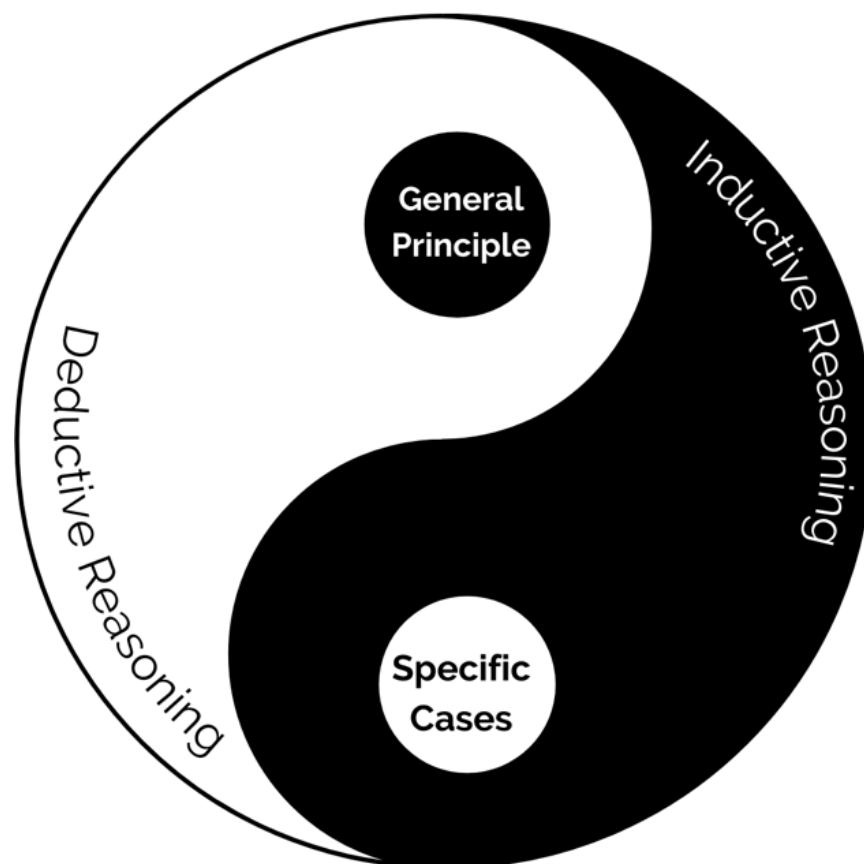


Figure 43: The holism of reasoning. Image designed by the author using Canva elements.

In CR, we have a paradigm that embraces the complementarity of disparate paradigms as well as that of the reasoning dichotomy: induction and deduction. Wikgren (2005, p. 12), points out that critical realism gets us closer to embracing the complexity of reality,

as a "philosophy of science it also assumes that reality is composed of different levels (e.g., the biological, the psychological, the social, and the cultural level)." In this sense, we can use CR to align with the anatomy of our project in all its wholeness.

Critical realist axiology

My natural leanings into CR make sense to me when I look at what it holds as its core agenda. In the last stages of writing up, I've had the warm fuzzy sensation that CR chose *me*, I didn't choose *it*. I've always been a person on a mission to Make Things Better, in the humble ways available to me. As Haigh et al. point out, a critical realist research agenda is formed in part by "emancipatory objectives" (2019). Their investigation contends that CR research features "an inherent focus on 'what to do' to improve people's human rights situation" (Haigh et al., 2019).

Looking around the HPE research, I don't think there are many who take on the challenges of social and educational theory unless they're here to make a positive change. The axiology of CR sits harmoniously with the deeper motivation of health sciences researchers to improve some aspect of how people experience not only health care, education, and policy, but also how we frame the questions of research to get at the causes of the phenomena of interest. CR's nested hierarchy of reality provides the Actual, so our research can work back to the Real to identify causal tendencies where positive change may be actioned. As Danermark puts it (2005), "A critical science often takes its starting point in notions that improvement of society is possible."

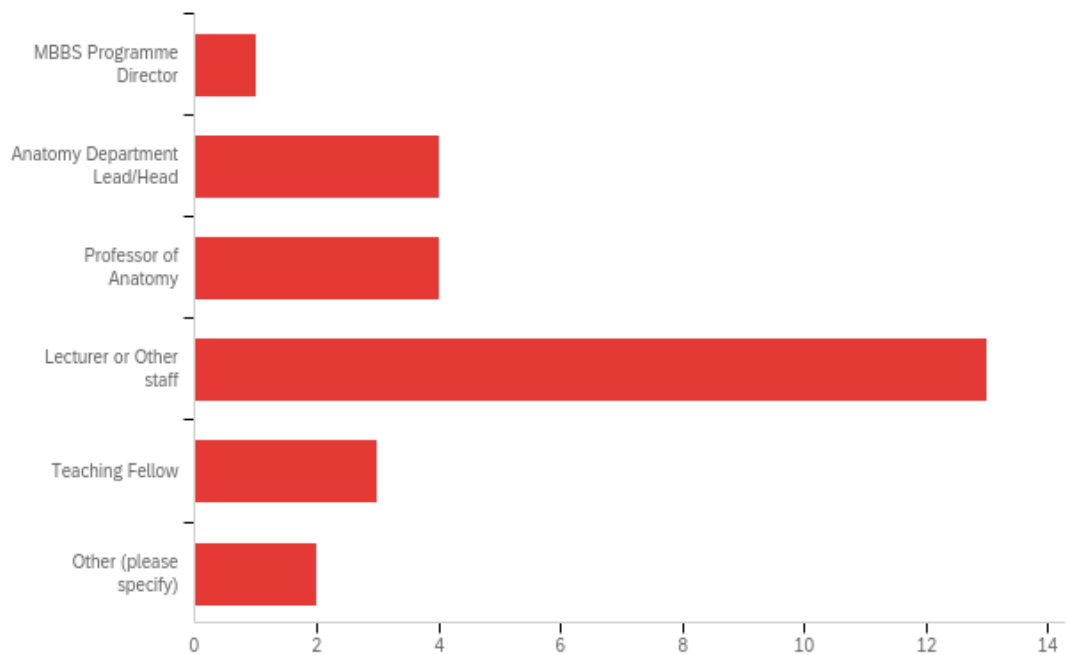
The implication of this unabashedly optimistic worldview is that we are investigating phenomena not simply for the sake of it. The aim is always to create positive change, chipping away at causation. To do this *authentically*, CR axiology sets out to own all aspects of the reasoning process, including the subjective identity of the

researcher and the implicit aim she has in working her way to the real mechanisms of nature through causes by way of interpretation and creativity.

I wrote this guide in the hope of aiding the journey into owning your best guesses and trusting your instincts. Stick with it, take risks, work with others, and keep climbing the perilous peak of philosophy. Before you know it, you'll have something substantial to look back on, and with some hindsight your project may reveal its own emergent logic.

Chapter 14: Appendix B: Anatomy Pedagogy: Constructive Alignment Questionnaire

Q1 - What is your role within the medical school at your institution?



#	Answer	%	Count
1	MBBS Programme Director	3.70%	1
2	Anatomy Department Lead/Head	14.81%	4
3	Professor of Anatomy	14.81%	4
4	Lecturer or Other staff	48.15%	13
5	Teaching Fellow	11.11%	3
6	Other (please specify)	7.41%	2
	Total	100%	27

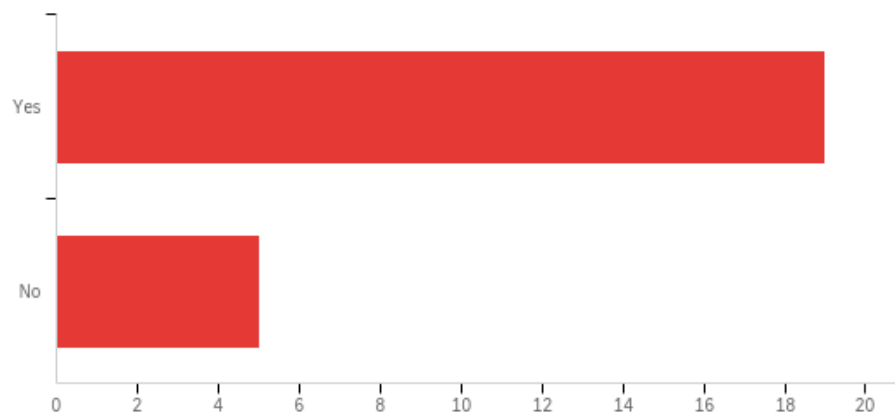
Q1_6_TEXT - Other (please specify)

Other (please specify) - Text

I was a former anatomy teacher and now I am a visiting Clinical Anatomist providing private anatomy courses to undergraduate and post-graduate specialists

Senior Lecturer in Anatomy. Lead for Educational Research and Scholarship

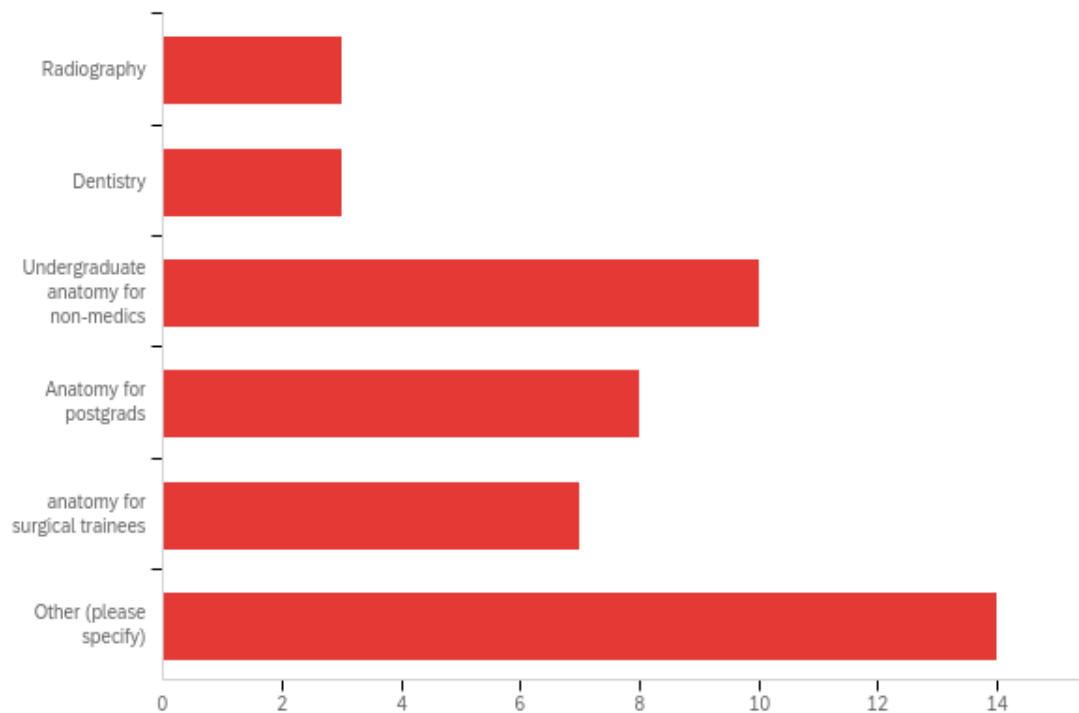
Q2 - Do you teach anatomy within the MBBS curriculum of medicine at your institution?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you teach anatomy within the MBBS curriculum of medicine at your institution?	1.00	4.00	1.63	1.22	1.48	24

#	Answer	%	Count
1	Yes	79.17%	19
4	No	20.83%	5
	Total	100%	24

Q3 - If you teach other healthcare disciplines, please select them here:



#	Answer	%	Count
1	Radiography	6.67%	3
2	Dentistry	6.67%	3
3	Undergraduate anatomy for non-medics	22.22%	10
4	Anatomy for postgrads	17.78%	8
5	anatomy for surgical trainees	15.56%	7
6	Other (please specify)	31.11%	14
	Total	100%	45

Q3_6_TEXT - Other (please specify)

Other (please specify) - Text

I provide courses to clinical anatomists/surgeons and other medical specialists from academic and clinical backgrounds who are involved in teaching clinically applied anatomy relevant to clinical procedures at undergraduate and/or postgraduate levels. Courses typically include:
 Regional anaesthesia: Paravertebral & brachial plexus block, epidural spinal block/lumbar puncture
 Airway procedures: Intubation, video laryngoscopy, surgical cricothyrotomy, difficult airway access
 Thoracic access: Thoracostomy & thoracotomy
 Cranial access: Burr hole & Craniotomy
 Orthopaedic procedures (upper limb): Fasciotomy & carpal tunnel release
 This course has been designed to provide an overview of the main anatomical regions and structures of the body. Key features will be taught in relation to their clinical significance and surgical practice.

Anatomy for online postgraduate students

Physiotherapy, you can only select one on this form... We teach 1,300 other non medic students from a range of Allied health care

N/a

Speech Sciences and Hygiene and Therapy Students

BSc Anatomy students, iBSc anatomy students, PAs, other healthcare professionals.

Radiography, Dentistry, undergraduate anatomy

It is not possible to select multiple boxes. We all deliver anatomy teaching across UG and PG courses, not just MBBS or BDS.

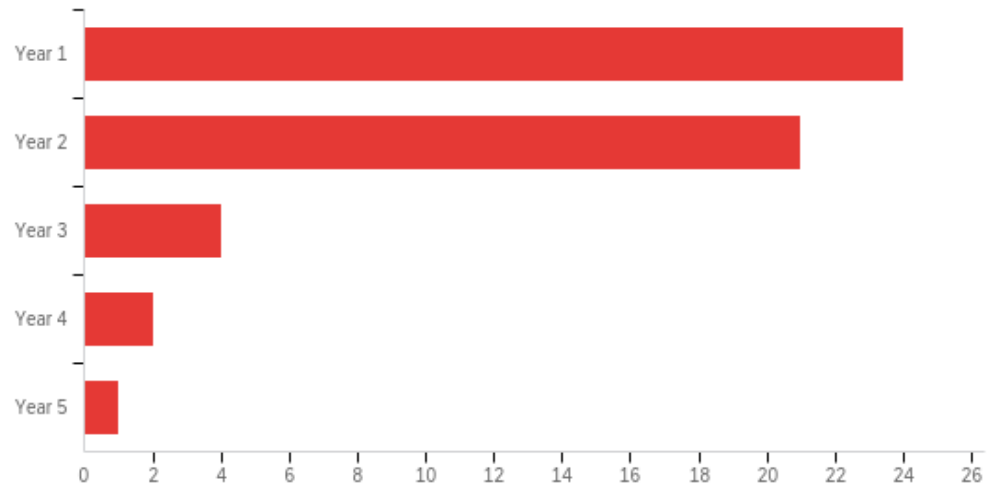
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Physician Associates

Physician Associates, MRes Surgical Anatomy, Radiology Trainees, Surgical Trainees, MSc Clinical Science, UG Biomedical Science, Masters of Medical Education, PhD Anatomy Education

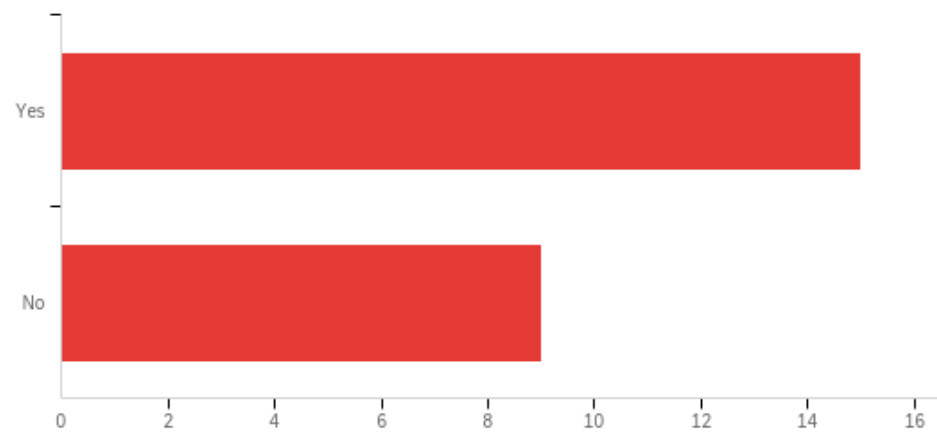
We also teach anatomy for postgrads

**Q4 - During which years is your teaching concentrated?
(choose all that apply)**



#	Answer	%	Count
1	Year 1	46.15%	24
2	Year 2	40.38%	21
3	Year 3	7.69%	4
4	Year 4	3.85%	2
5	Year 5	1.92%	1
	Total	100%	52

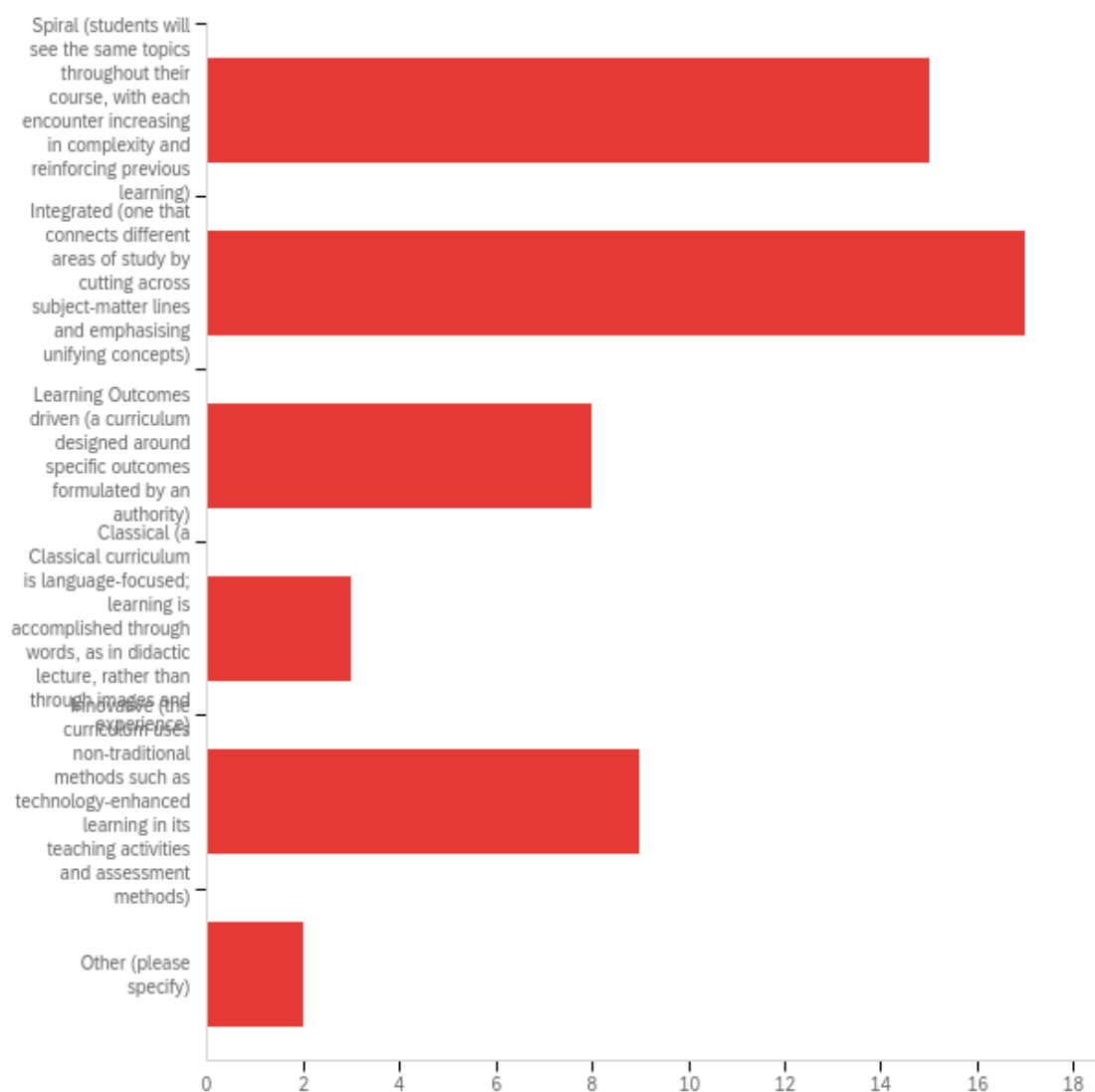
Q5 - Do you participate in the design of the MBBS / MBChB curriculum at your institution?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you participate in the design of the MBBS / MBChB curriculum at your institution?	1.00	3.00	1.44	0.57	0.33	25

#	Answer	%	Count
1	Yes	62.50%	15
2	No	37.50%	9
	Total	100%	24

Q6 - How does your institution describe its curriculum? (tick all that apply)



#	Answer	%	Count
1	Spiral (students will see the same topics throughout their course, with each encounter increasing in complexity and reinforcing previous learning)	27.78%	15
2	Integrated (one that connects different areas of study by cutting across subject-matter lines and emphasising unifying concepts)	31.48%	17

3	Learning Outcomes driven (a curriculum designed around specific outcomes formulated by an authority)	14.81%	8
4	Classical (a Classical curriculum is language-focused; learning is accomplished through words, as in didactic lecture, rather than through images and experience)	5.56%	3
5	Innovative (the curriculum uses non-traditional methods such as technology-enhanced learning in its teaching activities and assessment methods)	16.67%	9
6	Other (please specify)	3.70%	2
	Total	100%	54

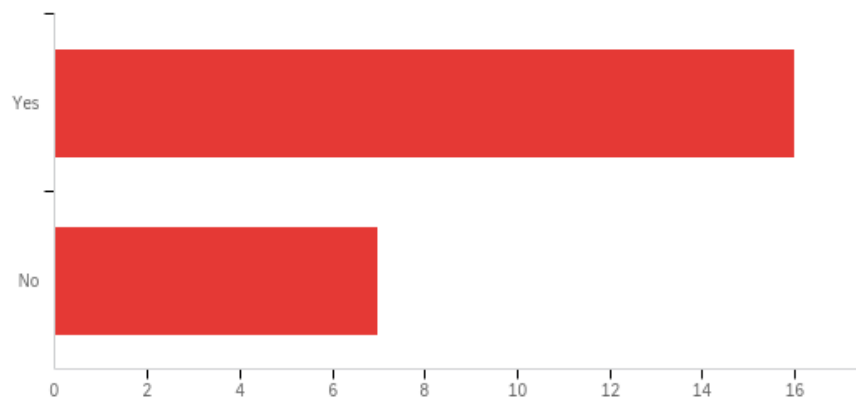
Q2_6_TEXT - Other (please specify)

Other (please specify) - Text

Problem-based learning

Case-based

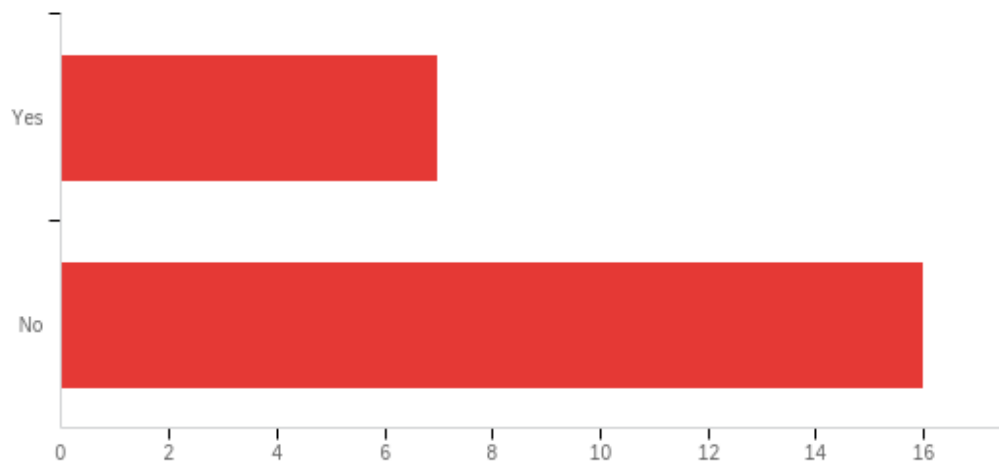
Q7 - Do you participate in the selection/implementation of the anatomy learning outcomes at your institution?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you participate in the selection/implementation of the anatomy learning outcomes at your institution?	1.00	2.00	1.30	0.46	0.21	23

#	Answer	%	Count
1	Yes	69.57%	16
2	No	30.43%	7
	Total	100%	23

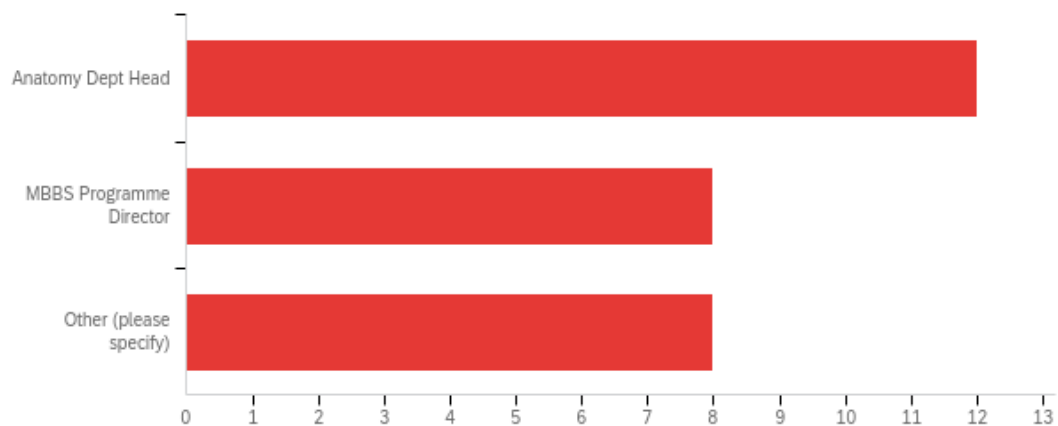
Q8 - Do you participate in the formulation of the programme's overall MBBS learning outcomes?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you participate in the formulation of the programme's overall MBBS learning outcomes?	1.00	2.00	1.70	0.46	0.21	23

#	Answer	%	Count
1	Yes	30.43%	7
2	No	69.57%	16
	Total	100%	23

Q9 - Who gives you the selection of learning outcomes from which you design your teaching activities?



#	Answer	%	Count
4	Anatomy Dept Head	42.86%	12
5	MBBS Programme Director	28.57%	8
6	Other (please specify)	28.57%	8
	Total	100%	28

Q3_6_TEXT - Other (please specify)

Other (please specify) - Text

Anat soc core curr

Block (topic specific) leads work with academic peers to review LOs. These are ultimately communicated through the Phase Lead (phase 1 is years 1 and 2 here)

We decide the outcomes following discussion with system leads, and align them with AnatSoc Syllabus as best possible.

Myself as anatomy lead to medical school

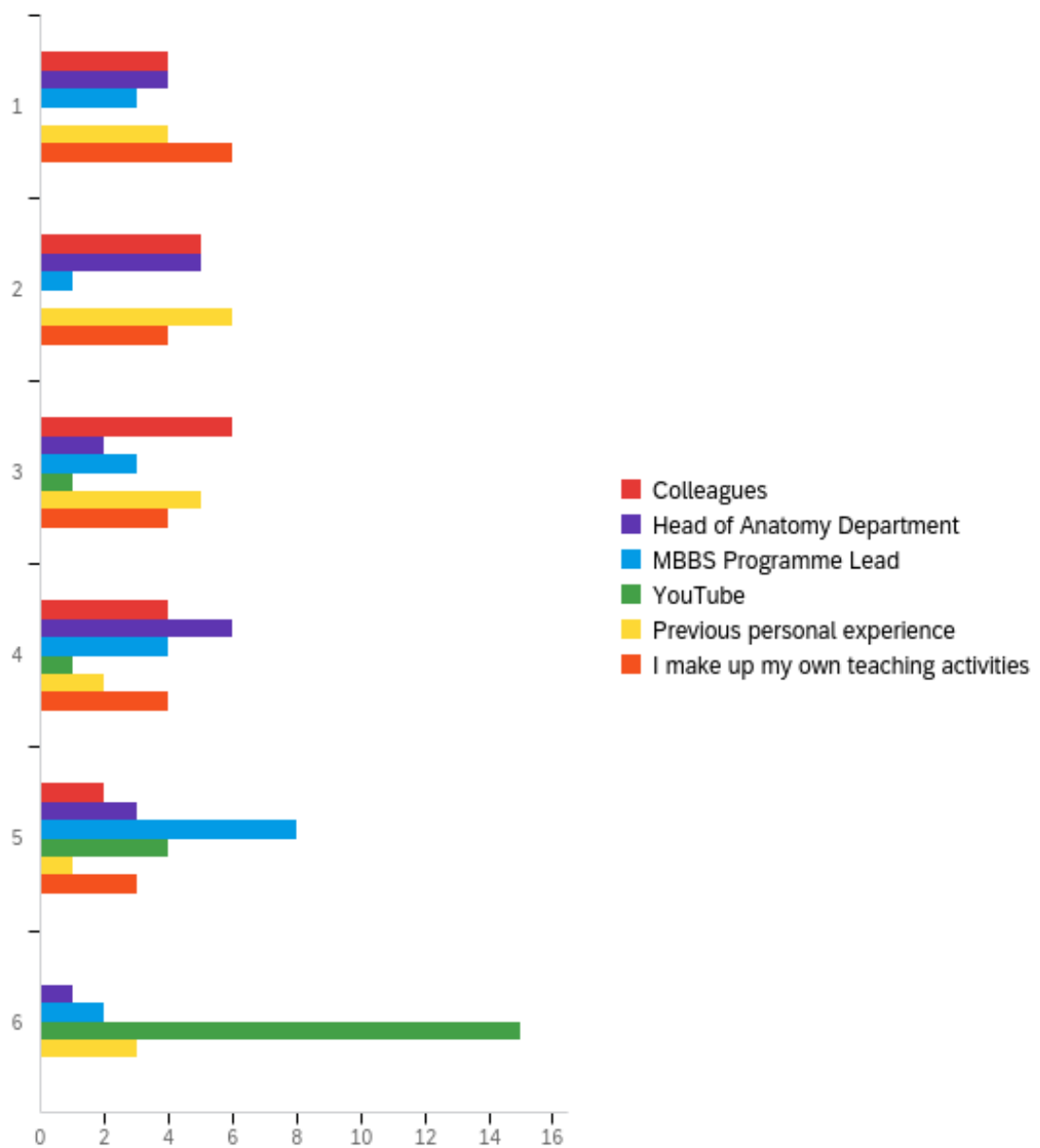
I provide them for the Anatomy team. I have mapped the Anatomical Society syllabus for UG medics to the curriculum, and the session LOs are taken from that.

Agreed upon via committee

I make them

Santa Claus

Q10 - Rank the sources from which you derive your teaching activities in order of most important influence:



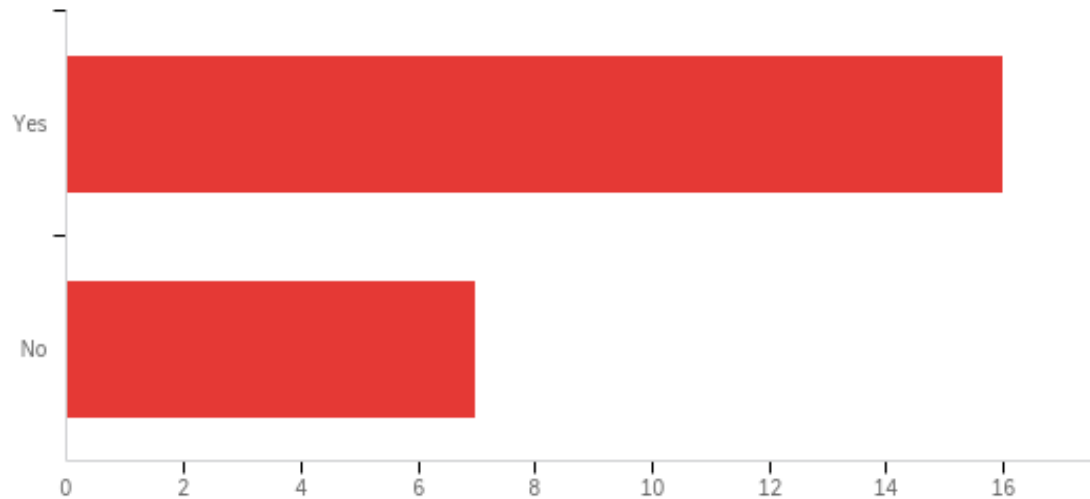
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance
1	Colleagues	1.00	5.00	2.76	1.23	1.51

Appendix B

2	Head of Anatomy Department	1.00	6.00	3.10	1.51	2.28
3	MBBS Programme Lead	1.00	6.00	3.90	1.54	2.37
4	YouTube	3.00	6.00	5.57	0.79	0.63
5	Previous personal experience	1.00	6.00	2.95	1.62	2.62
6	I make up my own teaching activities	1.00	5.00	2.71	1.42	2.01

#	Question	1	2	3	4	5	6					
1	Colleagues	19.05%	4	23.81%	5	28.57%	6	19.05%	4	9.52%	2	0.0
2	Head of Anatomy Department	19.05%	4	23.81%	5	9.52%	2	28.57%	6	14.29%	3	4.7
3	MBBS Programme Lead	14.29%	3	4.76%	1	14.29%	3	19.05%	4	38.10%	8	9.5
4	YouTube	0.00%	0	0.00%	0	4.76%	1	4.76%	1	19.05%	4	71.
5	Previous personal experience	19.05%	4	28.57%	6	23.81%	5	9.52%	2	4.76%	1	14.
6	I make up my own teaching activities	28.57%	6	19.05%	4	19.05%	4	19.05%	4	14.29%	3	0.0

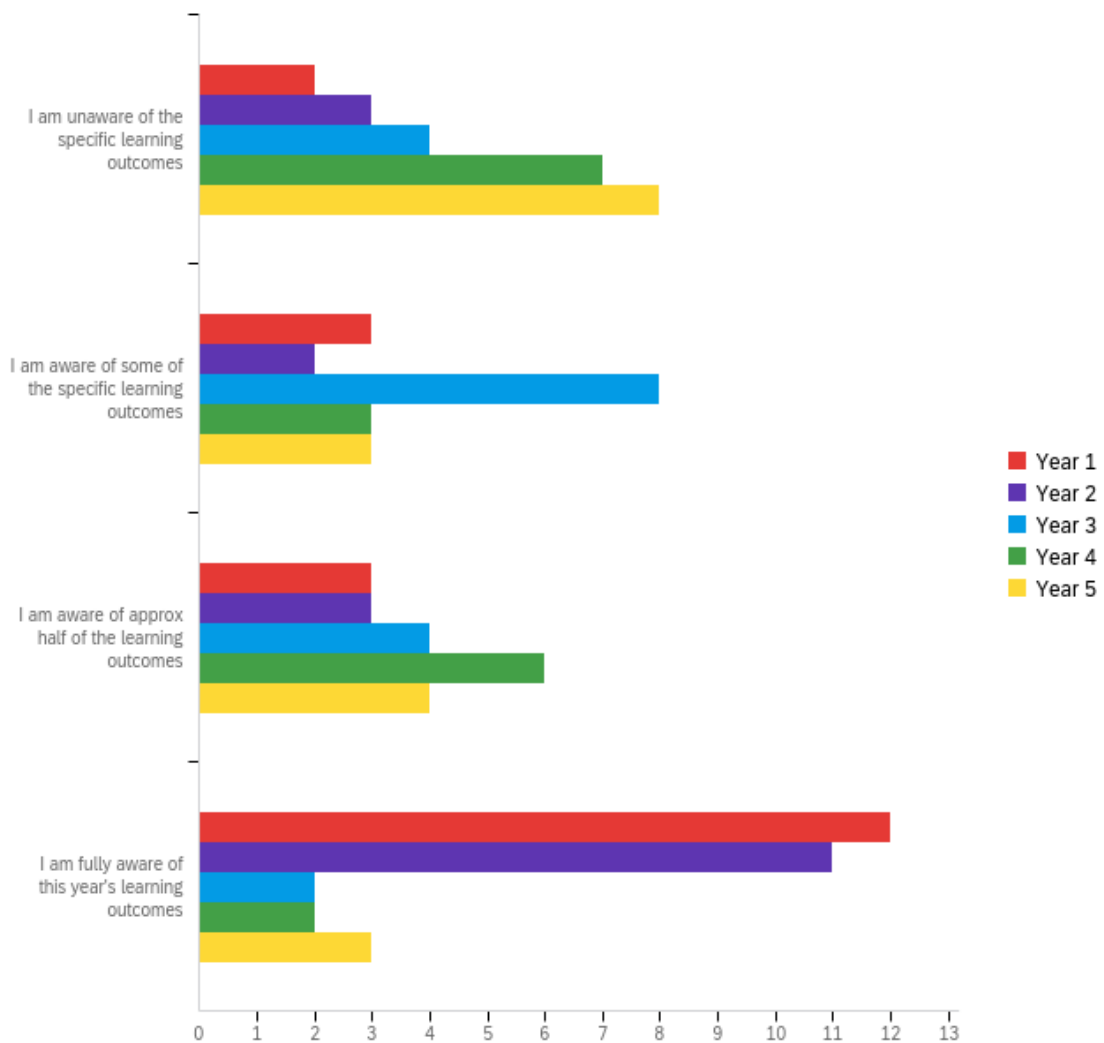
Q11 - Are the learning outcomes (LO's) for years one through two on the MBBS programme at your institution separate from the LO's for years three to five?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are the learning outcomes (LO's) for years one through two on the MBBS programme at your institution separate from the LO's for years three to five?	1.00	2.00	1.30	0.46	0.21	23

#	Answer	%	Count
1	Yes	69.57%	16
2	No	30.43%	7
	Total	100%	23

Q12 - For each year of the MBBS programme, select the level of your awareness of that year's learning outcomes:

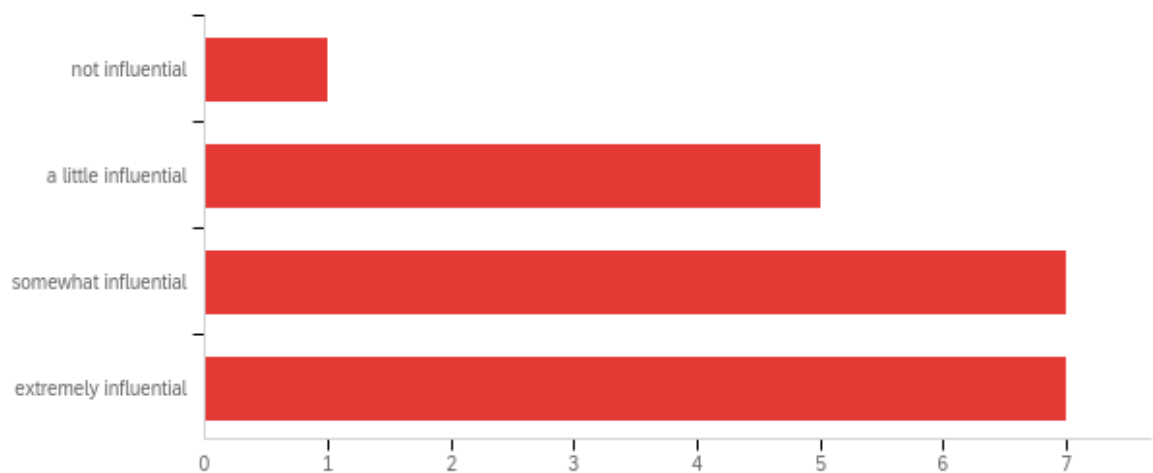


#	Question	I am unaware of the specific learning outcomes	I am aware of some of the specific learning outcomes	I am aware of approx half of the learning outcomes	I am fully aware of this year's learning outcomes	Total

Appendix B

1	Year 1	10.00%	2	15.00%	3	15.00%	3	60.00%	1 2	20
2	Year 2	15.79%	3	10.53%	2	15.79%	3	57.89%	1 1	19
3	Year 3	22.22%	4	44.44%	8	22.22%	4	11.11%	2	18
4	Year 4	38.89%	7	16.67%	3	33.33%	6	11.11%	2	18
5	Year 5	44.44%	8	16.67%	3	22.22%	4	16.67%	3	18

Q13 - How the intended learning outcomes influence my teaching methods":



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Please describe the extent to which the intended learning outcomes influence your teaching methods:	1.00	4.00	3.00	0.89	0.80	20

#	Answer	%	Count
1	not influential	5.00%	1

2	a little influential	25.00%	5
3	somewhat influential	35.00%	7
4	extremely influential	35.00%	7
	Total	100%	20

Q14 - Please describe your process for planning your teaching activities around the learning outcomes you intend to deliver.

Please describe your process for planning your teaching activities around the learning outcomes you intend to deliver.

We develop pre-work, practical and post-work activities. Much of what I do is derived from 3d anatomy software

Interpret learning outcome; Consider spread of learning resources that might be appropriate; Decide which activities will help meet outcomes; develop specific learning activities aimed at meeting outcomes.

I teach them 'how', especially when it is an element of an assessment task. I integrate several learning styles (visual, auditory, tactile and kinaesthetic) and provide demonstrations as well as supervised student directed learning.

I create my teaching activities around the LOs to make sure they are met

I depend on my experience, the time available and decide on how best to approach the group

The learning outcomes derive ultimately from the PRSBs but the detail they is too sparse to allow a course design. Therefore, I rely upon experience.

-

I have more control over teaching activities in my lectures than I do in the lab sessions that accompany these. In lectures, I use the LOs to identify the most important points and make sure I focus on these. An hour lecture trying to cover everything usually results in students switching off. However, an hour lecture that focuses on 2-4 key aspects that can be integrated will improve retention and forms a solid foundation which the students can use to build on in their self directed learning to ensure they learn the anatomy surrounding the lecture topic.

I think about whether it's best delivered in lecture or dissection lab or repeated in both. I think about which is best to deliver in a tutorial such as living anatomy. I think about the resources I need to deliver that content.

The learning outcomes for the clinical anatomy courses drive the preparation of the learning activity. I will consider what we are asking the students to do: identify, describe, interpret, explain, reason, compare. Then from there construct the task to best draw guide the student in completing that outcome. Describe - for example can be done simply through simple questions, but can also be done independently or in groups. Outcomes where students are asked to explain or reason, the task will be constructed with a higher level of difficulty but within a small group or pair. This facilitates more social learning and problem solving.

Learning outcomes are divided into practicals and lectures. These are then written around the LOs

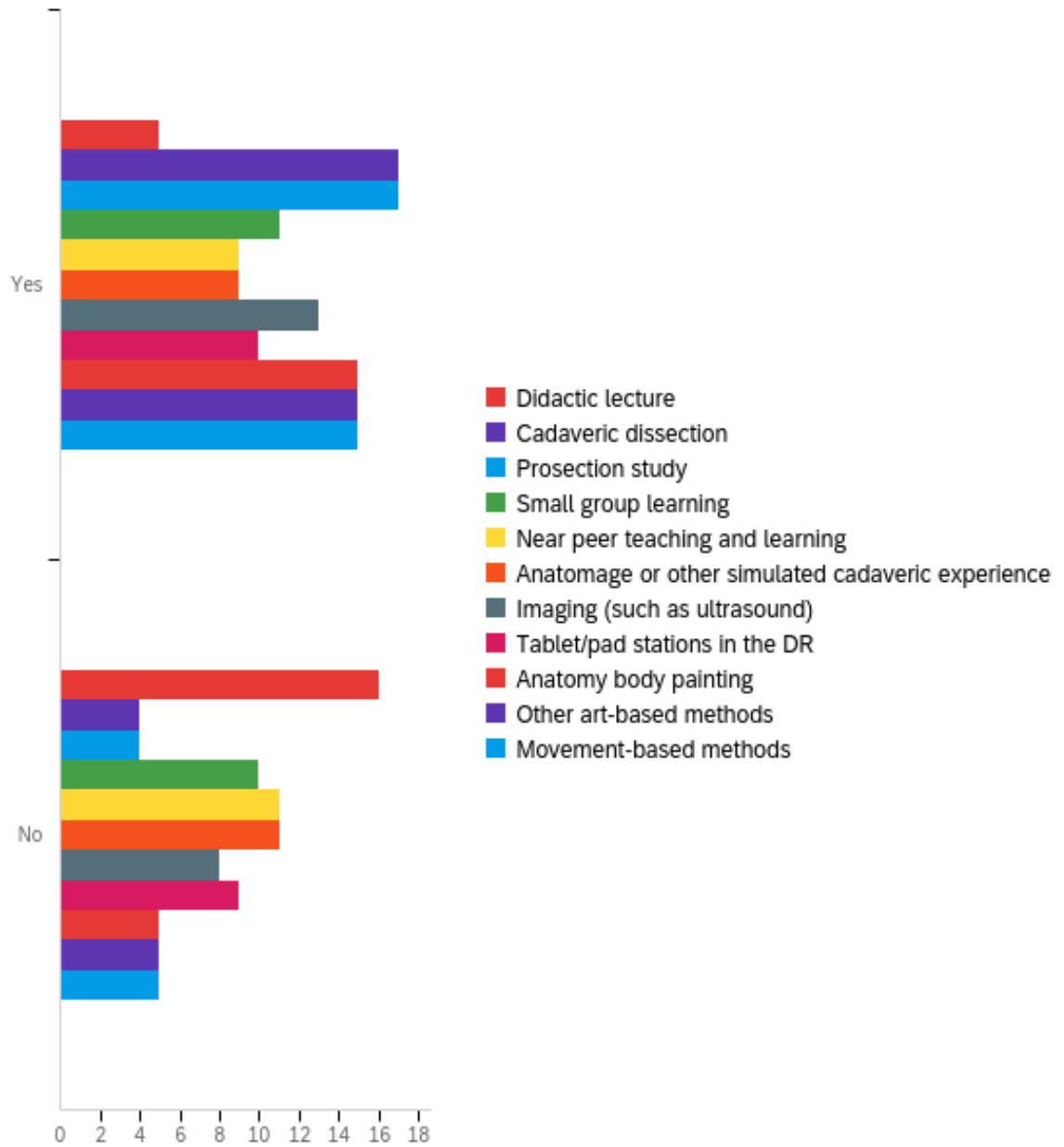
The MBBS programme wants only material directly related to a learning outcome taught, so one has to focus on these. The LOs direct all of our teaching on the MBBS programme.

I identify where this session sits in the curriculum, i.e. what teaching they have had prior to it and what they will have subsequently, so I can refer backwards and forwards along the spiral curriculum. I then identify teaching from other disciplines that is happening in that case unit so I can link the anatomy teaching to other sessions, helping students integrate their learning. Based on these factors, I identify whether small or larger group teaching would be more effective (i.e. surface anatomy and virtual dissections need smaller groups for students to make the most of their learning), and how much time we would need to teach this. We're currently undergoing curriculum redevelopment, and so have more flexibility with the choice of session duration and class size. When choosing activities, I identify the key functional anatomy principles we need to get across, and then choose the teaching resources that would best suit that activity. I consult the literature, discuss with colleagues and look online to see if others have suggested an effective approach, and then build the session from there.

The teaching activities are pre-set. We do what has always been done: Lectures and Practical Labs. Its instructional an facilitative. Students 'demonstrate' their learning at the end of the year through assessment. For postgraduates its much more interpersonal. You can adapt we can adapt approach to the students because we know them. Undergraduates are disadvantaged by their class sizes. We just do not know them - there are too many.

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Q15 We define "kinaesthetic" learning as tactile, when learners carry out activities as part of th... - I consider these as kinaesthetic in nature

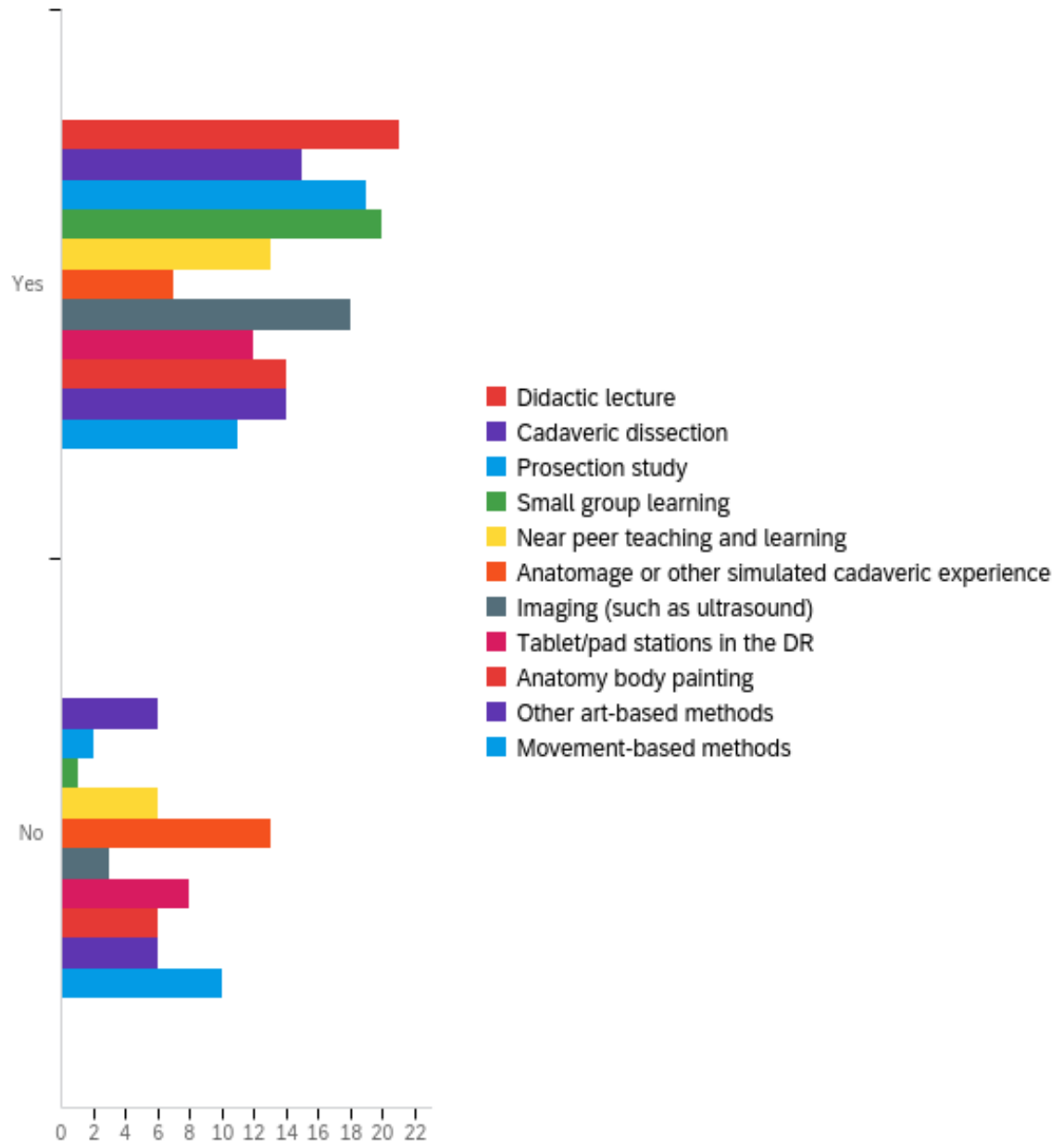


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Didactic lecture	1.00	2.00	1.76	0.43	0.18	21

2	Cadaveric dissection	1.00	2.00	1.19	0.39	0.15	21
3	Prosection study	1.00	2.00	1.19	0.39	0.15	21
4	Small group learning	1.00	2.00	1.48	0.50	0.25	21
5	Near peer teaching and learning	1.00	2.00	1.55	0.50	0.25	20
6	Anatomage or other simulated cadaveric experience	1.00	2.00	1.55	0.50	0.25	20
7	Imaging (such as ultrasound)	1.00	2.00	1.38	0.49	0.24	21
8	Tablet/pad stations in the DR	1.00	2.00	1.47	0.50	0.25	19
9	Anatomy body painting	1.00	2.00	1.25	0.43	0.19	20
10	Other art-based methods	1.00	2.00	1.25	0.43	0.19	20
11	Movement-based methods	1.00	2.00	1.25	0.43	0.19	20

#	Question	Yes		No		Total
1	Didactic lecture	23.81%	5	76.19%	16	21
2	Cadaveric dissection	80.95%	17	19.05%	4	21
3	Prosection study	80.95%	17	19.05%	4	21
4	Small group learning	52.38%	11	47.62%	10	21
5	Near peer teaching and learning	45.00%	9	55.00%	11	20
6	Anatomage or other simulated cadaveric experience	45.00%	9	55.00%	11	20
7	Imaging (such as ultrasound)	61.90%	13	38.10%	8	21
8	Tablet/pad stations in the DR	52.63%	10	47.37%	9	19
9	Anatomy body painting	75.00%	15	25.00%	5	20
10	Other art-based methods	75.00%	15	25.00%	5	20
11	Movement-based methods	75.00%	15	25.00%	5	20

Q16 We define "kinaesthetic" learning as tactile, when learners carry out activities as part of th... - I use these methods in my teaching practice

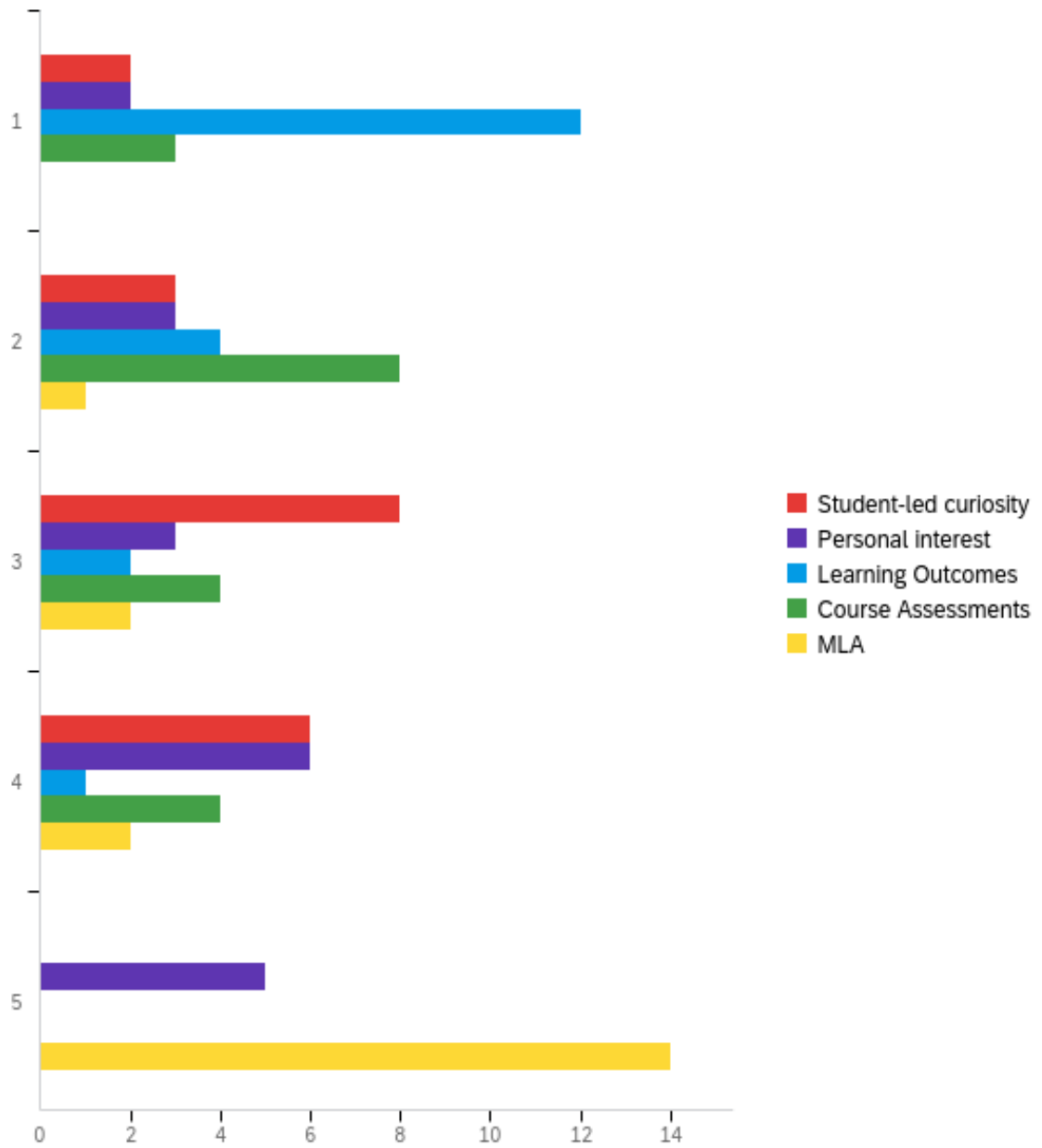


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Didactic lecture	1.00	1.00	1.00	0.00	0.00	21

2	Cadaveric dissection	1.00	2.00	1.29	0.45	0.20	21
3	Prosection study	1.00	2.00	1.10	0.29	0.09	21
4	Small group learning	1.00	2.00	1.05	0.21	0.05	21
5	Near peer teaching and learning	1.00	2.00	1.32	0.46	0.22	19
6	Anatomage or other simulated cadaveric experience	1.00	2.00	1.65	0.48	0.23	20
7	Imaging (such as ultrasound)	1.00	2.00	1.14	0.35	0.12	21
8	Tablet/pad stations in the DR	1.00	2.00	1.40	0.49	0.24	20
9	Anatomy body painting	1.00	2.00	1.30	0.46	0.21	20
10	Other art-based methods	1.00	2.00	1.30	0.46	0.21	20
11	Movement-based methods	1.00	2.00	1.48	0.50	0.25	21

#	Question	Yes		No		Total
1	Didactic lecture	100.00%	21	0.00%	0	21
2	Cadaveric dissection	71.43%	15	28.57%	6	21
3	Prosection study	90.48%	19	9.52%	2	21
4	Small group learning	95.24%	20	4.76%	1	21
5	Near peer teaching and learning	68.42%	13	31.58%	6	19
6	Anatomage or other simulated cadaveric experience	35.00%	7	65.00%	13	20
7	Imaging (such as ultrasound)	85.71%	18	14.29%	3	21
8	Tablet/pad stations in the DR	60.00%	12	40.00%	8	20
9	Anatomy body painting	70.00%	14	30.00%	6	20
10	Other art-based methods	70.00%	14	30.00%	6	20
11	Movement-based methods	52.38%	11	47.62%	10	21

Q17 - Please rank the following influences on the design of your teaching/learning activities (in order of importance):



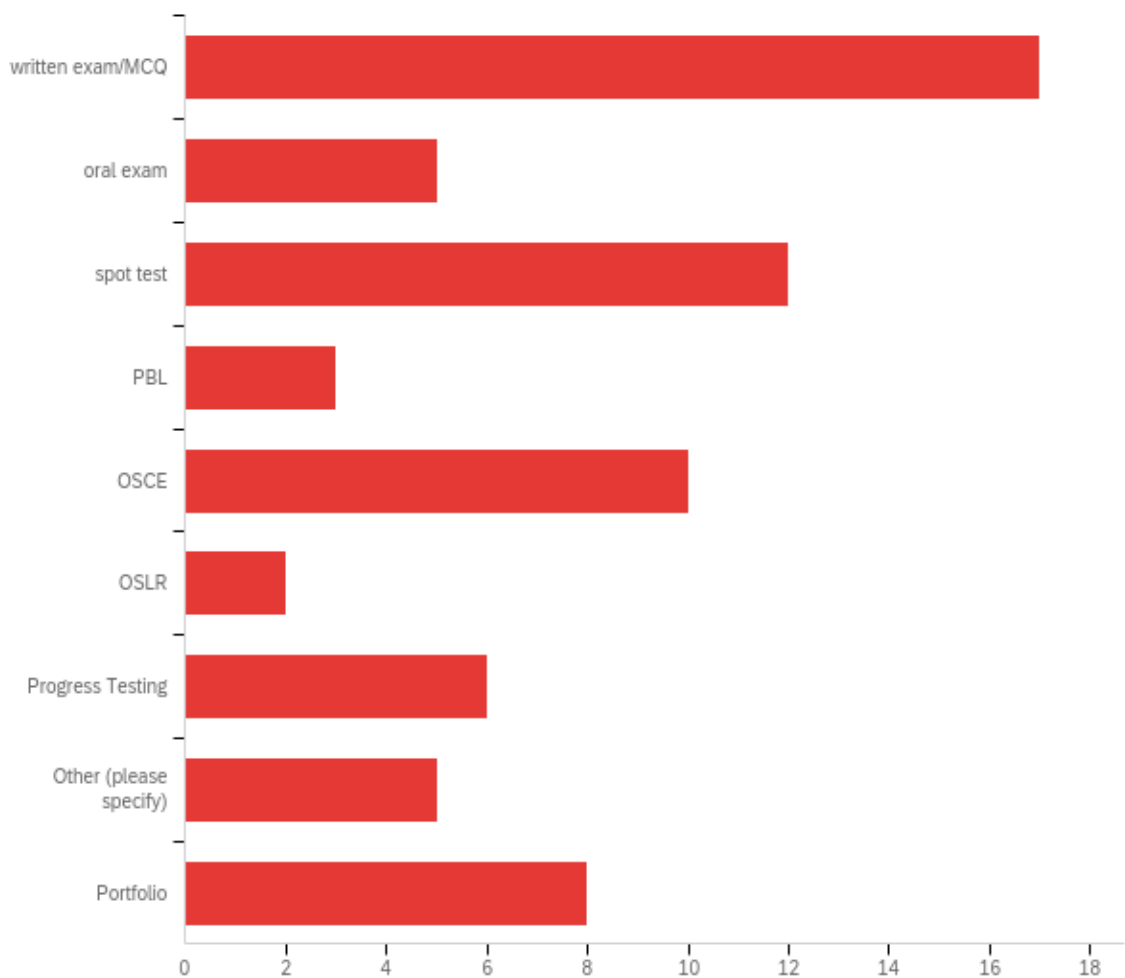
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Student-led curiosity	1.00	4.00	2.95	0.94	0.89	19

Appendix B

2	Personal interest	1.00	5.00	3.47	1.31	1.72	19
3	Learning Outcomes	1.00	4.00	1.58	0.88	0.77	19
4	Course Assessments	1.00	4.00	2.47	0.99	0.99	19
5	MLA	2.00	5.00	4.53	0.88	0.78	19

#	Question	1	2	3	4	5	Total					
1	Student-led curiosity	10.53 %	2	15.79 %	3	42.11 %	8	31.58 %	6	0.00 %	0	19
2	Personal interest	10.53 %	2	15.79 %	3	15.79 %	3	31.58 %	6	26.32 %	5	19
3	Learning Outcomes	63.16 %	1	21.05 %	4	10.53 %	2	5.26 %	1	0.00 %	0	19
4	Course Assessments	15.79 %	3	42.11 %	8	21.05 %	4	21.05 %	4	0.00 %	0	19
5	MLA	0.00 %	0	5.26 %	1	10.53 %	2	10.53 %	2	73.68 %	1	19

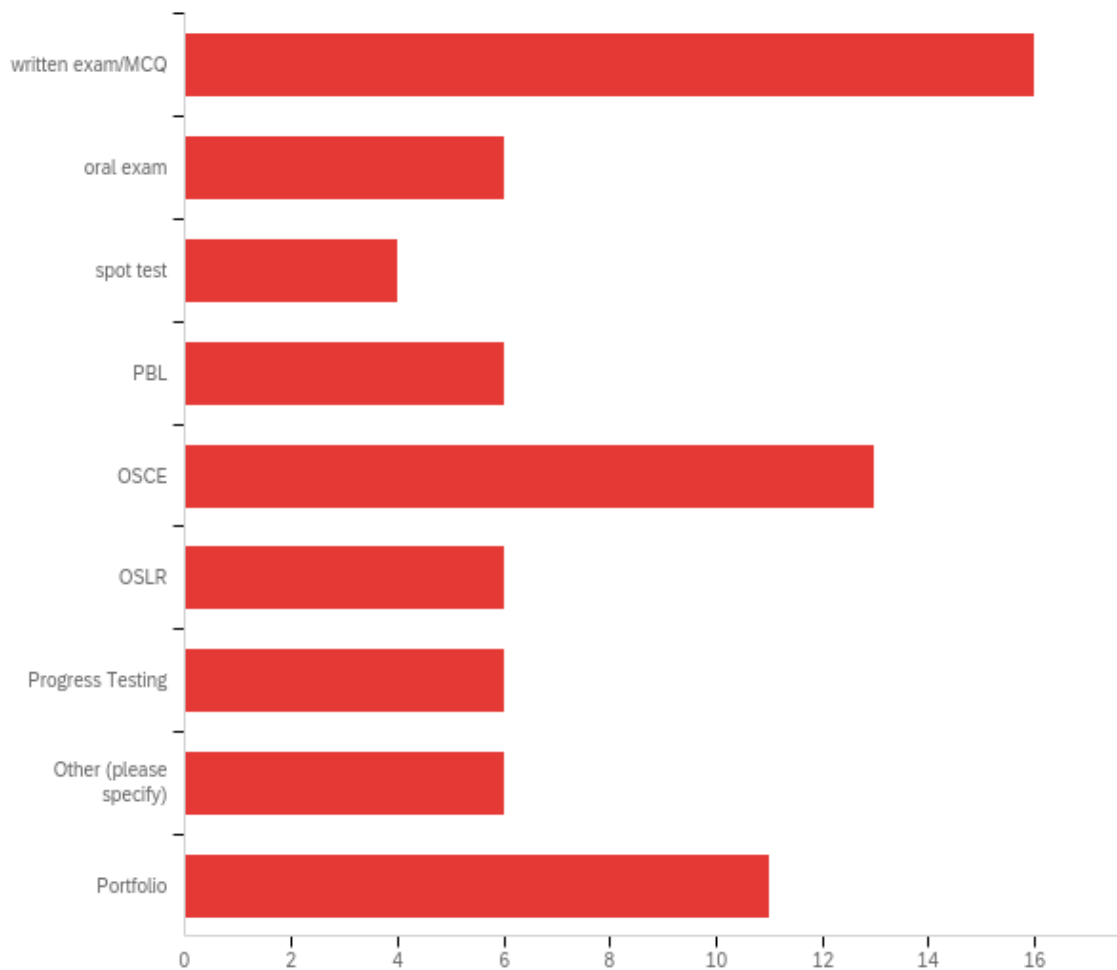
Q18 - What are the current methods of assessment in years one through two of your programme? (tick all that apply):



#	Answer	%	Count
1	written exam/MCQ	25.00%	17
2	oral exam	7.35%	5
3	spot test	17.65%	12
4	PBL	4.41%	3
5	OSCE	14.71%	10
6	OSLR	2.94%	2

7	Progress Testing	8.82%	6
8	Other (please specify)	7.35%	5
9	Portfolio	11.76%	8
	Total	100%	68

Q19 - What are the current methods of assessment in years 3 to 5 (tick all that apply):



#	Answer	%	Count
1	written exam/MCQ	21.62%	16
2	oral exam	8.11%	6
3	spot test	5.41%	4
4	PBL	8.11%	6
5	OSCE	17.57%	13
6	OSLR	8.11%	6
7	Progress Testing	8.11%	6

8	Other (please specify)	8.11%	6
9	Portfolio	14.86%	11
	Total	100%	74

Q2_8_TEXT - Other (please specify)

Other (please specify) - Text

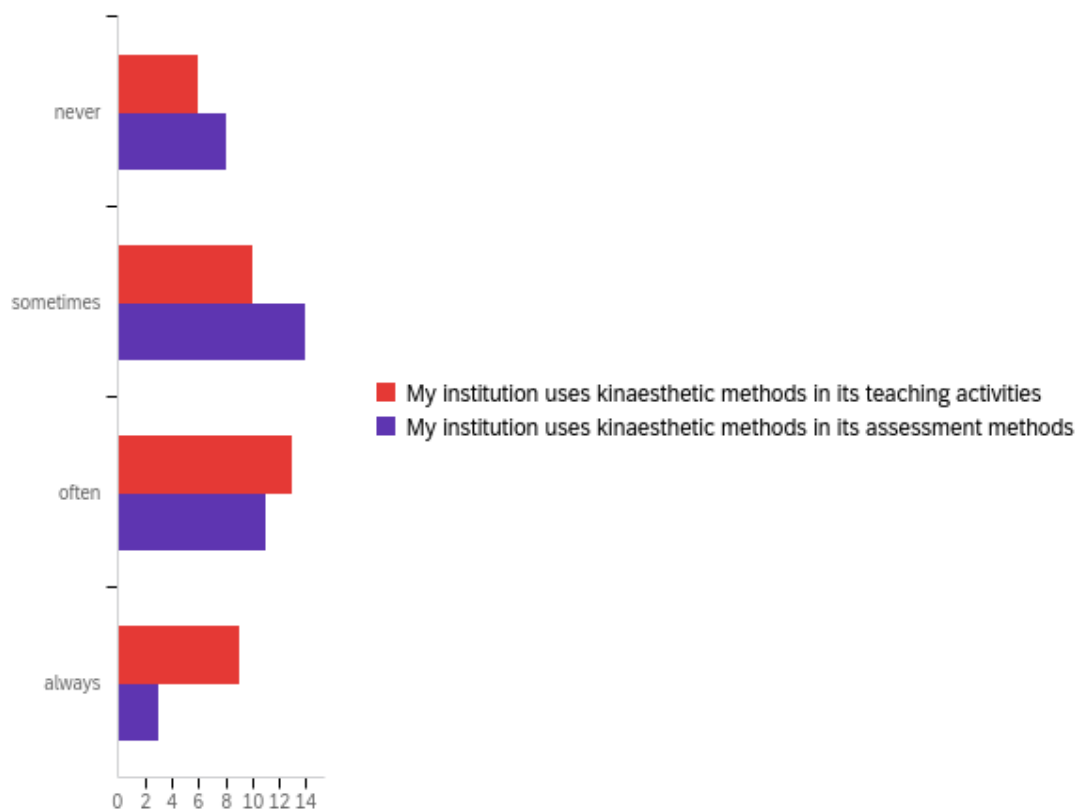
MOSLER

individual research project

Not 100% sure of other methods as not heavily involved in years 4 +5

Clinical competencies, professionalism judgments, student selected units
etc. Anatomy is assessed through progress tests

Q20 - Progress testing is an emerging assessment strategy for the integrated curriculum. Does your institution use "progress testing" as part of the assessment toolkit?

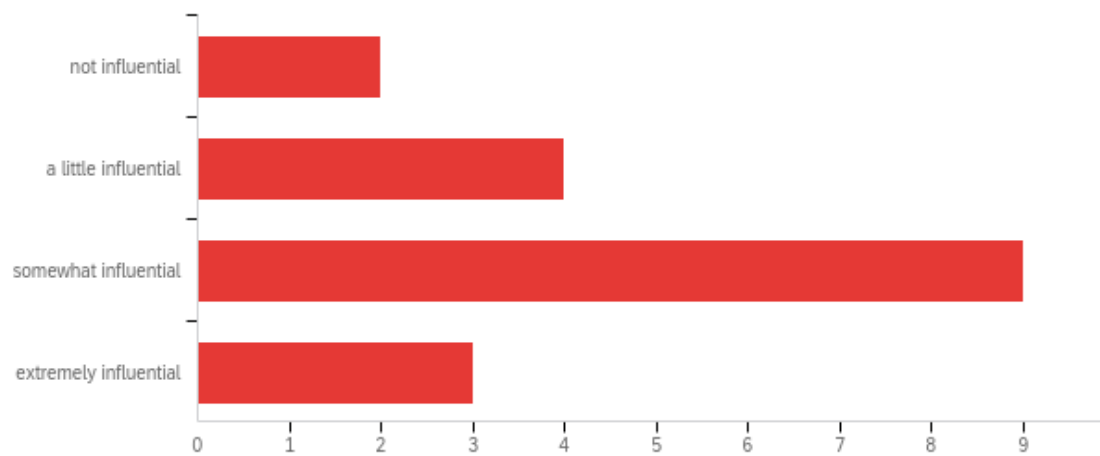


#	Question	never	sometime s	often	always	Total
1	My institution uses kinaesthetic methods in its teaching activities	15.79% 6	26.32% 10	34.21% 11	23.68% 9	38
2	My institution uses	22.22% 8	38.89% 15	30.56% 11	8.33% 3	36

kinaesthetic
methods
in its
assessment
methods

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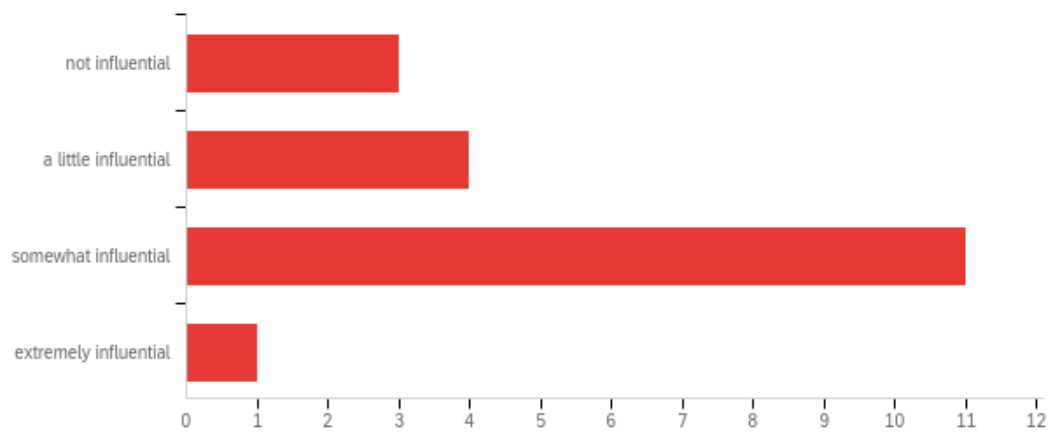
Q21 - How much do your institution's methods of assessment influence your teaching methods?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Assessment influences my teaching methods:	1.00	5.00	3.39	1.30	1.68	18

#	Answer	%	Count
1	not influential	11.11%	2
2	a little influential	22.22%	4
4	somewhat influential	50.00%	9
5	extremely influential	16.67%	3
	Total	100%	18

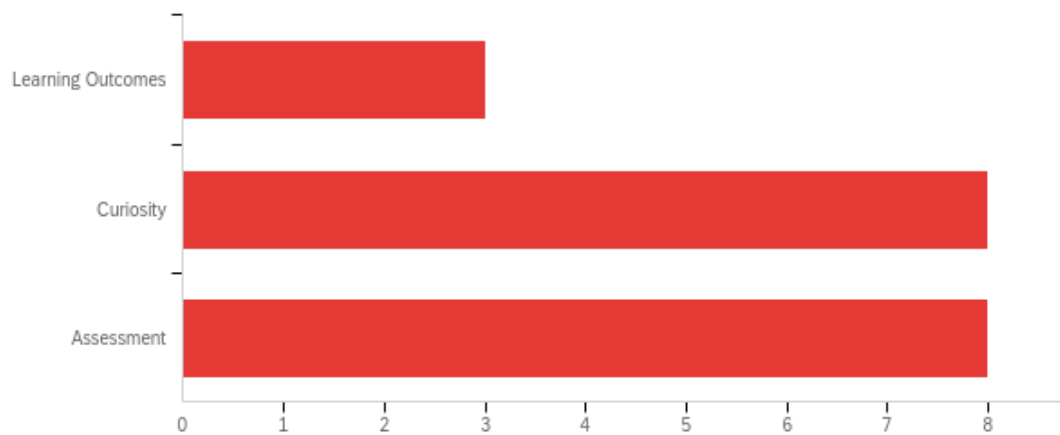
Q22 - How much does student-led curiosity influence your teaching methods?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Student-led curiosity influences my teaching methods:	1.00	4.00	2.53	0.82	0.67	19

#	Answer	%	Count
1	not influential	15.79%	3
2	a little influential	21.05%	4
3	somewhat influential	57.89%	11
4	extremely influential	5.26%	1
	Total	100%	19

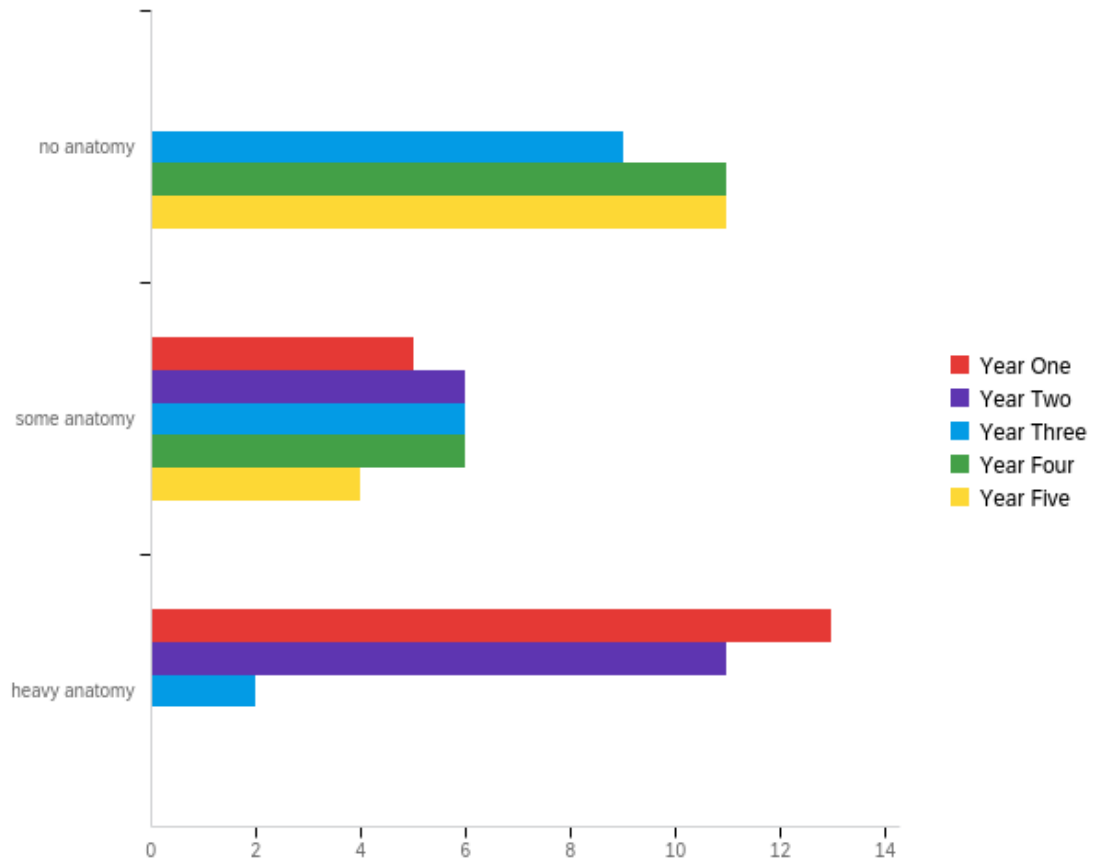
**Q23 - Fill in the blank with the term you think fits best: "
 _____ drives learning."**



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Fill in the blank with the term you think fits best: " _____ drives learning." ;	1.00	3.00	2.26	0.71	0.51	19

#	Answer	%	Count
1	Learning Outcomes	15.79%	3
2	Curiosity	42.11%	8
3	Assessment	42.11%	8
	Total	100%	19

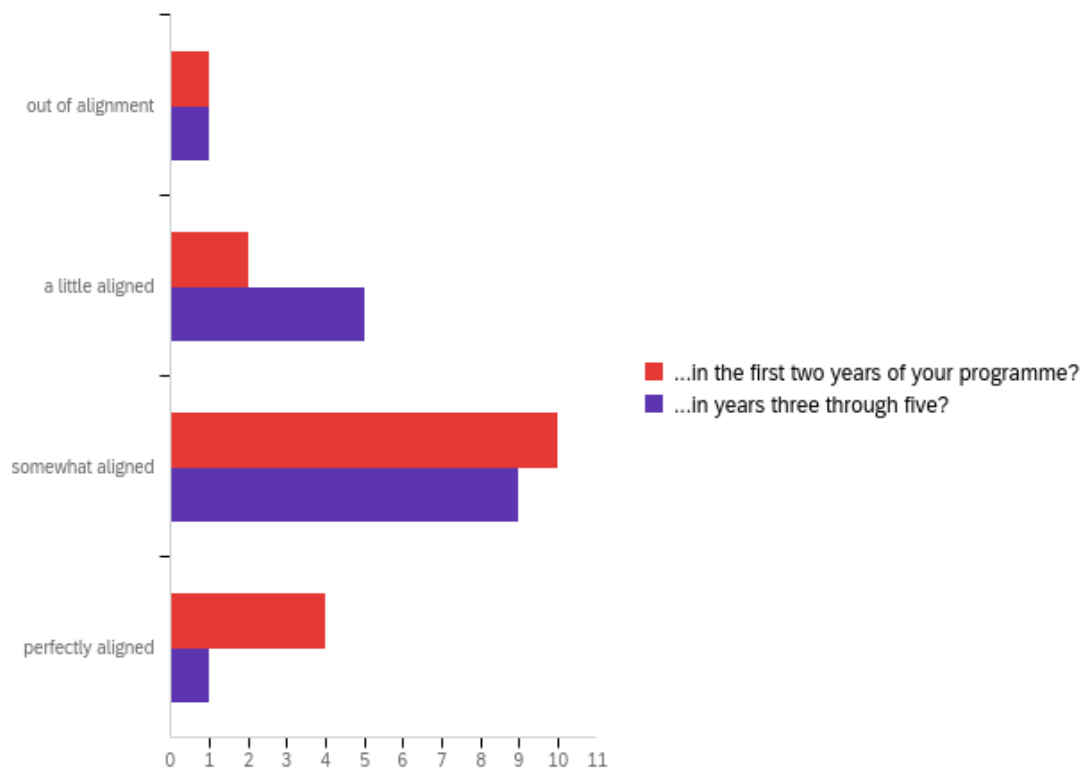
Q24 - Looking at each year of the MBBS course, please tell us how much anatomy is taught in each year (to the best of your knowledge):



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Year One	2.00	3.00	2.72	0.45	0.20	18
2	Year Two	2.00	3.00	2.65	0.48	0.23	17
3	Year Three	1.00	3.00	1.59	0.69	0.48	17
4	Year Four	1.00	2.00	1.35	0.48	0.23	17
5	Year Five	1.00	2.00	1.27	0.44	0.20	15

#	Question	no anatomy		some anatomy		heavy anatomy		Total
1	Year One	0.00%	0	27.78%	5	72.22%	13	18
2	Year Two	0.00%	0	35.29%	6	64.71%	11	17
3	Year Three	52.94%	9	35.29%	6	11.76%	2	17
4	Year Four	64.71%	11	35.29%	6	0.00%	0	17
5	Year Five	73.33%	11	26.67%	4	0.00%	0	15

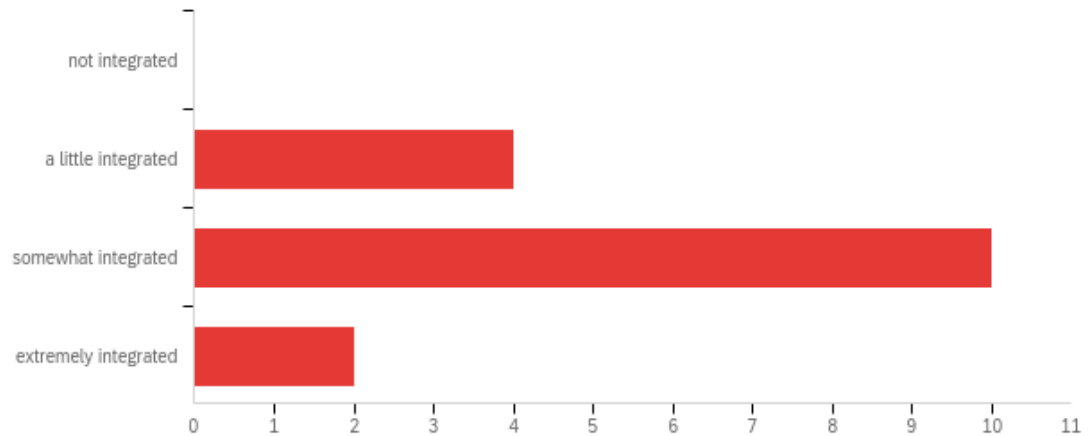
Q25 - How would you rate the alignment of learning outcomes, teaching methods, and assessment...



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	...in the first two years of your programme?	1.00	4.00	3.00	0.77	0.59	17
2	...in years three through five?	1.00	4.00	2.63	0.70	0.48	16

#	Question	out of alignment		a little aligned		somewhat aligned		perfectly aligned		Total
1	...in the first two years of your programme?	5.88%	1	11.76%	2	58.82%	10	23.53%	4	17
2	...in years three through five?	6.25%	1	31.25%	5	56.25%	9	6.25%	1	16

Q26 - In your opinion, how well are the first two years integrated with the so-called "clinical years" on the MBBS at your institution:

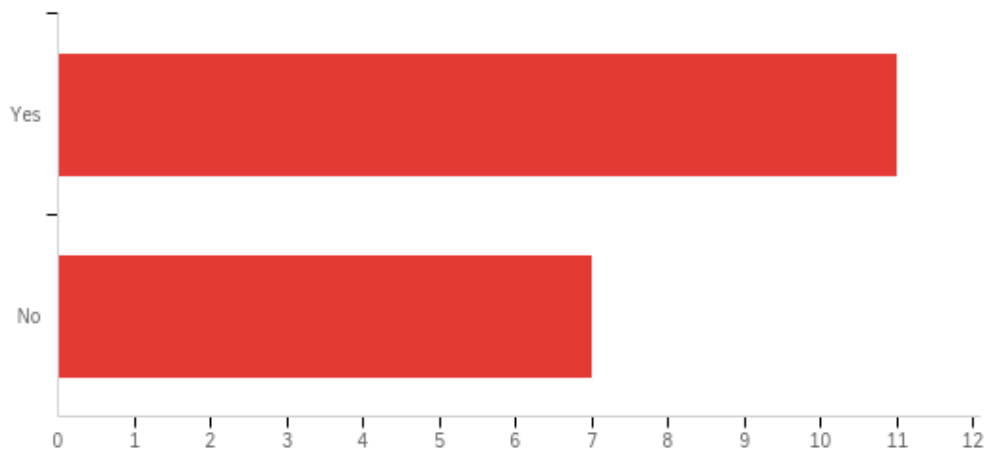


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	First two years are integrated with the "clinical years"	2.00	4.00	2.88	0.60	0.36	16

#	Answer	%	Count
1	not integrated	0.00%	0
2	a little integrated	25.00%	4
3	somewhat integrated	62.50%	10

4	extremely integrated	12.50%	2
Total		100%	16

Q27 - Are you aware of the GMC's plans to develop a new Medical Licensing Assessment?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you aware of the GMC's plans to develop a new Medical Licensing Assessment?	1.00	2.00	1.39	0.49	0.24	18

#	Answer	%	Count
1	Yes	61.11%	11
2	No	38.89%	7
	Total	100%	18

Q28 - If your answer to the above was yes, please tell us a bit about how you feel the MLA could impact the alignment of your curriculum:

If your answer to the above was yes, please tell us a bit about how you feel the MLA could impact the alignment of your curriculum:

no change anticipated

I do not believe this will have a significant impact as our students in their first year get to meet patients - on wards, in out patient clinics, in General Practice and in their homes.

N/A

NA

Due to the additional examination requirement of graduates, they are going to want to be prepared for this hurdle of their career. Depending on the format of the examination, teaching will continue to be on an applied clinically relevant basis, as it is currently. However, this has been a big point of discussion in the school as we are currently undergoing curriculum review. To which I am not a major part of, so couldn't comment further.

Finals will be pushed back to year 5, apart from the alignment of the curriculum is necessary without MLA

Depending on the important the GMC gives to different subject specialties, for instance to anatomy, this will feed down into the exams at years 1 and 2. Currently, anatomy is assessed very little in the exams, and not at all in the later stages.

I feel we already meet all the syllabus requirements, and so don't feel it necessary to change the LOs we teach. Our teaching approach is all about application of learning, and depending on how the MLA is structured, it may influence how we highlight to our students how this information is relevant to the MLA

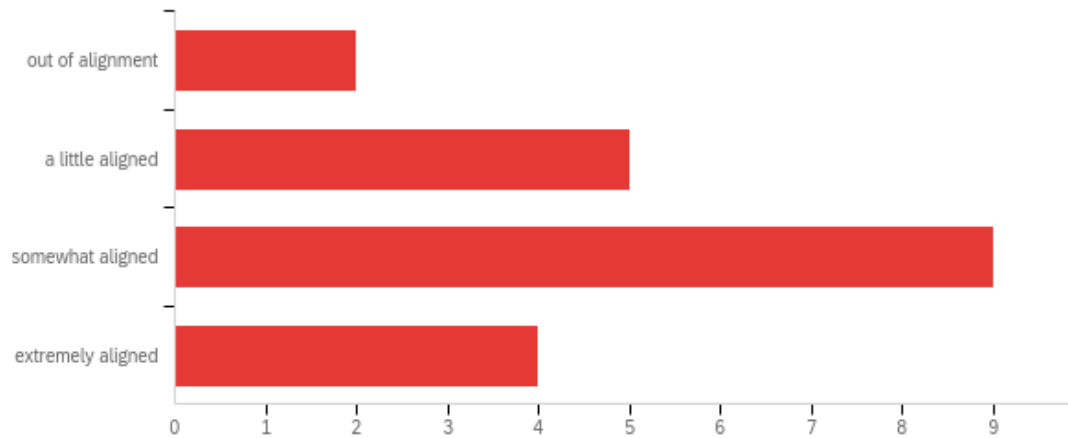
I am strongly opposed to the MLA. It strips medical schools of their autonomy. This will have an impact on many institutions academic freedom. It forces us into a position were we teach to assessment. We have not even begun to fathom the consequences of it on the curriculum. They remain to be seen. Presently, MLA does not account for localised differences - which often exist to serve the local population.

na

na

asdfj;lsdkfaj;lwkf

Q29 - Finally, how would you rate the alignment of the anatomy curriculum with the wider medical curriculum in the MBBS programme at your institution?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Rate your view of the alignment of the anatomy curriculum with the wider medical curriculum in the MBBS programme:	1.00	4.00	2.75	0.89	0.79	20

#	Answer	%	Count
---	--------	---	-------

1	out of alignment	10.00%	2
2	a little aligned	25.00%	5
3	somewhat aligned	45.00%	9
4	extremely aligned	20.00%	4
	Total	100%	20

Chapter 15: Appendix C: Link to Google Sheet used for coding the qualitative evidence synthesis presented in Chapter 4

Figure 44: See link for coded sheets, click here:

https://docs.google.com/spreadsheets/d/1rh54XIidhUul2RKODLeAJoDF6RDRxstBHCT7VGR_IY/edit?usp=sharing

The image shows a screenshot of a Google Sheet spreadsheet. The spreadsheet has a header row with a rainbow background, containing columns for 'Author', 'Year', 'Title', 'Abstract', 'Methodological approach', 'Analysis', 'Research objectives', 'Results', and 'Conclusions'. Below the header, there are numerous rows of data, each representing a study. The rows are color-coded in various colors (purple, yellow, orange, red, green, blue, pink). The text in the cells is dense and appears to be a synthesis of qualitative evidence, with many cells containing long paragraphs of text. The spreadsheet is viewed in a browser window, with the Google Docs interface visible at the top and bottom.

Chapter 16: Appendix D: Summary Table of Group Experiential Themes (GETs) from Chapter 5

Group Experiential Theme 1: Awareness and empowerment as a stakeholder in the medical curriculum	3
1a. Factoring connectedness to the curriculum as a proportionate source of empowerment	3
1b. Willingness to accept aspects of their role as unknown	4
1c. Grappling with limitations on involvement and decision-making in the curriculum	5
Group Experiential Theme 2: Variations in discussing curricular integration	6
Group Experiential Theme 3: Managing expectations to perform within paradoxical situations	6
3a: Observing contradictions between what students are using to learn vs what is used to teach	6
3b. Frustration arising from lack of congruence amidst aspects of the curriculum	7
3c. Consciousness that short and long term outcome measurements may be at odds	8
Group Experiential Theme 4: Emergence of innovative teaching within curricular constraints	9

Chapter 17: Appendix E: Selected Tables of Personal Experiential Themes (PETs) from Chapter 5

EXHIBIT 1. Table of Personal Experiential Themes From Analysis of A: Ruth (P1)

	Page/line	Quotes
Theme 1. Reflections on the journey to becoming an anatomy educator		
Own anatomy journey defined by dissection & SDL	1.5 - 1.8	<i>I did dissection... I was definitely probably quite nerdy...</i>
Acknowledgement of age in relation to peers on the master's degree	1.10	<i>I was a little bit older doing a master's....</i>
Sense of pride based on one's depth of anatomy experience	1.20	<i>So before I did the master's, I did have a background in it.</i>

Theme 2. Becoming aware of what the role demands

Subtheme 2.1 Understanding the curriculum and her place in it

Accepting that the curriculum is divided into 'preclinical' and 'clinical' years	3.56	<i>...they're called preclinical years...</i>
Sense of 'only' teaching in the preclinical years	3.71	<i>Well ...em... I only teach first and second years...</i>
Dealing with an inconsistent array of teaching hours; uncertainty around how much teaching	2.39	<i>...it's probably once or twice a week</i>
Developing consistency between what is delivered and assessed	10.24 3	<i>They should have that information.</i>

Subtheme 2.2 Developing confidence on the job

Lack of confidence about the relevance of own views in terms of the big picture curriculum	4.88	<i>I do question it sometimes... but... Yeah. There you go, that's just my...</i>
Enthusiasm and confidence in the teaching methods	7.156	<i>...but definitely, the ultrasound comes into the living anatomy session [goes on to enthusiastically describe the living anatomy session for 20 lines]</i>
Adaptation of teaching approach based on the individual learners	6.141	<i>A lot of how I will teach, depending on how the student is...</i>
Aiming to get students to be more self-directed	6.131	<i>I get the students to really work in groups and be as self-directed as possible</i>

Understanding that individuals learn at different rates

8.186 *I think it takes them a few sessions to actually get a good understanding...*

Subtheme 2.3 Balancing the particular constraints of her role

Overcoming obstacles to learn new skills (ultrasound in anatomy education)

16.40
5 *We're anatomists...So the only way to get proficient in it is to practise it yourself.*

Compelled by the effectiveness of ultrasound for teaching spatial awareness

8.194 *...they're going deeper and deeper and deeper through the body.*

Struck by the impact of non-experts learning on the job (ultrasound in clinical practice)

10.22
3 *It's not the sonographers... it's the nurse practitioners who are probably the most qualified and experienced at using it [ultrasound]*

Accepting that students are strategic in their learning (to prioritise what will be assessed)

11.25
9 *...that will probably last for about ten minutes and then the students will start to ask... "So what do we need to know for the exam"?*

Subtheme 2.4 Dynamic exploration of Teaching and Learning Activities

Use of Socratic questioning to facilitate the development of student confidence

6.143 *I'll ask as many questions as I possibly can...*

Utilising palpation skills but not body painting

7.155 *I don't do body painting, to be honest.*

Recognising the potential of teaching methods that engage learners through clinical relevance	7.164	<i>...when they're drawing on the boundary of the lung...</i>
Impact of bringing clinical relevance into anatomy teaching improves student engagement	9.200	<i>...the moment that you say ultrasound...</i>
Concern about students' level of understanding within the engagement	9.209	<i>I think sometimes it may be a step beyond...</i>
Valuing the importance of curiosity and spontaneous learning 'for learning's sake'	11.26 6	<i>I think they wouldn't be not interested.</i>

Subtheme 2.5 Dealing with incongruence

Disconnect between methods used by educators to teach and those used by students to learn	5.118	<i>I think when they're studying themselves at home they probably...</i>
Acknowledging some level of mismatch between how anatomy is taught and how it is assessed	12.28 9	<i>That's the only thing I would honestly say... I think is probably not very well aligned</i>

Theme 3. Framing the emergent tensions arising amongst conflicting demands

Subtheme 3.1 Sense of responsibility for student experience

Balancing the difficulty level of assessment questions	10.23 2	<i>...kind of maybe balance out of difficulty level of it...</i>
--	------------	--

Conflicted about fairness in terms of timing of exposure to content and assessing that content

18.44
2

I think that would be unfair if we're not actually teaching it in those clinical years.

Reconciling the challenging aspects of clinically relevant anatomy with the needs of preclinical students

10.24
0

So we do give students... optimal images.

Subtheme 3.2 Operating within the jungle of institutional approval

Feeling supported by colleagues in certain aspects

16.37
7

...most of us are on board with ultrasound.

Feeling at odds with colleagues

16.37
3 +
16.40
6

...one of my colleagues would prefer to "leave it to the experts"

Subtheme 3.3 Lack of awareness/access to clinical years

Uncertainty about what medical students are doing in the clinical years in terms of learning outcomes and assessment

5.97

So all I know is...

Uncertainty about what methods students actually use in their personal study

5.112

And I think they probably use the Visible Body app...

Believing that the best way to assess anatomy in the clinical years would be via the OSCE	17.43 0	<i>...but maybe into their OSCEs</i>
---	------------	--------------------------------------

Subtheme 3.4 Reconciling lack of agency with their urge to align student experience

Normalisation of the disconnect between preclinical and clinical years' content	13.31 4	<i>And we're trying to align it up better and that's kind of an ongoing process I think.</i>
---	------------	--

Dissociating from what happens in the clinical years	13.31 8	<i>Maybe... I don't know if I have strong personal feelings on it myself.</i>
--	------------	---

Concerned with delivering high standards of teaching in the face of rising student numbers	17.42 4	<i>...we're getting more students here next year and I think it's going to be even more difficult.</i>
--	------------	--

Processing feedback from former students without the agency to take action	13.32 0	<i>Just feedback I've heard from older years.</i>
--	------------	---

Disinterest in whether or not students are assessed on anatomy in the clinical years	18.45 1	<i>Yeah, I mean I don't know how much I would kind of push that, but it might be useful.</i>
--	------------	--

EXHIBIT 2. Table of Personal Experiential Themes From Analysis of B: Helen

	Page/line	Quotes
Theme 1. Cadaveric study informing education and teaching practice		
Own anatomy journey defined by cadaveric study with lectures	1.9	<i>...using cadavers and lecture-based</i>
Personal bias toward cadaveric study	6.140	<i>I'm a bit biased toward being in the cadaver.</i>
Confidence in the cadaver as a teaching and learning method	5.118	<i>I know that they, they do like the cadavers...</i>
Theme 2. Coming to terms with the curriculum		
Subtheme 2.1 Understanding temporal constraints		
Dealing with inconsistent teaching time	1.21	<i>So, how often...em, it varies...</i>
Problem-based learning (PBL) reduces lecturing time	1.22	<i>It's more problem-based learning a lot of the time. So, I don't have much lecture time.</i>
Recognising that time constraints can force adaptations of	6.144	<i>...like if you're pushed for time.</i>

teaching methods

Subtheme 2.2 Performing within temporal constraints

Grappling with the expectation to teach despite not knowing exactly what the students will face on the assesment	9.200	<i>I think maybe in first year, they might not actually get a full exam question...</i>
Seeing the constraints of PBL as fortuitous and 'novel'	4.81	<i>...they have a specific tutor for the full session.</i>
Accepting the distinction between preclinical and clinical years despite it being called a 'spiral' curriculum	3.47	<i>...it's a spiral curriculum.</i>

Theme 3. Grappling with impacts of the confidence continuum

Subtheme 3.1 Experiencing the growth of confidence

Cautious exploration of agency as an educator to explore own style	4.93	<i>...but you can put your own spin on it...</i>
Believing that students find drawing to be useful as a tool for developing higher-level interpretation skills	6.124	<i>...they find it very useful...</i>
Confidence and enthusiasm in own methods	5.110	<i>But for me, it's mostly drawing or using a template...</i>
Balancing cadaveric study with higher-level interpretation via	7.148	<i>I find that the best way. So... It's kind of a balance...</i>

drawing and description

Utilising palpation skills but not anatomy body painting

5.102 *I personally have never used the body paint...*

Subtheme 3.2 Experiencing uncertainty and lack of confidence

A sense of 'only' teaching anatomy in the preclinical years

3.61 *I have just experience with the first, kind of, couple of years.*

Lack of confidence due to being in a new role

2.37 *But I've been in my role just since October.*

8.188 *From what I've seen so far [chuckle].*

Uncertainty about what is assessed in the clinical years

10.22
2 *I'm not a hundred per cent sure what exactly is covered*

9.207 *I haven't seen the exams in the clinical years, so sorry I couldn't comment properly on that...*

Confusion about where else students might be going to learn anatomy in the clinical years

10.22
5 *So I'm not sure.*

Subtheme 3.3 Behaviour arising from lack of confidence

Eagerness to please

9.212 *Oooft. I mean I could try and find out for you if you*

Eagerness to demonstrate that anatomy is indeed pulled through to the clinical years despite not actually knowing the extent to which this is true or not

Trepidation about the relevance of own input

Anxiety about not answering interview questions properly

want?

8.177 *Yes. So in certain questions, they would be expected to...*

10.22 *...because I'm not sure, I don't know if I could say that they need more or less...*

9.218 *Could you just repeat the question again, I think I got it but just want to make sure I am answering properly.*

EXHIBIT 3. Table of Personal Experiential Themes From Analysis of C: Paul

	Page/line	Quotes
Theme 1. Self-awareness as wearing more than one hat in medical education		
Subtheme 1.1. Identifying as an educator teaching applied anatomy in a clinical setting		
Learned anatomy at medical school	1.4	<i>We had a combination of lectures and dissection.</i>
Preferring teaching in a small group clinical context	6.142	<i>...we are generally face to face, small group teaching in the context of a clinical scenario</i>
Believing that learning is more effective when it is applied to real human beings	10.23 8	<i>...in a way with a real human being and learn it in that way</i>
Assumes that students in the clinical years should have some underlying knowledge before they see him on the ward	7.147 - 149	<i>I'm assuming in the context of my direct teaching anatomy... they have some underlying knowledge.</i>
Reflection on his own dissection experience as a medical student as	1.6	<i>...time in the dissecting room which was fairly</i>

chaotic

unsupervised and chaotic, tbh

18.44
8 *...just a social event, to be honest, in a dissecting room.*

18.44
2 -
443 *...in my experience of dissection, we went to the lab and flicked fat around.*

Subtheme 1.2. Identifying as an MBBS Programme Director (PD)

Demonstrating a high level of overall understanding of the curriculum

2.38 -
3.55 *So year one and year two...*

1.12 *I'm programme director for the MBBS.*

Demonstrating a detailed understanding of assessment protocol throughout curriculum

3.58 -
4.88 *So they have an ongoing formative process where they...*

Feeling the professional responsibility for delivering most current Learning Outcomes (LOs) as received from the GMC to the cohort of students

5.109 *I have oversight and responsibility for that.*

Disdain for current anatomy teaching methods taking place in own programme

1.63 *I don't think they're using a lot of technology, to be honest...*

	7.167 - 173	<i>The feedback I've seen... would suggest it's not a very dynamic, interactive approach.</i>
Acknowledging some gaps in awareness of what is going on in the programme	8.179	<i>You're asking me... but I don't know the answer.</i>
	7.167	<i>So I think that's largely what they're doing. I mean, to be honest with you, occasionally, I think they sit there and let the students just wander around and look at stuff...</i>

Theme 2. Distinguishing what is ideal from what is happening

Subtheme 2.1. Making sense of methods

Believing that TLAs haven't changed much over time and include: practicals, lectures and textbooks	6.126	<i>...it probably hasn't changed much,</i>
Using the term "textbook" to mean other resources students may choose to use outside of those formally recognised by the curriculum	6.130	<i>When I say "textbooks"...</i>
Acknowledging there is a component of student learning that is 'off-grid'	6.132	<i>I suspect some of that learning is online.</i>

Subtheme 2.2. E Particular enthusiasm for clinically relevant imaging such as ultrasound

Professional enthusiasm for active learning	11.25 5	<i>And again, that's all about active learning.</i>
Using ultrasound to deliver anatomy LOs alongside clinical skills	11.25 6	<i>...ultrasound, once you understand ultrasound, it really helps you to understand</i>
Using simulated endoscopy in conjunction with learning the associated anatomy	11.26 1	<i>...students doing simulated endoscopy while thinking about the anatomical structures...</i>
Working with simulated laparoscopic cholecystectomy	11.26 6	<i>...really helps you to understand the anatomy of the biliary tree and the porta hepatitis... liver...</i>

Subtheme 2.3. Associating own teaching practice with hands-on experiential methods

Does not consider cadaveric study a relevant approach for teaching and learning	11.24 7	<i>...not many people are doing hands-on dissection.</i>
Believing that looking at prosections is not the same as dissection - dissection is more aligned with kinesthetic, active learning	11.25 3	<i>...dissection rather than just seeing prosections.</i>

Believing that there is no reason why novel methods such as imaging and anatomy body painting won't help people	10.24 3	<i>All you're trying to do is help them to remember things</i>
Suggesting that novel methods don't have to be assessed to have value	11.27 0	<i>I don't think that has to be necessarily assessed.</i>

Subtheme 2.4. Dealing with frustration around the apparent failure of novel methods to become operationalised

Frustration in the awareness that novel methods are studied extensively yet not widely implemented	8.188	<i>I mean the irony here is we do a lot of body painting...</i>
	8.195	<i>But it isn't pulled through into the medical school.</i>
	9.241	<i>...what we need is large scale implementation</i>
Acknowledging the importance of broad staff buy-in	9.200	<i>And sometimes it is the buy-in of the personnel.</i>
	9.207	<i>...we have to get the buy-in of all individuals,</i>
Recognising the disparity between key camps of academic staff	9.208	<i>Our research-based evolutionary anatomists have a different perspective....</i>

A suspicion that innovations lauded in the pedagogical literature remain largely unimplemented across medical schools	9.218	<i>a lot of people are talking about it - but when you actually look at what happens in medical schools...</i>
Looking at how to bring novel methods into the assessment process	12.27 9	<i>...and then get them to come in and draw on somebody...</i>

Theme 3. Believing in the ideal reciprocity of anatomy and clinical practice

Subtheme 3.1. Seeing the curriculum as a nonlinear problem space

Acknowledging the continuum of learning	16.41 6	<i>And it's all taught as though it's not a continuum of learning.</i>
Acknowledging there is a connection between the way you learnt it (methods) and the way it is assessed	13.30 5	<i>...there's a connection between the way you learnt it and the way you assess it</i>
Considering how to assess LOs, not necessarily the methods		
Considering the potential for assessing LOs in multiple modalities (methods) to demonstrate deeper understanding	13.30 9	<i>...assess an outcome in multiple modalities.</i>
Interest in aligning TLAs (methods) with assessment methods for consistency	12.28 4	<i>I think it is important.</i>

Subtheme 3.2. Moving toward embedded reciprocity in the learning environment

Asking anatomy questions following a clinical procedure and vice versa	17.42 0	<i>...it would be great to have anatomists...</i>
Believing in the reciprocity of anatomy and clinical practice as ideal	16.40 8	<i>...there should be more clinical in the early part of the course and more basic science later on.</i>
Importance of demonstrating applied knowledge in various clinically relevant scenarios	13.31 4	<i>...ask them to demonstrate something in a different way to the way they learnt it...</i>
	13.31 9 - 14.32 0	<i>...allows them to apply that knowledge to a different setting.</i>
	14.32 6	<i>...That would show applied knowledge of understanding anatomy and its function.</i>
	18.45 3	<i>...So moving away from that [dissection] to living, dynamic anatomy in the context of clinical scenarios</i>
Potential for spotter exams to include methods such as body painting	15.35 2	<i>...a spotter exam might not just include...</i>
Desiring increased reciprocity of anatomy in clinical and vice versa	18.45 8	<i>...being able to actually deploy their anatomy skills in that clinical environment.</i>

Subtheme 3.3. Acknowledging practical barriers to reciprocity

Recognising the limitations of delivering extended anatomy tuition	18.46 4	<i>Sometimes it's pragmatism, isn't it?</i>
Reflecting on personal experience of driving long distances to deliver content as needed	19.47 7	<i>I used to drive three hours to go for a two-hour meeting, you know...</i>
Dissing colleagues for their reluctance to drive the distances to deliver content to distributed sites	19.47 6	<i>People whinge about driving an hour...</i>
Comparing own commitment to driving long distances with that of colleagues	19.48 1	<i>I think a thirty-mile journey is quite a breeze. People here get very upset about it.</i>
Perceiving a lack of willingness of anatomists to visit clinical sites	19.48 2	<i>...an unwillingness of basic scientists to go out to clinical sites is probably a barrier.</i>

Theme 4. Recognising the continuum of learning

Renewing interest in the basic sciences as a route for improving congruence between pre/clinical years	17.43 4	<i>What you gotta make life sciences is, eh, is exciting and interesting,</i>
Managing the disappointment about students being made to focus on illness management to the exclusion of maintaining perspective of underlying causes via the continued study of basic sciences	15.36 4	<i>I sometimes am disappointed by that...</i>

Believing that being a good doctor means having a grasp of the health cycle rooted in basic sciences

16.40 *if I do, then I'm a better doctor...*
3

Theme 5. Integrating assessment, authentically

Comparing the explicit delivery of basic sciences LOs with assessment throughout the curriculum

15.35 *...in the first part of the curriculum, there's a very explicit question about basic science*
8

Exploring TLAs and assessment methods - both currently aligned to prosected specimen - potential to link these to living models

14.34 *...no reason why you couldn't have living models.*
3

Believing the lack of assessment in a particular method devalues that method

14.33 *Yes, I think it does.*
9

Believing that pulling basic sciences questions into the OSCEs is a practical way to integrate anatomy into clinical years' assessments

20.49 *I think there should be OSCE stations that are dedicated to basic science,*
8

Acknowledging that achieving "authentic assessment" has many potential avenues

14.33 *There are many ways to do it.*
2

EXHIBIT 4. Table of Personal Experiential Themes From Analysis of D: Yvonne

	Page/line	Quotes
Theme 1. Negotiating identity within the curriculum		
Subtheme 1.1 Wearing different hats		
Demonstrating a high level of education	1.8	<i>...while I was doing my PhD at Oxford.</i>
Identifying as a teacher with a high volume teaching load	1.21	<i>All the time! [laughter]</i>
Teaching primarily undergraduates over a range of courses including BMBS	1.15	<i>I teach primarily undergraduate medicine</i>
	2.28	<i>BMBS...diagnostic radiography... Physicians Assistant.</i>
	14.33 9	<i>I'm not just the programme lead... I was the coordinator for...</i>
Embracing unique aspects of home curriculum administratively	2.40	<i>...we have a very atypical structure...</i>

	11.26	<i>our program is problem-based learning.</i>
	3	
Teaching from the lifecycle perspective without individual systemic modules	2.41	<i>...they learn the life cycle.</i>

Subtheme 1.2 Divorced from didactic style

Feeling pride in the myriad kinesthetic teaching and learning resources available to students in support of the problem based learning (PBL) approach	6.134	<i>Anatomy isn't something you can learn just by reading a book.</i>
	6.129	<i>We do a good brachial plexus.</i>
	6.127	<i>...it is kind of getting them to draw it out or model it with...</i>
	6.137	<i>...we will try and create a myriad of resources...</i>
	7.148	<i>... helps them glue it all together in their brains.</i>
Using progress testing (PT) as the primary assessment modality	7.157	<i>...anatomy assessment is done through progress tests</i>

Teaching anatomy without the use of cadavers	3.64	<i>We don't use cadaveric anatomy here, we use the Anatomage system...</i>
Teaching anatomy using the Anatomage system in a student-centred learning environment (self-directed learning, SDL)	4.80	<i>The Anatomage table is available for the students to book for their own self-directed learning...</i>
Teaching anatomy using online resources	4.65	<i>...and online resources like the Complete Anatomy App</i>

Subtheme 1.3 Convinced of the efficacy of the integrated curriculum as such

Equating PT with an ethos of integration	7.162	<i>But it's about what the ethos of the program is...</i>
	7.166	<i>...to get students to apply the medical knowledge... from all different disciplines</i>
	9.211	<i>...this is the kind of ethos that works well for us.</i>
Enjoying the support and enthusiasm of colleagues	15.360	<i>I think we've got that in buckets.</i>
Feeling gratification that her programme is shown to be successful according to clinical trainers	9.212	<i>...our programme produces the best-prepared students in the country, according to clinical trainers.</i>
Satisfied with student uptake of her methods in their self-directed learning (SDL)	13.320	<i>The student uptake is pretty high, actually.</i>

Theme 2. Performing within the constraints of Progress Testing (PT) & Problem-based Learning (PBL)

Subtheme 2.1 Recognising that assessment drives learning

Considering that the PT allows a view on student progression from the first to the last test	8.176	<i>...progress test allows us to see how they're progressing...</i>
Considering the assessment of different disciplines is an 'artificial separation'	7.162	<i>...we try not to put artificial separation in between different disciplines</i>
Recognising that discipline-specific tests would make it easier to assess islands of knowledge but the tradeoff for integration is worth it	9.202	<i>then we could categorically say Yes, the students know it; or No, they don't...</i>
	9.205	<i>...we would then, potentially, silo the different disciplines</i>
	9.209	<i>There is always going to be a tradeoff,</i>
Using frequent formative assessment to drive learning	10.22 3	<i>...that drives the way in which we teach anatomy all the way.</i>
	10.23 9	<i>...we use that to adjust to teaching...</i>

Subtheme 2.2 Investing in the culture of learning

Emphasis on active engagement in the learning process	8.187	<i>...ensuring that the culture around learning anatomy...</i> <i>...they do engage with the process..</i>
Confident that methods of assessment match the teaching of anatomy	10.23 4	<i>I think because we assess the anatomy formatively very frequently..</i>
Committed to crafting sessions that support the learning experiences of both students and the educators	16.40 4	<i>...that structure has forced me to be innovative...</i>
Using activity focussed sessions to promote engagement	8.196	<i>...all of our sessions are very activity focussed.</i>

Subtheme 2.3 Using clinical relevance to improve student engagement

Introducing real patients into the clinical cases	11.26 8	<i>...their clinical cases are real patients.</i>
Allowing that clinically-relevant anatomy via surgery is enough	12.29 2	<i>I don't know...outside of, you know, watching surgery...</i>
Believing that clinical teachers will go on to facilitate next-level learning	3.50	<i>...they will then have clinical teachers that...</i>

Relating function to structure at early stages

4.74 ...trying to relate the structure to function...

5.116 ... instead of just thinking about learning a list of insertions

Explaining clinical relevance to students

8.190 ...we have to explain to students why... and how it's gonna be clinically relevant to them.

Subtheme 2.4 Eye on the prize: producing competent doctors, not anatomists

Accepting the tradeoff that cadaver-trained students would perform better on spotter tests than her students

9.214 ...they wouldn't do nearly as well...

Keeping focus on the strategy to produce good doctors

7.164 ...what we're aiming to do is produce very good quality foundation year doctors.

9.221 We're not teaching them how to identify structures on a cadaver.

Believing the value of integrating anatomy knowledge with clinical relevance is worth more in the bigger picture

9.216 But it's about what the endpoint is...

Using PBL to build a reciprocal gradient of anatomy and clinical competence

11.26 Because our program is problem-based learning...
3

Believing that a small group of students working with one

12.27 ...they do still get anatomy teaching later on, but it's

surgeon will be getting sufficiently grilled on their anatomy

9

not the whole group in a lecture theatre...

Subtheme 2.5 Understanding that PBL requires SDL

Invested in supporting SDL

4.81

...to book for their own self-directed learning...

15.34
9

...there is a lot of self-directed learning time within that...

16.39
9

...nudge them in the right direction...

15.35
2

...however they want to do the additional SDL around that is entirely up to them

Holding student-led teaching sessions

Inviting students to use various resources as part of their SDL

15.35
1

just giving them a little bit more focus for their SDL.

Offering kinesthetic methods with a facilitator and without

5.112

...but they don't need the facilitator because the session can be self-led...

Theme 3. Unpacking Teaching and Learning Activities (TLAs) as methods

Subtheme 3.1 Prioritising Learning methods over Teaching methods

Believing that providing students with myriad resources means they are more likely to carry out sustained SDL	17.42 4	<i>...just kind of crack on with it..</i>
Investing in the creation of bespoke online resources to support students' SDL	4.92	<i>...students use those resources that we've created for them</i>
Designing learning environments rather than teaching sessions	4.88	<i>We create... activities... sessions for them to apply all of that learning...</i>

Subtheme 3.2 Expecting students to be largely self-motivated

Assuming that providing tools with supportive interventions will be met with the motivation to carry out sustained SDL	14.32 3	<i>The online stuff... everyone does it...</i>
Unsympathetic to those who don't do the prep	14.32 8	<i>...but if they don't do the prep...</i>
	14.33 2	<i>It sounds pretty brutal but...</i>
Prepared to let unprepared students struggle in sessions	14.32 9	<i>...very little sympathy for those struggling in session.</i>
Unwilling to dumb down sessions to accommodate unprepared	14.33	<i>We're not...going down to the lowest common</i>

students

0 *denominator...*

Believing that unsuccessful medical students have chosen to forget or ignore the material when required to apply it in the presence of clinical educators

13.31 *That they've just **chosen** to forget it or ignore it*
1

Subtheme 3.3 Normalising novel methods

Using formative testing of novel methods

7.154 *We give them some formative assessment on the surface anatomy.*

Expectation that students are engaging with novel methods in their own time

17.43 *...resources that students can use in their own time*
6

Operationalising novel methods via prep and post-session consolidation

8.194 *They do engage more so by creating the prep...*

Investing in novel resources

6.143 *So we have a team of surface anatomy models as well.*

6.139 *...they could look at it with a video...medical imaging...dissection, mould a model, draw on a body or whiteboard...*

Theme 4. Fostering reciprocity at all costs

Depolarising preclinical and clinical years	4.93	<i>...they do still get anatomy teaching in years three to five...in a clinical setting.</i>
Teaching anatomy in the early years via clinical cases	11.26 3	<i>...each case in years one and two is two weeks long</i>
Emphatically supportive of more representation of anatomy in clinical years despite being unable to adapt assessment modalities to suit	13.29 9	<i>... always Yes!</i>
Maintaining a focus on basic sciences in their clinical teaching time	12.27 2	<i>Tutorials where they're kind of grilled</i>
Developing a proportionate anatomy focus in clinical scenarios	12.27 7	<i>...once they're on clinical rotations that are more anatomy-heavy</i>

Subtheme 4.2 Bridging the gaps with interventions

Working in the frequent assessment, rapid remediation approach	8.174	<i>That's the ethos of the program - to do frequent assessment, rapid remediation.</i>
Integrating spotters with novel methods through formative testing	10.24 2	<i>...we do also do spotter tests as well but ours are integrated.</i>
Providing students with preparatory and post-session	14.34	<i>...a more robust approach to preparation for sessions</i>

consolidation around practical anatomy sessions	2	<i>and post-session consolidation...</i>
Investing in a bigger bank of resources and providing a myriad of methods to support SDL	18.44 2	<i>...trying to build a bigger bank of resources</i>

Theme 5. Coping with tensions

Subtheme 5.1 Recognising the resource constraints

Increasing the number of Anatomage tables and staff members and other resources in response to rising student numbers	15.36 8	<i>...more staff and boards to mitigate that as well and we're getting 2 new Anatomage tables.</i>
Embracing the need to deliver content multiple times to small groups	15.37 1	<i>So students get a small group experience even in a larger cohort.</i>
Keen to see more spotter tests in later years despite time constraints	18.44 7	<i>If I had my way... I would probably introduce more spotters</i>

Subtheme 5.2 Accepting the complexities of integration

Recognising that where there is an expectation of more SDL (as in PBL), conscientious educators must provide more interventions	15.34 9	<i>...it being PBL there is a lot of SDL... giving them more focus...trying to give them as many options as possible</i>
Acknowledging the practical difficulty of getting students all in	18.45	<i>...which can be quite difficult</i>

one place to carry out a traditional spotter in the clinical years	4	
Accepting that she doesn't know exactly what kinesthetic methods might get pulled through into the clinical years if at all	12.28 7	<i>I think that they do. Although probably not in every single...</i>
Conceptualising potential summative anatomy assessments using novel methods or spotters despite knowing none would work with the PT ethos	8.172	<i>...we don't have the opportunity to kind of adjust the assessment modality based on what we would prefer...</i>
	7.170	<i>...we don't have different assessments of different disciplines</i>
	18.45 8	<i>...a myriad of other... summative assessment modalities that we could choose...</i>
	18.45 9	<i>...unlikely that we would get to do that given the ethos...</i>
Using summative tests to reinforce what's working and remediate what's not via activities assessed formatively	11.24 9	<i>...we also get feedback from the summative tests...</i>
Subtheme 5.3 Balancing relationships with clinical educators		
Aware that clinical educators are not well-integrated	13.30 5 -	<i>...clinical pathways where the clinical educators may</i>

	306	<i>not be as aware of what teaching goes on...</i>
Believing that better-informed clinical lecturers can demand and produce higher levels of understanding in students	16.41 6	<i>...and justifiably demand that...</i>
Annoyed that clinician-educators blame the anatomists for not sufficiently educating students	13.30 9	<i>...the clinician is going... "Well, what... What do they teach you?"</i>
Optimistic that more resources will allow staff to build stronger links with clinical lecturers	17.41 9	<i>...now that we've got some extra staff on board...</i>

EXHIBIT 5. Table of Personal Experiential Themes From Analysis of E: Finn

	Page/line	Quotes
Theme 1. Defining one’s own role within the interplay of constraints		
Subtheme 1.1 Reflecting on personal journey		
Reflecting on own anatomy journey having studied it un undergrad and master’s degrees	1.9	<i>Well, I did my undergraduate degree in sports therapy...</i>
Identifying with anatomy as an academic subject traditionally clustered with associated subtopics	1.15 - 16	<i>And we covered top to toe gross anatomy, did the embryology, did neuroanatomy...</i>
Subtheme 1.1 Constraints related to frequency and regularity of hours		
Teaching undergrad med students very frequently	2.27	<i>Quite a lot, [laughter]</i>
Dealing with inconsistent teaching hours	2.27	<i>...It's hard to put a number on it.</i>
Subtheme 1.2 Constraints related to alignment and relationships		

Sub-subtheme 1.2.1 Constraints between self and programme

Awareness of role as 'hired' and therefore from outside the medical programme sensu stricto	4.74	<i>And that's mostly determined by the clinicians, as we're basic sciences, really, hired by the school to come out to teach.</i>
	4.75	<i>We're not within the school of medicine.</i>
Operating with minimal involvement in the clinical years' assessments	3.71	<i>We do have a little bit of say in the OSCEs...</i>
Confident in support of colleagues and boss	13.308	<i>Oh, 100%...</i>
Dealing with a degree that is split into preclinical and clinical years	3.58	<i>The first three years, which I'm involved with...</i>
Taking pride in the development of technology-enhanced methods	5.10	<i>...we're the ones leading that...</i>

Sub-subtheme 1.2.2 Constraints between anatomy and medical school

Understanding the importance of institutional buy-in	14.333	<i>...for the institutions to be engaged with the demand</i>
Believing that the assessment process is too rigid to change	8.187	<i>Because our assessment process is so rigid</i>

Describing innovative anatomy methods as 'extracurricular'	5.112	<i>It's more extracurricular.</i>
Pointing to growing student numbers and GMC policy as barriers to flexibility in assessment	10.222	<i>large class sizes has a massive impact.</i>
Acknowledging that lack of assessment affects the alignment of the curriculum	9.218	<i>...alignment is sometimes a bit off</i>

Sub-subtheme 1.2.3 Constraints giving rise to identity formation

Claiming cadaveric dissection as favourite	5.118	<i>It would have to be the cadaveric dissection...</i>
Taking pride in being an early adopter of anatomy body painting	10.241	<i>I was the first one to try it up in the medical school</i>
Identifying with the apparent success of anatomy body painting	10.242	<i>...and students are starting to ask for it to be taught.</i>
Rationalising the lack of personal agency in the assessment process	9.200	<i>...we just haven't pushed it to be part of the assessment process.</i>
Demonstrating intention to drive anatomy body painting forward to become recognised as part of the programme	11.248	<i>I intend to try and make it definitely part of the first two years of the programme...</i>

Theme 2. Reconciling classical with contemporary pedagogy

Subtheme 2.1 Professional identity underpinned by cadaveric dissection experience

Identifying with cadaveric dissection as the gold standard of teaching and learning anatomy	4.93	<i>One of the best ways that you learn.</i>
Believing that cadaveric investigation is good for learning but not for assessment	16.372	<i>...good for learning but...</i>
Recognising the limited relevance of spotter tests	10.229	<i>whether spotter exams are becoming redundant now...</i>
Believing that dissection only works when the student is engaged in active learning	5.120	<i>Only works if... the student is willing to be active in the process of learning</i>
Believing in the importance of students being prepared before coming for dissection sessions	5.100	<i>...you get them to read the information themselves</i>

Subtheme 2.2 Compelled by the potential for redefining identity around innovative methods

Investing in anatomy body painting as a teaching and learning activity	11.271	<i>Everyone seems to really like it.</i>
Believing in the value of anatomy body painting as a tool for the consolidation of knowledge	9.208	<i>I see this session as not necessarily getting into an exam...</i>

	9.211	<i>...a new approach to investigate the current knowledge they already have.</i>
Enthusiasm and growing confidence about the activity receiving interest from colleagues and other programme leads	13.319	<i>I've got other leads and system conveners coming in...</i>
Enthusiasm for the Theil soft-fix allowing lifelike movement	10.234	<i>...lifelike movements...</i>
Convinced that live and lifelike models are more clinically relevant for teaching and assessment	16.374	<i>...in a clinical context if you have a live model,</i>

Theme 3. Believing that student engagement is crucial to success

Subtheme 3.1 Inspired by the high student uptake of anatomy body painting,

Recognising that the activity could be improved with more clinical relevance	15.352	<i>...and start to bring in more professional skills</i>
Concerned that part of the successful uptake of the activity is down to its novelty	12.287	<i>...just because it's different.</i>
Observing that the activity is more successful with older students	12.274	<i>...more willing to engage.</i>
Believing that anatomy body painting leverages other soft skills in addition to anatomy	9.209	<i>...it builds up all the soft skills...</i>

Believing that physical learning provides a boost to engagement 13.297 *...engages them to apply it..*

Subtheme 3.2 Expressing a sustained commitment to self-directed learning

Crafting sessions around self-directed learning 7.157 *I've got six groups running all with different outcomes...*

Providing more options to increase student engagement 6.129 *...give them options and make them more active...*

Facilitating sessions rather than leading them 8.173 *So I'm in a facilitatory role...*

Believing the clinical years are all about the application of knowledge 11.259 *In the clinical years it's all about application...*

Building active learning sessions around learning outcomes 7.148 *I'm starting to roll out body painting in a big way...*

14.341 *it needs to be led by learning outcomes*

Subtheme 3.3 Recognising there is no one-size-fits-all in terms of learning methods

Using innovative methods such as body painting to reinforce prior knowledge 7.58 *it's just regurgitating what they know.*

Accepting that no single method works for all students 6.127 *You're not going to get one method...*

Unconvinced that assessing innovative methods is germane to their value	9.211	<i>just a new approach to investigate</i>
	14.337	<i>I don't think it needs to be assessed in order to be successful.</i>
Concern around the importance of sensitivity and creative mitigation of religious/cultural constraints on the physicality of anatomy body painting	13.304	<i>They can paint on the white t-shirts</i>
Noticing that most medical students do an intercalation	3.49	<i>...an intercalated degree, which most of them do do.</i>

EXHIBIT 6. Table of Personal Experiential Themes From Analysis of F: Jenny

	Page/line	Quotes
Theme 1. Navigating personal transition to academia		
Subtheme 1.1 Identifying as an anatomy educator		

Coming from a medical degree background	1.4	<i>I did medicine at _____.</i>
Experience transitioning into academia, having to deepen her own anatomy knowledge through SDL	1.6 - 1.16	<i>I transitioned from clinical medicine ...into academia... to teach, you need to do it in a bit more detail so... it never ends.</i>
Teaching daily over a wide range of courses	2.26	<i>I do teach anatomy and I teach it daily.</i>
Committed to widening participation	2.45	<i>I do widening participation sessions...</i>
	3.52	<i>...these programs to widen access to medicine.</i>
	3.56	<i>I ran them for six years.</i>
Working as an anatomy educator as well as having involvement in curriculum design	5.110	<i>I'm quite heavily involved.</i>

Subtheme 1.2 Reconciling own place as a curriculum influencer

Currently involved in the MBBS curriculum design as it undergoes the process of realignment	5.109	<i>I also am the interprofessional education lead on the MBBS</i>
Reflecting on the curious fact that she doesn't have much to do with the anatomy programme design	5.103	<i>Maybe not so much the anatomy for whatever reason...</i>

Maintaining a detailed overview of the changing assessment process from preclinical to clinical years	5.118 - 7.158,	<i>...students have to pass all of those strands to pass a year.</i>
Describing the institution's curriculum as non-modular, integrated and case-based	5.117	<i>It's not a modular degree. So, everything is integrated...</i>
Feeling unsupported by her institution	23.57 5	<i>...from the educators' point of view that's not clearly supportive</i>
	23.57 7 - 579	<i>I would love to do short dissection sessions with them, but you know, no, I'm just going to say no, it's not supported.</i>

Theme 2. Navigating curricular transition

Subtheme 2.1 Reflecting on the 'old curriculum'

Using prosections in the preclinical years	10.23	<i>...but the students don't dissect them.</i>
Finding certainty in the success of methods through positive feedback from students	20.50 2	<i>We always got the best feedback from the anatomy sessions</i>

	22.55 9	<i>...quite a lot of good feedback from the students</i>
Comfortable with the 'old' method where every anatomy-oriented case has at least one DR session that goes along with it	11.25 2	<i>...we have at least one dissection room session...</i>
Describing how the preclinical years have early clinical experience with patient contact	5.98	<i>...they have early clinical experience...</i>
Accepting the programme is divided into preclinical and clinical years	4.94	<i>...two years of preclinical... followed by three years of clinical</i>

Subtheme 2.2 Grappling with 'this new curriculum'

Trying to get used to the new curriculum with progress testing aka integrated assessment	14.32 8	<i>...at the moment where we're kind of rolling out this new...</i>
Adequately describing the traffic light system of progress testing but not clearly supportive of it	7.162	<i>...has adopted this traffic light system...</i>
Experiencing confusion in the transition to progress testing	9.205	<i>Because we haven't rolled out the years three to five yet...</i>
	17.42 8 - 429	<i>...we haven't sat down and actually thought, "Are we covering all of these aspects".</i>

Accepting that the new curriculum with reduction of anatomy hours is problematic

20.50
9

But for the educator, it's a huge problem

Unsure whether students are enjoying their anatomy sessions as much

20.50
3

Now, in the new curriculum, I'm not so sure whether...

Subtheme 2.3 Observing the consequences of changing time constraints

Expressing concern that anatomy sessions have been dramatically cut down

23.57
3

...they've cut down on all of our face-to-face time but increased repetitions.

10.24
3

the anatomy sessions have been cut down...

Pointing to the reduction of anatomy hours as the reason why novel methods are not delivered

12.27
7

...but because there's no time now...

12.29
3

There simply isn't any time to kind of add anything else.

12.27
8

No time in the DR... we've got such a tight schedule now

Dumbing down the anatomy to cope with rising student

15.36

And at the end, they come out....

numbers and lack of time to adequately cover the broad anatomy LOs

0

Regretful that the new curriculum forces anatomists to repeat the same session multiple times to the detriment of personal experience

20.50
9

Instead of repeating a session twice like we did in our previous curriculum...

Creating supplementary material for SDL out of concern that they're not getting enough time face-to-face to cover the LOs

10.24
5

...to cover the outcomes, we're having to create material

13.31
0

So say I have five learning outcomes I need to cover...

Subtheme 2.4 Reflecting on the case-based approach

Not convinced about the efficacy of the case-based approach

23.58
2

the case-based method doesn't lend itself...

Recognising the lack of synchronicity between the case-based approach and anatomy education

17.42
0

you'd start with a case that is around the heart...

Concerned that students are left with an isolationist view of anatomy because of the case-based approach

17.43
3

they tend to think that things are in isolation...

Struck by the problematic aspects of case-based learning even in the knowledge that the medical school would not agree

17.43
7

Oh well, I think it's a problem...

Theme 3. Considering transitory alignment of curricular elements

Subtheme 3.1 Reflecting on Teaching & Learning Activities

Acknowledging that no innovative/novel activities are formalised in the curriculum	12.27 4	<i>None of those are formalised.</i>
Clarifying that they're not using small group teaching, only individual SDL	13.30 2	<i>...they just work through it on that on their own.</i>
Identifying lectures, DR sessions and digital resources for SDL as the top three learning methods students use	10.23 7	<i>Lectures, dissection room sessions, and ...digital resources</i>
Convinced that more time and more face-to-face contact would make TLAs much more effective	20.49 5	<i>... and we had so much time and much more face to face contact.</i>

Subtheme 3.2 Reflecting on Learning Outcomes (LOs)

Recognising that the curriculum is outcomes-driven	13.31 0	<i>it's... the whole curriculum is outcomes-driven.</i>
Exasperated by anatomy LOs described as overly 'broad'	15.35 7	<i>...we're giving them really broad outcomes and we're dumbing down the anatomy</i>
Seeing that LOs are out of synch as well as overly broad	17.41 9	<i>These outcomes are... disjointed as well</i>

Recognising the impact of overly broad LOs in the face of dwindling time to cover them sufficiently

15.36
6

...and they're not necessarily getting a full view... a full understanding of the clinical relevance of knowing anatomy.

Believing that most students are not doing the SDL as provided in order to achieve LOs

21.53
4

pick up a textbook, which ...is sacrilegious these days...

11.26
9

...but sadly not everybody does that.

Subtheme 3.3 Reflecting on Assessment

Believing that assessment does drive learning

25.63
7

...they do, em, learn the stuff a bit better...

Would like to see discipline-specific anatomy exams despite knowing these are outdated

25.63
3

Separate anatomy exams... I know this is a very outdated way of thinking...

Dumbing down the exam questions in an effort to mitigate the overly broad LOs creates a bigger problem

16.40
5

they get quite dumbed-down anatomy questions as well...

Acknowledging the randomness involved with the question bank alignment

8.194

I think some of it is a bit random...

Only able to talk with certainty about assessment in the old curriculum

9.207

*What I **can** tell you...*

Subtheme 3.4 Acknowledging alignment in transition

Acknowledging the interest in aligning assessment methods with learning methods	14.33 2	<i>You want to see whether we're assessing on the stuff...</i>
Having to run two curricula simultaneously	8.182	<i>so we have at the moment we've got two curricula running.</i>
	14.32 8	<i>Because we've got a transition period at the moment</i>
Accepting that the programme hasn't vertically integrated anatomy	18.46 1	<i>...we haven't ...vertically integrated any anatomy.</i>
Recognising disparity in clinical experience of colleagues	22.56 2	<i>But a lot of my colleagues are not... And they don't have that clinical experience</i>
Acknowledging that not all anatomy educators teach in the same way	22.56 3	<i>...they don't necessarily teach in that way.</i>

Subtheme 3.5 Consequences of lingering misalignment

Feeling there is a mismatch between what is taught and what is assessed	16.41 1	<i>yeah, I think there is a mismatch... these broad outcomes...</i>
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	17.42 7	<i>I'm in the process of... because we're struggling...</i>
Seeing that other anatomists are struggling	17.41 7	<i>I think a lot of the anatomists are struggling now because we've got... This new curriculum that we have...</i>
	23.59 0	<i>Kind of crazy.</i>
Believing that anatomy has been overwhelmed with clinical skills too early on	23.58 7	<i>...a humongous amount of clinical skills</i>
Acknowledging uncertainty about how assessments will be rolled out in the future	9.206	<i>I have no idea what we're going to be doing...</i>
Resigned to the consequence of uncertainty around what depth of anatomy students end up with as a result of variability in teaching	23.56 7	<i>...really difficult to say what they're coming out with as a whole.</i>
	22.56 4 - 565	<i>So it's it's very variable what the the end product is and what students get overall.</i>

Theme 4. Professional transitions in the face of changing goalposts

Subtheme 4.1 Dealing with frustration

Feeling that changes are impossible	14.34 2	<i>I'd love to but it's not possible.</i>
Frustration with feeling own enthusiasm suffering as a result of having to repeat sessions ad nauseum	20.51 6	<i>Obviously, I do it... But it just kills all my enthusiasm</i>
Feeling that the programme is failing students in anatomy education	15.35 0	<i>We're failing them in the anatomy education</i>
Accepting that there aren't enough staff to spread the load and reduce repetitions	21.52 7	<i>...if you have, you know, kind of fresh blood every time in the DR. teaching them, fine...</i>
Feeling disempowered with regards to raising issues with administration	18.45 3	<i>I can't argue with the powers that be.</i>
	18.44 9 - 451	<i>And I personally struggle with this BMBS approach that we have because I like to build on things. So for me, it poses a problem...</i>

Subtheme 4.2 Believing in the power of grounding students in clinically relevant anatomy

Importance of showing links between the anatomy and clinical scenarios	22.54 8	<i>...the links between the clinical stuff and the...</i>
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Ideally would like to include more anatomy time in every case	22.54 7	<i>I would include far, far more anatomy in ...the cases</i>
Preferring to build up anatomy understanding slowly	18.45 0	<i>I like to build on things.</i>
Reflecting on other programmes such as dental that offer a more holistic view of anatomy	17.43 9	<i>...we do things very differently on the dental program...</i>
Expressing strong belief that anatomy should be vertically integrated into the clinical years where it should focus on clinical relevance	19.47 7	<i>...there does not seem to be any, em, vertical integration of the anatomy and I would love that.</i>
	22.55 2	<i>...introducing ...a clinical reasoning session...</i>
	15.36 7	<i>a full understanding of the clinical relevance...</i>
	20.49 7	<i>we did manage to kind of address tricky key concepts...</i>
	19.48 0	<i>it needs to be really focussed on clinical procedures...</i>
	24.60 0	<i>Cut down clinical skills, repetitions, and just ground</i>

the students in clinically relevant anatomy.

Subtheme 4.3 Understanding the reality of student experience

Valuing student feedback	21.54 2	<i>...all of our feedback says that they want more...</i>
	22.55 8	<i>I get quite... quite a lot of good feedback from the students because sometimes I have to spell it out to them.</i>
Expressing the wish that students would be more prepared coming into the DR sessions	21.53 3	<i>...and also put some of the onus on them as well</i>
Recognising that students increasingly want access to the immediacy of snapshot-style content	24.61 0	<i>I don't know whether it is a snowflake generation thing...</i>
Concerned that short snapshots are not enough to provide a real understanding	25.61 8	<i>...but it doesn't mean that that's enough to understand it.</i>
Concerned that students need to be willing to prep or follow up DR sessions with SDL	24.60 6	<i>Not without the expectation that they need to...</i>

Subtheme 4.4 Staying hopeful and practising professionalism

Feeling a moral responsibility to teach anatomy along with	22.56	<i>I do feel kind of morally responsible to show them</i>
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clinical relevance	0	<i>the links.</i>
Guided by professionalism to not respond to lack of DR time by publicly placing blame on senior administration	22.54 4	<i>I'm not going to be the one telling them...</i>
Teaching widening participation despite uncertainty around student follow through	3.65	<i>One never knows how many of them follow it up... [laughter]</i>
Believing in the value of dissection despite it not being part of the formal curriculum	10.22 9	<i>I offer fourth years... the opportunity to come back and dissect</i>
Hopeful that the programme will integrate anatomy further in the near future	19.47 1	<i>I'm hoping that we'll be integrating some in the new curriculum but thus far...</i>
	8.171 - 172	<i>Then we've got a feedback system that allows you to see where you're failing</i>

EXHIBIT 7. Table of Personal Experiential Themes From Analysis of G: Catherine

	Page/line	Quotes
Theme 1. Reflections on the journey to becoming an anatomy educator		
Subtheme 1.1 Reflecting on early influences		
Identifying with self-directed learning	1.13	<i>Mainly self-directed.</i>
Own learning through dissection	1.15	<i>Ehh, yeah. Dissections.</i>
Believing that small group teaching and continuous assessment were the most effective activities for her own learning	1.6	<i>The small group teaching, to be honest with you...</i>
Subtheme 1.2 Reflecting on current role		
Sub-subtheme 1.2.1 Experiences as a teacher		
Teaching anatomy in a medical programme	1.20	<i>Ok. Yeah, medical school.</i>

Believing in the importance of cadaveric study 5.99 *All of our students. It's compulsory cadaveric.*

8.178 *...assigned to cadavers in the anatomy room.*

Dealing with an inconsistent teaching load 2.25 *Usually twice a week, I suppose.*

Teaching multidisciplinary systems-based modules 3.71 *And it's going to be multidisciplinary systems-based modules*

Teaching a range of students over a variety of courses 2.34 *...everything from first-year pharmacy students...*

Sub-subtheme 1.2.2 Experiences as an administrator

Expressing some tension between role as an anatomist/educator and defender of the curriculum as a whole 12.74 *It's challenging doing that vertical integration or that true spiral at times.*

Demonstrating an extensive administrative understanding of all the courses she is involved in 3.66 *And then for the surgical trainees,*
+

Recognising space limitations of the anatomy department 16.40 *The room itself gets very busy.*
2

Recognising staff costs are a potential issue	16.41 5	<i>We're fortunate that most of ours are retired clinicians.</i>
Expressing interest in developing more online resources	17.42 9	<i>It'd be nice to develop more online cases.</i>

Theme 2. Defending the status quo

Subtheme 2.1 Considering the curriculum to be integrated

Teaching in a set of curricula where anatomy is threaded vertically in the pharmacy programme but not clearly so in the medical	5.111	<i>...the pharmacy it's threaded vertically throughout their curriculum...</i>
Teaching on a programme that brings clinical competencies into the preclinical years	4.77	<i>...clinical competencies in from the very beginning...</i>
Rationalising the modular nature of the medical curriculum	5.116	<i>...everything about that system sits very modularised...</i>
Dealing with OSCE style assessment throughout the curriculum	6.137	<i>...our clinical competencies do OSCE stations in first year...</i>

Pointing to logistical obstacles as barriers to vertical representation via assessment

12.27
7 *Resources. And who's going to do it..*

Subtheme 2.2 Observing Alignment

Sub-subtheme 2.2.1 Using the same activities to teach anatomy as those she used to learn

Using didactic lectures, cadaveric small-group teaching and technology-enhanced learning

7.167 *...the resources that we would put in place would be...*

Demonstrating adherence to cadaveric study as comparable to patient-centric pedagogy

11.26
1 *...only in the clinical years, the patient is still breathing...*

Invested in small group teaching using Socratic questioning

9.200 *I go from one table to the other...*

Assuming that students are prepared for and engaged by prescribed learning activities

9.201 *Just guiding them towards working through...*

Expressing belief that dissection is kinesthetic learning

15.36
0 *I mean, if we didn't have cadaveric then maaaybe...*

Sub-subtheme 2.2.2 Defaulting to reflecting on discipline-specific anatomy assessment methods

Demonstrating a defensive stance when proved about assessment alignment	9.206	<i>...em, so arguably yes.</i>
Acknowledging anatomy is assessed as discipline-specific	4.93	<i>The anatomy aspect... That would be assessed...</i>
Acknowledging the axiom that assessment drives learning as a rationale for keeping the anatomy viva in the programme	9.220	<i>...they probably wouldn't engage as much...</i>
Acknowledging that students will not have prior experienced with the viva	10.23 0	<i>...they've never had to do that before...</i>
Rationalising the use of the viva in preclinical anatomy assessment	10.23 3	<i>So once they get into clinical stations and OSCEs...</i>

Sub-subtheme 2.2.3 Demonstrating optimism and points of pride

Expressing positive views about the progress test as one means of vertical integration via assessment	12.28 5	<i>it gets rid of this "once and done", you know, mentality</i>
Expressing pride that anatomy demonstrators are retired clinicians	13.30 1	<i>a lot of our small group teaching facilitators are retired clinicians...</i>
Careful to clarify that students are not being taught by	13.31 9	<i>No, they're not being taught by their peers</i>

peers or near peers

14.32 ...we don't have any 20-year-olds
6

14.32 ...most of them are qualified doctors.
3

Taking pride in the development of videos

17.43 ...spent a few hundred hours on it..
7

10.23 So once they get into clinical stations and OSCEs..
3

Feeling supported by colleagues

15.36 Oh yeah.
7

Sub-subtheme 2.2.4 Choosing tech over art-based learning activities

Teaching novel methods via technology

14.34 ...we have various resources that we've developed
7 online.

Understanding that her technology-enhanced learning is not novel

15.35 Yeah, they're different resources but not *novel*
7 novel.

Learning new tech skills on the job

18.44
3 *So if you want to call it scripting rather than programming...*

Theme 3. Acknowledging the disconnect

Subtheme 3.1 Sitting with the tension between what is taught and what students are using to learn

Sitting with some uncertainty around what students are using to learn

7.163 *I don't know for anatomy as a whole, em...*

Concerned with the distinction between methods students use to learn and those explicitly used in the curriculum to teach

7.153 *In what way is the question phrased, is it what they used to learn?*

Defaulting to explicitly stated teaching methods

7.166 *So from my point of view the resources that we would put in place would be...*

Subtheme 3.2 Insights around integration

Acknowledging that the programme is predominantly split into preclinical and clinical years

4.87 *...foundational sciences in the earlier years and then going more towards exposure of diagnostics in the later years.*

Reluctant to address questions about vertical integration of basic sciences assessment	18.45 5	<i>I don't knowwww?</i>
Expressing chagrin that she can't confidently state that anatomy teaching is fit for purpose	19.46 8	<i>I would certainly like to say yes...</i>
Views around relevance of cadaveric study in the patient care continuum	15.36 6	<i>Well, arguably it is the signature teaching of medicine...</i>

Subtheme 3.3 Dealing with obstacles to assessment alignment

Acknowledging the constraints of assessment integration	6.142	<i>...these are so examiner intensive...</i>
Experiencing disconnect in how anatomy is assessed longitudinally	18.46 2	<i>I'm not quite sure how to answer that one.</i>
Reckoning with compartmentalised anatomy assessments	5.121	<i>...MCQs, the viva voce assessments,</i>
Feelings around congruence	9.216	<i>I think they're well-paired... And we do consider it...</i>

Subtheme 3.4 Reflecting on constraints

Observing that medical students' anatomy knowledge needs 'reactivating'	19.47 9	<i>...it takes a while to reactivate it</i>
Expressing some tension around whose responsibility it is to do the reactivating	19.49 0	<i>...even just a short session with a clinician...</i>
Expressing frustration in the face of clinician feedback that students do not know their anatomy	19.47 6	<i>But you will always get clinicians saying, "Well I saw them this week and they knew nothing..." And it's like, "Well, they did when they left us".</i>
Feeling supported by institution and colleagues	15.36 7	<i>Oh yeah.</i>

EXHIBIT 8. Table of Personal Experiential Themes From Analysis of H: Nina

	Page/line	Quotes
Theme 1. Reflections on professional identity		
Subtheme 1.1 Reflecting on early influences		
Studied anatomy extensively as an undergrad	1.13	<i>...in fourth year we did sort of advanced anatomy..</i>
Identifying with not being a medic	1.4	<i>I didn't - I didn't - do a medical degree.</i>
Feeling in touch with roots as a student of anatomy	1.18	<i>Groups of four would dissect a region.</i>
Learnt anatomy 'actually' via demonstrating	2.27	<i>...once you actually have to teach it, you have to have to really go back and know it inside out.</i>
Personal learning of anatomy characterised by drawing	2.30	<i>when I was studying anatomy, I would draw everything out.</i>
Subtheme 1.2 Holding split roles where she is a relatively new contributor		

Sub-subtheme 1.2.1 Taking a coordinating role in anatomical sciences (non-medicine)

Working collaboratively with colleagues 8.196 *I saw her using it first with her medical class...*

Sub-subtheme 1.2.2 Teaching anatomy content that is dissection-led

Sub-sub-subtheme 1.2.2.1 Sharing experiences as a non-medicine anatomy educator

Taking pride in being an anatomist 6.138 *...the majority of the labs are dissection and prosection based.*

Highly engaged in the pedagogical practice of teaching anatomy where she has a coordinating role 6.132 *I got them to do workbooks last year but...*

Teaching both undergrads and on a master's course in clinical anatomy 3.71 *Mostly undergraduate, I guess,*

Dealing with inconsistent teaching hours 3.67 *But I suppose on average maybe nine hours a week (??)*

Sub-sub-subtheme 1.2.2.2 Experiences as a medical programme anatomy educator

Feeling supported by colleagues 16.400 *Everyone's very enthusiastic and supportive...*

Contributing minimally to the medical programme with inconsistent hours	4.78	<i>I guess but I wouldn't have as much to do with their course</i>
Not involved with the coordination of the course curriculum	4.82	<i>I don't really teach a huge amount on the medical degree so I don't have...</i>
Feeling limited in terms of her entitlement to engage/comment	4.95	<i>I do know it but I don't want to say...</i>

Theme 2. Highly engaged in anatomy pedagogy

Subtheme 2.1 Practising self-reflection as an educator

Identifying with art and drawing based learning activities	2.35	<i>I would be quite interested in art, I guess,</i>
Understanding the distinction between how she was taught and how she actually learnt anatomy	2.25	<i>...but in terms of when I actually learnt my anatomy,</i>
Feeling she can afford to try things out in the non-medic class	9.217	<i>...you have the flexibility to do that with an undergraduate science class that you might not have...</i>
	9.220	<i>...it's not maybe as much pressure in some ways (?)</i>
Believing in the usefulness of kinesthetic activities in education	15.370	<i>I think you need a bit of that sometimes in education to keep it interesting...</i>

Taking pride in the development of new TLAs

10.24 ...we're trying to make them use these virtual
5 images.

14.34 So I would make a little video,
3

Subtheme 2.2 Designing the anatomy learning environment

Sub-subtheme 2.2.1 Observing obstacles to engagement

Recognising problems with rising student numbers

14.34 Falter on the same issue... large numbers of
3 students...

16.40 ...you are sometimes limited with what you can do
8

Recognising that rising student numbers around a
cadaver reduces engagement

16.41 ...they're just not going to get the same level of
5 engagement...

Recognising that younger students are more likely to
want to just sit back in lecture-style sessions

8.190 ...they quite like the 'sitting back' aspects...

Recognising that younger students struggle with SDL

8.180 They're not brilliant at kind of going off on their own
steam.

Feeling that some kinesthetic activities can be gimmicky

15.36 And I think things like that can seem quite gimmicky

9 *but...*

Sub-subtheme 2.2.3 Observing problems with the dissection-led approach

Observing that students do like the dissection but aren't really learning from it	8.191	<i>They do like dissection, but...</i>
Acknowledging that students aren't really using dissection as a learning activity in actual practice	8.177	<i>I'd like to say dissection, but I don't think it's true.</i>
Recognising that students struggle with self-reliance for the SDL that dissection requires	17.43 1	<i>...our students are quite reliant on demonstrations to tell them what to do...</i>
Recognising that it is the demonstrators who are learning more than students with the current approach	17.44 0	<i>And you learn it very well, but it doesn't mean your students will know it very well...</i>

Sub-subtheme 2.2.4 Observing problems with assessment status quo

Using standard discipline-specific assessment	5.106	<i>The kind of standard spot tests.</i>
Observing conflation of goals with siloed assessment	13.32 1	<i>...almost as if we're teaching anatomists rather than clinicians...</i>
Believing it isn't possible to learn and retain anatomy for assessment in current time constraint	14.32 7	<i>I don't think anyone really can really learn anatomy in a year...</i>

Subtheme 2.3 Designing the anatomy learning environment

Sub-subtheme 2.3.1 Prioritising the alignment between LOs and assessment

Conscientious about maintaining congruence around LOs	11.25 3	<i>...when I give them the learning objectives they're almost in exam question format.</i>
	11.26 1	<i>because you have to make sure that you do follow the learning objectives...</i>
Formulating specific LOs rather than vague ones	11.25 7	<i>I don't believe in the very vague learning objectives</i>
	11.26 0	<i>I tend to be very specific...</i>
Convinced that students should know what they have to know	11.25 2	<i>...should know what they have to know to pass the exam.</i>
Designing teaching sessions around discrete goals	15.35 7	<i>...you want to have very discrete goals,</i>

Sub-subtheme 2.3.2 Investing in technology-enhanced methods

Recalling her previous success using technology for teaching	14.34 4	<i>...and they really quite liked that.</i>
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Observing that her students gravitate to the use of touchscreens in the DR 7.158 *The feedback though is pretty decent for that.*

Sub-subtheme 2.3.3 Responsive to student feedback & performance

Preferring interactive lecture activities 9.208 *So I do like that kind of aspect, more interactive...*

Noticing the popularity of workbooks, redeploying them 7.159 *I've noticed a lot of them, eh, they like little workbooks where they have to do drawings and labelling and colouring in.*

Using formative testing as a trial space for new assessment methods 10.24 6 *...just trialling it kind of on a formative basis just to see,*

Playing with performance as feedback 5.118 *I've done it one year already, and they quite liked it*

Impressed by the quality of work her students are producing 5.119 *some of the material is brilliant. It's really impressive.*

Sub-subtheme 2.3.4 Taking into account the constraints of cognitive load

Believing that students learn better through drawing than by PowerPoint 14.34 5 *...if you show a load of pictures up on a PowerPoint,*

Understanding the power of student-led pacing 15.34 9 *...students can follow it a lot easier if it's at their pace.*

Dripping content out in manageable chunks	15.35 0	<i>You can't fire all the information at them all at once.</i>
Using technology to simplify complicated subjects	15.35 4	<i>...something quite complicated, but just label this one thing...</i>
Utilising drawing techniques to engage students	15.34 7	<i>...actually drawing things out step by step...</i>

Sub-subtheme 2.3.5 Maintaining a wish list

Wishing to reduce student-to-cadaver ratio	17.43 0	<i>I would make it so that there are no more than four students around a cadaver...</i>
Wishing to increase student motivation for SDL	17.43 2	<i>I'd get rid of a lot of that dependency.</i>
Wishing for more integration with the medical curriculum overall	14.33 2	<i>...and everything is taught a little bit more in an integrated fashion.</i>

Theme 3. Lack of engagement with medical curriculum

Subtheme 3.1 Feeling disempowered to engage with the medical curriculum

Reluctant to comment on the organisation of the medical	4.94	<i>I do know it but I don't want to say... they are</i>
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curriculum

changing the course as well.

4.85 *I just show up and give a lecture or give a lab when I'm asked.*

Believing in the usefulness of kinesthetic activities in medical education

16.37 *there's no harm trying to incorporate some of those things...*
5

Feeling the medical programme is too time-constrained to explore TLAs

16.37 *...it's not a medical curriculum, it's not as time-constrained...*
3

Noticing that older medical students have forgotten their anatomy

13.29 *...you'll ask them basic enough questions and they won't have a notion.*
8

12.28 *And he says "Aaaah, Jeez, I've forgotten all that, I just know how to do it now."*
5

Observing a paradox in alignment

13.31 *...Like the progress testing, I suppose, they're trying to counteract that issue but...*
2

Subtheme 3.2 Wishing for integration

Feeling disappointed because medical students have forgotten their anatomy

13.29 *It does disappoint you a little bit.*
9

Recognising that students compartmentalise their anatomy

12.27 *That the students compartmentalise the anatomy...*

	9	
Believing the programme should be 'weaved' together better	14.33 4	<i>If everything was weaved together a bit more.</i>
Coming to terms with the new progress testing-based curriculum as proposed	13.30 2	<i>So they're hoping to integrate all the subjects a bit better with the new, what is it called, em...</i>

Subtheme 3.3 Dealing with disconnect

Recognising there are alignment issues with PT's assessing medical students solely with MCQs	18.46 1	<i>...one way that could weave it into the assessment...</i>
Observing a fairness problem with PT	13.31 8	<i>It's probably too high a level to assess them at.</i>
Believing that using OSCE stations in the preclinical years could help mitigate alignment issues inherent in PT	18.45 7	<i>...either OSCE-based stations that have prosections, or else,</i>
Recognising that the problem of disintegration/misalignment is systemic	12.27 8	<i>And maybe in a lot of schools all over...</i>
Resigned to the reality that no one approach can be perfect	13.31 3	<i>...but I don't know if that's perfect either...</i>

EXHIBIT 9. Table of Personal Experiential Themes From Analysis of J: Ben

	Page/line	Quotes
Theme 1. Reflections on the journey to becoming an anatomy educator		
Subtheme 1.1 Reflecting on own education		
Anatomy journey characterised by dissection experience	1.13	<i>Yeah, it was, it very... it was dissection based.</i>
Did not do a medical degree	1.3 - 6	<i>Anatomy in human biology... and PhD...</i>
Learned anatomy as an undergraduate science student	1.5	<i>...that was the undergraduate degree.</i>
Having experienced didactic learning environment in own anatomy learning journey	12.278	<i>...it really was just sitting there, eh, reading through in silence,</i>
Subtheme 1.2 Current role as an educator		
Describing current role as an anatomy lecturer and course lead	1.20 -	<i>So I'm an anatomy lecturer...</i>

for anatomy in the medical school	22	
Teaching only undergraduate level	2.30	<i>...we don't run any postgraduate courses here.</i>
Teaching anatomy regularly	2.26	<i>I'd say - at the moment - it's about 6-7 hours a week.</i>
Seeing his programme as a flagship of the institution	13.300	<i>I think it's seen as a flagship</i>
Feeling supported by institution and colleagues	13.299	<i>Yeah, absolutely.</i>

Subtheme 1.3 Having involvement as a coordinator

Maintaining an extensive overall understanding of how all related courses are organised	3.51 - 4.74	<i>Ok. Ok. So for the eh, for the anatomy degree...</i>
Acknowledging that the curriculum is often under review	8.187	<i>I think we've had about a million curriculum reviews...</i>
Students receive a range of qualifications at the undergrad level	2.37	<i>Oooh - Good question - eh, again, it's a range...</i>
Defaulting to talking about the pure anatomy course when asked about assessment	9.200	<i>For the anatomy course, we, I think it's 30% is a spotter examination, eh.</i>
Believing that the tight regulations around access to the anatomy department is problematic	13.317	<i>...probably a problem with all anatomy departments since they're so tightly regulated,</i>

Subtheme 1.4 Reflecting on the medical curriculum

Having a role in formulating LOs for medics	8.193 - 196	<i>And so I was playing a hand in the learning objectives</i>
Seeking to align medical course LOs with the Anatomical Society's published recommendations	8.194	<i>...trying to align them more towards the Anatomical Society paper.</i>
Describing the medical curriculum as systems-based	3.68	<i>...we do it in a systems-based manner...</i>
Confirming the separation of the preclinical and clinical years	4.77	<i>Yeah, yeah. Ok. Yeah, yeah.</i>
	4.79	<i>Absolutely</i>

Theme 2. Identifying as an anatomist

Subtheme 2.1 Genuinely loves teaching anatomy

Half-seriously keen to confirm anonymity	7.168	<i>...is this definitely anonymous? [laughter]</i>
Proud to declare that dissection is his favourite teaching method	6.125	<i>I do think dissection, eh, is still, for me, the best way to go</i>
Taking pride in his role as an anatomist teaching a pure	7.161	<i>I think we do a bit more dissection than them,</i>

anatomy degree

Enjoys teaching medics because of their higher level of engagement

8.178 *They're so switched on and asking great questions...*

8.179 *It's great to teach students who really, really want to learn*

Enjoys teaching pure anatomy on the undergrad science course because of the relationship developed with students over a longer period

8.172 *it's a small group, so I really get to know the students and can take them through the three years...*

8.175 *I've got that bond with the students...*

Subtheme 2.1 Invested in dissection

Convinced of the popularity of dissection

7.147 *You know, that the students absolutely love the dissection.*

13.320 *the students would love that, I think...*

Referring to the positive feedback from students about dissection

13.301 *because of the good feedback we get for it.*

7.150 *...still do a lot of dissection, that's always well*

received.

Never wanting to lose the dissection experience	6.127	<i>That's certainly how I... I'd never want to lose that.</i>
Distinguishing the medical students from the pure anatomy students in their manner of cadaveric study - medics don't dissect	3.70	<i>And they only, they, they don't dissect... the medical students only use prosections...</i>
Believing students actually choose his course because it is dissection-led	7.148	<i>I genuinely think that's one of the reasons they come onto the course, the anatomy course,</i>

Theme 3. Engaged in the pedagogical problem space

Subtheme 3.1 Reflecting on TLAs

Aware of the distinction between what is taught and what students are using to learn	4.84	<i>Do you mean outside of the... outside of what we're teaching?</i>
Believing that students are using prosections in their SDL	4.93	<i>...it's mostly using the models and the prosections for their private study.</i>
Acknowledging textbooks as a resource that students use	4.96	<i>And definitely textbooks</i>

Uncertain exactly how much students are using textbooks	5.98	<i>I don't know how much they're using the textbooks outside of the HARC</i>
Assuming that students are using lecture recordings at an increasing pace	5.100	<i>...instead of revising from textbooks, they'll go over the lecture.</i>

Subtheme 3.2 Believing in the supremacy of engagement through interaction

Believes that dissection and art-based methods are a means to promote interaction & engagement	12.274	<i>...any methods that get students to talk,</i>
The best method is that which promotes interaction	12.276	<i>...the best method... It's a good method, as far as I'm concerned.</i>
Positive about art-based methods	12.281	<i>And I think they work...</i>
Believing that art-based methods work because they promote interaction	12.282	<i>...but I think what's better is the fact that they're talking about it and getting it in their head...</i>
	12.295	<i>...but I think it's doing, it's doing it together, and going through it that helps them remember it.</i>
Convinced that student interaction is key to engagement	12.286	<i>they've gotta think about it and chat about it, you know.</i>

Subtheme 3.3 Developing online resources

Taking pride in the online resources he has created for students	5.110	<i>we've been very, very hot on making videos</i>
	5.111	<i>I'm halfway through doing an online course for the students...</i>
Acknowledging the increased use of apps by students in their SDL	4.94	<i>...you know the apps are becoming more popular outside of the HARC</i>

Subtheme 3.4 Observing and responding

Acknowledging that students will not remain engaged without sufficient facilitation	6.136	<i>...they start to zone out.</i>
Feeling that he should be doing more in terms of making videos	5.109	<i>Probably we should be doing more...</i>
Believing that medical students should be getting assessed on anatomy in the clinical years	9.215	<i>...asking them basic science questions, I think would be very beneficial to them.</i>
Enthusiastic about offering increased anatomy exposure opportunities to clinical students	10.226	<i>...we have started - literally in the last month - to offer,</i>
Admitting that previous attempts to open anatomy to clinical students via evening workshops were met with low uptake	10.230	<i>Well, in the past, it has been quite low,</i>

Theme 3. Reckoning with disconnect

Subtheme 4.1 Recognising barriers to success

Pointing to faulty logistics for the poor uptake of evening workshops	10.237	<i>...but I think that's more to do with the logistics</i>
Recognising that time constraints are to blame for reduction in anatomy hours and poor vertical integration on the medical course	11.262	<i>the students have massive pressures on what they...</i>
	11.268	<i>...because they're just out of time.</i>
Believing that medical students would ideally have more time in the anatomy department to revise	13.308	<i>the med students don't get to come to the anatomy department to revise...</i>
Would like more space in the anatomy dept	13.311	<i>we've got to remedy that with more space...</i>
Feeling that resources overall are not currently a barrier	13.299	<i>we do get a lot of resources for the anatomy department</i>
	13.314	<i>We're certainly not lacking for resources, I don't think.</i>

Subtheme 4.2 Acknowledging a mismatch in alignment

Sitting with the tension between knowing anatomy is crucial for clinical practice but resigned to the impact of constraints	13.319	<i>...it's hard to give the students space for revision,</i>
Acknowledging that medics don't get any spotter exams	9.207	<i>No, so, eh, the medics don't get any spotter exams, no.</i>
Sitting with uncertainty around how much if at all clinical students are being assessed on their anatomy	9.221 - 222	<i>Eh, but I don't think, and I should check this, but I don't think they're getting any basic science questions after year two.</i>
Wishing for spotter tests in the clinical years as a way of vertically integrating anatomy in the curriculum	14.327	<i>I would like to see a specific anatomy assessment. I would like my students to do spotter exams.</i>
	14.328	<i>I think that's the gold standard for anatomy.</i>

Subtheme 4.3 Awaiting alignment... potentially?

Acknowledging the lack of vertical integration as a mismatch	11.250	<i>Yeah, yeah, absolutely, I think, eh, I think there's a mismatch..</i>
Believing that the mismatch might be mitigated by the new MLA	11.251	<i>I think that's going to be addressed..</i>
Expressing some uncertainty around what the MLA will require	11.252	<i>we don't know the shape of this new MLA, eh, the Medical Licensing Assessment, that's coming in...</i>

Hopeful that the MLA will constrain for vertical integration of basic sciences

11.255
- 256

...if that wants any basic science, you know, it's guaranteed the med school...

EXHIBIT 10. Table of Personal Experiential Themes From Analysis of K: Emma

	Page/line	Quotes
Theme 1. Reflections on the journey to becoming an anatomy educator		
Subtheme 1.1 Reflecting on education & teaching		
Own anatomy journey defined by dissection	1.3	<i>Through dissection.</i>
Connecting her dissection education with her teaching practice	1.5	<i>That's the way I learnt it... that's the way why I now teach it.</i>
Teaching preclinical medics and biomedical science undergrads	1.13	<i>So I teach, em...</i>
Teaching 3-4 days per week as a teaching associate	1.17	<i>Em, ooh, I would say three, if not four days a week.</i>
Subtheme 1.2 Reflecting on the bigger picture of her current role		
Demonstrating an overall understanding of the degrees she's teaching on	2.33 - 43	<i>If it's biomed, it's three years. And if it's medicine, it's five years...</i>

Sitting with the knowledge that the medical curriculum is drastically about to change

3.47 ... is going through a sort of a medical curriculum overhaul at the minute.

Pointing to her role as based outside the Centre for Medical Education as the reason she isn't involved in the medical curriculum decisions

5.118 ...They just sort of use us to teach their basic sciences,
-
6.124

Invested in thinking about the curriculum longitudinally while simultaneously feeling 'othered'

13.29 So with long term goals in mind, I do think there
8 should be...

Theme 2. Dealing with the 'othering' of anatomy staff

Rationalising her lack of decision-making involvement with the medical programme

5.121 So I don't actually belong to the Centre for Medical Education

12.27 Like, I'm also aware that I am relatively new to the
9 post and...

Reflecting on her opinions with an explicit disclaimer that she is not involved as a decision-maker

5.119 Sorry, I should explain, the centre that I'm from...

12.27 But because I'm not the Centre for Medical
3 Education...like, my input to that is very minimal.

	11.26 5	<i>In the sort of grand hierarchy of things, like I'm very junior...</i>
Using humour to cope with a degree of frustration about being marginalised	5.113	<i>I would...Not be the best person to ask about that... [laughter]...</i>
	6.123	<i>I'm not quite sure what happens to them. It's probably better that way [laughter].</i>
	12.28 1	<i>Twenty years more experience than I do... probably do know what they're talking about [laughter]</i>
Resigned to going along with what comes	4.95 - 96	<i>Play it by ear and maybe change things as we go along.</i>
	12.28 3	<i>...we'll go with that and trust their judgement and see how it works out.</i>
Believes her input as a contributor should be factored into the curriculum	12.27 9	<i>I do. Yeah.</i>

Theme 3. Operating in the realm of discipline-specific alignment

Subtheme 3.1 Reflecting on LOs

Demonstrating a nuanced approach to delivering LOs from umbrella to specific

9.200 *...umbrella learning outcomes, at the start.*

9.202 *And week on week, they get much more specific learning outcomes.*

Writing exam questions as LOs with a question mark at the end

9.206 *...go to your learning outcomes and put a question mark at the end of it*

Reconciled to the fact that students might not be listening

9.210 *I don't know how much they listen to it [laughter].*

Subtheme 3.2 Designing Teaching & Learning Activities

Sub-subtheme 3.2.1 Seeking engagement

Describing own TLA methods as 'classic'

5.99 *Yeah, yeah, I would*

Recognising that some students take a much more active approach

6.139 *...other students who may take a much more active approach*

Acknowledging the use of rote memorisation

6.133 *A lot of the students sort of get roped into the rote learning.*

Not advocating rote memorisation	6.136	<i>I tell them off for it quite a bit. [laughter]</i>
Acknowledging that students who wish to use apps have to invest their own money	7.149	<i>I know some of the students will go and get that off their own accord...</i>

Sub-subtheme 3.2.2 Reflecting on the use of kinesthetic activities

Viewing kinesthetic methods as additional add-ons, never core	7.160 - 168	<i>...it's kind of been talked about like maybe having like a body painting class there...</i>
Believing anatomy body painting could be useful	8.172	<i>I do see how it could be useful.</i>
Feeling some colleagues would consider body painting superficial	7.169	<i>I think other people think it's maybe be a little bit flowery...</i>
Pointing to the high costs of maintaining cadaveric study as a reason for not offering more tech-enhanced methods	6.145 - 7.148	<i>...because dissection itself is expensive...</i>
Acknowledging that imaging would be useful if the anatomists could get trained on how to use it in teaching	8.187	<i>We would just need to get trained up in it ourselves [laughter]</i>

Subtheme 3.3 Assessment in anatomy

Demonstrating detailed knowledge of current discipline-specific assessment methods	3.52	<i>So at the minute, em, they have like three spot tests a year.</i>
Acknowledging that imaging is not used in assessment	8.191 - 193	<i>They don't get any radiological images.</i>
Observing that preclinical students wouldn't be expected to interpret imaging as part of assessment	8.193 - 195	<i>they're not really expected to... to make much of that, sort of, this early on.</i>
Doesn't see matching TLAs with assessment as important	10.24 0 - 246	<i>So I don't see it as a huge issue.</i>
Believing that in a discipline specific sense, TLAs and assessment are matched	10.22 4	<i>But I think it's very well standardised and very well matched.</i>

Subtheme 3.4 Anatomy aligned within the medical curriculum

Confirming the current distinction between preclinical and clinical years	2.37	<i>...they get their basic sciences in first and second year, at the minute.</i>
Believes it would be beneficial for clinical students to have more anatomy exposure	11.25 0	<i>Yeah, I do. I think that, I think that that would only be beneficial.</i>

	11.25 6	<i>So, yeah. I think integrating it further is a good idea.</i>
Sympathetic with students who are so time-constrained	11.25 1 - 256	<i>And you know, that's not their fault.. You can't you can't blame them for that.</i>
Fairly certain that students only get anatomy questions in their preclinical years	5.106 -	<i>Em, So I am not 100 percent sure, but I would be inclined to go with...No.</i>
Reconciled with her lack of input into the clinical years assessments	5.105 - 106	<i>So I don't set examinations...The module coordinators would do that.</i>
	5.118 - 119	<i>But, I don't really know the details - em - of all of that.</i>

Theme 4. Waiting for the change to Progress Testing

Subtheme 4.1 Expressing concerns

Believing that the PT will make up the entirety of student marks, pushing out the spotters	4.77	<i>...the progress assessment is gonna make up 100 per cent of their marks...</i>
Concerned that spotters will go from summative to formative	4.79 - 80	<i>...they won't be summative assessment, they'll only be formative...</i>

Sitting with uncertainty about if/how/when the proposed curricular change to PT will actually take place

4.72 *So that seems to be the way it's it's gonna go*

3.65 *We don't know how it's gonna work.*

4.94 *So I'm not sure how it will work in that regard.*

12.28 *Well at the minute they're thinking of...*
8

13.31 *Well, it's just it's sort of a work in progress. I don't*
9 - *know if this is actually... I mean that's the goal at the*
321 *minute...*

Very concerned to confirm her anonymity

Subtheme 4.2 Believing that it makes sense to vertically integrate anatomy

Seeing the benefits of PT

4.84 *I can see the benefit of the progress testing. I think it's a good idea*

Believes that keeping the OSCEs alongside the PT will be

12.28 *I think is a good thing...*
9 -

beneficial	290	
Pushing for anatomy stations within the OSCEs	12.29 1	<i>...we could have anatomy stations within the OSCEs</i>
Believes that spotters - a practical element - are important for encouraging professionalism	12.29 5 - 296	<i>It's not just assessing their knowledge, it's preparing them for their profession.</i>

Subtheme 4.3 Recognising a paradox in the aim to vertically integrate anatomy

Grappling with the awareness that PT aims to integrate anatomy into the assessment of the medical degree as a whole	3.62 - 63	<i>...they would like all of their basic sciences sort of integrated... First through fifth year.</i>
Recognising that PT will constrain for students to keep up their anatomy knowledge	4.87	<i>...hopefully retain their information a lot better.</i>
	4.89	<i>I think the progress assessment will work well for that.</i>
Unsure if the anatomy spot tests will remain summative		

Concerned that PT will negatively impact student motivation if the spotters become merely formative

4.91

I don't know what that will do for the student's motivation

Believing that it is important for spotters to remain summative in order for students to take them seriously

13.29
8 -
300

...practical elements that should be summative that should count for something.

EXHIBIT 11. Table of Personal Experiential Themes From Analysis of L: Vanessa

	Page/line	Quotes
Theme 1. Reflections on the journey to becoming an anatomy educator		
Subtheme 1.1 Reflecting on educational experience		
Characterising her anatomy journey as pre e-learning	1.5	<i>I'm of a generation where e-learning wasn't available</i>
Describing first degree where she did both animal and human dissection	1.6 - 8	<i>My first degree was anatomy...where I did both animal and human dissection</i>
Identifying with kinesthetic methods of learning	1.9 - 10	<i>...a lot of the learning happened when I got to actually put my hands in and feel for things...</i>
Subtheme 1.2 Reflecting as a teacher		
Currently teaching anatomy on a medical programme	1.16	<i>Yes. Medicine.</i>
Teaching predominantly preclinical medics	2.25	<i>I guess predominantly year two medical students.</i>

Describing teaching load in terms of yearly number of hours 1.19 *I do over two hundred and fifty hours a year.*

Teaching a range of learners outside of medicine 2.26 - *...from widening access to medicine events at one*
28 *end...*

Subtheme 1.3 Sharing awareness of the wider curriculum

Maintaining an extensive overall understanding of the 2.35 - *...they graduate with BMBS - Bachelor of Medicine*
36 *Bachelor of Surgery... MSc in surgical simulation*

Having an awareness of the assessment methods throughout 3.57 *Predominantly MCQ SVAs and OSCEs.*
the five-year medical programme

Aware of the length of study for each degree 2.42 - *...the medical students are five years. And the MSc is*
43 *usually one or two years.*

Confirming the distinction between preclinical and clinical years 3.50 *I guess year one and two are system-based*
modules...

Teaching on a programme where anatomy is revisited in the 3.53 *They revisit anatomy in year four...*
clinical years

Theme 2. Operating in the realm of curriculum alignment

Subtheme 2.1 Basic sciences: achieving vertical integration and beyond

Taking responsibility for vertically integrating basic sciences in the curriculum	7.146 - 147	<i>...my job role, em, is to ensure that anatomy is represented and appropriately covered in the assessment.</i>
Would like to see continued commitment to making anatomy easier and more accessible to clinical students	11.26 3	<i>...make the anatomy more easy and accessible for students or identifiable for students... in their clinical years.</i>
Thinking about how a public display license could widen their ability to make anatomy more accessible	10.24 1	<i>We're applying for a public display license because...</i>
Recursive anatomy exposure gives anatomists more opportunity to focus on clinical relevance	4.71	<i>...year four they come back it's team-taught with myself and the EMT surgeons, consultants...</i>

Subtheme 2.2 Keeping the cadaveric element

Keen to demonstrate reverence to cadaveric study methods	5.116 - 117	<i>I mean cadaveric use and things are amazing and I would always recommend that...</i>
Believing that revisiting clinically relevant anatomy via cadaveric study is useful	4.76	<i>...they're furthering their knowledge of anatomy.</i>

Would like to vertically integrate cadaveric study further in the curriculum	3.67	<i>I think it should probably happen more and I'd like to do it more.</i>
Describing the particular manner cadavers are used in different years	3.62	<i>...first-year students dissect cadavers, em, second-year students...</i>
Aware that revisiting cadaveric study in clinical years may well be unique	3.67	<i>It might be.</i>

Subtheme 3.3 Assessment integration

Confirming that students will see living/surface anatomy questions in assessment	6.129	<i>Yes, so they can be asked questions on em, SVAs or SAQs on living anatomy or surface anatomy.</i>
Recognising that students are strategic and focus on learning what they know will be assessed	6.136 - 137	<i>...a lot of our students are very strategic,</i>
Believing that clinically-relevant ultrasound would generate engagement regardless of whether it is widely assessed	6.137 - 138	<i>...because it's so clinically centred, I think they would still be really good uptake and use of it anyway.</i>
Recognising the struggle to evenly distribute exam questions for broad representation of all subjects	7.148 - 152	<i>I guess there's always a fight for time and assessment numbers...only so many questions...</i>
Recognising that anatomy knowledge is implicitly assessed in the OSCEs	11.25 8 -	<i>...by then it's so intertwined into clinical practice, that it doesn't need to be labelled as anatomy.</i>

Subtheme 3.4 Reflecting on TLAs

Sub subtheme 3.4.1 Working with imaging in the curriculum

Recognising the utility of ultrasound machines	6.121	<i>...as ultrasounds are becoming as usable as stethoscopes...</i>
Interested in connecting surface anatomy drawing with ultrasound	4.87	<i>...surface anatomy drawing and using live ultrasound...</i>
Using clinically relevant task-based methods to guide the ultrasound in near-peer session	5.103	<i>And in those sessions, the first task is often to draw out certain structures...</i>
Describing the utilisation of ultrasound as a spiral that recurs throughout the programme	7.157	<i>Yeah, so imaging continues as a spiral in - eh - so the use of ultrasound continues...</i>

Sub subtheme 3.4.2 Celebrating near-peer

Connecting near-peer with ultrasound	4.87	<i>...using live ultrasound on each other.</i>
Engaged in the use of near-peer learning	4.94	<i>We have near-peer teaching sessions.</i>

Interested in further developing the near-peer resource 10.23 *I guess I'd like to do more with the near-peer*
9 *teachers in those later years.*

Subtheme 3.5 Acknowledging limitations

Aware of the time/space constraints on lab access 9.215 *Because I don't plan on opening my lab to be there*
24/7.

Embracing technology-enhanced learning in response 9.212 *...that's where the 3D printing and where technology-*
- 213 *enhanced learning comes in really well.*

Recognising that rising student numbers may represent a 10.23 *...worried that we will lose the personal element...*
challenge 4

Theme 3. Demonstrating characteristics of an engaged educator

Subtheme 3.1 Taking ownership of a signature TLA

Describing learning ultrasound 'on the fly' 8.179 *Yeah, completely on the fly.*

Reflecting with pride on her initiative for learning ultrasound 9.172 *Yeah. I've never been trained in how to use*
independently *ultrasound...*

Taking pride in her wider success with ultrasound in anatomy	5.112 - 113	<i>...as I'm sure you've seen out of that came the Grey's surface anatomy and ultrasound book, em...</i>
Maintaining a convincing rationale for her continued use of ultrasound	5.118 - 122	<i>...most medical students are not going to see dead people too often.</i>
Demonstrating awareness of which other institutions are also using ultrasound and to what extent	7.166 - 169	<i>I know Newcastle are using ultrasound quite a lot.</i>

Subtheme 3.2 A sense of emergent personal and professional well-being

Feeling very supported by colleagues and institution	9.219	<i>Oh yeah, 100 per cent</i>
Recognising that while they could do more, her institution maintains strong vertical integration of anatomy	8.185	<i>I think there's always more opportunities. I think we're doing a good job...</i>
Taking pride in the high institutional ranking based on student feedback	9. 198 - 200	<i>...we're sitting top of the National Student Satisfaction Survey and so whatever we've been doing...</i>
Happy to note that clinical educators and anatomists maintain good communication	7.161 - 162	<i>...there's been many meetings between all of us so we all know who's teaching what bit along that journey.</i>
Recognising that she used to champion for more anatomy in the	11.24	<i>I was always looking for, you know, anatomy to be</i>

clinical years, now realises it is already happening

8 -
260 *branded later on... But then when you go through an OSCE...*

Subtheme 3.3 Enjoying a high level of professional confidence

Recognising that anatomy is a selling point for her institution and that she is part of that

10.22
2 *...and anatomy has been a strong selling point of _____ for a number of years.*

Assuming that others are aware of her success

9.197
- 198 *...we're in a very privileged position because - you're probably aware -*

Feeling that she is not being scrutinised

10.22
4 -
225 *...I know I'm in a fortunate position - we're not under scrutiny for what we do.*

Confident about reflecting off-the-cuff

11.24
8 265 *Em... what would I like to see... So I don't... That's not a clear answer.*

Does not see the need to add anything further into the clinical years to support vertical integration of basic sciences

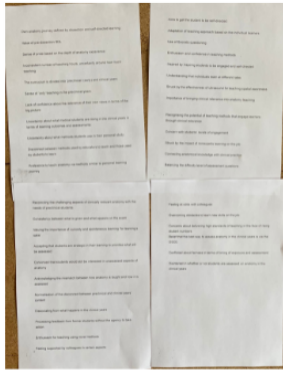
11.26
2 *I don't think anything in particular...*

Theme 4. Embracing the Hidden Curriculum

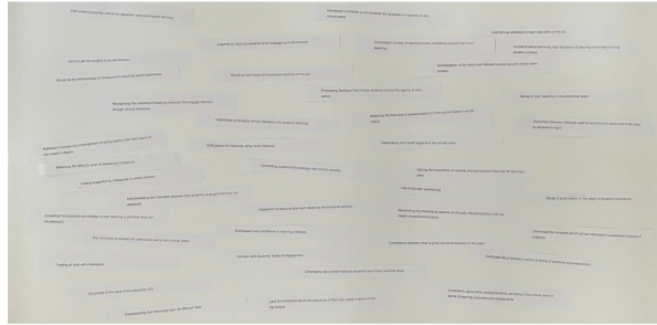
Aware that students use anatomy apps in their private study

4.90 *They have access to Visible Body as an app*

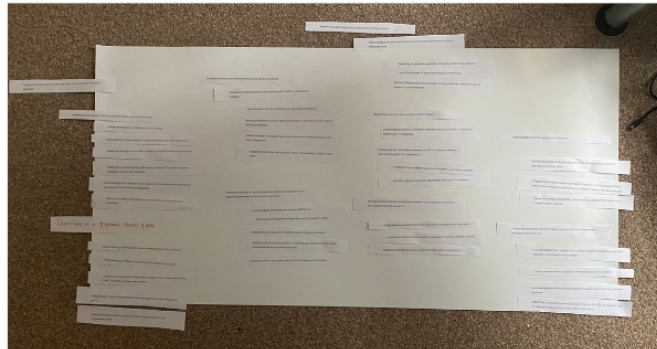
Accepting the distinction between explicitly given and 'private' study	4.91	<i>...so I know they use that in their private study time.</i>
Committed to delivering a range of learning opportunities	9.205 - 206	<i>...we really have to make sure that we're delivering learning in lots of different ways.</i>
Recognising the nonlinear aspects of learning	9.208 - 209	<i>...also that we recognise that learning occurs outside of our own teaching</i>
Convinced of her responsibility to deliver TLAs so students can choose when and how they engage	9.209 - 212	<i>I guess it's about trying to make sure that there are resources for them to pick up that learning when they want to... and how they want to do it.</i>



A) Personal experiential statements in no particular order



B) Clustering of experiential statements



C) Beginning to name the Personal Experiential Themes

Chapter 18: Appendix F: The IPA process of generating PETs