



Designing an Inclusive Game-Based Framework for Enhancing Chinese Students' Teamwork in UK Engineering Programmes

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Abstract

With the internationalisation of higher education, the number of international students (mainly Chinese) in UK universities—particularly in one-year postgraduate taught (PGT) engineering programmes—has increased significantly. At the same time, engineering education has shifted towards project- and problem-based approaches, making teamwork a critical competence for students' academic and professional success. However, many Chinese PGT students have limited prior exposure to teamwork training during their undergraduate studies and little relevant work experience, resulting in weak teamwork skills. On the other hand, UK educators also lack a comprehensive understanding of these students' teamwork learning behaviours, leaving a gap in the development of relevant inclusive teaching practices.

This study is an action research project employing a mixed-methods design, aiming to achieve two primary objectives: (i) to explore Chinese students' teamwork learning behaviours and challenges in UK engineering courses; and (ii) to design and evaluate pedagogical interventions to enhance their teamwork learning experiences. Data collection included classroom observations, questionnaires, exploratory cognitive (working memory) tests, and semi-structured interviews. Based on the findings, a game-based teamwork workshop was developed to support PGT students in understanding team roles and enhancing collaboration competencies through interactive learning activities.

The workshop was implemented at two UK universities with 145 engineering PGT students. Post-workshop surveys revealed that 88% of participants expressed interest in continuing to engage in such teaching activities, and 74% self-reported an improvement in their understanding of teamwork via self and peer evaluation. Overall, the study demonstrates that integrating game-based practice design can enhance interaction, engagement, and teamwork awareness among students in cross-cultural teams, providing a practical and inclusive pedagogical model to support international students' learning in UK engineering programmes.

Keywords: Postgraduate taught students; Teamwork; Game-based learning; Chinese students; Engineering education.

Declaration

I hereby declare that this thesis is my own work and that all sources used have been acknowledged. The work presented here has not been submitted previously, in whole or in part, for any degree or qualification at any other institution.

I also confirm that there is no conflict of interest in relation to this research. All ethical guidelines were followed during the research process.

Signature: He Ya

Date: 30/03/2025

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List of Abbreviations

BTRSPI - Belbin Team Role Self-Perception Inventory

CHCs - Confucian Heritage Cultures

CN - Chinese

EN – English

GBL – Game-Based Learning

GTAs - Graduate Teaching Assistants

Manchester CE - Chemical Engineering-related Programmes at the University of Manchester

MIS - Math-Item-Sequence Scoring System

MRM- Mixed Research Methods

OBE- Outcome-Based Education

Ospan - Operation Span

PBL - Problem-Based Learning

PCU - Partial Credit Unit Method

PGR - Postgraduate Research

PGT - Postgraduate Taught

PjBL - Project-Based Learning

RL - Rote Learning

RQ – Research Question

SAF - Self-Assessment Form

SDT - Self-Determination Theory

SDGs - United Nations Sustainable Development Goals

Sheffield CMBE - Environmental and Energy Engineering Programmes at the University of Sheffield

Sheffield EEE - Electronic and Electrical Engineering-related Programmes at the University of Sheffield

SRL - Self-Regulated Learning

SSIs - Semi-Structured Interviews

UG - Undergraduate

WM - Working Memory

WMC - Working Memory Capacity

ZPD - Zone of Proximal Development

List of Publications

Conference/Publisher	Paper Title	Type	Author(s)
ISEE 2022 8th International Symposium for Engineering Education Education for Chemical Engineers	Investigating Inclusivity of Digital Learning and Teaching for Overseas Students Enrolled in the UK STEM Programmes Investigating Chemical Engineering Students' Perceptions of Feedback: A Glimpse Into Current Problems and A Platform for Improvement	Conference proceedings Journal	Ya He and Mo Zandi Ya He, Olumide Olumayagunand Mo Zandi
The Chemical Engineer	Unlocking the power of learning: top tips for chemical engineering students and teachers	Magazine	Mo Zandi and Ya He
Journal of PGR Pedagogic Practice	Unveiling the Crossroads: Reflections on Teaching Chinese Master's Students in Chemical Engineering Labs	Journal	Ya He
EERN 2023 UK & Ireland Engineering Education Research Network Annual Conference 2023	Investigating the Experiences, Performance and Expectations of Chinese Master Students Studying UK Engineering Courses	Conference proceedings	Ya He and Mo Zandi
ASEE 2024 American Society of Engineering Education Annual Conference	Designing Inclusive Teamwork Activities to Improve International Master's Students' Teamwork Skills in Chemical Engineering.	Conference proceedings	Ya He, Eleni Routoula and Mo Zandi
SEFI 2024 European Society for Engineering Education Annual Conference	Enhancing International Chemical Engineering Postgraduate Taught Students' Teamwork Skills via the Inclusive Workshop and Team- building Games	Conference proceedings	Ya He and Mo Zandi

CHAPTER 1: INTRODUCTION

1.1 Background and rationale of the study

With the development of global higher education and increased student mobility, the number of international students enrolled in UK universities has grown steadily in recent years. In the UK, over 150,000 study visas have been issued annually to international students between 2020 and 2024 (GOV.UK, 2024). A large proportion of these students come from non-English speaking countries, and most are enrolled in one-year postgraduate taught (PGT) programmes (GOV.UK, 2025). Moreover, many of these students are encountering the UK higher education system for the first time, which may present them with multiple challenges, including linguistic adjustment, cultural unfamiliarity, and academic adaptation (Andrade, 2006; Gu, 2015; Lee & Rice, 2007; Newsome & Cooper, 2016).

Beyond these initial transitions, international students in UK universities also cope with the growing competitive demands of the global job market. In particular, the development of Industry 4.0 has reshaped the learning priorities and competence requirements of engineering graduates, who are now expected to demonstrate not only technical expertise but also strong transferable and human-centred skills (Trevelyan, 2019; World-Economic-Forum, 2020). In collaborative engineering practice, competencies such as teamwork, communication, and problem-solving are often as crucial as disciplinary knowledge (Engineering-Council, 2014; Shuman et al., 2005). Unlike technical skills, which may become outdated with technological change, transferable and human-centred skills such as project management, adaptability, and collaboration are essential for engineering students' long-term employability and career progression (Male, 2010). On the other hand, employers increasingly recognise that while technical proficiency may secure entry-level roles, sustained professional success depends more on a balanced skill set that integrates technical and interpersonal abilities (May & Strong, 2011).

For engineering students, therefore, university education should not only emphasise disciplinary achievement but also deliberately foster the development of human-centred professional skills. Yet, despite widespread recognition of their importance, the integration of such competences into higher education curricula remains uneven (ABET, 2025; Graham, 2018). At the same time, the changing characteristics of contemporary learners also influence

how such skills should be taught. New generations of “digital natives” often prefer interactive, experiential, and technology-enhanced approaches to learning (Feise & Schaer, 2021; Hussin, 2018; Prensky, 2001). They are accustomed to communicating through digital platforms, social media and games, and increasingly drawing on online search engines to support self-regulated learning (Prensky, 2001; Selwyn, 2009). These shifts highlight the need for higher education institutions to adapt teaching practices to maintain the engagement and learning effectiveness of the new generations of students.

Thus, traditional teaching models may not always align with these evolving learning preferences. Without adjustment, educators may risk student disengagement and suboptimal learning outcomes (Gaston, 2006; Wu et al., 2015). Therefore, in the context of evolving cross-cultural and international education, further research into international (Chinese) students' learning behaviours holds significant importance for advancing inclusive teaching practices within UK universities. While previous studies on Chinese students in UK higher education have explored academic performance and language proficiency broadly (Bodycott & Walker, 2000; Gu, 2015; Zhou & Todman, 2009), relatively few have focused on their teamwork learning experiences. Yet, teamwork is central to UK engineering curricula, where collaborative projects and group assignments form a major part of assessment and professional preparation (Graham, 2018). Especially, for many Chinese PGT students, whose prior undergraduate training often emphasised individual study and examination performance (Turner, 2006; Wu, 2015), thus adapting to teamwork-intensive learning environments may present them with distinctive challenges.

In light of this background, this study focuses specifically on Chinese PGT engineering students in UK universities, aiming to explore their teamwork learning behaviours and to design inclusive pedagogical models (game-based approaches) that can enhance their teamwork learning outcomes. This focus reflects both the practical importance of teamwork in engineering education and the relative neglect of this area in research on Chinese engineering students' teamwork behaviours.

1.2 Research objectives

This study aims to investigate the teamwork learning behaviours and experiences of Chinese PGT engineering students in UK universities and to design an inclusive teaching practice that enhances their teamwork skills. Resonating with the previous statement, this research contributes to two key areas:

- Expanding and updating understanding of Chinese students' teamwork learning behaviours and their perceptions of collaborative learning in UK engineering courses;
- Developing, implementing, and evaluating an inclusive, game-based teaching practice to promote Chinese students' teamwork skill development within engineering curricula.

The interest in this focus stems both from identified gaps in previous research and from practical challenges observed in UK classrooms. Existing studies on Chinese students in UK higher education have mainly examined academic performance, language proficiency, and individual study habits (Bodycott & Walker, 2000; Gu, 2015; Zhou & Todman, 2009). Much less attention has been paid to their experiences of teamwork-based learning, despite its centrality in UK engineering education, where collaborative projects and group assignments form a significant part of the curriculum (Graham, 2018). Moreover, Chinese students' prior educational experiences are often dominated by independent and exam-oriented learning (Turner, 2006; Wu, 2015), which means they may lack both the training and the confidence to engage effectively in teamwork-based activities. This underexplored area highlights a critical research gap: the need to understand how Chinese PGT engineering students learn in teams and how inclusive pedagogy can better support them.

In response, this study takes students' teamwork learning behaviours in practical courses as its starting point. Adopting an action research approach, it follows a cycle of problem identification, literature-informed gap analysis, practical observation, intervention design, and iterative implementation with feedback. Within this framework, mixed-methods strategies are employed to provide a holistic understanding of students' experiences, including classroom observations, questionnaires, learning ability tests, and semi-structured interviews. Findings from these stages directly inform the development of game-based teaching interventions designed to improve students' understanding of team roles, collaboration strategies, and

engagement in teamwork. The interventions are then implemented and evaluated through student feedback and performance data, ensuring that practice is continually refined in response to evidence.

Ultimately, the research not only addresses the initial questions but also contributes to the development of research-informed, inclusive pedagogical strategies. It provides empirical evidence on Chinese students' teamwork learning in UK engineering programmes and offers a practical model for integrating human-centred skills into engineering education. The overall research development is summarised in Figure 1.1, which illustrates the action research cycle from problem identification to implementation and evaluation.

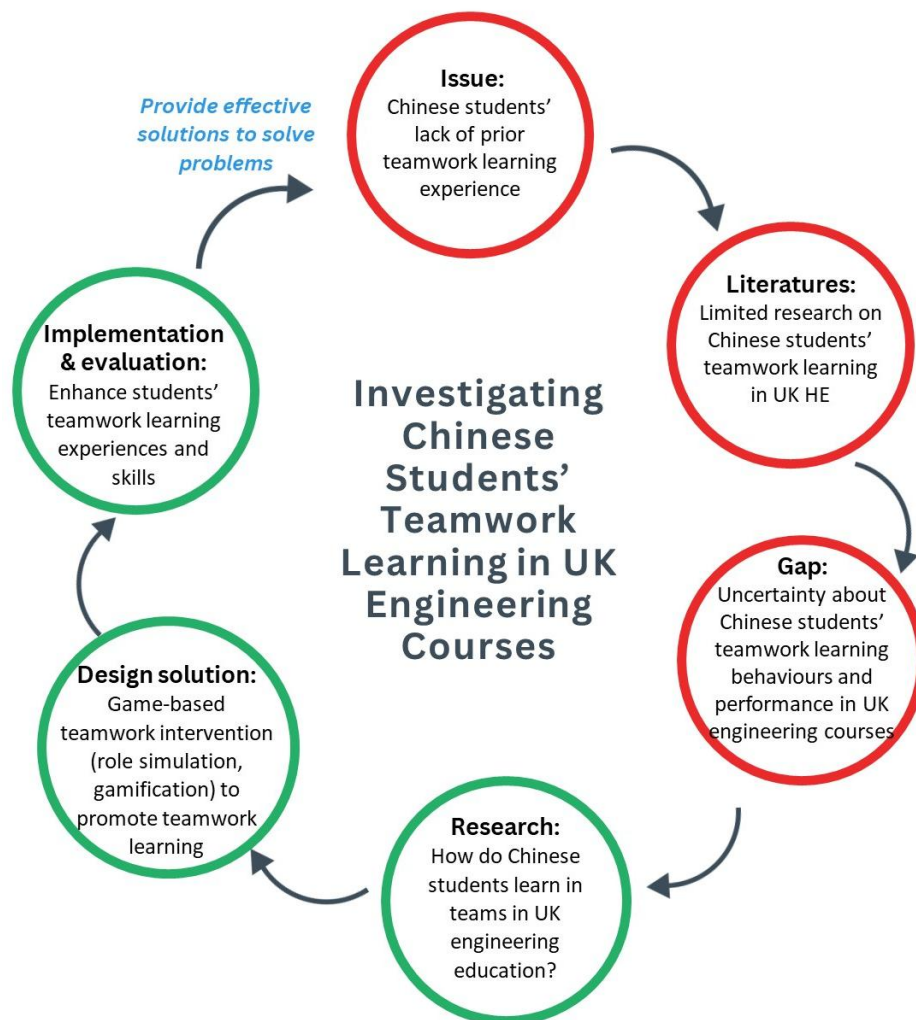


Figure 1.1 Research development roadmap.

This diagram illustrates the action research cycle underlying the study. Beginning with the identification of Chinese students' lack of prior teamwork learning experience, it highlights the limited literature and research gaps concerning their teamwork learning in UK engineering education. The cycle progresses through research on teamwork learning

behaviours, the design of a game-based teamwork intervention, and its implementation and evaluation. The feedback from each stage informs the refinement of practice, ensuring that the study addresses both the identified gap in the literature and the practical challenges in teaching.

To ensure that the research progresses in manageable stages, the following targeted objectives were formulated:

1. To explore Chinese PGT engineering students' learning expectations, preferences, and cognitive capacities (working memory capacity) in UK higher education, through classroom observations, learning questionnaires, and working memory tests.
2. To investigate Chinese students' teamwork learning behaviours and perceptions, using semi-structured interviews and feedback from laboratory-based teaching.
3. To design and implement an inclusive, game-based teamwork workshop framework, drawing on Belbin team role theory and gamification techniques to promote teamwork learning.
4. To evaluate the effectiveness of the workshop and provide recommendations for enhancing teamwork and transferable skills development among international students in UK engineering education.

These objectives are directly aligned with the research questions presented in the next Section 1.3, ensuring that the study is both theoretically grounded and practically actionable.

1.3 Research questions

The research questions of this research were formulated in a staged manner. The first two questions (RQ1 and RQ2) take a broader perspective by investigating Chinese students' general learning expectations and behaviours in UK universities. This diagnostic exploration was necessary to identify the key challenges that students face when adapting to a new educational context. Building on the findings of this initial stage, the second stage (RQ3 and RQ4) narrows the focus to teamwork learning. Teamwork emerged as a particularly critical area of challenges for Chinese students in UK engineering courses, and one that has been underexplored in existing research. Therefore, the study concentrated on understanding their

teamwork learning experiences and on developing and evaluating inclusive pedagogical practices to enhance them.

Accordingly, the four research questions are:

Research Question 1 (RQ 1): What are Chinese students' learning expectations in UK higher education?

Research Question 2 (RQ 2): What are the learning behaviours of Chinese students studying in UK engineering practical courses?

Research Question 3 (RQ 3): How do Chinese students perform and experience teamwork in UK engineering courses?

Research Question 4 (RQ 4): To what extent can an inclusive workshop, incorporating teamwork games, enhance Chinese students' teamwork learning skills and experiences in UK engineering programmes?

1.4 Significance of the study

Engineering education does not only rely on the construction of educational theories and the improvement of the system, but its fundamental value lies in the cultivation of talents capable of effectively responding to and solving practical engineering problems. This process involves not only the transfer of knowledge and the cultivation of skills, but also the shaping of engineering thinking, innovation, and interdisciplinary collaboration. The core objective of engineering education should be to closely integrate theory and practice, so that learners can apply what they have learnt in the complex and changing real-world scenarios, and promote the progress of engineering technology and the development of society. Thus, the field of engineering education is not confined to classrooms or laboratories, but is constantly evolving and being optimised as a result of advances in the real world. Much of what is achieved in the physical world today is due to the success of engineering technologies and innovations. Thus, it is the responsibility of the global community to ensure that engineering education continues to develop and innovate along with industry and the wider society.

There is no denying that engineering education plays a crucial role in shaping the future workforce, driving technological advancements, and addressing global challenges. As

engineering problems become more complex and interdisciplinary, engineering education must evolve to equip students with not only technical expertise but also skills in critical thinking, problem-solving, teamwork, and adaptability. A well-developed engineering education system ensures that graduates are industry-ready, innovative, and capable of contributing to society through sustainable and ethical engineering practices.

Furthermore, modern engineering students have diverse learning needs influenced by globalisation, digital transformation, and changing industry demands. Today's students come from various cultural and academic backgrounds, which requires educational models that adapt to different learning styles, prior knowledge, and career aspirations. Moreover, the new generation of students often prefer interactive, hands-on learning experiences over traditional lecture-based instruction. Staying updated on these learning needs enables educators to design more engaging, effective, and relevant courses that enhance student motivation, retention, and skill development.

Based on these perspectives, the significance of this study can also be considered on two complementary levels: theoretical significance and practical significance.

- Theoretical significance: This study contributes to the growing body of literature on international students' learning in UK higher education by focusing specifically on Chinese PGT engineering students' teamwork learning, an underexplored area in previous research. It expands the theoretical understanding of how cultural and educational backgrounds shape students' engagement with teamwork in UK higher education contexts. By integrating insights from pedagogy, experiential learning theory, and cognitive science (e.g., working memory), the study offers a multi-dimensional perspective on how learning behaviours and teamwork performance are interrelated. Furthermore, the design and evaluation of a game-based inclusive teaching framework extends the application of game-based learning and action research in engineering education, providing a novel model that bridges theoretical inquiry and practice.
- Practical significance: At the institutional level, the findings provide empirical evidence that can inform the design of inclusive teaching practices and policies, supporting international students' adaptation and promoting effective teamwork in engineering curricula. The inclusive game-based workshop developed in this research offers a replicable model that can be adopted or adapted by educators across different courses

and institutions. At the international level, the study contributes to the global dialogue on engineering education by providing insights into cross-cultural teamwork learning, helping universities worldwide respond more effectively to the challenges of student mobility and cultural diversity. At the student level, the research demonstrates how targeted interventions can enhance students' teamwork skills, self-awareness, and engagement, thereby improving not only their academic outcomes but also their employability and capacity to contribute to society as well-rounded engineers.

1.5 Scope of the study

This study employed a mixed-methods research design, with the main investigation conducted at the University of Sheffield, a public university in the UK. The primary focus of the study was on Chinese postgraduate taught (PGT) engineering students, as they represent one of the largest international student groups in UK higher education and face distinctive challenges in adapting to team-based learning environments. The findings can offer insights for wider international student cohorts, although the scope of this research is explicitly centred on Chinese students' learning expectations, behaviours, and teamwork experiences in UK engineering programmes.

The research participants were predominantly Chinese PGT students enrolled in engineering courses. Data were collected through classroom observations, learning questionnaires, working memory tests, and semi-structured interviews. In the later stages of the study, an inclusive game-based teamwork workshop was designed and implemented with three PGT cohorts at both the University of Sheffield and the University of Manchester. Student feedback was subsequently collected to evaluate the effectiveness of the intervention and to refine the design for broader application.

By defining its scope in this way, the study ensures a clear alignment between its research questions, methodology, and significance, while avoiding overgeneralisation beyond the intended focus.

1.6 Thesis structure

This Thesis consists of eight chapters. The overall schematic map of the thesis structure is shown in Figure 1.2.

Chapter 1 provides an introduction to the study, including the research background, objectives, research questions, and significance of the study.

Chapter 2 presents the theoretical foundation and a review of relevant literature. It begins with an overview of the development of Chinese students and the Chinese education system, then narrows the focus to Chinese students studying at UK universities, and examines their current learning experiences. To further explore the challenges these students may face in different educational settings, the second section discusses the nature of learning. While learning is an inherent human ability, external environmental factors may influence the process. However, there is still relatively limited research on how the learning abilities of diverse students are affected when there are changes in the teaching and learning environment. This literature review chapter also introduces the educational theories and pedagogical approaches applied in this study. Given that one of the key aims of this study is to understand the academic performance of Chinese engineering students and to design practical strategies to enhance their learning experience, the final section explores the implementation of engineering education in UK universities and the essential competencies required for engineering students. This discussion underscores the broader significance of this study, contributing to the development of engineering education practices and fostering well-rounded engineers in the future.

Chapter 3 outlines the research design and methodological approach adopted in this study. It begins with an overview of the research design, incorporating both quantitative and qualitative approaches. The chapter then details the data collection procedures, which include questionnaires, interviews, learning ability tests, and the design of inclusive practice (game-based teamwork workshop and educational games). Additionally, this chapter includes the ethical considerations associated with the study.

Chapters 4 to 7 present the research findings and discussions, systematically addressing each research question with an integrated analysis of data to provide comprehensive insights and recommendations.

Chapter 8 presents a case study of the implementation of the designed game-based teamwork workshop and games in the University of Manchester, highlighting the impact of this new teaching practice within the wider engineering educational community.

Chapter 9 discusses the limitations and contributions of the study and offers recommendations for future research.

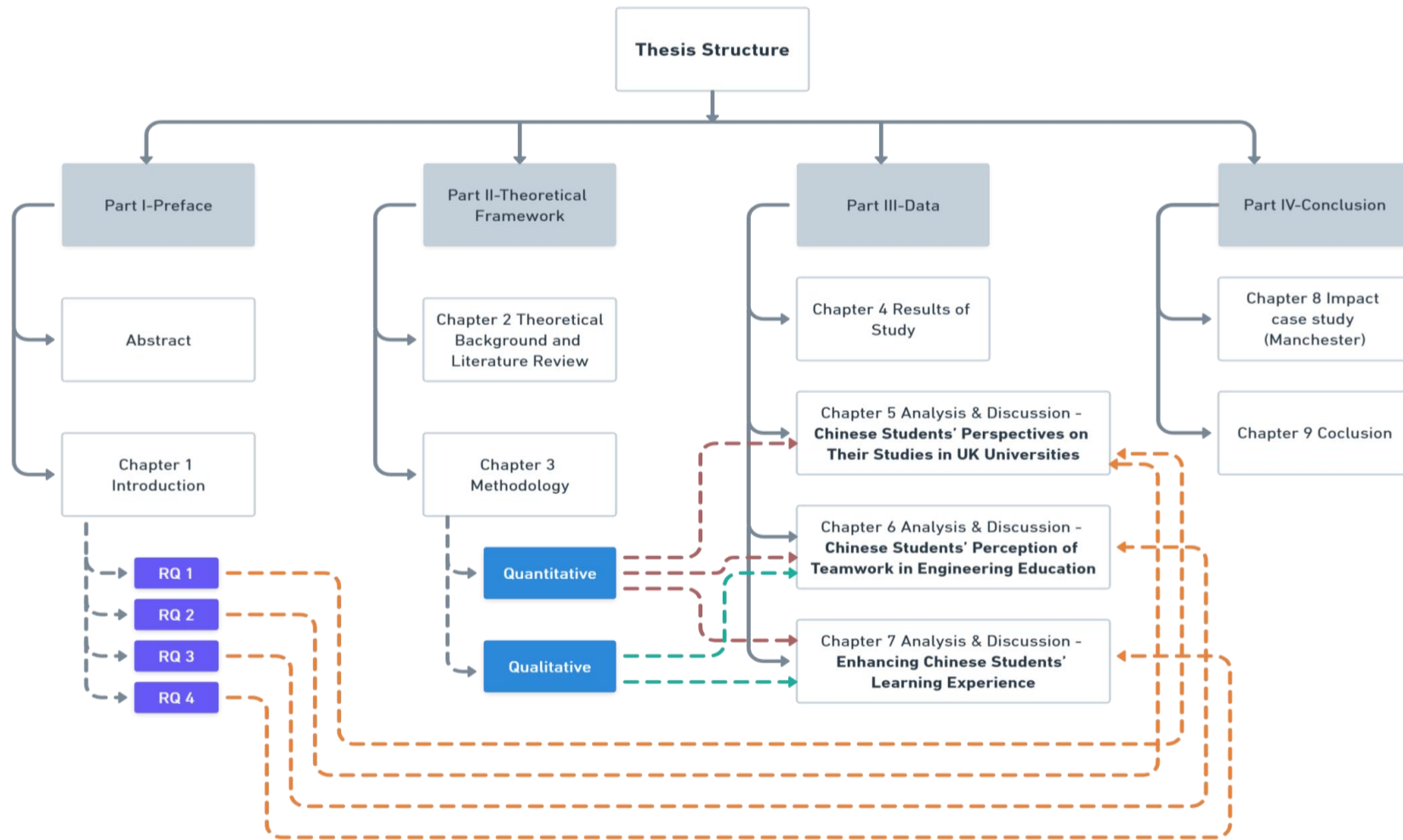


Figure 1.2 Schematic map of the thesis structure.

This thesis structure map explains the scope of the main content covered in each of the chapters of this thesis, as well as the interconnectedness of the content of the chapters.

CHAPTER 2: THEORETICAL BACKGROUND & REVIEW OF LITERATURE

PART 1: Education Systems

Part 1 Introduction

In recent years, with the acceleration of globalisation and the increasing frequency of international educational exchanges, comparative research on Eastern and Western higher education systems has become a significant topic of academic inquiry. The distinct cultural backgrounds, social institutions, and historical traditions of these two educational systems have shaped unique pedagogical models. Western higher education systems prioritise student-centred learning, emphasising individualised development, critical thinking, and a flexible, practice-oriented teaching approach that fosters autonomy in learning. In contrast, Eastern higher education systems, particularly that of mainland China, are deeply influenced by Confucian traditions and the broader socio-cultural changes brought about by economic reforms since the 1980s. The Chinese system places a stronger emphasis on knowledge transmission, collectivist values, and academic grades, particularly as reflected in standardised examinations. Such differences extend beyond pedagogical methods and learning objectives to include variations in students' study habits, teachers' instructional strategies, and educational assessment frameworks. Thus, these differences may consequently lead to challenges and feelings of disorientation for Chinese students upon entering Western universities.

Against this backdrop, the first part of the literature review explores the characteristics of mainland Chinese students and the structure of their education system. Through a comparative analysis of Chinese and UK higher education systems, this section evaluates their cultural and social contexts, pedagogical models, and systemic strengths and weaknesses. This discussion provides the foundation for understanding a key theme of this research: the motivations and expectations of Chinese students pursuing higher education in the UK, and the specific challenges they may encounter in adapting to a contrasting learning environment.

By critically reviewing these issues, this section not only deepens the understanding of Chinese student learning and their experiences in UK education, but also highlights why cultural and institutional perspectives alone are insufficient to fully explain students' learning processes and outcomes.

2.1 Mainland Chinese learners

2.1.1 Characteristics of mainland Chinese learners

In line with the demands of global industrialisation 4.0 and the internationalisation of education, more and more international universities face increasing development pressures. They are, therefore, expanding the proportion of recruiting international students (Chen, 2016) to cover their financial budget deficits. The increase in the proportion of international students in Western universities makes higher education more profitable and commodified. Among these international students, those from mainland China constitute the overwhelming majority. The surge of Chinese students pursuing higher education in Western universities can be attributed not only to changes in China's domestic socio-economic landscape but also to their curiosity and desire to explore more diverse educational methodologies. Rooted in a traditional Confucian cultural background, Chinese students bring distinct learning characteristics shaped by their educational upbringing. When these students enter a predominantly Western academic environment, their learning approaches inevitably interact with Western pedagogical models, resulting in a unique process of adaptation and exchange.

Based on past studies, Western educational researchers usually define Chinese learners as students from the People's Republic of China, Hong Kong, Taiwan, and Singapore (Biggs & Watkins, 1996), or what we might call a class of learners with traditional Confucian culture and thinking (Tan, 2017). Traditionally, students from East Asian societies rooted in Confucian cultural values have been collectively referred to as "Chinese students" in educational research. This definition, however, encompasses students from Hong Kong, Taiwan, and Singapore—regions whose education systems have been shaped by Western influences to some extent (Liao, 2017; Zhang, 1998). In contrast, mainland China, after the economic reform and opening-up, has undergone profound transformations in its economic structure, infrastructure, and technological research. These changes have also significantly impacted its education system, leading to the emergence of a distinct pedagogical model and learning culture compared to other Asian countries. Whereas, in this study, the discussion will focus on mainland Chinese students only.

The education system in mainland China is predominantly examination-oriented, deeply rooted in Confucian cultural values such as "diligence," "perseverance," and "respect for teacher authority" (Biggs & Watkins, 1996; Li, 2006). Students raised in this context typically

demonstrate strong academic motivation and place a high value on knowledge acquisition (Liu & Littlewood, 1997). They generally believe that hard work is the primary pathway to success, with learning objectives predominantly focused on grades, rankings, and examination outcomes.

Regarding learning habits, Chinese students during basic education develop a dual approach characterised by "passive reception" and "rote memorisation." In classrooms, teachers maintain dominant roles, while students primarily rely on teacher-led explanations with limited opportunities for active questioning or participatory discussions (Jin, 2001; Li & Chen, 2018; Tsegay & Ashraf, 2015; Xu & Valdez, 2024). After class, extensive homework assignments and repetitive drills become normative practices. This "practice-problem-intensive" learning approach reinforces content mastery but may simultaneously inhibit the development of critical thinking and innovative capacities (Gu & Maley, 2008; Niu, 2007).

Furthermore, within collectivist cultural frameworks, Chinese students generally exhibit rule-compliance tendencies and avoid "standing out" in class to maintain group harmony (Cohen, 2007; Lin et al., 2017; Liu et al., 2019; Oyserman, 2006).

When mainland Chinese students initially enter Western universities, their learning behaviours and cognitive patterns face significant challenges requiring adaptation (Gu et al., 2010). Western higher education emphasises critical thinking, active learning, and classroom interaction—pedagogical approaches that substantially differ from traditional Chinese instructional models (Ryan, 2011). In Western classrooms, Chinese students often manifest characteristics of "silent learners," demonstrating low classroom participation and lacking initiative in questioning or challenging ideas (Kingston & Forland, 2008). This phenomenon stems partially from language barriers but more fundamentally reflects cultural differences (Mathias et al., 2013; Niu, 2007; Zhou et al., 2020). Additionally, their reverence for teacher authority and fixation on "correct answers" generate discomfort when confronting open discussions or tasks without definitive solutions (Wu, 2015).

With prolonged interaction, Chinese students can gradually adapt to Western pedagogical approaches, transitioning from "exam-oriented" to "comprehension-based" learning strategies (Meng, 2023; Yin, 2013). They begin engaging in critical literature review, participating in group discussions, and gradually accepting knowledge uncertainty and

pluralism. Particularly in collaborative group work and project-based learning (PBL), students can progressively recognise the importance of teamwork and intellectual exchange, showing improvement in self-expression and critical thinking skills (Tian & Lowe, 2013).

Nevertheless, some Chinese students may face persistent adaptation challenges in Western institutions. These include misunderstandings of academic integrity principles (e.g., proper citation and plagiarism), deficiencies in self-regulation and time management, and uncertainties when encountering open-ended assessments (Turner, 2006). These issues relate not only to individual capabilities but more fundamentally reflect inherent differences between Chinese and Western educational philosophies and cultivation paradigms.

2.1.2 Traditional Chinese education (focused on the Chinese mainland)

Western scholars have argued that the Confucian tradition has influenced the philosophy of learning of students from several Asian countries, of which mainland China is one of the most dominant Confucian countries. For example, Chinese educators and students take learning as a social and moral responsibility (Xia & Tong, 2020; Zhang, 1996). In China, the typical teacher-student relationship is a "superior-subordinate" relationship (Liu, 2017). Under the influence of traditional Confucianism, the teacher-student relationship in the classroom is highly hierarchical (Li, 2022), which means the teacher has a higher status than the students. Compared to Western education, the teacher-student relationship is more of an equal relationship, and both are in reciprocal positions (Guo, 2022; Liu & Li, 2017; Thornberg et al., 2020)

The behaviour of students asking questions and teachers responding to questions in China differs from the West. In the Chinese classroom, the teacher spends most of the time teaching while the students listen quietly. Students' participation in class is limited to answering the teacher's questions and having few discussions (Jin & Cortazzi, 2006; Li, 2022). Thus, most learning is passive (Biggs & Watkins, 1996). The silence of Chinese students in the classroom is also related to the traditional concepts of "face" and "the doctrine of the mean" under Confucianism (Ha & Li, 2014; Wang, 2019; Wu, 2009). Chinese students do not ask questions easily to avoid being ridiculed by their peers or even criticised by their teachers for asking too simple questions (Huang, 2015; Malik et al., 2017; Wang & Roopchund, 2015). Further, in the

Chinese learning culture, students asking questions is a supplement but not essential to learning (Huang, 2015). These limited interactive teaching and learning behaviours may then lead to the lack of Chinese student participation in the classroom (Cheng, 2000; Cortazzi & Jin, 1996). However, in Western learning cultures, teachers encourage students to express themselves and are concerned with their individual development (Li, 2022; Shreeve, 2008). Therefore, in the Western classroom, students can be more active and engaged in teaching activities.

On the other hand, influenced by its own traditional social and cultural atmosphere, the traditional classroom in mainland China is usually seen as hierarchical and teacher-centred. In traditional Chinese culture, the principle of “尊师重道” (reverence for teachers and adherence to their teachings) has long been upheld, leading to a hierarchical dynamic in which students view their teachers as authoritative figures. The knowledge taught by teachers should be accepted without question. As a result, many Chinese students tend to adopt a passive learning approach, refraining from questioning teachers or proposing novel perspectives (Jepsen et al., 2015; Magulod, 2019; Tian, 2019). Therefore, Chinese students' learning objectives in classrooms mostly consist of memorising learning materials and passing exams. This authoritarian educational mode has been argued that may restrict students' creativity and original thinking (Chinnapun & Narkkul, 2024; Salili, 1996). Moreover, Chinese teachers are conservative in their use of teaching materials, and most never teach anything beyond the textbook. While Western teachers are more "open" to the content of textbooks and prefer to use questions to guide students to find answers from outside (Huang, 2015).

2.2 Comparison between Chinese (mainland) and the UK Education

2.2.1 The origins of Chinese and the UK education

When discussing Chinese students or the Chinese approach to learning, rote learning (RL) (死记硬背) has become a defining characteristic of this educational system. This default learning concept originates from the profound influence of Confucian heritage cultures (CHCs) on Chinese society.

RL, as a prominent feature of Chinese learning methods, is widely believed to be shaped by Confucian ideology and has persisted for thousands of years. However, a critical question

arises: how did this perception develop? When Western educators discuss Chinese education and students, they frequently associate both with Confucian culture (Bergen & Mi, 1995; Biggs & Watkins, 1996; Li & Hayhoe, 2012). But if we trace back to the original purpose of Confucianism, its fundamental emphasis should be on the importance of education and learning for personal development (which is the same as emphasised in modern Western universities), rather than the passive Chinese style of learning that is widely observed today. At a more fundamental level, Confucian education originally centred on critical thinking and reflective learning (Luo, 2021; Zhong, 2018).

The later misinterpretation of Confucian culture may have originated from the examination system developed during the ancient Chinese talent selection process—known as the "Imperial Examination (科举)", which originated in the Sui Dynasty in 605 AD—became the sole means of assessing students' academic achievements for over a thousand years. The only way to succeed in this system was to memorise a standardised set of Confucian texts that formed the core of the examination syllabus. Instruction in these classical texts was predominantly conducted in "private academies (私塾)", which were small, privately or family-run educational institutions primarily focused on Confucian classics. The teaching methods used in these institutions heavily relied on rote memorisation. However, the imperial examination system, which lasted nearly 15 centuries, further institutionalised mechanical memorisation and examination-based learning as the default strategy for both teachers and students in China.

For centuries, Chinese students have not been required to engage in creative thinking beyond the examination framework or to express opinions that diverge from orthodox perspectives. In addition, there is the influence of Confucianism on the social order, which reinforces the hierarchical distinction between teachers and students (Martinsons & Martinsons, 1996), positioning students from Confucian cultural backgrounds in a predominantly passive role in teacher-student interactions.

Therefore, the development of Chinese education and its students has been shaped by a dynamic and complex interplay of historical, social, and cultural factors. Even nowadays, it is impossible to define Chinese education in absolute terms. Following nearly three decades of social-economic reform and opening-up, Chinese society has undergone profound

transformations. These developments have inevitably influenced the education system and students in China, including reforms to the National College Entrance Examination (Gaokao, “高考”), the internationalisation of Chinese universities, and the digitalisation of education (EDU.CN, 2022).

Despite the ongoing reforms and advancements in China’s modern education system, examinations remain the dominant means of assessing knowledge. Beyond merely evaluating students’ academic performance, examinations often play a decisive role in shaping their career prospects. Historically, success in ancient Chinese society was closely linked to success in examinations, as high performance led to upward social mobility (Li, 2004). Consequently, examination-oriented education has persisted, with teachers and students focusing primarily on content that facilitates exam success while practical skills and critical thinking are increasingly neglected. Ultimately, Chinese students, who are accustomed to this system, often experience difficulties in adapting when they first enter universities in the UK and other Western countries.

This contrast arises because, unlike the Chinese education model, the origins of the Western education system can be traced back to ancient Greece and Rome, where the foundations of liberal education were laid. Philosophers such as Socrates, Plato, and Aristotle emphasised the importance of reason, rhetoric, and dialectical inquiry as core educational principles, advocating for the cultivation of civic virtue and knowledge (Polyakova, 2019). Building on these philosophical traditions, the medieval period saw the establishment of universities—primarily in Europe—which became centres for higher education and intellectual discourse (Perkin, 2014; Polyakova, 2019).

Later, the Renaissance further introduced humanism, emphasising the study of classical texts and the intrinsic value of the individual. This intellectual shift spurred broader educational reforms, encouraging critical thinking and placing greater emphasis on the arts and sciences (Black, 1991; Grendler, 2004; Polyakova, 2019). The emphasis on classical education became a normative standard, shaping the structure and expectations of the modern Western education system (Oplatka & Arar, 2017). The evolution of Western education was also deeply influenced by socio-political factors. During the Enlightenment, the concepts of democracy and civic responsibility became intertwined with educational objectives. The emergence of

public education systems in the 19th century marked a shift towards greater accessibility and inclusivity, driven by the belief that an educated citizenry was essential for the health of democratic societies (Robert & Yu, 2018).

In contrast to the Chinese education system, which historically aligned with the imperial selection mechanism for government officials, Western education places greater emphasis on individualism and personal autonomy. This focus enables students to pursue personal interests, develop critical thinking skills, and cultivate a sense of independence and agency in their learning process (Metz, 2017). Such a cultural foundation has fostered an education system that prioritises learners' individual rights and educational choices, standing in stark contrast to Eastern education models, which emphasise collective values and community (Metz, 2017).

Furthermore, Western education systems often adopt a liberal arts framework, promoting a broad educational experience rather than a singular technical training approach. This structure encourages students to engage with diverse disciplines, including the humanities, social sciences, and natural sciences, fostering interdisciplinary understanding and holistic development. The origins of this approach can be traced back to ancient Greece, where a well-rounded education was highly valued (Polyakova, 2019). Liberal education is also often regarded as essential for cultivating informed citizens capable of making thoughtful contributions to societal discourse (You & Morris, 2015).

As a result, Western classrooms tend to emphasise critical pedagogy, encouraging students to question assumptions and explore the socio-political contexts of knowledge. This pedagogical approach promotes active student participation and fosters critical awareness among learners (Demirdağ & Khalifa, 2020). Consequently, modern Western teaching practices often incorporate reflective practice, creating inclusive classrooms that embrace diverse perspectives and backgrounds (Ali, 2016).

Following the discussion on the fundamental differences between Chinese and the UK educational traditions, it is evident that significant distinctions exist in their educational models and learning habits. In contemporary education, educators need to navigate increasingly diverse and internationalised learning communities. Understanding these historical foundations and key differences is crucial for designing and implementing inclusive

teaching approaches tailored to different student groups, ensuring that all learners receive effective and equitable educational support.

2.2.2 Differences between the Chinese Mainland and the UK education system

In Chinese higher education, most courses usually use the traditional "lecture" teaching method in large classes (Mo & Liu, 2022; Yang, 2010). A fixed number of teachers teach all courses to a fixed number of students at a fixed time. The most fundamental teaching model in China is teacher-centred, while students are only the audience (Zhao, 2020). The class overemphasises the "teaching" aspect of teachers and weakens the "learning" initiative of students. The single model of teaching and learning is tailored to most average students and easily ignores individuals' characteristics and creativity development (Xie et al., 2014; Yao & Ren, 2012). A recent study also indicates that Chinese students' critical thinking tends to decline after completing university courses, as seen in both top elite and average universities in China (Loyalka et al., 2021).

In contrast, more different teaching methods are applied to support "lecturing" in Western university classrooms. For instance, group learning and discussion, interactive Q&A, and presentations are the typical forms of instruction in Western classrooms (Boetje & Van Ginkel, 2021; Ferreri & O'Connor, 2013; Pollock et al., 2011; Smith et al., 2009; Springer et al., 1999). Also, there are more extra-curricular research events, programme-related tutorials and seminars after the class (Balwant & Doon, 2021; Crosson, 1983). Additionally, the Western evaluation system includes a more diverse and cumulative form of examinations (Struyven et al., 2005), such as self and peer evaluations (Dochy et al., 1999; Van den Berg et al., 2006). The discrepancies between Chinese and the UK education are summarised in Table 2.1.

Table 2.1 Comparison between the Chinese and the UK education systems

	Chinese Education Style	The UK Education Style
Teaching Style	Teacher-centred, textbook-centred	Student-centred, problem-based
Role of Teachers	Instructors	Supporters/Coaching
Learning Style	Detail and precision-oriented, rote learning	Communication, discussion-based, extensive reading
Role of Students	Listeners	Participants
Knowledge Content	Understand basic principles and theories	Develop professional abilities and experiences

	Chinese Education Style	The UK Education Style
Learning Objectives	Cultivating intelligence	Cultivating abilities to practice, social skills and personality
Assessment and Evaluation	Exam-centred, process-oriented	Practical experience/abilities, outcome-oriented
Expectations for Students	Accept the knowledge system already existed	Create their own knowledge system

From this comparison, we can see that there are indeed differences in educational styles between Chinese and Western universities. In China, the classroom is primarily a stage for the teacher while the students are busy taking notes and having little time to think independently. Furthermore, teachers' instruction is one-way and hierarchical, so students tend to listen more, speak less, and think less. As a result, the development of students' communication skills, interest in learning and creative thinking are somewhat limited in a traditional Chinese classroom (Li & Cao, 2017). In Western, the teacher is the facilitator who guides students to express their own opinions and intrigues students' initiative to learn via teamwork and discussion (Jones, 2007).

2.3 Contextualising mainland Chinese students learning in UK universities

Chinese students are the largest group of UK's international students (Universities-UK, 2022). Based on an online report, Chinese students have been the largest group of international students at UK universities in recent years (Beard, 2021). Moreover, the economic benefits and socio-cultural development brought by Chinese students to local communities are neglected (Hillman, 2021). Then more international students came, and more benefits they brought, such as increasing diversity and inclusivity on campus, bringing additional financial income to UK higher education providers and making a significant contribution to educational research efforts (Gill, 2007; Hillman, 2021). Chinese students comprise the majority of international students on Western university campuses today (Cebolla-Boado et al., 2018). However, due to the differences in pedagogical and cultural backgrounds between Western and Eastern societies, they have troubles with adaptation. Western academic standards are often applied to evaluate Chinese students' learning behaviours, and they indicate that most Chinese students lack active engagement and critical thinking skills (McMahon, 2011). However, looking from Chinese students' perspective, the reason they are unable to fully

adapt to the Western-style teaching environment may be that they are unfamiliar with the Western education mode; because they are accustomed to traditional Chinese education, they may prefer to work alone rather than in groups; and they often do not like to ask questions and might not understand well the meaning of peer-to-peer discussions (Zhu & O'Sullivan, 2022). In group discussion and communication, international students often keep silent (Cortazzi & Jin, 1996; Matalene, 1985). These situations may be caused by the differences of educational culture between East and West, which lead these students to spend more time adapting and transforming their learning habits and strategies when entering Western classrooms. But the concepts of active engagement and critical thinking are central to problem-based learning (Akcanca, 2020; Gram et al., 2013) and project-based learning (Kokotsaki et al., 2016) in engineering education. The lack of these learning skills may further affect the learning outcomes of international students and exacerbate the mismatch between the UK education model and the learning habits of Chinese students.

2.3.1 Reasons for Chinese students to choose to study in UK universities

As the internationalisation of global education grows, the UK higher education institutions with the unique curriculum, teaching style and research opportunities, especially one-year PGT programmes, is very attractive to Chinese students and their families who are seeking high-quality educational opportunities. The short duration of these UK degree courses is quite an appealing situation in the context of the highly competitive domestic education system in China (Zhai & Cao, 2022). The UK curriculum often emphasises critical thinking, practical skills and team-based learning, contrasting with the more theoretical focus prevalent in Chinese education (Wang et al., 2022). Furthermore, UK universities are often regarded as prestigious institutions that offer high standards of teaching and research. Liu (2012) highlights that the belief in studying abroad as a worthwhile investment is prevalent among Chinese students and their families, who expect significant improvements in their English language skills and overall educational experiences. The emphasis on university prestige is echoed in other findings, which reveal that university rankings significantly influence Chinese students' choices (Gong & Huybers, 2015; Hu et al., 2022; Li & Ai, 2022).

In addition to focusing on academic development, employability is a crucial factor driving Chinese students to pursue higher education in the UK. International experience is

increasingly linked to enhanced employability, as students perceive a UK degree as a competitive advantage in the job market (Huang & Turner, 2018). The social recognition and career benefits associated with a UK education further reinforce this motivation (Peng, 2023).

On the other hand, cultural exchange experiences and personal growth also play a vital role in attracting Chinese students to the UK. Studying abroad is often seen as an opportunity for self-improvement and cultural immersion, with motivations including relaxation, self-development, and adventure (Huang & Tian, 2013). The transformative learning experiences offered by UK universities further contribute to students' personal growth and global perspectives (O'Dea et al., 2023). Additionally, advanced socio-economic factors and the appeal of a diverse educational environment also influence the international students' decisions (Manns & Swift, 2015).

2.3.2 International students' expectations of learning in UK universities

Not only for Chinese students, all International students studying in UK universities will face a complex landscape of learning expectations and outcomes shaped by various cultural, academic, and social factors. Thus, understanding these dynamics is crucial for enhancing their educational experiences and ensuring successful integration into the local academic environment. One of the primary challenges international students encounter is the adjustment to a new educational culture, which often differs significantly from their home countries. Many international students arrive with limited understanding of the academic expectations in Western institutions, including the norms of classroom participation and the style of academic writing required (Maringe & Jenkins, 2015; Preston & Boateng, 2024). This lack of familiarity in education mode can lead to feelings of isolation and inadequacy, particularly when students perceive their language skills as insufficient (Aisha & Mulyana, 2020). The pressure to conform to these new academic standards can exacerbate stress and hinder their overall learning experience (Iorga et al., 2020).

Moreover, the social integration of international students is another critical aspect that influences their educational outcomes. Previous research indicates that a sense of belonging is essential for academic success, yet many international students report feelings of alienation due to cultural differences and social barriers (Tian et al., 2021; Tian, 2019). Thus, applying

programmes designed to foster community among diverse students, such as orientation sessions and peer mentorship, can enhance their sense of belonging and facilitate smoother transitions into university life (Aisha & Mulyana, 2020). Additionally, universities that actively promote diversity and inclusion through campus-wide initiatives can help bridge the gap between local and international students, fostering collaborative learning environments (Earnest et al., 2010).

The psychological well-being of international students has also received increasing attention in recent years. Many of international students will face acculturative stress, which can stem from navigating a new cultural landscape while managing academic pressures (Schartner & Young, 2016). Institutions that provide robust mental health support and counselling services tailored to the unique needs of international students can mitigate these challenges and promote better academic outcomes (Li et al., 2016; Smith et al., 1999). Furthermore, the role of university and faculty in recognising and addressing the diverse needs of international students is crucial. Faculty members who are trained in culturally responsive teaching practices can create more inclusive classrooms that acknowledge and value the contributions of international students (Devezy et al., 2023).

In addition to these challenges, international students often have high expectations regarding the quality of education and the opportunities available to them in Western universities. Many of them pursue studies abroad to gain cultural capital and enhance their employability in a global market (Dobosz & Hetmańczyk, 2023; Jin & Schneider, 2019). However, the reality of their experiences can sometimes fall short of these expectations, particularly when they encounter barriers related to language, cultural misunderstandings, and institutional support (Page & Chahboun, 2019). To address these gaps, universities and educators should develop comprehensive support systems that not only focus on academic skills but also on cultural acclimatisation and career development (Crockett & Hays, 2011; Page & Chahboun, 2019).

It is clear that the learning expectations and outcomes of international students at Western universities are influenced by a variety of factors, including academic culture, social integration, mental health and institutional support and even more. Chinese students, who now make up the majority of the international student body in the UK, have similar expectations of the UK university experience, but are more motivated by the desire to gain an international qualification that will be recognised in the highly competitive job market. Many

of them see the postgraduate study in the UK as a strategic move away from the fierce competition of the Chinese education system, while the shorter duration and lower tuition fees of the UK's PGT programmes make them highly attractive (Monk, 2012; Zhu & Reeves, 2019). The international education experience gained is seen as a significant asset for enhancing employability upon returning to China (Huang & Turner, 2018). Nevertheless, the extent to which these anticipated benefits can be realised largely depends on students' ability to adapt to the new academic and cultural environment, which presents significant challenges.

The great challenge for Chinese students is how to make a smooth and effective transition and adapt to the UK education system. The shift from a rote learning culture to one that emphasises independent thinking and critical analysis can be difficult, particularly for those unfamiliar with autonomous learning (Quan & Reilly, 2024). Some students can adapt well after prior exposure to UK education, while others may struggle with language proficiency and academic expectations (Dai, 2023). Cultural adaptation further shapes students' academic and social integration, with those possessing greater familiarity with UK educational norms more likely to succeed (Ma, 2024). Studying abroad is not merely an academic pursuit but also a transformative life experience that fosters personal development and cultural understanding (Zhang, 2023).

2.3.3 UK educators' perceptions of mainland Chinese students

Within any education system, teachers and students coexist, forming the interconnected cycle of teaching and learning. Therefore, when assessing and discussing students' learning experiences, the perspectives of educators are equally indispensable. Over the past two decades, as an increasing number of Chinese international students have enrolled in UK universities, UK educators have gained more understanding of this growing student cohort's learning. The UK educators' insights extend to various aspects, including academic performance, cultural adaptation, teaching preferences, and overall educational experiences. This evolving teaching and learning interaction has not only enhanced the UK educators' awareness of Chinese students' learning characteristics but has also driven pedagogical adaptations within UK higher education to better support their academic development and cross-cultural experience.

A key concern in the literature is the academic attainment gap between Chinese and the UK students. Over the course of a three-year undergraduate degree, Chinese students often lag behind their UK counterparts, a disparity largely attributed to differences in teaching and learning approaches (Richardson & Sun, 2016; Spencer-Oatey et al., 2017). This highlights the importance of UK educators recognising the unique challenges faced by Chinese students, particularly in adapting to the interactive and critical learning environment characteristic of UK higher education. Similarly, other research indicates that while the UK students tend to adopt a consistent approach to studying, Chinese students often employ different learning strategies, leading to potential misalignments in expectations between educators and students (Sun & Richardson, 2012).

Beyond academic performance, cultural integration is another critical aspect influencing the UK educators' perceptions. The model minority stereotype can contribute to a lack of support, as educators may assume that Chinese students do not require additional resources due to their perceived academic success (Dai, 2023; Ma, 2024; Quan & Reilly, 2024). This assumption can inadvertently result in social isolation, as students may feel pressured to meet high expectations without adequate institutional support. However, despite cultural differences, Chinese students share similar expectations with their UK peers regarding the importance of academic support, particularly in relation to personal tutorials (Comerio & Walker, 2021).

Furthermore, the pedagogical preferences of Chinese students play a significant role in shaping educator perceptions. Differences in educational backgrounds often result in learning preferences that may not align with UK teaching methods, creating challenges for both students and instructors (Winch, 2015). This misalignment can lead to frustration, as the UK educators may struggle to engage students accustomed to more structured or exam-oriented learning styles. Nevertheless, technology-supported teaching may offer opportunities to bridge this gap. The integration of mobile technologies, for instance, has been shown to enhance student motivation in language learning, suggesting that digital tools could be leveraged to improve engagement and learning outcomes (Zhang, 2024). It also proves that adopting innovative teaching methods can help international students make effective learning adjustments.

Finally, employability also remains a central concern for both Chinese students and the UK educators. Understanding how Chinese students perceive their employability in the context

of international education is essential for institutions seeking to support their career aspirations (Huang & Turner, 2018). The credential inflation and intense competition in the Chinese job market drive more and more students to pursue degrees abroad, underscoring the need for UK institutions to provide relevant employability skills and career support (Li, 2013) Wang. By understanding these academic, cultural, and career-related challenges, the UK educators can better facilitate the integration and success of Chinese students in UK higher education.

2.3.4 Dilemma of Chinese students studying in UK universities

For most Chinese international students, studying at a UK university marks their first full immersion in a Western teaching environment. This transition often presents a range of challenges, with language proficiency being one of the most significant barriers. Many Chinese students struggle with English, which can hinder both academic performance and participation in classroom discussions. Language adaptation is a major source of dissatisfaction, affecting students' ability to access lectures and fully engage with their education (Wang & Shi, 2018). In addition, language difficulties, combined with differences in content knowledge and the fast-paced nature of course delivery, create further academic obstacles (Lin & Zhang, 2021). Beyond comprehension challenges, the language barrier also contributes to feelings of isolation and anxiety, reinforcing the tendency for Chinese students to remain silent in the classroom (Peng, 2023).

Although Chinese students, like all other international students, are required to pass standardised English proficiency tests—such as IELTS, TOEFL, or PTE, etc.—before formally entering their academic programmes at Western universities, passing these exams does not necessarily equate to possessing the requisite academic language skills for degree-level study. In practice, many Chinese students, despite meeting the language entry requirements, continue to face challenges in applying academic English. These difficulties extend beyond general language proficiency to include comprehension of specialised terminology, academic writing, classroom discussions, and the articulation of critical thinking (Huang, 2012; Peng, 2023; Wang, 2022; Yuan, 2022).

Cultural differences further compound these challenges. The Chinese education system, which emphasises rote learning and standardised testing, contrasts sharply with the interactive and critical-thinking-based pedagogy prevalent in the UK. Adapting to these differing educational expectations can be overwhelming (Cranwell et al., 2021). This pedagogical mismatch not only causes frustration for students but also presents challenges for educators, making it difficult for the system to become more inclusive and adaptable (Quan & Reilly, 2024). Moreover, cultural capital and habitus play crucial roles in students' academic and social integration. A lack of awareness of these cultural dynamics among students and educators can further complicate their educational experiences (Ma, 2024).

Beyond academics, social integration presents another critical challenge. Many Chinese students struggle to form connections with their peers, often experiencing feelings of isolation. The highly competitive nature of the Chinese job market shapes students' motivations and expectations, leading them to prioritise individual achievement over collaborative learning (Li, 2013). Additionally, the perception of Chinese students as "passive" learners perpetuates stereotypes, further alienating them from their UK peers (Simmons et al., 2021). On the other hand, economic factors can exacerbate the difficulties of adaptation. Financial pressures may limit students' ability to participate in extracurricular activities and social events, which are crucial for building relationships and enhancing the overall university experience. This economic barrier can also create a cycle of isolation and academic struggle, preventing Chinese students from fully engaging in university life (Tian et al., 2021).

Overall, the barriers faced by Chinese students at UK universities are complex and interrelated. As international students who primarily use English as a second language, they must not only overcome linguistic challenges but also navigate the cultural adjustments required to thrive in an unfamiliar academic and social environment. This reality further underscores the necessity for UK universities and educators to foster a more inclusive and supportive learning environment—not only for Chinese students but also for all international students encountering similar adaptation challenges.

2.3.5 Approaches for supporting Chinese students' learning in UK universities

It is undoubtedly because of the problems faced by Chinese students that the UK educators are experiencing and experimenting with more diverse approaches to learning support. Exploration and discussion of these approaches can provide insights into how to teach different groups of students more effectively in the future.

A potential approach to supporting Chinese students is the implementation of tailored induction programmes that facilitate their transition to the UK educational system. Quan and Reilly's study (2024) emphasises the importance of induction activities that address the unique challenges faced by Chinese students, particularly in adapting to the critical thinking and independent learning expectations prevalent in UK higher education. Such programmes can help bridge the gap between the educational practices in China and the UK, thereby fostering a smoother transition for students. This aligns with another study's findings indicate that positive transition experiences are crucial for personal and academic growth, enabling students to develop a sense of belonging and independence (Ploner, 2018).

Studying at UK universities, language support is a critical component in enhancing the learning experiences of Chinese students, as it directly influences both academic success and broader social integration. Providing Chinese students with, and teaching them to use, language resources appropriately can enable them to become effective communicators in the academic environment (Liu, 2012). This is particularly important given that language skills are closely linked to employability and social recognition, reinforcing the need for universities to prioritise robust language support services (Huang & Turner, 2018). Additionally, integrating technology into language support can further enhance learning outcomes, as mobile technologies have been shown to motivate Chinese students in their English language acquisition (Zhang, 2024). These findings suggest that combining traditional content with innovative pedagogical approaches can yield significant benefits in academic and professional settings.

While language support is fundamental to facilitating Chinese students' academic success and social integration, it is equally important to acknowledge the role of culturally responsive teaching practices in shaping their learning experiences. Cultural sensitivity and awareness among educators also play a crucial role in supporting Chinese students. Challenging the stereotype of the "passive learner," research suggests that interactive and engaging teaching methods, such as group work and role-playing, can significantly improve these students'

participation and learning outcomes (Nield, 2004). This aligns with the argument that fostering intercultural understanding through diverse pedagogical approaches can create a more inclusive educational environment for different students (van Noort, 2021). By recognising and valuing different learning styles, educators can bridge cultural gaps and enhance the overall learning experience for Chinese students, ensuring that their academic needs and cultural backgrounds are acknowledged in the UK classroom.

Beyond the classroom, peer support networks are also instrumental in promoting international students' social integration. For example, online communities, particularly those utilising familiar platforms like WeChat, have proven effective in facilitating communication and providing Chinese students with a sense of belonging (Zhou & Wolstencroft, 2022). Such initiatives not only enhance students' social well-being but also serve as valuable academic support systems.

Part 1 Summary

In summary, this section has outlined the educational characteristics of mainland Chinese students and highlighted the contrasts between Chinese and UK higher education systems. These cultural and institutional perspectives shed light on many of the challenges Chinese students face when adapting to a different academic environment. However, they do not fully account for the underlying mechanisms that shape how students actually learn and adapt. To address this gap, the following section turns to cognitive and neuroscientific perspectives on learning, with particular attention to the potential role of working memory that might influence Chinese students' learning processes in UK engineering education.

PART 2: What is Learning?

Part 2 Introduction

For educators, one of the most crucial responsibilities is to teach students how to learn. Yet, what precisely is the nature of learning? While cultural and institutional factors, as discussed in the previous section, help to explain why Chinese students may experience difficulties in UK higher education, these perspectives alone cannot fully account for the mechanisms that

underpin learning itself. To gain a deeper understanding, it is necessary to examine learning through the lens of cognitive science and neuroscience as well.

In the past, educators did not fully acknowledge the significance of cognitive and neuroscientific research in the teaching process. However, contemporary studies in pedagogy demonstrate that neuroscience is increasingly influencing curriculum design, instruction, assessment, and feedback (Bransford et al., 2000; Goldman & Pellegrino, 2015). Findings from neuroscience indicate that learning is a highly complex process involving the interaction of cognition, emotion, and behaviour, all of which are deeply dependent on neural activities in the brain. Importantly, for students from diverse cultural backgrounds, these processes may manifest in distinct ways—an area that remains underexplored.

For Chinese students studying at UK universities, their learning habits are profoundly shaped by the traditional education system and cultural values in mainland China (as described in Section 2.1). While these habits may not inherently conflict with UK educational practices, they can influence students' perceptions, behaviours, and ultimately their academic adaptation. This section, therefore, explores the nature of learning, the processes by which it occurs, and the cognitive factors, such as working memory, that may influence Chinese students' outcomes in cross-cultural educational contexts.

2.4 Mechanisms for learning

2.4.1 Concepts and importance of learning

Biologically, learning is our brains building and strengthening new neural links in the cortex when new information is received. By listening, watching, reading information and even tactilely sensing external matters (e.g., explanations from teachers, reading textbooks, experiential activity), brains make various neural connections like a highway to link prior knowledge/experience with the new information. In terms of human physiology, learning can be divided into biological primary cognitive abilities (easy) and biologically secondary cognitive abilities (hard) (Sweller, 2009). The biological primary cognitive abilities are more like survival instincts, while the biological secondary cognitive abilities are the capacity to handle complex social challenges. Most people learn at school to develop biological secondary

cognitive abilities to meet society's requirements on individuals (Wentzel, 1991; Wentzel et al., 1990), for example, learning maths and engineering.

The process of learning and the transfer of learning are the core for understanding how humans develop (Bransford et al., 2000). Although learning is an ability everyone has, no one is born knowing how to learn well. Therefore, in addition to learning knowledge, the ability to transfer and connect what is learned in one context to other new contexts is crucial for human development (Byrnes & Fox, 1998). For example, engineering educators expect students can apply the knowledge gained from thermodynamics second law to design a combustion engine. This learning transfer enables engineering students to grow as engineers. Thus, teaching students how to transfer gained knowledge and skills is more important than training them to complete a specific task (Broudy, 1977). Learning is a process of development from static to dynamic. The static part can be obtained from passive lecturing, and the active part focuses on the practice experienced by the learners.

Learning is also a continuous lifelong development process that moulds the individual in various domains such as social, emotional and intellectual. Learning facilitates the acquisition of basic skills and knowledge, which are essential for personal growth and social progress (Upadhyay et al., 2023). In addition, there are studies that emphasise the neurobiological basis of learning, illustrating that the brain constantly adapts and refines neural circuits in response to new information learnt (Dhawale et al., 2019; Pan et al., 2016). Therefore, the ultimate goal of learning is not to simply acquire knowledge or skills, but to help the learner to apply, make connections, and reflect on what has been learnt, and thus to continually improve the metacognition to develop a better personal and unique mode of learning. Figure 2.1 explains the basic mechanism of learning for human development.

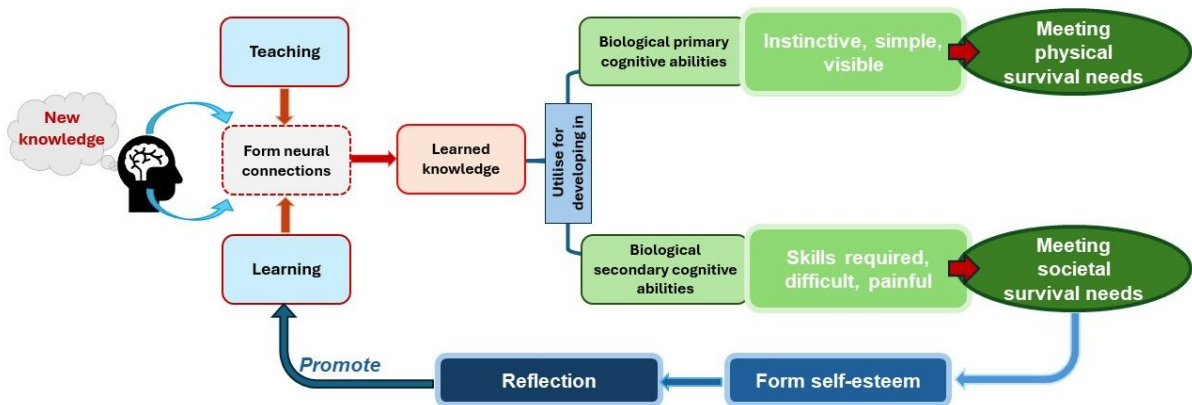


Figure 2.1 The process of the brain establishing cognitive patterns in learning for complex development.

Human learning and cognitive development derive from external input. The learning process that takes place in the brain varies according to the survival needs of human societies, i.e., there are simple ones to only fulfil basic survival, and those are difficult ones to carry out more advanced cognitive development. Difficult learning can help us to develop reflective processes that can influence the way we learn in the future.

In higher education, the learning process can be even more complex. For instance, in the UK international universities, student diversity—including differences in cultural backgrounds and pre-existing learning habits—must be carefully considered. This diversity implies that students' learning patterns and processes may not necessarily align with existing teaching models.

The primary student group examined in this study is Chinese students at UK universities. Previous research has indicated that Chinese students' learning behaviours in Western universities are influenced by their original cultural habits. Even after entering Western universities, their predominant learning behaviour patterns remain aligned with a Chinese learning style (Heffernan et al., 2010; Mast, 2016). If teaching approaches are not appropriately adapted, misalignment between teaching and learning may occur or enlarge, ultimately hindering the learning process rather than facilitating it.

However, fundamentally, learning is an innate ability shared by all individuals, and its core neurological processes in the brain remain consistent across individuals. Thus, the key difference lies in how learning is triggered and reinforced for students with different cultural backgrounds and learning habits. For educators, a clear understanding of the mechanisms

underlying learning is essential for designing and refining teaching strategies that effectively support diverse student groups.

2.4.2 Learning process in our brain

The nature of learning is the creation of neural links within the brain (Karpicke & Grimaldi, 2012; Owens & Tanner, 2017). Specifically, the working memory in our brains is the sector that helps us learn, dealing with new and old information (Baddeley & Hitch, 1994); after repeating and practising the working memory, the information can be converted to long-term memory. The functions of the working memory system have been studied and associated with various human learning abilities, such as mastering foreign languages (Van den Noort et al., 2006), mathematical skills (Passolunghi et al., 2007), writing (Yogo & Fujihara, 2008) and reading abilities (Daneman & Carpenter, 1980).

The learning process in the brain is a complex interplay of neural mechanisms, cognitive functions, and environmental influences. When a person learns, the brain goes through a complete process from information input to storage and extraction. First, external information enters the brain through the senses (e.g., vision, hearing) and is filtered by the attention system for important content for further processing (Marr, 2010; Schnupp et al., 2012). This information is briefly stored in short-term memory and manipulated and understood through working memory (Baddeley & Hitch, 1974; Çelikkok et al., 2016; Goldstein, 2007). During the deep processing stage, the brain uses existing knowledge for logical reasoning, semantic understanding and contextual connections to make new knowledge more meaningful and enhance its memorability (Binder et al., 2009; Huth et al., 2016; Kofler et al., 2014). Subsequently, the hippocampus is responsible for encoding short-term memory into long-term memory, which is consolidated into the cerebral cortex during multiple review or practice sessions (Hariri et al., 2003; Roy et al., 2013). Once information is stored as long-term memory, its extraction relies on the activation of neural networks, reinforces memory stability through recall and application, and facilitates the transfer and flexible use of knowledge (Berti, 2016; Manohar et al., 2019). In addition, the brain has neuroplasticity, and the connections between neurons are constantly adjusted and enhanced during the learning process, making information processing more efficient (Cabral et al., 2021; Han et al., 2020). Thus, understanding the brain's learning mechanisms can help us optimise learning strategies, such

as active learning, spaced review, multi-sensory integration and knowledge linkage to enhance learning efficiency. The general process of learning new information in the brain is demonstrated in the Figure 2.2.

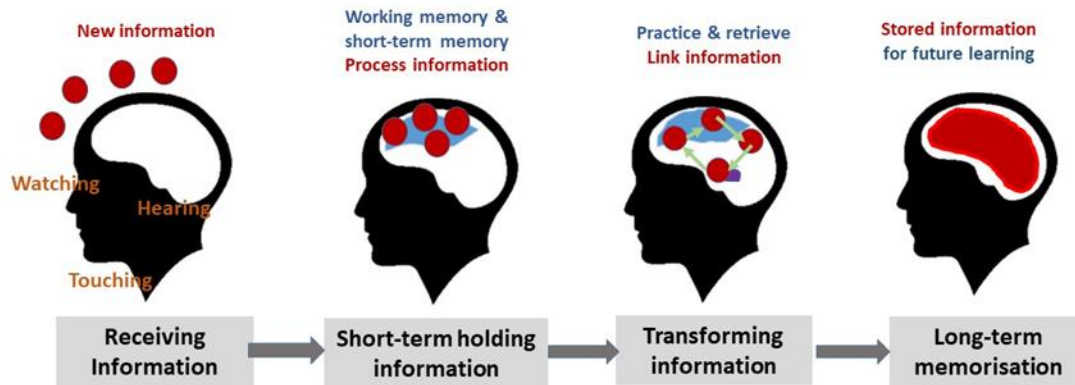


Figure 2.2 The process of the brain learning new knowledge.

The brain's learning of information firstly processes data in the short-term memory and working memory areas, and then consolidates the information into long-term memory as well as storage by integrating links and understanding.

In addition to the coordination of the functional areas of the brain, neuroplasticity, the brain's ability to reorganise itself by forming new neural connections, is also fundamental to the learning process. Gkintoni et al. (2023) suggest that neuroplasticity serves as the foundation for learning, allowing the brain to adapt to new information and experiences. This adaptability is crucial for educational contexts, as it underlines the importance of creating learning environments that stimulate cognitive engagement and foster the development of new skills. Similarly, Goswami (2004) discusses how understanding the mechanisms of neuroplasticity can inform educational practices, suggesting that educators can enhance learning outcomes by designing curricula that align with how the brain processes and retains information.

Additionally, cognitive mechanisms, such as attention, memory, and executive function, are integral to understanding how learning occurs in the brain. Wu et al. (2018) argue that insights from cognitive neuroscience can inform educational practices by identifying how learners allocate attention and process information. Another research also suggests that incorporating neuroscience into educational frameworks can lead to more effective teaching strategies that cater to the cognitive needs of learners (Lim et al., 2019). Understanding the neural basis of

memory can help educators develop techniques that enhance retention and recall, such as spaced repetition and active learning strategies.

Undoubtedly, the integration of neuroscience into educational practices has significant implications for curriculum design and instructional methods. Faizah et al. (2023) highlights the importance of linking neuroscience with educational strategies to improve learning outcomes, advocating for the use of evidence-based practices that consider the brain's functioning. This approach is further supported by Tan and Amiel (2019)'s views, which emphasise the need for professional development programmes that equip educators with the knowledge to apply neuroscience principles in their teaching. By fostering a deeper understanding of how the brain learns, educators can create more effective and engaging interventions.

2.4.3 Working memory in learning

2.4.3.1 Working memory capacity

Working memory capacity (WMC) is an innate cognitive system in human brains that represents how a person controls or focuses attention and ensures that the brain receives the information it needs (Conway et al., 2005; Cowan et al., 2005; Friedman & Miyake, 2004). Based on neuroscience research on the human brain, working memory (WM) is seen as a system in the brain primarily responsible for receiving and processing incoming information, making associations and comparisons between old and new information, and reconnecting or reshaping pre-existing consciousness and behaviour; in addition, by maintaining focus, the brain can store additional information for future requirements (Baddeley, 2003). The memories produced by this system are mostly short-term (Daneman & Merikle, 1996). Through further research, WMC is used to predict people's performance and ability to engage in different dimensions, such as learning science (Geiger & Litwiller, 2005; Sanchez & Wiley, 2006), reading and comprehending contexts (Conway et al., 2003; Unsworth & Spillers, 2010), as well as writing and learning languages (Van den Noort et al., 2006; Yogo & Fujihara, 2008; Baddeley & Hitch, 1994). Its widely recognised compositions are: the central executive, the visuospatial sketch pad, and the phonological loop (Baddeley & Hitch, 1974; Gathercole & Baddeley, 1993) (the summarisation of the system can be seen in Figure 2.3)

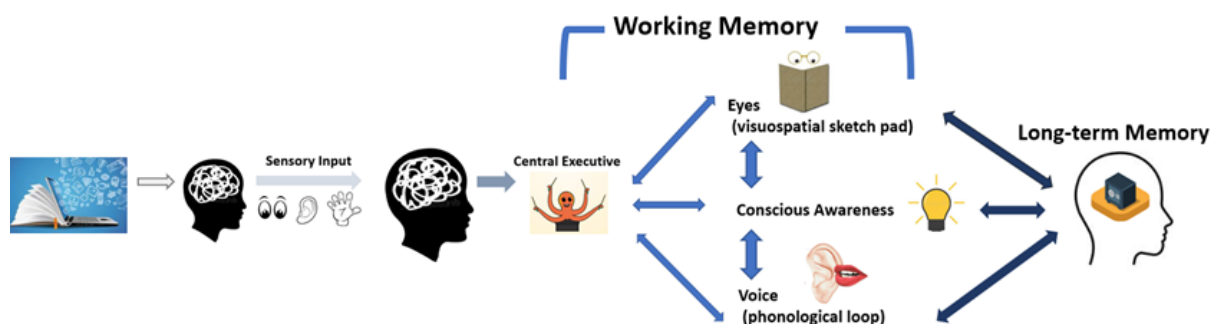


*Figure 2.3 Working memory capacity (WMC)
(Modified based on Baddeley and Hitch's theory, 1994).*

2.4.3.2 Factors affecting working memory

Working memory (WM) is a crucial cognitive function that allows individuals to temporarily hold and manipulate information necessary for various tasks, including reasoning, learning, and problem-solving. The size of WMC of the average adult is generally in the range of 4-9 items or contents (Baddeley & Hitch, 1974; Cowan, 2001; Miller, 1956), but differences in the individual's own as well as in the surrounding environment can also have an impact on it. The most frequently discussed influences are as follows:

a). Genetic and environmental influences

Research indicates that both genetic and environmental factors significantly contribute to individual differences in WMC. Dhanda (2020) find that genetic factors account for approximately 50% of the variations in WM cognitive functions, while the remaining 50% is attributed to environmental influences. Similarly, Wang and Saudino (2013) report that moderate genetic and non-shared environmental factors impact WM in children, suggesting that both nature and nurture play essential roles in shaping this cognitive ability.

b). Semantic knowledge and prior experience

Semantic knowledge, or the understanding of concepts and relationships, has been shown to enhance WM performance. Starr et al. (2020) demonstrate that increases in semantic knowledge could positively influence WMC, particularly in children.

c). Emotional and psychological factors

Emotional states and psychological factors also significantly affect WM performance. Dowd and Mitroff (2013) find that WM can guide attention, even overriding salient cues in visual

search tasks, indicating that emotional engagement can influence cognitive processes. Additionally, Hurriyati et al. (2018) highlight the role of mood and emotional reactivity in WM among individuals memorising texts, suggesting that emotional factors can impact cognitive performance in specific contexts.

d). Cognitive load and attention

Cognitive load, or the amount of mental effort being used in the WM, is another critical factor influencing performance. Van Ede (2020) explore how goal-directed and stimulus-driven attention affects WM, indicating that attentional resources are vital for maintaining information in WM. Furthermore, Blasiman and Was (2018) review various factors that influence WM performance, including attention, stress, and mental fatigue, which can all impact cognitive load and, consequently, WMC.

e). Age and developmental factors

Age-related changes also play a significant role in WMC. Cansino et al. (2018) examine how age mediates WM performance across the adult lifespan, revealing that meta-memory—awareness of one's memory capabilities—affects actual WM performance.

In addition to the personal factors discussed above, research on improving WMC through mindfulness meditation (Zeidan et al., 2010) and training has been conducted accordingly (Anguera et al., 2012; Bomyea & Amir, 2011; Zinke et al., 2014). More interesting performance of bilingual participants taking part in WM tasks has also been found in several studies. Corresponding experimental results suggest that bilinguals' WM performance is more prominent in the testing task (Miyake & Friedman, 2013; Walter, 2004), but scholars still argue about whether WM increases the chances of success in the second language learning or learning a foreign language improves WM functions (Blasiman & Was, 2018). These findings suggest that there is substantial evidence indicating that the use of bilingualism in learning may influence students' academic performance. This underscores the importance of examining changes in Chinese students' WMC within an English-language learning environment. Gaining insights into this aspect could provide valuable guidance for the development of more effective, diverse, and inclusive teaching strategies and curriculum designs.

2.4.3.3 Working memory and learning

Understanding WMC and its functions has important implications for cognitive processes and educational practices. Zavitsanou and Drigas (2021) emphasise the necessity of integrating strategies that enhance WM and attention in educational settings. By recognising the interplay between these cognitive functions, educators can develop interventions that support students' learning and cognitive development. Furthermore, interventions that focus on enhancing attentional skills may lead to improvements in WM performance, thereby benefiting overall cognitive functioning (Shipstead et al., 2014; Shipstead et al., 2015).

Obviously, WM is involved when humans learn in school, whether doing simple word copying or solving complex reading comprehension, arithmetic, and verbal writing (Alloway, 2006; Alloway & Gregory, 2013). Previous research has shown a link between math skills and WM in different-aged children and various task contents (Alloway & Copello, 2013). More studies have indicated that once children reach adolescence, WM is no longer significantly associated with mathematical ability (Reuhkala, 2001). As children grow older, mathematical knowledge and application strategies can impact individual mathematical ability (Thevenot & Oakhill, 2005). If an individual's WM is weak, their performance on computational skills and arithmetic-related problems is affected (Bull & Scerif, 2001; Swanson & Sachse-Lee, 2001). Additional studies have also consistently shown that WMC is one of the critical predictors of reading comprehension (Unsworth & Spillers, 2010). For example, WMC influences remembering information while reading, drawing inferences, and integrating information across multiple sentences (Lee & Tedder, 2003; Palladino et al., 2001; Donolato et al., 2019). In addition to mathematical and reading skills, the interaction between writing and WM has also been studied. Past research has suggested that participants with better WM capabilities can produce more complex, higher-quality written content (McCutchen, 2000). A strong WM allows one to hold information longer and manipulate it for writing tasks. Overall, WMC differences can directly impact an individual's ability to learn. WM is an important building block in the development of learning and it serves as a mental workspace that allows individuals to store and manipulate information necessary for learning

2.4.4 Measuring learning

Cognitive psychologists have conducted cognitive research on the nature of human executive abilities and the principles of problem-solving in a variety of domains (Vosniadou, 1996). Neuroscientists have also provided more evidence based on laboratory data to support the principles of learning and revealed how learning changes the physical structure of the brain and its functions (Goswami, 2004). Emerging technologies are also helping neuroscience and education researchers to better study the brain's learning processes and students' learning behaviours (Morgan, 2022). So far, many methods and techniques have been developed to measure WM, as summarised in Table 2.2 below:

Table 2.2 Summary of working memory capacity measurements

Reference	Focus of Study	Tools/Techniques	Design Details
Daneman & Carpenter, 1980	WMC links to language comprehension	Reading span task	Participants read a series of sentences and recalled the last word of each sentence, testing their ability to simultaneously process and store information.
Turner & Engle, 1989; Unsworth et al., 2005	Relationship between processing and storage components of WM	Operational span task (OSPAN)	Participants solve simple math problems while attempting to remember a sequence of unrelated words.
Shah & Miyake, 1996	Spatial thinking and language processing	Spatial span task	Participants recall sequences of spatial locations presented on a grid, requiring them to process spatial information while maintaining it in WM.
Eriksson et al., 2015	Neurocognitive architecture of WM	Review of working memory models	Discusses the role of attentional control mechanisms in WM and their implications for learning and memory retrieval.
Khaligh-Razavi et al. 2019	Integrated cognitive assessment	Cognitive assessment tools (e.g., CVLT-II, BVM-T-R)	Examines speed and accuracy of visual processing as proxies for cognitive performance, highlighting correlations with established cognitive tests.

The measurement of WM is essential for understanding cognitive processes and their implications for learning and development. Research has consistently demonstrated that working memory plays a critical role in various cognitive functions, making its assessment vital for both educational and clinical contexts. One of the primary reasons for measuring working

memory is its predictive value in academic achievement. For instance, Biańska-Pikul et al. (2016) find that WM, particularly the visual-spatial component, significantly predicts vocabulary development in early childhood. This suggests that effective measurement of WM can help identify children who may benefit from targeted interventions to enhance their language skills. Similarly, Janse and Jesse (2014) highlight that WM affects older adults' ability to use contextual information in spoken-word recognition, emphasising its importance in communication and auditory processing. Moreover, the relationship between WM and task performance is well-documented. Bui et al. (2012) suggest that individuals with higher WMC benefit more from repetition in learning tasks, indicating that measuring WM can inform educational strategies tailored to individual cognitive profiles. Additionally, Sarno et al. (2019) indicate that individuals with greater visual WMC are better at utilising relevant information, further underscoring the need for accurate assessments of WM to enhance cognitive performance. Overall, the need to measure WM is underscored by its integral role in enhancing learning, improving cognitive performance, and designing innovative teaching and training.

Part 2 Summary

In summary, this section has outlined the cognitive and neuroscientific foundations of learning and highlighted how these perspectives provide valuable insights into the potential challenges faced by Chinese students in UK higher education. By examining processes such as working memory and the interaction of cognition, emotion, and behaviour, it becomes clear that learning is not solely determined by external cultural or institutional contexts but also by internal cognitive mechanisms.

These insights carry important implications for pedagogy: if learning is shaped by both cognitive constraints and cultural/educational backgrounds, then teaching practices must be deliberately designed to scaffold students' learning processes. Building on this understanding, the following section turns to educational theories and practices such as problem-based, experiential, team-based and game-based learning, which offer practical frameworks for designing teaching approaches in this study that can respond to these cognitive and cultural/educational challenges.

PART 3: Theoretical Background of Teaching Intervention Applied in the Study

Part 3 Introduction

The previous two sections reviewed Chinese students' learning characteristics, their challenges in UK universities, and the cognitive mechanisms underpinning the learning process. These discussions highlight that while cultural and cognitive perspectives provide valuable insights, they also point to an essential question: how can teaching be designed to better support Chinese students' learning in cross-cultural higher education contexts?

Addressing this question requires not only a general understanding of pedagogical theories but also a careful selection of approaches that directly inform the design of this study. The teaching and learning frameworks discussed in this section are therefore not presented as a broad overview; rather, they constitute the principal theoretical foundations and methodological basis for the game-based teaching framework developed in this research.

Teaching and learning are inherently interconnected processes, and implementing pedagogical interventions that are responsive to students' needs can significantly influence their learning outcomes. Contemporary higher education has developed a range of strategies aimed at improving student engagement, learning efficiency, and overall educational experience. However, students from different cultural backgrounds may not interpret or adapt to these methods in the same way. For Chinese students in particular, their learning styles, cognitive habits, and cultural values can shape how they respond to pedagogical practices in Western higher education settings. This underscores the need to explore more inclusive teaching strategies that both respect students' prior learning experiences and scaffold their adaptation to new environments.

This section, therefore, reviews key pedagogical frameworks—constructivism, motivation theory, problem-based learning (PBL), project-based learning (PjBL), experiential and cooperative learning, team-based and game-based approaches—which together provide the conceptual and practical foundation for the design of the inclusive, teamwork-focused framework proposed in this study.

2.5 Theoretical foundations of effective teaching and learning

Learning is a complex process that involves knowledge construction, emotional motivation, cognitive reception, and transformation (Vygotsky, 1978; Johnson & Johnson, 1989; Anderson, 1990; Sweller, 1988; Mezirow, 1991). These elements interact dynamically within the educational process and directly influence students' learning outcomes. For educational researchers, understanding how learning occurs must be accompanied by a deep comprehension and application of core instructional design theories. These theories help align pedagogical approaches with key learning mechanisms, ensuring the effectiveness of teaching.

Educational theories not only provide a scientific foundation for instructional design but also enable researchers and educators to respond more effectively to the diverse learning needs of students. In internationalised teaching environments, these theories play a crucial role in helping educators to develop inclusive and adaptive strategies that support international students' academic and personal growth.

This section reviews two significant educational theories involved: Constructivism and Motivation Theory.

- Constructivism underscores the importance of students actively engaging in the learning process to construct knowledge, offering a foundation for student-centred instructional design.
- Motivation Theory examines the internal and external factors that drive student learning behaviours, providing a framework for fostering sustained learning interest and motivation.

Together, these two theories form the main theoretical basis for designing inclusive and effective teaching strategies in this study. These two theories were chosen as the basis for this study because my research objective is to understand and promote student learning, and both are constructed around a student-centred approach.

2.5.1 Constructivism applied in education

Constructivism, as the most popular cognitive theory of learning, emphasises the active role of learners in constructing their own understanding and knowledge through experiences and interactions (Hammoodi & Alishah, 2020; Miranda, 2011; Koptseva, 2020; Grier-Reed &

Williams-Wengerd, 2018; Kritt & Budwig, 2022). The roots of constructivism can be traced back to the works of early educational theorists, including Jean Piaget (1952) and Lev Vygotsky (1978). Piaget's theory of cognitive development posits that learners actively construct knowledge through stages of development, emphasising the importance of hands-on experiences and the role of social interactions in learning (Grier-Reed et al., 2009). Vygotsky, on the other hand, introduced the concept of the Zone of Proximal Development (ZPD), which highlights the potential for learning that occurs when learners engage with more knowledgeable peers or educators (Deng, 2024). These foundational ideas laid the groundwork for constructivist teaching methods that prioritise student engagement and collaboration. As constructivism gained traction in educational theory, it began to influence various teaching practices across disciplines. For instance, the application of constructivist principles in career development for culturally diverse college students illustrates how constructivist approaches can empower learners by fostering a sense of agency and ownership over their educational experiences (Grier-Reed et al., 2009; Grier-Reed & Williams-Wengerd, 2018).

The evolution of constructivism in education has also led to the development of constructive alignment, a framework proposed by John Biggs (1999). Constructive alignment is based on the principle that teaching methods, learning activities, and assessment tasks should be aligned with intended learning outcomes (Maffei et al., 2022). This approach encourages educators to design curricula that facilitate active learning and ensure that students engage with content in meaningful ways. In addition to its theoretical underpinnings, constructivism has practical implications for teaching and learning. For example, incorporating active learning techniques, such as project-based learning and collaborative problem-solving, can reinforce the principles of constructive alignment by ensuring that what is taught and assessed aligns with the intended learning outcomes (Vanfretti & Milano, 2012). In constructivist approaches, students can improve their academic performance via deep engagement to think critically and apply their knowledge practically in real-world scenarios (Silalahi et al., 2022). Moreover, using a constructivist framework, engaging students in collaborative and peer-related activities not only promotes understanding of complex concepts but also increases their enthusiasm for learning (Hennessey et al., 2011).

Furthermore, the integration of technology into constructive frameworks has opened new avenues for enhancing learning experiences. Fernando and Marikar (2017) discuss the use of participatory teaching methods that align with constructivist principles, highlighting the importance of active engagement and collaboration in the learning process. This aligns with the findings of Chuang (2021), who examines the applications of constructivist learning theory in adult education, exploring the role of technology in facilitating self-directed learning and knowledge construction. This framework also encourages educators to design curricula that facilitate active learning and promote deep understanding. Babkair (2023) reinforces this idea by highlighting the necessity of aligning educational tools, activities, and assessments to achieve students' deep learning.

The development of constructivism further emphasises the need for learning activities to focus on students' learning. By integrating it with teaching and learning practices, consistency in teaching and learning strategies can be ensured, and meaningful learning experiences can be facilitated. As educational environments continue to evolve, the integration of constructivist approaches in teaching and learning remains critical to promoting active participation and enhancing learning outcomes across disciplines.

2.5.2 Motivation theory for students' learning

In addition to constructivism, this study also incorporates motivation theory, which serves as another key theoretical foundation. This theory is particularly relevant given the focus of my research on Chinese international students studying at UK universities. Compared to the mainstream home student population in these institutions, this group represents a minority, making their motivations for studying in an international academic environment an important area of exploration. Motivation theory provides insights into the intrinsic and extrinsic factors that drive Chinese students' learning behaviours. By applying this theory, we can develop more effective pedagogical strategies that enhance their learning experiences and academic success in cross-cultural education settings.

The motivation theory in education has evolved significantly over the years, drawing from various psychological frameworks to understand how motivation influences learning outcomes. The origins of motivation theory can be traced back to early psychological theories

that sought to explain human behaviour. One of the foundational theories is Maslow's Hierarchy of Needs (1954), which posits that individuals are motivated by a series of hierarchical needs, starting from basic physiological needs to self-actualisation. This framework laid the groundwork for understanding how unmet needs can impact motivation in educational settings. As motivation theory developed, researchers began to differentiate between intrinsic and extrinsic motivation. Intrinsic motivation refers to engaging in an activity for its inherent satisfaction, while extrinsic motivation involves performing a task to achieve separable outcomes, such as rewards or recognition. Lepper et al. (2005) highlight the positive relationship between intrinsic motivation and academic performance, suggesting that students who are genuinely interested in their learning tend to achieve better results. Within the broader context of motivation theory, self-determination learning and self-regulation learning theories provide the theoretical basis for further refining the development of student-centred teaching and learning.

2.5.2.1 Self-determination learning

As a variety of specific frameworks within motivation theory, self-determination theory (SDT), developed by Deci and Ryan (1985), further refines the understanding of motivation by emphasising the role of autonomy, competence, and relatedness in fostering intrinsic motivation. This theory explains that when students feel autonomous in their learning, competent in their abilities, and connected to others, their intrinsic motivation is enhanced. The application of motivation theory in education has led to various pedagogical strategies aimed at enhancing student engagement and learning outcomes. Cerasoli et al. (2014) conducted a meta-analysis that demonstrated the joint predictive power of intrinsic and extrinsic motivation on performance, suggesting that a balanced approach to motivation can yield better results in educational settings. This finding reveals the need for educators to create environments that support both types of motivation. Interventions designed to enhance motivation have also been explored in various educational contexts. Finch (2004) examines the motivations of therapy students, revealing that intrinsic motivations often outweigh extrinsic ones at the beginning of their studies, but this balance may shift as students' progress through their education. The findings of Hamdan-Mansour et al. (2015), who identify psychosocial correlates of motivation for academic accomplishment among

university students, underscore the multifaceted nature of motivation in educational settings. Research by Rahmi and Neviyarni (2022) also indicate that both intrinsic and extrinsic motivations play significant roles in students' learning processes, particularly in online environments.

Furthermore, SDT has made significant contributions to engineering education through its emphasis on autonomy-supportive teaching strategies. The integration of self-determination alongside technical skill development has been identified as crucial for preparing graduates to address complex professional challenges (Saigushev et al., 2017). Empirical evidence from simulation-based learning environments demonstrates that autonomy-supportive approaches effectively enhance student motivation (Koh et al., 2010). Furthermore, collaborative learning environments that incorporate peer-based projects positively impact motivation and performance by addressing students' fundamental need for social connection (Carvalho & Santos, 2021). Peer interactions have been further demonstrated to enhance self-efficacy, which mediates the relationship between learning experiences and innovative behaviours (Goto & Gutiérrez-Gómez, 2023). Other studies also indicate that skill-building interventions can significantly enhance both self-efficacy and learning motivation (Wehmeyer et al., 2010), with strong correlations observed between self-efficacy beliefs and academic performance in engineering disciplines (Khoury et al., 2023). Moreover, combining educational and sociological perspectives in teaching has demonstrated effectiveness in enhancing career intentions and self-efficacy among engineering students (Bugallo & Kelly, 2014). The above findings suggest that more inclusive and interactive pedagogical practices need to be applied to promote students' motivation to learn.

2.5.2.2 Self-regulated learning

Self-regulated learning (SRL) theory is centred around students taking charge of their educational processes and using various strategies to manage their learning effectively. Self-efficacy plays a crucial role in self-regulated learning strategies. Research indicates that students who display high self-efficacy are more likely to employ a range of self-regulation strategies in their learning processes. Bozpolat (2016)'s study illustrates a direct positive correlation between self-efficacy and the utilisation of self-regulated learning strategies

among education students, asserting that students who believe in their learning capabilities tend to engage in these strategies more frequently. Moreover, Pange's (2021) findings affirm that structured self-monitoring and goal-setting are vital strategies in group learning contexts, demonstrating how collaboration can enhance individual regulation across learning tasks. This aligns with a study that reported participants engaging in goal setting and environment structuring are often more effective in managing their learning environments and activities, particularly in online settings (Barnard-Brak et al., 2010).

Motivation constitutes another critical aspect of self-regulated learning. Self-regulated learners exhibit awareness of their control over the learning process, applying strategies like self-evaluation and environmental structuring to achieve their academic goals (Kaphesi, 2017). Furthermore, via the interplay between cognitive and motivational factors in SRL, students can be motivated and more likely to optimise their learning through regulation processes. In addition, the educational environment can have a significant impact on self-regulated learning practices. For example, applying contextual variables (e.g. applying the flipped classroom model) can also enhance self-regulation by promoting active learning among students (Jovanović et al., 2019). Kaphesi's (2017) study also notes that self-regulated learners are adept at using strategies such as self-evaluation and goal setting to achieve desired learning goals, which shows the interaction between motivation and self-regulation. Thus, applying appropriate teaching methods is extremely necessary to better help students develop self-regulated learning methods.

2.6 Effective teaching practices

Supported by foundational educational theories, applying the appropriate pedagogical approaches to align with the objectives and research questions of this study is critical. The primary aim of this research is to explore Chinese students' experiences and learning behaviours in engineering programmes at UK universities, to implement effective pedagogical interventions to enhance their learning experiences.

In engineering education, problem/project-based learning (PBL and PjBL), experiential learning, cooperative learning, and gamified learning are widely recognised as effective approaches for developing students' holistic competencies (Filipe et al., 2023; Alafouzou et al.,

2018). These methods closely align with the practice- and innovation-oriented nature of engineering education, emphasising active exploration and hands-on engagement rather than traditional lecture-based instruction. They are particularly effective in equipping students with the skills needed to analyse and solve complex engineering problems (Almulla, 2020; Brito et al., 2025).

The prevalence of PBL and PjBL is driven by real-world engineering challenges, encouraging students to independently search for information, analyse requirements, design solutions, and validate outcomes (Wijnia et al., 2024; Brilingaite et al., 2018). By following a structured process of needs analysis, solution design, project implementation, and final presentation, PBL and PjBL enable students to gain an in-depth understanding of engineering project management, quality control, and resource coordination (Lavado-Anguera et al., 2024; Zhou et al., 2012). Additionally, experiential and cooperative learning emphasises teamwork, role distribution, and mutual learning, allowing students to engage in collaborative problem-solving within a simulated cooperative environment (Ferguson, 2000; Kayes et al., 2005; Slavin, 2010; Lau et al., 2013). Then team-based learning is inherently team/group-oriented, giving students the opportunity to collaborate with others and learn with a focus on achieving team goals and developing teamworking skills. Moreover, gamified/game-based learning incorporates competitive elements, point systems, and level-based challenges, transforming theoretical knowledge into a more engaging and interactive experience (Huang et al., 2023; Iskandar et al., 2025). Given the evolving industry and societal demands, these approaches not only enhance students' mastery of technical skills but also foster interdisciplinary thinking, problem-solving abilities, teamwork skills and integrated knowledge application, as well as sustain motivation, engagement and enthusiasm for learning.

2.6.1 Problem/Project-based learning

The integration of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in engineering education has gained significant attention, reflecting a shift towards active, student-centred pedagogies. Both approaches, grounded in constructivist learning theory, emphasise knowledge construction through active engagement and social interaction (Thongprasit & Piriyaawong, 2023). PBL originated in medical education in the late 1960s at McMaster University as an alternative to traditional lecture-based instruction, aiming to

prepare students for real-world problem-solving (Yadav et al., 2011). Over time, its principles were adapted to engineering education, where studies have demonstrated its effectiveness in enhancing problem-solving skills, teamwork, and communication (Yadav et al., 2011). As PBL evolved, diverse methodologies emerged, such as action-oriented curricula to foster creativity and positive learning attitudes that integrate sustainability into engineering education (Guerra, 2017).

The application of PBL and PjBL in engineering education has been widely explored across various contexts. Research suggests that PBL enhances theoretical understanding while improving students' perceptions of learning compared to traditional lectures (Hwayyin & Ameen, 2019). Furthermore, its implementation in materials, food, and chemical engineering courses has been shown to promote critical thinking, innovation, and teamwork (Fortelius & Akerman, 2015). The growing emphasis on active learning methods in engineering education underscores the role of PBL and PjBL in developing both technical and transversal competencies, encouraging learners to take ownership of their learning and apply theoretical knowledge to practical challenges (Neves et al., 2021). The flexibility of PBL allows educators to tailor problem selection to students' interests, increasing motivation and engagement while accommodating diverse learning preferences (Urbano et al., 2022). Additionally, integrating digital tools and collaborative learning frameworks can further enhance engagement, creativity, and problem-solving skills essential for modern engineering challenges (Tsalapatas et al., 2019).

Beyond academic benefits, PBL and PjBL have been linked to improved intrinsic motivation and research engagement (Rieg et al., 2021). This is particularly relevant in engineering education, where students frequently encounter complex, interdisciplinary research problems that demand collaborative efforts and innovative thinking. However, integrating PBL into existing curricula often necessitates adjustments to assessment strategies and learning outcomes, leading to inconsistencies in implementation across institutions and varying student experiences (Sokalingam & Schmidt, 2011; Dolmans, 2019). Facilitating PBL effectively requires a shift from teacher-led instruction to student-centred learning, which may not align with all instructors' training or pedagogical comfort levels (Rakhudu et al., 2016). Additionally, the time-intensive nature of PBL and PjBL poses challenges for both students and educators, with extensive preparation demands and potential group-related issues such as

unequal participation (Suganthi et al., 2019). The variability in facilitators' skills and experience further contributes to inconsistent learning experiences, raising concerns about the overall effectiveness of PBL in achieving deep learning and academic performance improvements (Li et al., 2019).

While there are still challenges to implementing PBL and PjBL across all areas of higher education, adopting common principles in designing pedagogical practices can increase inclusivity and ensure that PBL can be adapted to students with different learning styles and abilities (Gebeshuber & Hersh, 2024). Overall, however, PBL and PjBL are the effective applications that have been used in engineering education to promote student learning and practice in the development of their technical and human-centred skills, enabling them to acquire a more comprehensive range of skills required for their future careers (Pierrakos et al., 2016).

2.6.2 Experiential learning

With the growing number of practice-based pedagogical methods, it is also important to increase student participation and engagement. Therefore, experiential learning has become a pivotal aspect of engineering education, involving more active engagement and reflection from the students' perspective and allowing them to integrate theoretical knowledge with practical experience. At the heart of experiential learning is Kolb's experiential learning theory, which posits that effective learning occurs through a cycle of four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Bruni-Bossio & Delbaere, 2020). This cyclical process encourages students to engage in hands-on activities, facilitating the application of theoretical concepts in real-world situations. More evidence suggests that such engagement can lead to deeper learning and greater retention of knowledge compared to traditional didactic teaching methods (Lees-Murdock et al., 2024). Furthermore, experience-based projects, such as simulations and live cases, have been identified as an effective strategy for developing students' critical thinking, problem-solving skills, and decision-making capabilities, which are essential for success in various professional environments (Radford et al., 2015). Additionally, in language education, a learner-centred

approach incorporating experiential learning enables students to immerse themselves fully in the language acquisition process (Philominraj et al., 2020).

The benefits of experiential learning extend beyond traditional academic boundaries. In engineering education, students are often required to solve specific problems. By integrating experiential learning into engineering teaching, it can provide initial support and create structured environments to cultivate students' necessary engineering competencies (Singh et al., 2018; Garcés & Peña, 2022). Experiential interventions are practical as they help students navigate the complexities of engineering tasks and foster a collaborative, interdisciplinary skill set essential in modern engineering practice. Doyle and McDonald (2022) outline a case where an integrated project-based curriculum allows students to engage with progressively challenging projects, enhancing their skills through real-world applications. Another research also highlights the importance of student design competitions as a means of promoting engagement and human-centred skills, enabling students to better understand the practical applications of their studies (Gadola & Chindamo, 2017). Furthermore, another essential element of experiential learning is critical reflection, which enhances the learning process by allowing students to evaluate their experiences and integrate teamwork, problem-solving, and communication skills (Mattucci et al., 2022).

2.6.3 Cooperative learning

Cooperative learning is an instructional strategy where students work in small groups to achieve shared educational goals, fostering both individual accountability and group interdependence. This approach suggests that individuals are motivated to learn when they perceive their success is linked to the success of their peers (Johnson & Johnson, 2009; Johnson & Johnson, 2019). Research indicates that cooperative learning enhances student engagement, motivation, and social skills by promoting positive interactions and collaborative problem-solving (Zhu et al., 2024; Rivera-Pérez et al., 2020; Lee, 2014). Furthermore, it has been shown to improve academic outcomes across various subjects, including mathematics and physical education, by allowing students to construct knowledge collectively (Goodyear et al., 2012; Wang & Liu, 2018). The effectiveness of cooperative learning to support the development of interpersonal skills and fostering a supportive learning environment has also been highlighted in engineering education (Tran, 2013).

Engineering education now requires a combination of technical expertise and collaborative work, not only to help prepare future graduates for the workplace, but also to make students to be well-rounded engineers. One notable trend is the integration of cooperative learning with PBL, which has been shown to improve students' collaborative abilities and positive attitudes towards learning (Korkmaz, 2018). This combination not only fosters technical competencies but also encourages teamwork, critical thinking, and creativity, which are essential in engineering fields (Alves et al., 2018). Programmes that incorporate cooperative learning within an industry-oriented framework have been shown to enhance students' practical application skills and foster a positive interaction between academia and industry (Fang, 2024)

Collaboration with others is an integral aspect of our existence in society, and in the field of engineering, most projects are rarely executed by a single individual but rather rely on teamwork and interdisciplinary cooperation. Therefore, integrating and reinforcing teamwork and collaboration skills in engineering education is essential. This not only promotes students' academic performance but also enhances their ability to communicate, coordinate, and problem-solve effectively within diverse teams, equipping them to tackle complex engineering challenges more efficiently. Past research has indicated that students who engage in cooperative learning outperform their peers in traditional learning environments, particularly in mathematics and science (Hossain & Ariffin, 2018; Acharya, 2023). The structure of cooperative learning encourages students to work together, share knowledge, and support each other's learning, which leads to a deeper understanding of the material and better retention of information (Widiastuti, 2024). The collaborative approach can enhance individual learning and foster a sense of accountability among group members, as each student's contribution is vital to the group's success (Montagud et al., 2019; Johnson & Johnson, 2019). The emphasis on teamwork and collaboration also helps students develop empathy and respect for others, which are critical competencies in today's interconnected world (Lumban Gaol, 2022; Suwartono & Romdona, 2024). In addition to academic and social benefits, cooperative learning significantly enhances student engagement and enthusiasm for the subject matter (Trần, 2019; Sun & Guan, 2021).

Therefore, cooperative learning is vital in engineering education due to its multifaceted benefits, including improved academic performance, enhanced social-oriented skills, and

increased student engagement. By fostering a collaborative learning environment, educators can prepare students not only for academic success but also for effective participation in society.

2.6.4 Team-based learning

Team-Based Learning (TBL) is defined as a learner-centred instructional strategy that maximises student engagement through a sequence of carefully designed activities. These activities encourage independent preparation followed by collaborative problem-solving in teams/groups. The approach traditionally comprises three key phases: individual preparation, readiness assurance testing (RAT), and application exercises, during which students apply their knowledge to solve complex, real-world problems in teams (Burgess et al., 2020; Fatmi et al., 2013). This structured format is intended to transform passive learning into an active process, thereby improving both knowledge retention and critical thinking abilities (Maslakkpak et al., 2015; Fatmi et al., 2013).

The theoretical foundation of TBL lies in social interdependence theory, which posits that an individual's success is intrinsically linked to the success of their group. This perspective fosters accountability, mutual responsibility, and collective effort (Currey et al., 2018; Sisk, 2011). The structured design of TBL provides opportunities for meaningful engagement, which has been associated with improved academic outcomes (Liu & Beaujean, 2017).

2.6.4.1 Team development process

While TBL highlights the structured design of collaborative learning in educational contexts, its effectiveness is closely tied to the dynamics of how teams evolve over time. Understanding the processes through which teams develop is therefore critical to maximising the pedagogical and professional benefits of TBL. Within organisational behaviour literature, team development is most prominently explained through Tuckman's widely recognised model, which outlines five stages of progression: forming, storming, norming, performing, and adjourning (Abudi, 2010; Tuckman & Jensen, 2010).

In the forming stage, members become acquainted and establish initial impressions. This phase is characterised by dependence on the leader for direction, minimal conflict, and a focus

on clarifying goals and roles (Mueller, 2012). Research emphasises that early role clarification and goal-setting are essential for laying the foundation of effective collaboration (Chandler, 2023; Isaac & Tormey, 2015).

The storming stage is typically marked by conflict and disagreement as individuals assert their views and challenge emerging group norms. Although often accompanied by tension and power struggles, this stage is vital for fostering honest expression of perspectives. Effective management of conflict can transform this potentially destabilising phase into an opportunity for growth (Akan, 2005; Pugalis & Bentley, 2013). Tuckman's model suggests that successful navigation of storming is what enables teams to progress towards cohesion and trust in the subsequent norming stage (Farrell et al., 2001; Miller, 2003).

During the norming stage, teams begin to resolve differences, develop stronger interpersonal relationships, and build a cooperative spirit. Roles become clearer, and psychological safety is fostered, enabling open dialogue and collective problem-solving (Raes et al., 2015; Guttenberg, 2020). Literature highlights that cultivating belonging and community significantly strengthens the transition from storming to norming (Aydın & Gümüş, 2016; Roy, 2019).

The performing stage represents the peak of group effectiveness, where members demonstrate high levels of collaboration, accountability, and synergy. Teams in this phase leverage individual strengths to achieve collective goals with efficiency and adaptability. Studies identify this stage as critical for maximising group potential, while effective leadership remains key to sustaining momentum and addressing emergent challenges (Mueller, 2012; Sokman et al., 2023; Jahng, 2012).

Finally, the adjourning stage, added later to Tuckman's original four, focuses on team dissolution once objectives are met. This stage emphasises reflection, closure, and the celebration of achievements, allowing members to consolidate lessons learned for future endeavours (Hall, 2007; Davoli & Fine, 2004). Emphasising structured closure has been shown to reinforce members' sense of accomplishment and to enhance subsequent collaborative efforts (Khan et al., 2024; Tudor, 2013).

2.6.4.2. Belbin team role theory

Building on the understanding of how teams develop through sequential stages, it is also important to recognise the diversity of roles that individuals adopt within teams. In this study, Belbin's team role theory is introduced to provide a complementary perspective by focusing on the behavioural contributions of individual members. This distinction is particularly relevant in engineering education, where group effectiveness depends not only on the overall stage of development but also on how different roles are enacted and balanced within the team (Burke et al., 2019; Goh et al., 2013).

Also considering this study aims to investigate postgraduate taught (PGT) students' learning and teamwork behaviours in engineering courses. In recent years, UK universities have experienced a substantial increase in international enrolments on PGT programmes, resulting in international students often comprising the majority of such courses. Engineering education requires students to engage not only in theoretical learning within lecture rooms but also in practical, hands-on activities. However, the teamwork skills of international students vary considerably (He & Zandi, 2024). Consequently, understanding how engineering students collaborate in teams/groups and applying appropriate teamwork teaching theories and methods have become a crucial concern for educators.

For engineering students, teamwork is indispensable both for their current academic success and for their future professional practice. To examine more closely the behavioural patterns underpinning teamwork among PGT engineering students, this study integrates the Belbin Team Role Test into a project-based workshop. The application of Belbin's framework serves as an exploratory step towards understanding the diversity of student contributions in team contexts, offering insights into how international and home students collaborate within engineering education.

The Belbin team role theory was proposed and developed by Dr. Meredith Belbin in 1981. It outlines nine distinct team roles: Plant (PL), Monitor Evaluator (ME), Coordinator (CO), Shaper (SH), Implementer (IM), Completer Finisher (CF), Resource Investigator (RI), Specialist (SP), and Team Worker (TW) (Belbin, 2010; Aritzeta et al., 2007). Each role is defined by specific behavioural characteristics and unique contributions to team performance. These roles are generally grouped into three categories: action-oriented, social-oriented, and thinking-

oriented (Nikolaeva & Synekop, 2020; Van de Water et al., 2008). The typical features of Belbin Team Roles can be briefly summarised in Table 2.3 (Belbin, 2010; Belbin, 2012).

Table 2.3 Belbin team role description

Team role orientation	Team role	Contribution	Weakness
Social-oriented	Coordinator (CO)	Mature, confident, identifies talent. Clarifies goals. Delegates effectively.	Can be seen as manipulative. Offloads own share of the work.
	Teamworker (TW)	Co-operative, perceptive and diplomatic. Listens and averts friction.	Indecisive in crunch situations. Avoids confrontation.
	Resource investigator (RI)	Outgoing, enthusiastic, communicative. Explores opportunities and develops contacts.	Over-optimistic. Loses interest once initial enthusiasm has passed.
Thinking-oriented	Plant (PL)	Creative, imaginative, free-thinking. Generates ideas and solves difficult problems.	Ignores incidentals. Too preoccupied to communicate effectively.
	Specialist (SP)	Single-minded, self-starting, dedicated. Provides knowledge and skills in rare supply.	Contributes only on a narrow front. Dwells on technicalities.
	Monitor evaluator (ME)	Sober, strategic and discerning. Sees all options and judges accurately.	Lacks drive and ability to inspire others. Can be overly critical.
Action-oriented	Shaper (SH)	Challenging, dynamic, thrives on pressure. Has the drive and courage to overcome obstacles.	Prone to provocation. Offends people's feeling.
	Implementer (IMP)	Practical, reliable, efficient. Turns ideas into actions and organises work that needs to be done.	Somewhat inflexible. Slow to respond to new possibilities.
	Completer finisher (CF)	Painstaking, conscientious, anxious. Searches out errors. Polishes and perfects.	Inclined to worry unduly. Reluctant to delegate.

The value of Belbin's theory lies in its emphasis on the importance of a well-balanced team, where a diverse combination of roles contributes to higher overall performance. Studies have shown that teams incorporating a range of roles are better equipped to tackle challenges and balance individual strengths, thereby improving problem-solving abilities and fostering innovation (Aguilar et al., 2023; Aritzeta et al., 2007). However, despite its extensive use, the theory has faced criticism regarding its reliability and validity. This suggests that while the Belbin roles offer practical insights, it should be applied with caution and ideally complemented by other assessment tools (Aritzeta et al., 2007; Anderson & Sleaf, 2004; Fisher et al., 2001).

2.6.4.3 Applications of team-based learning in Engineering Education

In addition to specific team role theories like Belbin, more detailed TBL approaches have also been effectively integrated across diverse engineering disciplines, demonstrating their versatility and relevance. For example, in architectural engineering, students have engaged in projects that replicate industry practices, thereby enhancing their critical thinking, procedural knowledge, and teamwork capabilities (Kim & Shin, 2014; Burgess & Mellis, 2015). In most engineering contexts, TBL is implemented through case studies and project-based learning that mirror real-world professional challenges, enabling students to consolidate technical expertise while simultaneously developing transferable human-centred skills.

Beyond knowledge acquisition, TBL has been recognised for its capacity to increase student engagement and foster self-directed learning within engineering curricula (Chandrasekaran et al., 2016; Liu & Beaujean, 2017). The accountability embedded in team dynamics encourages greater motivation and active participation (Reinig et al., 2011). Moreover, the practice of maintaining stable teams over extended periods contributes to stronger interpersonal relationships and improved collaboration, which are critical for future professional practice in engineering (Langer et al., 2021; Orsini et al., 2021).

Insights from TBL in healthcare education also offer valuable parallels for engineering, particularly regarding the cultivation of interdisciplinary teamwork (Moore-Davis et al., 2015; Thompson et al., 2015). The demonstrated success of TBL across multiple fields reinforces its potential for broader integration within engineering programmes, suggesting that students can benefit not only in terms of academic performance but also through the development of competencies essential for collaborative professional environments (Currey et al., 2018; Fatmi et al., 2013).

2.6.5 Game-based learning

In the educational context, game-based learning (GBL) is not merely about "playing games"; rather, it utilises game-based elements, such as points, levels, leader-boards, virtual rewards, role-playing, and narrative-driven challenges to enhance students' motivation and

engagement (Deterding et al., 2011; Hamari et al., 2016). This approach enables students to acquire knowledge, develop skills, and cultivate critical thinking in a structured yet enjoyable and goal-oriented environment.

Compared to traditional instructional methods, GBL not only increases student engagement but also provides immediate feedback and diverse reward mechanisms, allowing students to assess their progress and adjust their learning strategies accordingly. This approach moves away from the traditional, one-size-fits-all approach and enables learners to develop collaborative and social skills through team challenges and collaboration.

For international students who are unfamiliar with the UK university teaching environment, gamified learning can offer an easy-to-start, inclusive and adaptive learning experience. By incorporating visualised information and structured tasks, this approach can help students adapt more gradually to a new academic environment, encourage active participation and promote self-directed exploration in an engaging and accessible way.

2.6.5.1 Game-based learning in education

GBL in education refers to the integration of game design elements and mechanics into non-game contexts to enhance student engagement, motivation, and learning outcomes (Deterding et al., 2011). A systematic review found a strong correlation between gamification and increased student participation, demonstrating its effectiveness in fostering positive attitudes towards learning (González-Fernández et al., 2022). This is further supported by Oliveira et al. (2022), who argue that tailored gamification systems improve both engagement and the time students spend in learning environments. Adaptive gamification has been shown to enhance student motivation in science education by aligning game elements with students' interests and learning activities (Zourmpakis et al., 2023).

In addition to increasing student engagement by making learning more interesting, gamification can foster active learning and collaboration. For example, applying serious gaming strategies has been shown to enhance student learning outcomes in medical professions (Gentry et al., 2019). Similar effects have been observed in social sciences, where gamified teaching significantly impacts student learning performance and active participation (Rueda et al., 2023). The incorporation of game mechanics such as points, badges, and

leaderboards not only promotes a sense of achievement but also encourages students to take ownership of their learning (Saggah et al., 2018). Moreover, the adaptability of gamification can be applied to meet different learning styles and preferences, fostering active participation and reducing anxiety related to academic performance (Widodo et al., 2023). By encouraging students to embrace challenges without fear of failure, gamification can create a more inclusive and supportive learning environment (Kovalenko & Skvortsova, 2022).

In engineering education, gamification has been increasingly applied as a means of improving student engagement, motivation, and problem-solving abilities. One previous study has demonstrated that gamification enhances student participation in technical disciplines, making learning more interactive and enjoyable (Gamarra et al., 2021). Gamified strategies have also been particularly beneficial in developing critical thinking and problem-solving skills, as evidenced by their use during the COVID-19 pandemic to facilitate active participation in engineering education (Chamorro-Atalaya, 2023). Moreover, empirical findings highlight gamification's role in enhancing teamwork and communication skills, particularly in software engineering education, where collaboration is essential (Ren & Barrett, 2023). This is further reinforced by research demonstrating how gamification strategies can motivate students to engage more deeply with complex engineering concepts, particularly in process modelling and software development (Soares et al., 2022; Bedwell et al., 2022; Kasinathan et al., 2018). Additionally, gamification has been successfully integrated into scientific writing courses for engineering students, illustrating its potential to enhance discipline-specific academic skills (Núñez-Pacheco, 2023).

Despite these promising findings, challenges remain in implementing gamification effectively within engineering education. The field is still in its early stages, for example, in software engineering, where more empirical studies are needed to validate its impact on learning outcomes (Alhammad & Moreno, 2018). Additionally, inconsistencies in gamification strategies across institutions highlight the need for standardised evaluation methods to assess their efficacy in different educational contexts (Monteiro et al., 2021). The implementation of gamification also requires careful consideration. While its growing popularity in education suggests its potential, there is still insufficient evidence supporting its long-term effectiveness (Dichev & Dicheva, 2017). Educators need to therefore design gamified teaching that aligns with pedagogical objectives rather than prioritising entertainment over meaningful learning.

In addition, robust methodologies are necessarily required to evaluate the effectiveness of gamified learning, ensuring that these interventions enhance rather than distract from educational goals (Hamari et al., 2016).

The development of GBL in education has been significant and multifaceted, reflecting its growing recognition as a tool to enhance learning experiences and outcomes. One of the advantages of gamification is its adaptability across diverse educational contexts. Recent research suggests that teachers perceive gamification as an inclusive and engaging strategy that fosters creativity and imagination by mirroring real-life scenarios (Aksoy et al., 2022). The emergence of adaptive gamification has further refined its applications. By tailoring game elements to individual student needs, adaptive gamification can enhance motivation and learning outcomes while addressing diverse learning preferences (Zourmpakis et al., 2023). Other studies also indicate that gamified strategies can lead to improved academic performance and increased participation (Kim & Castelli, 2021; Kostenius et al., 2018).

2.6.5.2 Cognitive benefits of game-based learning

Building on the broader applications of game-based learning in education, its adoption within higher education has gained substantial traction in recent years, transforming pedagogical practices across a range of disciplines. The incorporation of game elements into university teaching not only enhances students' overall learning experience but also fosters their cognitive capabilities, like critical thinking, problem-solving abilities, and knowledge retention. Empirical studies show that GBL supports cognitive development across diverse contexts. For instance, it has been shown to enhance executive functions in early learners, facilitating the development of essential cognitive and social skills, with implications that similar effects may extend to adult learners (Annur et al., 2024). Digital educational games have also been found to positively influence cognitive, affective, and psychomotor domains, actively engaging learners (Bigdeli & Kaufman, 2017). Immersive games in particular can foster cognitive engagement, thereby encouraging learners to address complex knowledge (Lin et al., 2024). This resonates with Mayer's comprehensive review, which explains how specific game features align with cognitive processes central to effective learning (Mayer, 2019).

Furthermore, the integration of personalised elements within GBL has also been shown to reduce cognitive load and improve learning efficiency. Matching game dynamics with individual learning preferences can reduce mental effort and support deeper understanding (Tlili et al., 2019). Moreover, serious games have been associated with improvements in attention and working memory, both critical for academic achievement, even among older adults with cognitive impairments (Abd-Alrazaq et al., 2022a; Abd-Alrazaq et al., 2022b). Beyond direct cognitive outcomes, gameplay simultaneously motivates learners and develops higher-order cognitive skills. Virtual reality and educational games, for example, have been found to enhance computational thinking, an increasingly vital skill in technology-driven environments, while stimulating processes such as analysis, synthesis, and evaluation (Agbo et al., 2023).

In short, through reasonably integrating gamified teaching into regular professional teaching, it can engage diverse learners more effectively, rendering complex concepts more accessible and memorable, and thus offers significant promise for enriching educational practice and enabling personalised learning experiences, including within engineering education.

2.6.5.3 Board game-based design in education

Based on the cognitive benefits already highlighted in the literature on game-based learning, certain game forms have been researched and applied more extensively within educational communities. For example, Noda et al. (2019) demonstrate that board games can stimulate higher-order thinking and collaborative learning, both of which are critical for cognitive development. Similarly, Debit et al. (2024) highlight how interactive board game experiences promote problem-solving and cooperative learning, thereby enhancing engagement. Findings from Gitgeatpong and Ketpichainarong (2022) further emphasise that the design elements of board games motivate students to acquire deeper knowledge while enjoying the process.

Beyond engagement, a growing body of research also reveals more pedagogical benefits of using board games in education, including improved knowledge retention and the development of higher cognitive functions. For instance, Chew et al. (2023) show that a tutorless board game used in disaster response training not only increased learner interaction but also had a positive impact on outcomes. This resonates with Noda et al.'s (2019)

systematic review, which confirms that board games enhance educational knowledge while reducing learner anxiety. Moreover, Wicaksana and Mangundjaya (2022) observe that integrating board games into instruction encourages peer interactions and supports collaborative learning to enhance individual achievement. This is reinforced by Luchi et al. (2019), who showed that board games led to significantly better learning outcomes compared with traditional guided study, underlining the value of collaboration in knowledge construction. Furthermore, Kuo et al. (2025) argue that board games cultivate critical thinking and problem-solving skills, particularly among younger learners, creating a more engaged and participatory classroom environment.

The existing literature has illustrated that educational board games offer wide-ranging benefits, from enhancing engagement and motivation to improving knowledge, learning, and collaborative skills. However, despite these promising findings across various disciplines, research on the design and application of board games within engineering education remains relatively limited. This gap underscores the need to explore how game-based approaches can be adapted to support the unique demands of engineering learning contexts.

2.6.5.4 Role simulation game in education

In addition to board game formats, role simulation games have increasingly been recognised as innovative pedagogical tools that foster engagement, critical thinking, and self-directed learning across multiple educational contexts. Unlike traditional didactic instruction, RSGs immerse learners in authentic scenarios that replicate real-world challenges, requiring them to assume roles, make decisions, and reflect on outcomes. This experiential approach provides opportunities for students to actively construct knowledge while enhancing interpersonal skills.

A key strength of role simulations lies in their capacity to stimulate higher-order thinking and adaptive reasoning. Ríos et al. (2023) demonstrate how virtual and augmented reality simulations encourage learners to navigate complex, dynamic environments, thereby strengthening self-learning and problem-solving skills. Similarly, Ertmer et al. (2010) found that participation in role-play simulations enabled students to develop critical thinking by confronting realistic situations that demanded collaboration and adaptability. This aligns with

Berry and Kowal's (2022) findings, which reveal that role-play in online discussions engages students more deeply by encouraging them to explore diverse perspectives and reflect critically on content. Moreover, role simulations have been shown to enhance teamwork, communication, and resilience. Li et al. (2025) report that role-play in nursing education not only improved critical thinking but also fostered collaboration among students preparing for complex clinical scenarios. Similarly, Latif et al. (2018) compared debate and role-play, concluding that both approaches significantly strengthened students' communication and reasoning abilities. These findings have emphasised the capacity of applying role simulations to cultivate interpersonal competencies essential for professional practice.

The integration of role simulations in teaching also reflects a broader pedagogical shift towards student-centred learning. For instance, Chen and Jenks (2023) demonstrate the effectiveness of online games to boost students' learning outcomes in history education at the secondary level, while Supangat et al. (2025) also highlight their impact in strengthening technical and critical thinking skills within vocational training for shipping education. Such examples have illustrated the versatility of role simulation games and their potential to adapt to the evolving requirements of education and workforce preparation.

Evidently, existing research demonstrates that role simulations contribute not only to the development of cognitive and critical thinking skills but also to the cultivation of more human-centred capacities. However, despite their proven benefits across a variety of disciplines, their application within engineering education remains limited. This gap highlights the need for further research to explore how role simulation games might be designed and implemented to address the specific learning challenges and professional competencies required in engineering contexts.

Part 3 Summary

In summary, this section has examined a range of pedagogical theories and approaches that serve not merely as general educational strategies, but as the principal theoretical underpinnings of this study. Frameworks such as constructivism, motivation theory, problem-based and project-based learning, experiential and cooperative learning, team-based and

gamified methods provide both the conceptual rationale and the methodological foundation for the practical design of this research.

Together, these approaches highlight the importance and feasibility of creating inclusive and student-centred learning environments that can support both cognitive and cultural adaptation for Chinese students in UK higher education. More importantly, they converge to inform the development of the game-based framework proposed in this thesis, which is designed to enhance teamwork as well as academic learning among engineering students.

Yet, as engineering education increasingly demands not only disciplinary expertise but also interpersonal and professional competencies, it is essential to further consider the human-centred skills required of modern engineers. The following section therefore shifts focus to teamwork and other transferable skills, situating them as critical components of inclusive engineering education and as central objectives of the proposed framework.

PART 4: Engineering Education: Educating the All-Round Engineering Students

Part 4 Introduction

Building on the discussions in the previous sections, this final part shifts the focus from pedagogical foundations to the broader context of engineering education in UK universities and the competencies required of engineering students. The earlier review has shown that Chinese students encounter distinct challenges when adapting to UK higher education (Part 1), that their learning outcomes are shaped not only by cultural and institutional contexts but also by underlying cognitive mechanisms (Part 2), and that inclusive pedagogical approaches such as problem-based, experiential, team-based and game-based learning can provide effective responses to these challenges (Part 3).

Against this background, it is essential to situate these insights within the expectations of modern engineering education. The importance of engineering education in contemporary society is indisputable: as a discipline that drives technological innovation and equips graduates with practical competencies, its quality directly affects both students' career trajectories and their future contributions to society. However, success in engineering is no longer measured solely by mastery of technical knowledge. Increasingly, employers and

professional bodies emphasise the development of higher-order skills such as critical thinking, creative problem-solving, and effective teamwork, particularly in cross-cultural and interdisciplinary contexts.

For Chinese engineering students studying in the UK, this dual expectation presents unique challenges. Their prior educational experiences, shaped by different pedagogical traditions, combined with the inherent complexity of engineering disciplines, can make adaptation difficult. Therefore, enhancing the inclusivity and adaptability of engineering education is not merely desirable but an urgent priority, one that requires intentional frameworks to support both academic and interpersonal development. It is within this context that this study proposes a game-based teaching practice designed to enhance teamwork skills while simultaneously strengthening technical learning outcomes for Chinese students in UK engineering education.

2.7 Engineering education within the UK higher education context

The landscape of engineering education in UK universities has undergone significant transformations, driven by the need to adapt to contemporary challenges and evolving industry demands. Numerous studies have highlighted key developments in UK engineering education, including the shift towards interdisciplinary learning, the integration of technical and human-centred skills, and the adoption of innovative teaching methodologies. Common theses are listed below:

2.7.1 Interdisciplinary learning and sustainability in Engineering Education

Modern engineering challenges often require knowledge beyond traditional technical disciplines. There has been a growing push for curricula that integrate engineering with business, sustainability, and social responsibility (Barnard et al., 2013; Lappalainen, 2011). The incorporation of liberal education principles aims to cultivate socially responsible engineers capable of addressing global issues such as sustainability and resource management (Berg & Lee, 2016). Further research suggests that students benefit from curricula that emphasise real-world applications and ethical considerations in engineering practice (Berg, 2019).

Sustainability has gradually become a central focus in engineering education, with studies advocating for a "living lab" model where students engage in real-world sustainability projects

(Purcell et al., 2019). This model facilitates collaboration between students, faculty, and industry partners, allowing learners to address complex sustainability challenges while developing practical skills (Purcell et al., 2019; Fenner et al., 2014). The integration of sustainability principles aligns with global objectives such as the United Nations Sustainable Development Goals (SDGs), reinforcing the need for action-oriented and impact-driven engineering curricula.

2.7.2 Integration of human-centred skills learning with technical contents

The integration of human-centred skills learning into engineering education in the UK represents an essential evolution of academic curricula to align with industry expectations and enhance graduate employability. Human-centred skills—including communication, teamwork, problem-solving, and adaptability—are increasingly recognised as crucial competencies that complement technical knowledge in the engineering field. Employers are also emphasising that these competencies are essential. For instance, communication and teamwork are among the most sought-after skills in engineering candidates according to employer ratings (De Campos et al., 2020a; De Campos et al., 2020b).

Research indicates that engineering disciplines are well-suited to embed human-centred skills into educational frameworks. Methods such as PBL and PjBL not only encourage technical competencies but also enhance interpersonal skills, self-motivation, and leadership among students (Rodríguez et al., 2021). Similarly, other studies advocate for experiential learning opportunities as a means to foster essential human-centred skills among engineering students, demonstrating the necessity of a multifaceted approach in education that merges these skills with technical training (Malykhin et al., 2021; Hwang, 2022).

Moreover, the growing gap between industry expectations and the capabilities of graduates has prompted educators to reassess curricula. In the fields of engineering, future graduates are expected to manage projects effectively, communicate clearly, and operate collaboratively within diverse teams. Thus, human-centred skills play a critical role in enhancing employability and adaptability in the workforce (Nilsson, 2010). The research further elucidates that employing a student-centred pedagogic approach can significantly enhance the acquisition of these human-centred skills through tailored learning experiences (Holik & Sanda, 2021).

2.7.3 Inclusivity and equitable access in Engineering Education

Creating an inclusive learning environment is also gaining recognition as a key priority in UK engineering education. Further research indicates that inclusive practices significantly enhance student engagement and learning outcomes, particularly for underrepresented and international groups, by considering cultural sensitivities and employing diverse assessment methods, educators can foster an environment where all students feel valued and supported (Jayatilake & Rosunally, 2024; Okada et al., 2025; Danial et al., 2024). This focus on inclusivity is vital for attracting a diverse student body and ensuring equitable access to engineering education.

Fostering inclusivity in engineering education is not limited to creating an equitable learning environment but is also critical for ensuring international students' success. Research suggests that culturally responsive teaching practices can enhance student engagement by acknowledging diverse perspectives and learning styles (Ma, 2024). By integrating intercultural learning experiences and encouraging collaborative projects that value contributions from students of different backgrounds, universities can create more enriching educational environments (Zheng, 2024).

Despite these advancements, challenges remain in implementing reforms across all engineering programmes. Resistance to change and entrenched traditional teaching practices often hinder the adoption of innovative curricula (Mitchell et al., 2019; Hayhurst et al., 2012). Additionally, continuous evaluation and adaptation of engineering curricula are necessary to keep pace with technological advancements and industry demands (Langie & Pinxten, 2018).

As engineering education continues to evolve, the focus will shift beyond simply addressing challenges to actively developing more adaptive and inclusive teaching frameworks. The presence of international students in engineering programmes is a driving force for innovation in educational practices. Addressing issues such as curriculum inclusivity, alternative assessments, targeted language support, and career guidance will be essential in shaping a future engineering education system that better prepares students for the global workforce.

2.8 What kind of skills are required for engineering students?

In today's world, there is a demand for graduates with a comprehensive range of skills in all sectors, not just in engineering fields. Today, society's demands on engineering students have become more diverse and challenging. Engineering students are required to have sufficient essential skills, including problem-solving, leadership, creativity, critical thinking, attention to detail, collaboration, and mathematics in broad STEM fields (Sen et al., 2018; Karimi & Pina, 2021). The importance of equipping diverse skills for engineering students has been widely recognised recently, as the demand for highly-skilled workers continues to increase in the global labour market (John & Chen, 2017). Figure 2.4 shows the summary of essential STEM skills for students to have. These skills allow STEM students to identify and solve complex problems, analyse data and information, think outside the box to develop innovative solutions to problems and communicate/work effectively with others.

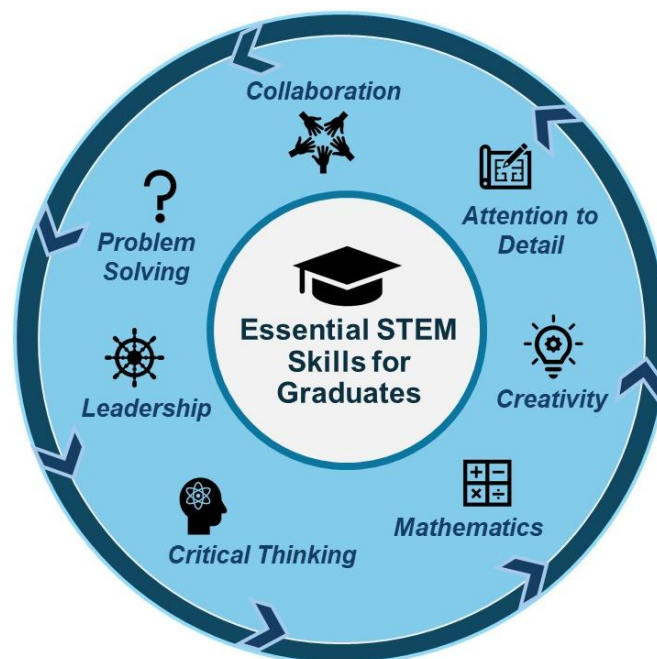


Figure 2.4 Essential skills that STEM students should gain
(modified from: <https://www.routledge.com/qo/essential-stem-skills>, Routledge 2023).

2.8.1 Technical expertise

Technical competencies are the cornerstone of engineering education, encompassing the specialised knowledge and skills required for engineers to perform effectively in their roles. Key areas of expertise include mathematics, mechanics, and scientific principles, which form

the bedrock of engineering education. Mastery of these subjects enables engineers to approach and solve complex problems effectively, as evidenced by expectations from professional bodies that emphasise the necessity of mathematical and engineering competence in engineering curricula (Passow & Passow, 2017). Similarly, mathematical competencies play a fundamental role in many engineering applications (Puzi et al., 2022). Moreover, contemporary engineering education increasingly incorporates computer modelling and computer-aided design (CAD) techniques, which are essential for visualising and implementing engineering concepts (Smirnova et al., 2020). Moreover, based on PjBL and PBL, the development of the technical competencies can be further enhanced by exposing students to real-world challenges that require innovative solutions (Juárez-Ramírez et al., 2016).

2.8.2 Human-centred/transferable skills

Success in the engineering industry requires more than just technical expertise. Graduates must also develop professional skills that enhance their ability to work effectively in diverse contexts. In addition to technical expertise, transversal competencies—including teamwork, communication, leadership, and lifelong learning—are becoming increasingly integral to engineering education. More employers are placing growing emphasis on non-technical competencies, including communication, teamwork, leadership, and adaptability, which are crucial for collaboration in multicultural and interdisciplinary environments (Viegas et al., 2020; Pasha-Zaidi, 2015). In addition, proficiency in project management, ethical decision-making, and innovation has been identified as keys for engineering graduates to meet the evolving demands of the workforce (Graham & Porterfield, 2018; Shahbazi et al., 2017). As engineering practice becomes more interconnected with global challenges, achieving success in an increasingly globalised workforce requires a balanced blend of technical expertise and interpersonal skills (Male, 2012).

The evolution of Industry 4.0, which integrates technical knowledge with employability skills, has further reinforced the need for graduates to develop interdisciplinary thinking, self-awareness, and risk tolerance (Sangwan & Venugopal, 2022; Isaeva & Grigorash, 2022). Current employers increasingly seek candidates who can demonstrate adaptability, critical

thinking, and leadership in complex professional environments (Cruz & Saunders-Smiths, 2019). In response, accreditation bodies are also advocating for a more holistic approach to engineering education, ensuring that curricula integrate both technical and transversal competencies to enhance employability and prepare graduates for multidisciplinary and dynamic work environments (Cruz et al., 2021). Equipping with comprehensive skill set not only allows engineering students to navigate evolving industry demands but also fosters resilience and life-long development in professional practice.

2.8.3 Cultural and ethical considerations

Cultural competence is an essential component of engineering education, particularly as engineering projects increasingly require collaboration in multicultural and interdisciplinary environments. Research by Main and Wang (2020) underscores the need for engineers to develop intercultural competency, enabling them to navigate cultural differences and work effectively within diverse teams. Beyond cultural awareness, ethical reasoning is also a fundamental competency for engineers, and ethical decision-making should be embedded within engineering curricula to prepare graduates for the moral complexities of their profession (Passow & Passow, 2017).

The role of engineers extends beyond technical problem-solving; they also significantly influence societal outcomes and sustainability. Monteiro and Sousa (2024) argue that fostering cultural competence alongside socio-political awareness is essential, as engineers are responsible for designing solutions that impact communities on a global scale. Developing ethical decision-making skills through exposure to diverse perspectives and challenge-based learning enables future engineers to navigate the ethical dilemmas that arise from rapid technological advancements (Tobias & Alvarez, 2024).

Furthermore, engineers should be able to recognise the dual impact of technological advancements, balancing innovation with responsibility. Acknowledging both the benefits and risks of engineering solutions is crucial for safeguarding public safety and promoting social justice (Zhang, 2024; Tian & Zhang, 2024). By integrating cultural competence, ethical reasoning, and sustainability considerations into engineering education, universities can

better equip graduates to engage with global challenges responsibly and contribute to the advancement of equitable and ethical engineering practices.

2.9 Problems of effective implementation of engineering education

In recent years, engineering education have become the focus of attention, particularly in the context of global technological transformations, industrial upgrades, and the evolving demand for skilled professionals (Huang, 2025; Saputro et al., 2025; Fantozzi et al., 2025). In engineering education, the current teaching model often struggles with the integration of theory and practice, as many courses remain predominantly theoretical and lack practical components, making it difficult for students to quickly adapt to the workplace upon graduation (James et al., 2024; Headley & Benson, 2024). Additionally, modern engineering issues frequently require interdisciplinary collaboration, such as the integration of artificial intelligence with engineering projects (Saguy et al., 2025). However, existing curricula remain relatively singular, failing to meet the growing need for interdisciplinary development. Although active learning models such as PBL and PjBL have gained increasing recognition, their implementation in large-scale classrooms or resource-limited environments continues to face challenges.

At the same time, issues related to diversity and inclusivity in engineering education also require attention. For instance, international engineering students encounter great challenges in their studies in UK universities due to differences in cultural backgrounds, language proficiency and teamwork patterns. These students not only have to think about their own academic performance, but they also have to bear the brunt of different socio-cultural differences more than their UK counterparts (Zhou & Yarapirom, 2024; Purba & Wahyuni, 2024; Gibson et al., 2024). As international education providers (UK universities), creating a more inclusive learning environment to facilitate the learning transition and adaptation for diverse students should be the duty to achieve.

Another significant challenge is the alignment between engineering education and industry needs, which exists globally. Many universities still design their curricula in traditional modes, lacking deep collaboration with industry, which results in graduates requiring an extended

adjustment period when entering the workforce. However, modern engineers are expected not only to grasp solid technical expertise but also to develop strong communication, leadership, and teamwork skills—areas that have often been underemphasised in traditional teaching approaches (Pandey et al., 2024; Jiang et al., 2017). Meanwhile, emerging technologies such as artificial intelligence, the internet, and sustainable engineering are advancing rapidly, yet engineering curricula have been relatively slow to update, making it difficult to align with the fast-changing demands of the industry (Rubio et al., 2019; Wilson, 2019; Rampasso et al., 2018; Vehmaa et al., 2018; Monna et al., 2022).

Moreover, engineering education should not focus solely on short-term employability but should also consider students' long-term career development (Hecht et al., 1995; Rodríguez et al., 2021; Malykhin et al., 2023). Looking toward the future, industries and technologies are evolving rapidly, without a commitment to lifelong learning and continuous innovation, engineering graduates may struggle to adapt to new challenges when entering the workforce (May & Strong, 2011; Soupeze, 2023; Chand et al., 2019; Trevelyan, 2019). By strengthening training in fundamental problem-solving and critical thinking, offering flexible curriculum pathways, and fostering collaborations with research institutions and industry, universities can help students develop a strong foundation for continuous learning and future research engagement.

In conclusion, engineering education continues to evolve while still facing many challenges. Future educational reforms will continue to optimise aspects such as practical training, teaching and learning inclusivity, alignment with industry, digitalisation, human-centred skills development and sustainability to cultivate well-rounded engineering professionals who are prepared for future workforce needs. By integrating engineering education research in teamwork, cross-cultural learning and pedagogical innovation, such as the application of gamified team-based learning to enhance the learning experience and academic outcomes of diverse students.

Part 4 Summary

In short, this section has highlighted that engineering education in the UK must equip students with both disciplinary expertise and human-centred professional skills such as teamwork, communication, and problem-solving. These competencies are increasingly recognised as critical for success in a globalised and interdisciplinary professional environment. However, despite their importance, such transferable skills are not always systematically embedded into engineering curricula, and international students, particularly Chinese students, may face additional challenges in acquiring them due to differences in prior educational experiences and learning expectations.

This underscores the need for innovative and inclusive teaching frameworks that can simultaneously support students' mastery of technical knowledge and the development of interpersonal competencies. Addressing this dual challenge is at the heart of the present study, which proposes a game-based framework specifically designed to enhance teamwork skills and foster more inclusive learning experiences for Chinese students in UK engineering courses.

2.10 Rationale and aims of this study

The reviewed literature indicates that Chinese engineering students in UK universities face a range of adaptation challenges that extend beyond cultural and linguistic barriers. Prior research highlights that while international students demonstrate adequate subject knowledge and language proficiency, they still encounter difficulties in adapting to the UK's pedagogical approaches, particularly those emphasising active participation, teamwork, and problem-based learning (Adisa et al., 2019; Ramachandran, 2011; Wu & Hammond, 2011; Jin & Cortazzi, 2017). These challenges can be conceptualised as an "adaptation lag," where students' learning behaviours, shaped by Confucian Heritage Culture and prior educational systems, do not align with the expectations of UK engineering programmes.

Furthermore, existing studies emphasise the importance of implicit competencies such as teamwork, communication, collaboration and self-regulated learning in engineering education (Johnson & Johnson, 2014; Litzinger et al., 2011; Zimmerman, 2002; Johnson & Johnson, 1989). Yet, these competencies are often less visible in traditional assessments, and

limited research has explored how international students, particularly Chinese students, can effectively develop them in cross-cultural contexts. This indicates a gap in understanding how students' learning expectations, capacities, and behaviours interact with their teamwork experiences, and how targeted pedagogical interventions might support their adaptation.

On the other hand, a growing body of research indicates that game-based and gamified learning approaches have been suggested as promising tools to enhance engagement, foster collaboration, and promote experiential learning in engineering education (Kolb, 1984; Salas et al., 2018). However, empirical evidence on their effectiveness for international students in UK postgraduate programmes remains scarce. This underscores the need for research that not only explores students' learning and teamwork experiences but also evaluates innovative pedagogical interventions that can address their adaptation needs.

Based on the above rationale, this study pursues three aims (simplified and concluded from the scope of four key research questions mentioned in Chapter 1.3):

- To investigate the learning expectations, capacities, and behaviours of Chinese engineering students in UK universities.
- To examine how these students experience and engage in teamwork in engineering programmes.
- To explore whether gamified learning approaches can enhance their learning and teamwork experiences.

2.11 The development of the research hypothesis

In this study, the research hypothesis is derived from investigating Chinese students' learning experiences in engineering programmes at UK universities.

In recent years, the number of Chinese students in UK higher education institutions has exhibited significant growth (GOV.UK, 2025), with engineering PGT programmes emerging as a popular choice due to their international accreditation advantages. However, data from the Higher Education Statistics Agency (HESA, 2023) indicate that this student cohort demonstrates a significant gap in academic performance compared to domestic students

($p < 0.05$), prompting a deeper academic discourse on the adaptability of cross-cultural education.

Existing research suggests that Chinese students may experience "dual cognitive dissonance" in cross-cultural learning contexts: they must overcome the passive learning habits ingrained by their prior educational environments (Mathias et al., 2013; Lamberton & Ashton-Hay, 2015) while simultaneously adapting to the UK engineering education model, which emphasises active construction and situated problem-solving (Litzinger et al., 2011). Other research has also explored cognitive style differences among bilingual learners, revealing that among engineering master's students with an average IELTS score above 6.5, most of them still reported "no fundamental difficulty in understanding lecture content but significant challenges in effectively engaging with Problem-based learning (PBL) pedagogy" (Jin & Cortazzi, 2017).

These insights imply that research on Chinese students' learning in UK universities should move beyond surface-level linguistic factors. Research should focus on exploring more of the structural differences inherent in the education systems and cultures of different countries, and what fundamental factors shape the differences in students' academic performance. A summary of these structural disparities is presented in Table 2.4.

Table 2.4 Dimensional differences between the Chinese and the UK education systems

Dimension	Chinese Paradigm	The UK Paradigm
Knowledge construction	Stepwise accumulation	Existing knowledge association
Assessment orientation	Deterministic answers	Argumentation
Teacher-Student relationships	Authority-obedience	Collaboration-critique-innovation

As summarised in the table above, in terms of knowledge construction, the Chinese paradigm emphasises stepwise accumulation. In contrast, the UK paradigm advocates for the association of existing knowledge, then building new ones. With regard to assessment orientation, the Chinese approach prioritises deterministic answers, while the UK paradigm places greater emphasis on critical thinking and logical reasoning skills. Finally, in the dimension of teacher-student relationships, the Chinese style is dominated by the authority-submission model, whereas the British paradigm promotes equal relationships.

Thus for the formation of the hypotheses of this study, firstly, it stems from the fact that the increasing enrolling number of Chinese students at UK universities in recent years has presented a pedagogical challenge for the UK educators in effectively teaching this student cohort. This challenge may have led to a mismatch in teacher-student interactions, ultimately affecting both teaching effectiveness and learning outcomes. Consequently, this study seeks to further explore the underlying causes of this pedagogical misalignment. From a teaching perspective, systemic reforms within the UK higher education system cannot be implemented in the short term. Therefore, this study focuses on designing practical, concrete and feasible instructional strategies to support these students' learning.

On the other hand, from a student's perspective, learning is a process of acquiring new knowledge and developing new cognitive and behavioural patterns. Chinese students studying in the UK are not only expected to improve their academic skills, but also to acquire competencies that will enable them to survive in the future workplace. Whereas, Chinese students' learning in UK universities will be affected by their language proficiency and learning behaviours. Therefore, the hypothesis in this study starts by exploring whether Chinese students' English proficiency and learning behaviours affect their learning experience in UK universities. Then, after identifying the potential influencing factors, design effective teaching practices to help these students enhance their learning experience.

According to the above statement, this study proposes the core hypothesis that the differences in academic performance of Chinese engineering students may be attributed to either variation in their language proficiency or an “adaptation lag” in the process of transferring educational behaviours. This learning lag does not stem from the understanding and learning of specialised knowledge, but is more likely to stem from the lack of some implicit competencies, which is a fundamental aspect of engineering education (Nonaka & Takeuchi, 1996). The formation and development pathway of this research hypothesis is illustrated in Figure 2.5.

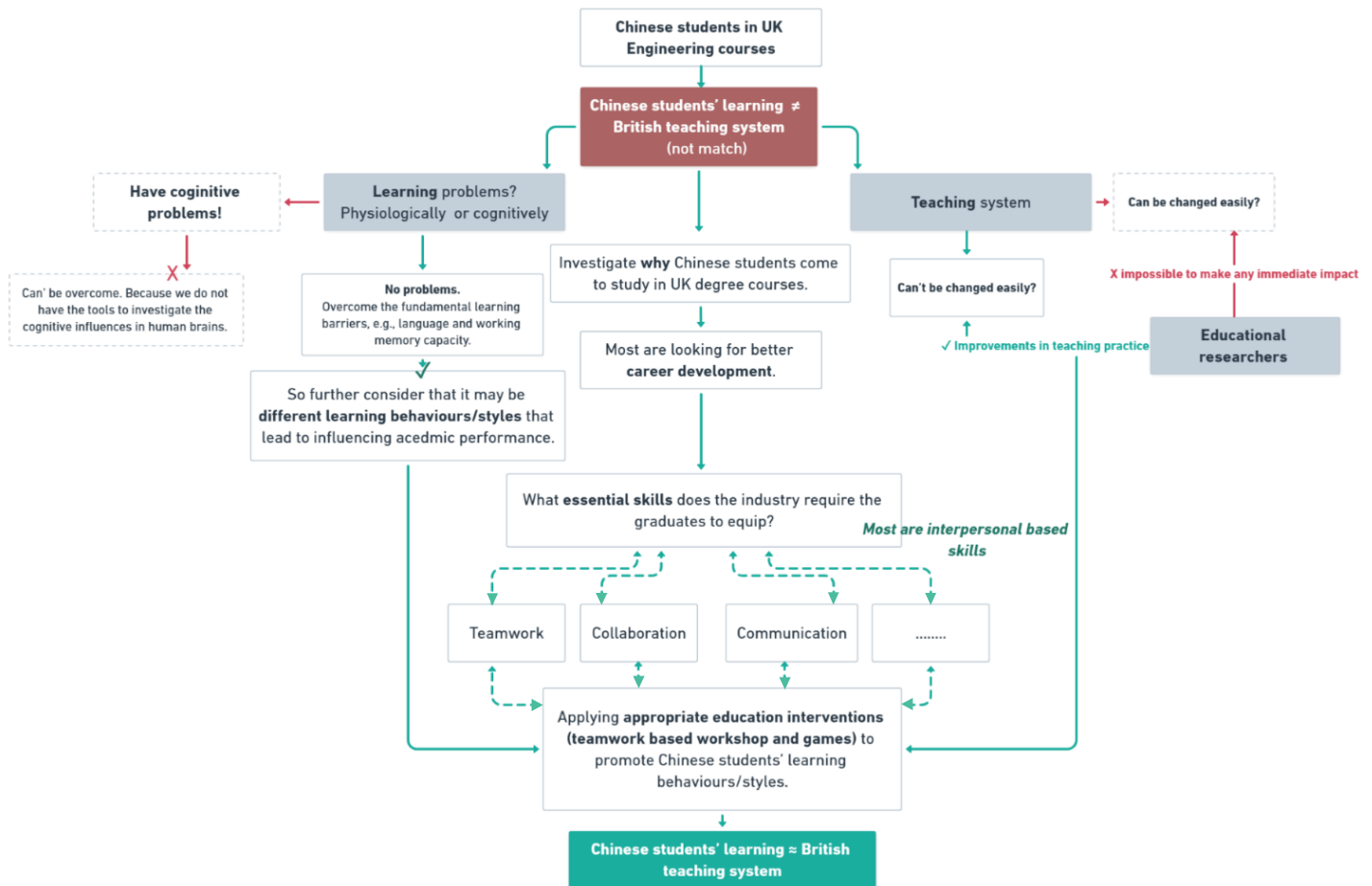


Figure 2.5 The rationale for the research hypothesis development. The hypothesis development includes identifying research problems/gaps and forming potential solutions.

Therefore, in summary and corresponding to the aims mentioned in section 2.11, the study develops the following hypotheses:

H1: The academic performance differences of Chinese engineering students are associated with an “adaptation lag” in transferring learning behaviours across different educational contexts.

H2: Challenges in teamwork may be a factor contributing to the “adaptation lag” observed among Chinese students, exerting an equal influence to language barriers or technical knowledge.

H3: Game-based teamwork interventions can mitigate these challenges and improve these students' learning outcomes.

2.12 Chapter summary

This literature review has progressively built a holistic understanding of the challenges and opportunities for Chinese students in UK engineering education, moving from their educational background and adaptation issues, through the cognitive mechanisms of learning, to pedagogical theories that can inform inclusive teaching, and finally to the broader requirements of modern engineering education. While extensive research has examined Chinese students' academic adaptation and challenges in UK higher education, relatively little is known about their teamwork learning experiences and effective practice designs for this student cohort. Given that teamwork forms a central component of engineering curricula through project-based and collaborative learning, this under-researched area constitutes a significant gap that the present study aims to address. Together, these strands establish the rationale for this study: the urgent need for an inclusive, game-based framework that fosters both technical learning and teamwork for Chinese students in UK universities. The following methodology chapter, therefore, details the research design, data collection, and analysis methods used to investigate Chinese students' general/teamwork learning experiences and to evaluate the effectiveness of the proposed framework.

CHAPTER 3: METHODOLOGY

3.0 Introduction

Building on the literature review and the identified research gaps, as well as the scope of the research questions, this study is guided by three research aims: (1) to investigate the learning expectations, capacities, and behaviours of Chinese students in UK universities; (2) to examine how these students experience and engage in teamwork in engineering education; and (3) to explore whether gamified learning approaches can enhance their learning and teamwork experiences.

The methodology of this study is therefore designed to address these aims through an action research framework combined with mixed methods. Action research can provide a cyclical process of planning, acting, observing, and reflecting that is well-suited to investigating and improving pedagogical practice in real classroom contexts. The integration of mixed methods allows the study to examine both the measurable outcomes of interventions and the nuanced experiences of students, ensuring a comprehensive understanding of their learning and teamwork. The following sections outline the research philosophy, methodological design, data collection, and analysis employed in this study.

3.1 Research theoretical framework

This study is situated within the broader context of Chinese engineering students' learning experiences in UK universities. Existing research has documented the challenges these students face, particularly in language proficiency, cultural adaptation, and academic integration. However, it remains unclear whether the factors influencing their learning outcomes arise primarily from their individual learning capacities (e.g., cognitive abilities such as working memory) or from the learning behaviours (e.g., teamwork-based learning) they bring from prior educational experiences. This ambiguity represents an important research gap, especially given that engineering education not only requires technical knowledge but also emphasises collaboration and teamwork skills. For Chinese engineering students studying in UK universities, the ability to adapt their learning behaviours and teamwork strategies in a cross-cultural environment is critical for their academic success and professional development.

In addition, while game-based and project-based learning have been increasingly employed in higher education to enhance motivation and engagement, there is little empirical evidence on their effectiveness in the specific context of Chinese students studying engineering in the UK. Gamification, grounded in motivational theories such as Self-Determination Theory (Deci & Ryan, 2000), offers potential to create inclusive and interactive learning environments. Yet, its role in addressing the unique learning and teamwork challenges faced by Chinese students remains underexplored.

Therefore, the conceptual framework of this study draws on three interrelated theoretical dimensions:

1. Learning behaviours and capacities informed by theories of student learning approaches (Biggs, 1987) and the potential learning behaviours revealed by cross-cultural learning challenges between China and the UK (Tian et al., 2021; Gu & Maley, 2008), to investigate Chinese students' learning expectations, capacities, and behaviours.
2. Teamwork and collaboration competencies, underpinned by social constructivist theories (Vygotsky, 1978) and collaborative learning frameworks (Johnson & Johnson, 1999), to explore the role of teamwork in engineering education and how Chinese students engage in collaborative settings.
3. Gamified instructional design guided by motivational theories (see in section 2.6) and research on game-based learning (see in section 2.7.4), to examine how gamification can be applied to improve inclusivity, engagement, and teamwork effectiveness.

These dimensions inform the study's key research questions:

- What are the learning expectations, capacities, and behaviours of Chinese engineering students in UK universities?
- How do these students experience and engage in teamwork in engineering education?
- Can gamified learning approaches enhance their learning and teamwork experiences?

By integrating these three dimensions, the conceptual framework provides a theoretical foundation for designing and evaluating an inclusive, gamified workshop aimed at improving both learning and teamwork experiences of Chinese engineering students in UK programmes.

3.1.1 Research philosophy

This study is guided by a pragmatic paradigm (Biesta, 2010; Creswell & Plano Clark, 2018), which provides the philosophical foundation for combining action research with mixed methods. Pragmatism emphasises practical solutions to real problems and values methodological flexibility (Morgan, 2007), aligning well with the aim of improving the learning and teamwork experiences of Chinese postgraduate engineering students in UK universities. In addition, the study draws on social constructivism (Vygotsky, 1978), recognising that learning is socially mediated and shaped through interaction, negotiation, and shared experiences. This constructivist orientation connects directly with the theoretical rationale of the study, which highlights experiential learning (Kolb, 1984), cooperative learning (Johnson & Johnson, 1999), and self-regulated learning (Zimmerman, 2002) as central to effective knowledge construction and teamwork.

Ontologically, the study assumes the coexistence of multiple realities (Guba & Lincoln, 1994). Students' learning outcomes can be captured through measurable indicators such as surveys and performance data (Tashakkori & Teddlie, 2010), but their lived experiences, shaped by cultural background, language proficiency, and teamwork engagement, represent subjective yet equally valid realities (Denzin & Lincoln, 2018). This pluralist stance enables the research to investigate both observable patterns and context-specific perspectives in cross-cultural learning.

From an epistemological perspective, knowledge is understood as being generated through cycles of action, observation, and reflection (Kemmis et al., 1988; Lewin, 1946), consistent with the iterative nature of action research. Within this framework, knowledge is not passively transmitted but co-constructed between the researcher and participants in authentic learning contexts (Reason & Bradbury, 2008). The incorporation of mixed methods strengthens this epistemological stance: quantitative approaches provide evidence of the effectiveness of gamified teamwork interventions (Creswell & Plano Clark, 2018), while qualitative feedback captures the depth of students' individual learning perceptions, reflective practices, and adaptive strategies (Merriam & Tisdell, 2016).

Methodologically, the study integrates the plan–act–observe–reflect cycles of action research with a mixed-methods design (Kemmis et al., 1988; Tashakkori & Teddlie, 2010). This dual structure enables the study to examine both the measurable impact of pedagogical interventions and the nuanced processes through which students adapt to cross-cultural learning. The dual role of the researcher as both an educator and investigator requires reflexivity and continuous self-awareness to minimise bias (Finlay, 2002). To ensure trustworthiness, the study includes participant feedback/member checking (Lincoln & Guba, 1985) and reflective notes (Ortlipp, 2008), reinforcing both the credibility and contextual grounding of the findings.

In sum, the research philosophy can be described as pragmatism with a constructivist orientation (Feilzer, 2010), ensuring coherence between ontology, epistemology, and methodology while directly linking to the educational theories that inform the study. This alignment provides a robust philosophical foundation for investigating and enhancing Chinese engineering students' learning and teamwork experiences in UK higher education.

3.1.2 Engineering education research design in this study

The design of teaching practices must be underpinned by theoretical foundations, while the empirical data derived from practice can, in turn, be analysed through theoretical lenses (Loui & Borrego, 2018). Given that engineering education research is inherently practice-oriented, its initial design often integrates interdisciplinary and multi-theoretical perspectives. This approach facilitates the development of methodological frameworks suitable for engineering education and enhances the broader impact of research outcomes within the academic and wider communities. As discussed in the literature review - Part 3, regarding relevant educational research theories, this study synthesises theoretical and practical insights from general and engineering educational research to optimise and establish a research methodology suited to the objectives of this study.

In this study, the theoretical perspective mainly on cognitive constructivist and motivation-driven mechanisms form a dual-dimensional supporting framework that positions the potential direction and innovation of this research on teaching practices and strategies. In the cognitive constructivist dimension, social constructivism inherently emphasises the dynamic

nature of knowledge generation through social collaboration. This theoretical foundation lays the groundwork for project-based (PBL) and experiential learning approaches. For engineering students in particular, the acquisition of specialised knowledge is often reinforced through active engagement in practice (Menekse et al., 2013; Anwar et al., 2022; Debnath & Pandey, 2011). Therefore, in engineering education, the emphasis on interactive collaboration within real engineering scenarios and problem-solving processes can more effectively improve learners' cognitive development. This also constitutes the fundamental basis for the methodological development of this study.

On the other hand, the increasing emphasis on collaborative/experiential learning in engineering education necessitates corresponding enhancements in students' development of human-centred skills, particularly team cooperation and communication competencies (Hecht et al., 1995). However, the acquisition and cultivation of these implicit team-based skills are not directly quantifiable through traditional academic assessments. This reality underscores the critical importance of designing appropriate pedagogical approaches and tools to effectively stimulate students' self-motivated learning initiative. Thus, in this study, to establish a more interactive and inclusive platform that allows students as active participants in the learning process, gamified pedagogical design has been implemented to enhance autonomous learning capabilities, problem-solving skills, and collaborative learning competencies.

In terms of specific practice design, this study incorporates gamification mechanisms through the implementation of "group survival challenge points" and "team achievement presentation showcases" to reinforce team belongingness (Kou & Gui, 2014; Kabát et al., 2024; Salas et al., 2018). Additionally, it allows students to freely choose team roles and to specify role tasks to strengthen perceived task competency and improve overall team performance (Colomo-Palacios et al., 2012; Kusumasari et al., 2018; Lacerenza et al., 2018; Suter et al., 2009). The gamified framework utilises rule-based interaction mechanisms to mitigate common issues in traditional group work such as free-riders, while fostering stronger inter-member connections through resource-sharing game elements. This is also complemented by post-workshop evaluation forms for comprehensive process analysis.

Also building on the above, this study draws inspiration from the Conceive-Design-Implement-Operate (CDIO) framework proposed by MIT and other universities around 2000 (Bai, 2022;

Gaidi, 2003; Gunnarsson & Swartz, 2022) to construct ideas for the specific teaching practices design. Central to the CDIO framework is its focus on student-centered learning, which cultivates critical competencies and enhances employability. It is achieved through active learning strategies such as PBL that align closely with real-world scenarios. Students engage in hands-on projects, allowing them to develop essential skills, including teamwork, problem-solving, and communication (Lunev et al., 2013; Fusic et al., 2022). The integration of PBL within the CDIO framework not only reinforces theoretical concepts but also fosters an entrepreneurial mindset among students, encouraging them to become well-rounded professionals rather than traditional engineers (Fusic et al., 2022).

Guided by this framework, part of the teaching design is structured around game-based teamwork project. The team project design concept is as follows:

- Conceive Phase: Students develop ideas based on design project requirements;
- Design Phase: Translate conceptual requirements into detailed prototype designs;
- Implement Phase: Construct prototype products using materials;
- Operate Phase: Validate product reliability and market potential through data collection and analysis, followed by group presentations to demonstrate and promote the design solutions.

Based on the application of the CDIO standards to define the framework of the design project, then via further combination with gamification, the teaching methodology may enable students to gradually deepen their understanding of teamwork and apply their professional knowledge in design practice.

In sum, the design of the game-based teamwork teaching approach aims to enhance student engagement through the integration of disciplinary knowledge and teamwork concepts into game strategies and role simulations, thereby stimulating their intrinsic curiosity and self-directed learning. Peer-to-peer interactions and connections were further facilitated through the setting of team winning rules. Through the synthesis of multidimensional theoretical frameworks and practical methodologies, this study attempts to validate the effectiveness of teamwork and game-based practical teaching on students' teamwork skills learning. Ultimately, the successful implementation of the practice design can facilitate the

transformation of human-centred skills cultivation in engineering education from an empirically oriented approach to a more scientific and systematic cultivation paradigm.

3.2 Mixed research methods

3.2.1 Overview of mixed research methods (Qualitative & Quantitative)

Mixed research methods (MRM) in educational research involve the systematic integration of qualitative and quantitative approaches within a single study to provide a comprehensive and nuanced understanding of complex educational phenomena (Brown et al., 2017; Corr et al., 2020; Alhassan, 2024). This approach can address multifaceted research questions that cannot be fully explored by a single method. By utilising the strengths of both qualitative and quantitative data, MRM can enhance the depth and richness of educational inquiry, offering insights that neither method can achieve in isolation.

At its core, MRM is defined as a research design that combines qualitative and quantitative data collection and analysis techniques, either concurrently or sequentially, to address research objectives more effectively (Doyle et al., 2009). This integration is particularly valuable in educational contexts, where multiple interacting factors shape learning outcomes (Corr et al., 2020). Mixed methods research is often positioned within a pragmatic philosophical framework, which supports the blending of methodologies to best address targeted research questions (Johnson & Onwuegbuzie, 2004). This perspective underscores the flexibility and adaptability of MRM, allowing researchers to tailor their approaches based on the unique demands of their studies.

The advantages of employing MRM in educational research are extensive and well-documented. MRM facilitates a holistic exploration of educational issues by capturing the complexity of human experiences and interactions within educational settings (Doyle et al., 2009). Additionally, the integration of qualitative and quantitative data enhances the validity and reliability of research findings, as triangulating multiple data sources allows researchers to corroborate their results and strengthen the credibility of their conclusions (Santos et al., 2020). The methodological flexibility of MRM has led to its recognition as an effective approach for conducting high-quality educational research, particularly in interdisciplinary

settings where diverse expertise can enrich the research process (Sandelowski, 2013; Bowers et al., 2013).

Furthermore, MRM is particularly well-suited for addressing complex educational challenges that require nuanced interpretations and multifaceted solutions. While many MRM studies maintain separate analyses for qualitative and quantitative data, those that adopt an integrated approach during interpretation tend to generate richer and more comprehensive insights (O’Cathain et al., 2007). This level of integration is crucial in educational research, where understanding context, stakeholder perspectives, and the interplay of various factors is essential for developing effective and sustainable educational interventions.

Based on the above review of the mixed methods applied in pedagogical research, and in order to gain a more comprehensive understanding of Chinese students’ learning in UK engineering courses, the MRM used in this study and the corresponding research phases are summarised in Table 3.1 below:

Table 3.1 Research stages and corresponding research methods, tools and objectives

Stage	Research Methods	Tools/Techniques	Objectives
1	Participatory Classroom Observation	- Classroom observation notes - Structured observation record sheet	Identifying non-verbal behaviour, interaction patterns and cultural differences in practice-based courses.
2	Questionnaires	- Student learning expectations & preferences - Post-class feedback - Teamwork behaviour	Quantitative exploration of students' learning behaviour preferences and challenges.
3	In-depth interviews	- Semi-structured interview outline - Thematic analysis	In-depth discussions of the personal perceptions and experiences of learning in the UK engineering courses.
4	Educational Game Design	- Game prototype testing - Teamwork game workshop engagement	Developing and validating the effectiveness of the designed learning game to improve students' learning experience in the UK classroom.

- Data and method triangulation

Further to ensure the credibility and depth of this research on the phenomenon of Chinese postgraduate students' teamwork and learning experiences in UK engineering programmes, a data triangulation strategy was adopted. Specifically, methodological triangulation was achieved by combining classroom observation, surveys, and post-session interviews, thus integrating both qualitative and quantitative data. Classroom observation provided real-time insights into students' collaborative behaviours and team dynamics during team-based tasks. Quantitative surveys offered measurable data on students' self-assessment of learning satisfaction, expectations, preferences, and engagement. Post-session interviews added depth by exploring students' subjective interpretations, challenges, and reflections on their collaborative experiences.

The convergence of these multiple methodological angles enabled cross-verification of findings, for example, students' self-reported improved understanding of teamwork in surveys aligned with positive reflections in interviews and observable cooperative behaviours in class. This triangulation offered a comprehensive and credible account of how Chinese students' teamwork and learning are shaped and developed within the UK engineering education context.

3.2.2 Quantitative and qualitative data collection

The data collection process is tailored depending on the research methodology design (quantitative, qualitative or mixed methods) used in the study. The method of conceptualising data collection for a mixed methods design study is based on the type of data collection, which can be concurrent or sequential (Creswell & Plano Clark, 2007). Concurrent data collection is also primarily used in triangulation or embedded mixed methods design studies (Creswell & Plano Clark, 2007). Using concurrent data collection, quantitative and qualitative data are collected around the same time. While sequential data collection methods involve collecting quantitative data or qualitative data at different phases. Thus, sequential methods are commonly used in interpretive, exploratory, and embedded mixed methods designs (Creswell & Plano Clark, 2007; Creswell, 2003). This study is an action research aimed at establishing new effective instructional practices, hence the sequential data collection method was used.

This study employs a mixed-methods approach by integrating both qualitative and quantitative data to achieve a comprehensive understanding of international Chinese students' learning experiences in UK engineering programmes. By utilising both types of data, the study ensures a well-rounded analysis that captures not only students' perceptions and reflections but also measurable changes in their teamwork-related skills.

- Quantitative Data Collection

This study collects quantitative data through structured self-assessment surveys to discuss the students' experience of learning in engineering practical courses, their learning expectations, their learning abilities, teamwork experience and their reflection and feedback after engaging in the game-based teamwork workshop and games. These surveys measure key aspects such as self-perceived learning experience in the UK engineering courses and teamwork abilities. The data collected will be statistically analysed to identify measurable trends, patterns, and potential improvements in student learning experience, teamwork-related competencies and instructional design.

- Qualitative Data Collection

The qualitative component of this study aims to capture the depth and complexity of students' comprehensive experiences of their learning and teamwork. Semi-structured interviews will be conducted with voluntary participants on these two main aspects separately. Additionally, classroom and workshop observations will also be carried out to examine real-time team interactions, collaboration dynamics, and learning behavioural patterns during team-based activities. The qualitative data will be analysed using NVivo software, employing thematic analysis to identify recurring patterns and themes.

Overall, the phenomenon under study is the teamwork and learning experiences of Chinese postgraduate students in UK engineering programmes, focusing on how they engage, perceive, and develop through collaborative learning in a cross-cultural academic environment. Figure 3.1 illustrates the data collection strategy design related to the research questions of the study, based on the mixed methods discussed above. The design of this study is not limited to measuring variants in more than one dimension, but rather expects to develop and shape

further research and exploration of subsequent dimensions based on the clarification of one dimension.

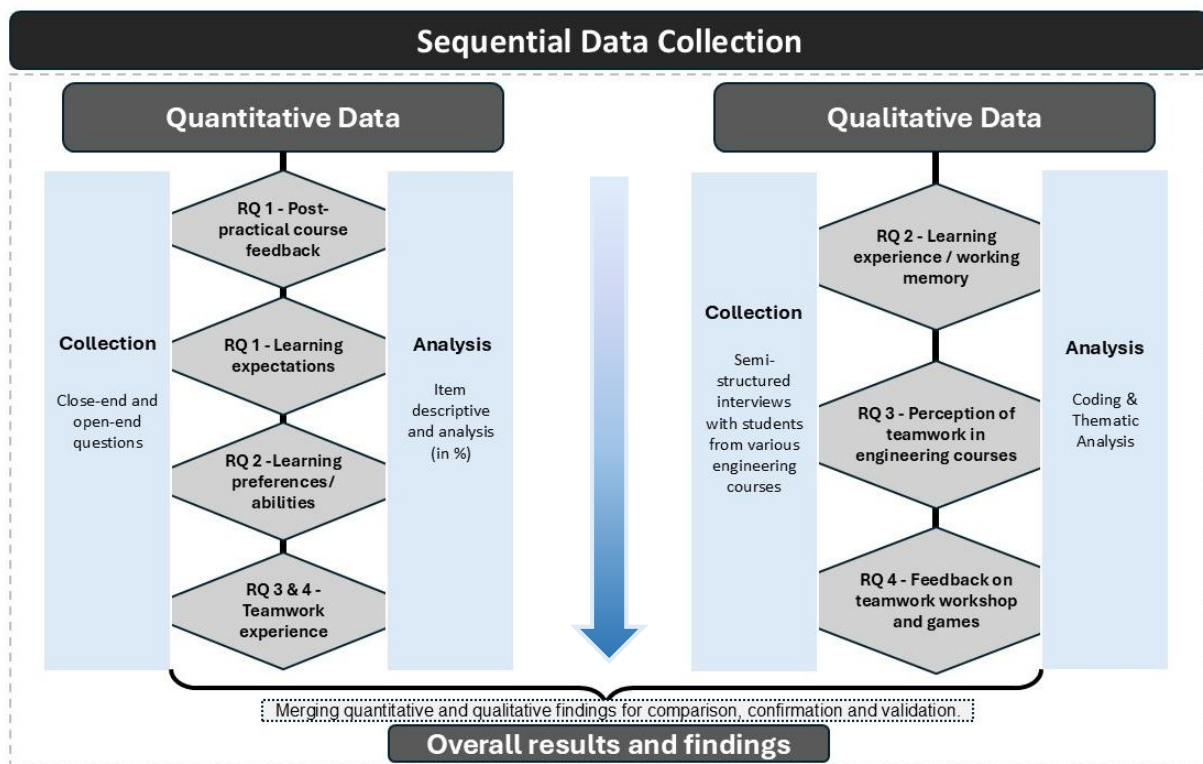


Figure 3.1 Data collection design

3.3 Data collection methods – survey, interviews, and classroom observations

3.3.1 Surveys

The use of questionnaire surveys in educational research serves as a pivotal method for gathering data that informs educational practices, policies, and outcomes. These surveys are particularly valued for their ability to efficiently collect quantitative data from large populations, enabling researchers to identify trends and patterns in educational settings. Their capacity to reach broad audiences makes them essential for capturing diverse perspectives, which contributes to the development of inclusive and effective educational strategies, as well as to the assessment of satisfaction and educational effectiveness in specific programmes (Gucciardi et al., 2023; Kwon, 2022).

Beyond the efficiency and broad applicability, questionnaire surveys are highly adaptable, allowing researchers to tailor instruments to specific educational contexts and populations. For instance, structured surveys have been used to examine students' perceptions of specific

teaching implementation, demonstrating their relevance in assessing contemporary educational technology (Ayeni et al., 2024). Validated questionnaires also play a crucial role in ensuring data reliability and accuracy (Edokpolor & Omiunu, 2017).

- Questionnaire design

Questionnaires are one of the main research methods used in this study. It can ensure efficient data collection from a large number of respondents. In this project, a questionnaire would allow researchers to gather data from a representative sample of many Chinese students studying in engineering courses in a relatively short time. Also, the questionnaire can provide standardised responses, which makes it easier to compare and analyse responses across different cohorts and identify patterns and trends in the data set. The questionnaire surveys designed for the study were conducted anonymously via Google Forms, ensuring the confidentiality of information and data.

The designed questionnaire incorporated a combination of Likert scale options, multiple-choice, and open-ended responses. The design of questionnaires was informed and inspired by previous research, ensuring the scientific validity and reliability of the items. Based on established studies and adapted to the specific context of this research, the questionnaire was structured into four main dimensions:

- Post-course feedback: This section focuses on students' engagement, perceptions of the learning, and views on teaching practices. The questions was guided by prior studies on learning experience and student engagement (Biggs & Tang, 2011).
- Expectations of the university learning: This section investigates Chinese students' expectations regarding course objectives, teaching support, and anticipated learning outcomes. The questions were developed with reference to research on study motivation and expectations (Watkins & Biggs, 1996; Eccles & Wigfield, 2002; Sit, 2013; Wu, 2009; Wu, 2014; Wu, 2015; Wu & Hammond, 2011; Huang & Turner, 2018).
- Learning preferences and approaches: This section aims to explore Chinese students' preferences for learning methods, strategies, and study habits. The questions was informed by existing research on various learning styles and approaches to learning (Kolb, 1984; Fleming & Mills, 1992; Entwistle, 2009; Watkins & Biggs, 1996; Syofyan & Siwi, 2018; Mašić et al., 2020; Hu & Wu, 2020).

- Perceptions and feedback on teamwork-based learning: This section addresses students' experiences and reflections within teamwork and collaborative learning settings. The questions were derived from well-established studies on cooperative and team learning (Johnson et al., 2014; Riebe et al., 2010; Riebe et al., 2016; Laal & Ghodsi, 2012; Colbeck et al., 2000; Oakley, 2004; Pfaff & Huddleston, 2003).

Together, these four dimensions provide a framework for capturing the multifaceted aspects of students' learning experiences and needs.

The survey question designed for each research dimension is summarised in Table 3.2, and the full content of all questions is listed in Appendix 11.

Table 3.2 Questionnaire designed in this study

Aspect 1: Post-practical course feedback		
No.	Content	Type
1.1	Are you satisfied with today's session? Rates from 1-5, 1=poor, 5=excellent	Likert-5 scale
1.2	Which part of today's session did you find most useful? (for example, e-resources on BlackBoard, hands-on activities, demonstrations from instructors, etc.)	Open-end
1.3	Can you recall one point you remember in today's lab?	Open-end
Aspect 2: Learning expectations		
2.1	Why did you choose to study in the UK?	Multiple-choice
2.2	Why did you choose to study the degree course?	Multiple-choice
2.3	What activities would you like to take part in more besides studying?	Multiple-choice
2.4	If the university offers additional post-course workshops/seminars, etc., what would you like these activities to be about?	Multiple-choice
2.5	What are you most looking forward to gaining in the following academic year?	Open-end
2.6	What would you like to do after graduation?	Multiple-choice
Aspect 3: Learning preferences		
3.1	Before your current course, have you studied at other overseas universities/institutions?	Multiple-choice
3.2	How many hours per week do you volunteer to study? Except for the scheduled teaching time at the university.	Multiple-choice
3.3	What is your average grade for most current assignments and exam?	Multiple-choice
3.4	What is your expected grade for the whole study?	Multiple-choice
3.5	Do you think it is important to be proficient in English in your current studies?	Likert-5 scale
3.6	What is the frequency of using software/Apps during your studies, such as DeepL or ChatGPT, to improve/revise your writing?	Likert-5 scale
3.7	How much do you think you can understand when listening to lectures/seminars/tutorials?	Multiple-choice
3.8	What is your first reaction when you read a question in English?	Multiple-choice

3.9	How do you self-evaluate your current level of English proficiency?	Likert-5 scale
3.10	If you are required to remember a river right now, which of the following would be easier for you to remember ?	Multiple-choice
3.11	What are you most likely to do to spell out a complex word?	Multiple-choice
3.12	What's the best way for you to learn about something new (like a phone App or a video game)?	Multiple-choice
3.13	What do you find most helpful when solving a complex problem (e.g., no obvious solution and may involve wide-ranging steps, and you may need to be creative and use different resources)?	Multiple-choice
3.14	What do you find most helpful when working on a hands-on project?	Multiple-choice
Aspect 4: Teamwork learning		
4.1	You've worked with your group, so your preference for the group work is:	Multiple-choice
4.2	How well do you know your current teammates?	Multiple-choice
4.3	What is effective teamwork you think?	Open-end
4.4	When faced with uncertainty in the workshop, do you feel you can adapt and find solutions better and more quickly in the team than working alone?	Likert-5 scale
4.5	After attending this workshop, do you feel that you would be more willing to engage in team-based activities?	Likert-5 scale
4.6	What was your best experience at the event?	Open-end
4.7	What was your worst experience at the event?	Open-end
4.8	Self-evaluation: I clearly understood the objectives of the activity.	Likert-5 scale
4.9	Self-evaluation: I actively contributed useful ideas to play the game.	Likert-5 scale
4.10	Self-evaluation: I read and explained the clue information clearly and helped others understand it.	Likert-5 scale
4.11	Self-evaluation: I effectively collaborated with my teammates, helping them survive in the game.	Likert-5 scale
4.12	Self-evaluation: I communicated clearly and respectfully with my team.	Likert-5 scale
4.13	Self-evaluation: I actively engaged in solving problems during the workshop.	Likert-5 scale
4.14	Self-evaluation: I learned something new and improved my understanding of teamwork from the workshop.	Likert-5 scale
4.15	Group evaluation: All team members understood the objectives of the activity.	Likert-5 scale
4.16	Group evaluation: Every team member contributed useful ideas to play the game.	Likert-5 scale
4.17	Group evaluation: Every team member read and explained the clue information clearly and helped each other understand it.	Likert-5 scale
4.18	Group evaluation: Every team member worked well and respectfully with others and helped each other.	Likert-5 scale
4.19	Group evaluation: Every team member communicated effectively and respectfully.	Likert-5 scale
4.20	Group evaluation: Every team member was actively involved in solving problems during the workshop.	Likert-5 scale
4.21	Group evaluation: Every team member demonstrated learning improvement and good teamwork during the workshop.	Likert-5 scale

4.22	What kind of aspect do you think you improved after the workshop? (Select all that apply)	Likert-5 scale

To determine the validity of the questionnaire indicators, face validity methods were used. Face validity was determined by asking a professor in the field of engineering education (School of Chemical, Materials and Biological Engineering, University of Sheffield) to conduct an expert review of the indicators developed within questionnaires. The internal consistency of questionnaires composed of Likert-scale items measuring teamwork improvements and single-choice in learning preferences was also assessed using Cronbach's Alpha test (see Appendix 11).

- Sampling method

In this study, a non-probability voluntary sampling method was employed. The survey was distributed via email to a specific group of students, and participation was entirely voluntary. This approach was chosen due to the feasibility of reaching participants within the given timeframe and the practical constraints of obtaining a complete sampling frame of the target population. While voluntary sampling allows researchers to collect data efficiently from willing respondents, it may also introduce self-selection bias, as individuals who choose to participate could differ from those who do not.

The sampling size and response rate for each survey:

- The learning expectation survey: aimed at the first-year Chinese students registered in the University of Sheffield, who came to attend an orientation welcome event, in total of 147 Chinese students attended, the response rate is 49%.
- The learning preference surveys: aimed at the Chinese students registered in the Faculty of Engineering, over 300 students, the response is 6%.
- The post-course feedback: aimed at the PGT students registered in MSc CPE6311 Applied Chemical Engineering, in total 212 students attended, and the average response rate across three years is 83.3%.
- The teamwork learning survey: aimed at the Chinese PGT students who attended the game-based teamwork workshop in the University of Sheffield and Manchester, in total of 116 Chinese students attended, the response rate is 67.2%.

3.3.2 Semi-structured interviews (students' perception of teamwork and the teamwork-building workshop & game)

The qualitative data in this study were collected through two primary sources: open-ended responses from surveys and interview transcript analysis. Interviews serve as a critical data collection tool, as they enable researchers to verify, supplement, or refute findings obtained from other sources (Fraenkel & Wallen, 1990). The primary objective of conducting interviews is to gain deeper insights into participants' perceptions and experiences regarding specific issues. Semi-structured interviews (SSIs), one of the many interview formats, are also widely used in qualitative research because of their inherent flexibility and adaptability, allowing researchers to explore complex topics while maintaining a focus on specific themes. This method combines a structured interview guide with the freedom to deviate based on participant responses, facilitating a more in-depth exploration of individual experiences and perspectives (Kallio et al., 2016; DiCicco-Bloom & Crabtree, 2006). Moreover, SSIs also allow for a dialogue that can adapt to the participant's knowledge and comfort level, fostering a more engaging and informative exchange (O'Keeffe et al., 2016).

Thus, this study employs SSIs as the primary interview method, primarily due to their flexibility, which prevents the interview process from becoming overly rigid while allowing respondents the freedom to elaborate on their thoughts. As one of the study objectives was to understand Chinese engineering students' teamwork behaviours and experiences in depth, SSIs ensured that the core topics were explored in depth, whilst also allowing for more in-depth investigations into more details as they emerged. In turn, the information gained from the interviews served as the basis for the subsequent design of an inclusive teaching practice to promote teamwork skills among engineering PGT students. The elements of gamified learning design, teamwork integrating with technical contents, engineering PBL and role-based simulation incorporated in this designed practice were all mentioned and valued in the interviews with the students.

In the interviews assessing Chinese engineering students' teamwork experiences and learning, the primary objectives were to explore:

(a) Chinese students' personal teamwork experiences in studying engineering courses (both previous and current academic contexts);

- (b) Their perceptions of teamwork in UK engineering courses;
- (c) Their understanding of essential teamwork concepts;
- (d) The potential impact of teamwork on their future career development.

In the post-workshop interviews evaluating the effectiveness of the teamwork workshop and games, the discussions primarily focused on:

- (a) Students' perceptions of the overall workshop design;
- (b) Their feedback on whether their teamwork awareness has improved after participating in the workshop;
- (c) Suggestions for improvement on the design and implementation of the workshop.

In this study, the semi-structured interviews triangulate with the designed surveys (in section 3.3.1) primarily through data triangulation, since both instruments targeted similar constructs (e.g., Chinese students' learning preferences, communication challenges, and perceptions of teamwork) at different stages. The surveys provided broad patterns, while the interviews added contextual depth and nuance. At the same time, the design also reflects methodological triangulation, as the use of quantitative surveys and qualitative interviews allowed the findings to complement and validate each other, thus enhancing the robustness of the conclusions.

3.3.2.1 Interview preparation

As interview guides play an important role in semi-structured interviews, preparation is essential to ensure that the interviews are conducted with a minimum of disruption. The following measures advocated by Bryman (2008) were taken into account in the preparation of the interviews for this study: (a) the interview topics and questions were formulated in a certain order: the questions were not too specific, recognising that the order of the questions could be changed to avoid being too rigid; (b) the interview questions were formulated in a language suitable for the target audience: jargon was avoided; in addition, since the majority of the interviewees in this study were Chinese students and the primary researcher was also of Chinese nationality, the interviews with Chinese students were conducted directly in

Chinese in order to maximise the possibility of allowing them to express themselves freely, comfortably, and explicitly, (c) Before the interviews were conducted, basic demographic information (e.g., age, degree courses, nationality, gender) about interviewees was collected using a pre-interview form, (d) The location of the interviews was determined before the interviews were conducted: all interviews were conducted in on-campus study sites familiar to the interviewees, (e) The use of a digital recorder for all interviews (a trusted device and application evaluated by the university's regulatory oversight to ensure that no interviewee information would be compromised); (f) use of a note book to write notes during the interviews; and (g) a list of interview questions was shared with interviewees at the interview site to view if they have any confusion.

3.3.2.2 Coding and categorisation: thematic coding

Qualitative research relies heavily on coding techniques to analyse textual data, allowing researchers to identify themes, patterns, and insights from interviews, focus groups, and other qualitative sources. Thematic analysis is one of the most widely used methods in qualitative research. It involves identifying, analysing, and reporting patterns (themes) within data. This method is particularly flexible and accessible, making it suitable for various educational research contexts (Pimmer & Rambe, 2018; Astrid et al., 2023; Musgrave et al., 2024). This method not only aids in organising data but also enhances the transparency and rigour of qualitative research (Lockwood, 2024). Tools such as NVivo facilitate thematic coding by allowing researchers to manage and organise their qualitative data efficiently. In this study, NVivo 14 was mainly used as the qualitative analysis software.

When coding the qualitative data, as the principal researcher, I positioned myself as an interpreter, viewing the analytical process as a reflexive interaction with the data (Cohen et al., 2002). I began by reading through the interview and observation transcripts, conducting line-by-line open coding to deconstruct and understand the textual content while transforming it into a series of categories (codes) that reflected participants' perspectives. This process involved creating individual summaries for each participant, highlighting their unique contributions to provide a more comprehensive exploration and understanding of the core research themes (Ritchie et al., 2003). Finally, overarching thematic categories were developed based on the codes derived from each interview and structured accordingly.

3.3.3 Classroom observations

Classroom observation applied in the research acts as a valuable research method because it allows researchers to observe students in their natural settings and gain a first-hand understanding of the dynamics that shape their learning experiences in teaching activities (Burgess, 1984; Cohen et al., 2017; Volpe et al., 2023). Classroom observation can provide insight into students' non-verbal behaviour, such as body language and facial expressions, which can reveal information about their engagement and level of interest in the learning process (Thorne, 2005; Leff et al., 2011; Freeman et al., 2014). Observing students in the class can also shed light on the interactions between students and students, students and instructors, which gives a glance at the class culture, the quality of teaching and the effectiveness of pedagogical strategies (Lam, 2018; Halim et al., 2018; Rodgers et al., 2022).

3.3.3.1 Student groups

The primary group observed in this study consists of PGT students enrolled in the MSc Environmental and Energy Engineering programme within the School of Chemical, Materials and Biological Engineering at the University of Sheffield. The observed course is a compulsory laboratory module - CPE6311 Applied Chemical Engineering, which is part of the PGT programme core module. This module is one of the most internationally diverse PGT programmes within the school, with Chinese students making up a significant proportion of the student cohort.

The main objective of this laboratory course is for students to record operational data from a gas boiler combustion system and subsequently evaluate its thermal efficiency based on the collected data. The classroom observations take place during the autumn semester of each academic year from 2021 to 2025. Each laboratory session lasts two hours and involves one lead instructor, one to two graduate teaching assistants (GTAs), and one student group (varying from three to five students).

3.3.3.2 Observation sheet

To conduct a more targeted observation of student group dynamics and individual learning behaviours in the laboratory course, as well as to gain a deeper understanding of how international (mainly Chinese) PGT students unconsciously exhibit learning behaviours and interaction patterns in UK engineering practice-based courses, a classroom observation sheet was applied. This tool allows for a more systematic capture of students' behavioural patterns during class and facilitates reflections on the effectiveness of the instructional process.

The primary objective of implementing classroom observation is to support subsequent research stages, including surveys, interviews, and workshop design, by establishing a foundational understanding of PGT students' learning behaviours and characteristics. Accordingly, the framework of the classroom observation sheet includes key components such as the main instructional content of each laboratory session, overall group interactions, and notable individual learning or communication behaviours (Springer et al., 1999; Tanner, 2009; Burke, 2011; Lacey et al., 2020; Agustian & Seery, 2017; Van Beek & McCahan, 2021). A sample classroom observation sheet is presented in Table 3.3 below.

Table 3.3 An example of the classroom observation sheet designed and used in laboratory teaching courses.

Data	XX-XX-20XX
Course name	Gas boiler combustion lab
Teaching contents	Familiarise with preparing a lab risk assessment; The structure of a fuel gas boiler; How to operate a gas boiler; Monitor several combustion data sets; Draft a P&ID for the gas boiler.
Group No.	1 (5 students in full)
- Team composition	Mixed group setting: 2 Chinese students + 3 home students.
Student performance	
- Preparation	Didn't prepare for the risk assessment well (4 out of 5).
- Engagement	Participate in hands-on activities actively and ask questions when noticed. One Chinese student didn't engage well (quiet and not respond to questions, may because of a lack of understanding of the problem).
- Active learning	Need a reminder to take notes of key data and information.
- Instructor-student interaction	Active in answering questions.
- Student-student interaction	Group discussion about problems or confusions encountered during the experiment.
- Language use	Chinese students communicated mostly; one acted as an interpreter to assist the other in communicating with other home students.
- Teamwork	Divide the work to collect data. One home student took the lead to oversee the progress.

Feedback from observer	
	- Introduce the lab environment, symbols, and equipment at the beginning. It would be helpful to make them feel relaxed. - Standardise the demonstration procedures. - Cooperation between the instructor and GTA is good for a clear demonstration.

3.3.4 Pilot study on PGT students' teamwork behaviour preferences (Belbin team role theory)

- Pilot study of PGT students' teamwork behaviour preferences with Belbin role test

As a pilot study of PGT engineering students' teamwork preferences, the Belbin team role test was used in the designed workshop to study the PGT students' teamwork behaviour. PGT students were asked to complete the Belbin team role test before the workshop. Based on the results, they were assigned to a new Belbin role-based engineered group later in the workshop. During the workshop, the students were required to complete two self & peer-assessment forms. By analysing the scores on the self & peer-assessment forms, the performance and experience of the students in the different groups can be observed and evaluated. This preliminary designed workshop consisted of two learning activities: the first part (Activity 1) focused on understanding and learning teamwork skills (non-technical activity) (conducted based on a traditional team-building activity – “*Lost at Sea*”, see Appendix 10 for the original content); The second part (Activity 2) required students to design an engineering system/product related to their degree courses (technical activity).

In activity 1, the students freely decided their groups (Group 1: self-selected group); in activity 2, the students are assigned to a new arranged group (Group 2: Belbin engineered group) based on their Belbin test results. After each activity, the students needed to complete a self & peer-assessment form. A general framework of the pilot workshop is presented in Figure 3.2.

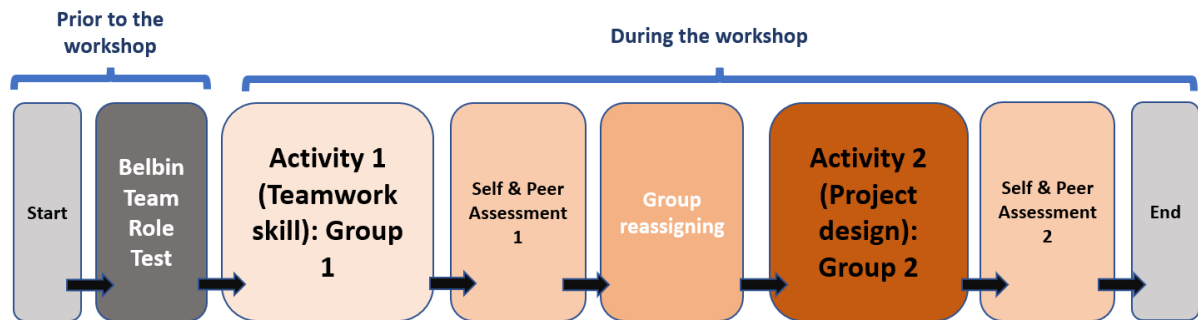


Figure 3.2 The basic framework of the PGT design project workshop

This pilot study was conducted to investigate PGT students' teamwork preference based on Belbin team roles; Group 1 represents the self-selected group; Group 2 represents the Belbin-engineered group.

3.4 Methods of measuring students' learning

This study aims to investigate the differences in international students' working memory capacity (WMC) during their studies at a UK university. Working memory (WM) is needed when people engage in intentional or incidental learning and helps them learn new information and convert it into long-term memory. However, individual differences in working memory may vary depending on different learning environments and conditions. Most international students enrolled at UK universities are from non-English speaking countries. They need to know or understand English as a prerequisite before learning more about academic and professional content. Although research on Chinese students' performance and experience at UK universities has been reported for many years, there has yet to be a clear conclusion as to whether the Chinese-English translation processes that may take place in their brains affect their working memory capacity. This means that international students may need more time and strategies to process the same learning materials as home students. Thus, this study attempts to figure out whether the WMC of international students will vary significantly if they are learning in English environments.

By conducting this exploratory study of Chinese students' WMC differences in memorising Chinese and English items, two main objectives were expected to be achieved:

- i. Will Chinese students' WMC be limited while learning in English environments?
- ii. Do Chinese students show significant differences in memorising Chinese and English items?

These two aspects were explored through an operation span (Ospan) test. The WM test was designed to memorise Chinese and English words.

3.4.1 Working memory test design

To enable further study of the differences in how international students' ability to learn new information in different language contexts, this study designed a modified Ospan (Unsworth & Spillers, 2010). The Ospan recall tasks were designed in two language versions, one in English and the other in Chinese. Both task versions' word lists are identical, but in different languages and orders. For example, "Rose" in the English version, "玫瑰" will be added to the Chinese version, which means precisely "rose" in Chinese. Each participant would take three rounds of tests, each consisting of seven sets of calculations and memorising seven sets of words. A simplified sample of the English and Chinese versions of the working memory test can be seen in Figure 3.3.

The main purpose of the recall task is to see how well and the accuracy students remember the order of the word list. The mathematical operations inserted between the display of each word are used as interval distractors. After collecting the data from recall tests, an Ospan scoring method was used to assess students' working memory capacity. The detailed calculation method of WMC scores (predicting students' WMC) is described in the following section. Participants were given a 5-minute break between the English and Chinese tests. A single test would take no more than 5 minutes. The total time to complete all tests is around 15 minutes. The primary research data obtained were the number of participants' correct responses in recall tasks and algorithm tests. Statistical methods were used to analyse these response scores.

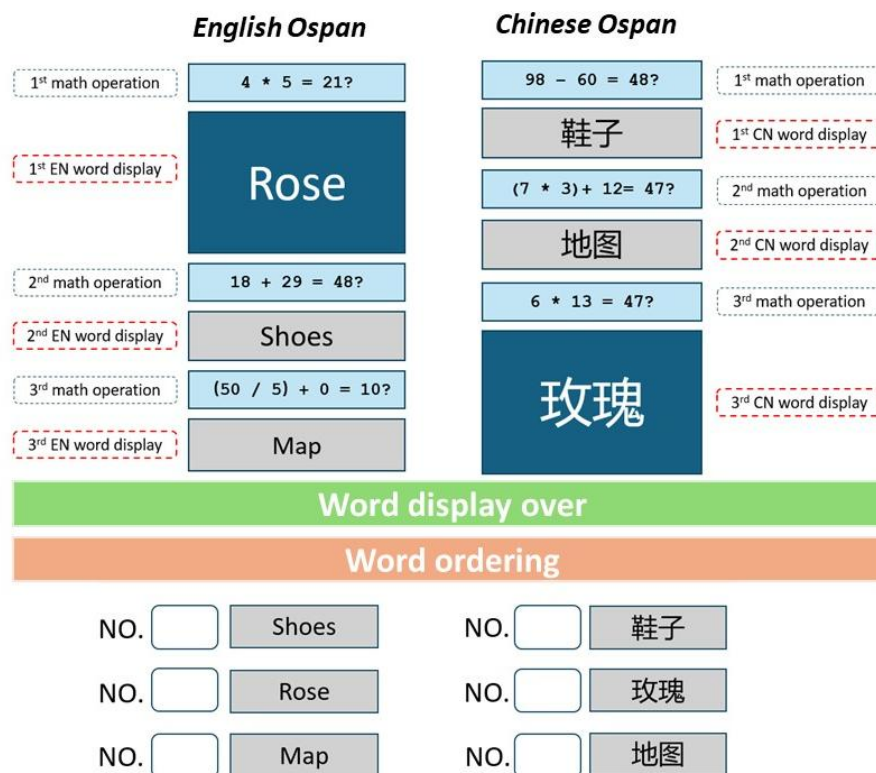


Figure 3.3 The Ospan sample test of working memory in English and Chinese. Participants memorise the English (EN) and Chinese (CN) words and then write the order in which the corresponding words appear according to their memory.

3.4.2 Validity of the test results (MIS system)

To validate the Ospan test results in this study, the Math-Item-Sequence (MIS) scoring system to assess working memory performance in the operation span (Ospan) task was employed (Lammert et al., 2019). This scoring system was used because, compared to the traditional Partial Credit Unit (PCU) method in Ospan data processing and task weighting (Conway et al., 2005; Peters et al., 2007), MIS reduced data exclusion. The PCU method requires setting exclusion criteria (e.g., 85%) for mathematical tasks, resulting in the exclusion of some subjects, which may result in reduced sample size or even bias. The MIS method avoids this problem and allows data from all subjects to be included in the analysis, especially important in small sample studies. Moreover, the MIS method provides a more fine-grained cognitive measure. Its distinction between the correctness of memorised content (letters) and sequence position can provide a more fine-grained measure of working memory capacity, rather than just focusing on overall correctness. In the MIS approach, performance on the math task affects the overall score, rather than being used only as an exclusion criterion. This

ensures that subjects focus on both tasks rather than just memorising letters and ignoring math operations. This approach can also provide richer information for studying subjects' attention allocation strategies and their effects on working memory. Another thing is that the MIS also has greater internal consistency and repeatability (Cronbach's $\alpha > 0.8$).

The MIS method evaluates performance based on the following three dimensions:

1. Mathematical Task Performance (M): The accuracy in solving the distractor mathematical problems is incorporated into the scoring calculation rather than being used solely as an exclusion criterion. This adjustment ensures a more balanced assessment of working memory performance.
2. Item Memory (I): The number of correctly recalled letters is evaluated, reflecting short-term memory capacity.
3. Sequence Memory (S): The ability to recall letters in the correct order is measured, capturing sequential processing ability.

The MIS score for each trial is calculated using the following equation:

Equation 3.1

$$MIS_{ij} = \left(\frac{M_{cor} - 1}{M_{tot} - 1} \right) \times \frac{1}{2} \left(\frac{I_{cor}}{I_{tot}} + \frac{S_{cor}}{S_{tot}} \right)$$

where M_{cor} and M_{tot} represent the number of correct and total mathematical problems (excluding the first mathematical task in each trial), respectively; I_{cor} and I_{tot} denote the number of correctly recalled letters and the total number of letters; and S_{cor} and S_{tot} indicate the longest correctly recalled sequence and the total number of letters. The total MIS score for each participant is obtained by summing the MIS scores across all trials.

3.4.3 Limitations

One major limitation of the working memory test method used in this study is the small sample size (a total of 17 participants, all from China mainland). Consequently, the study currently cannot effectively predict or define behavioural patterns in a larger student population. The limited sample size may affect the reliability and generalisability of the findings in the following ways:

The first evident limitation is the lack of statistical validity. A small sample size could reduce the sensitivity of statistical tests, making it difficult to detect subtle group differences in working memory capacity or the actual effects of experimental interventions, thereby increasing the appearance of Type II errors (false negatives).

Secondly, the limited sample may not be representative enough. The small number of participants may fail to adequately capture the diversity of the target population (e.g., age, educational background, baseline cognitive levels), lacking generalisability of the findings. Additionally, with a small sample, individual outliers may exert a disproportionate influence on mean values, standard deviations, and other statistical indicators, potentially reducing the reproducibility of the results.

3.5 Design of an inclusive workshop to encourage teamwork

3.5.1 Design of the inclusive workshop

In contemporary engineering education, project-based learning (PjBL) and problem-based learning (PBL) have been widely recognised as effective pedagogical approaches that cultivate students' professional competencies while fostering essential human-centred skills. However, international students in UK universities often encounter challenges in developing these non-technical skills due to language barriers, cultural differences, and varying levels of prior exposure to teamwork-based learning environments. To address these challenges, this workshop has been designed as an inclusive platform that enables students with various backgrounds to develop the essential human-centred skills required for successful participation in collaborative engineering projects. By engaging students in a structured, team-based learning experience, the workshop aims to enhance their ability to navigate project teamwork effectively, thereby improving both their academic performance and future professional adaptability.

Based on the pilot workshop introduced in section 3.3.4, the workshop is further refined and structured into two interdependent teaching and learning phases, each designed to progressively develop students' teamwork-related competencies through experiential and cooperative learning.

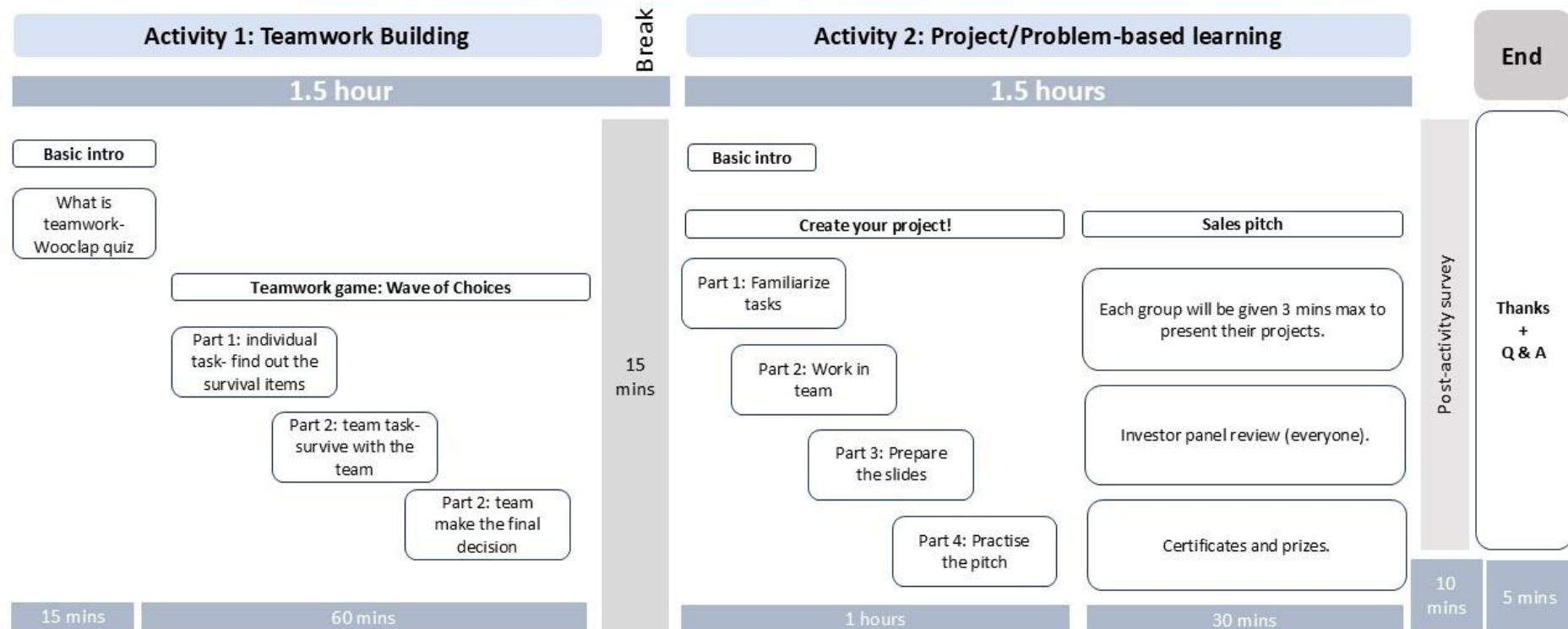
Phase 1: Activity 1 - Team collaboration games

The first phase introduces students to fundamental concepts and challenges associated with teamwork through interactive, board game-based activities. These activities serve as an entry point for students to engage with key teamwork principles, such as ice-breaking, communication strategies, information sharing, and decision-making. The design of the new team-building board game is derived and developed from a traditional team-building activity - *Lost at Sea*. Engaging in this team-building board game first allows participants to gain a foundational understanding of teamwork-related challenges in a low-stakes environment before engaging in more complex collaborative tasks. Additionally, this phase provides the time for students to reflect on their own collaboration styles and identify potential areas for improvement.

Phase 2: Activity 2 – Engineering concept-based project simulation

Building on the insights gained from the first phase, the second phase requires students to work collaboratively on a project-based task, simulating real-world engineering/business product development. Each team is assigned a project design brief, and members assume distinct roles within their teams, such as team leader, engineer, marketing strategist, financial officer and product design manager. This design allows students to experience role-specific responsibilities and interdependencies, reinforcing the importance of teamwork in achieving collective success. During the project design stage, learning is not only working in teams to analyse the learning materials, but also to complete individual tasks as required. In addition to paper-based learning, each group needs to create a simple product prototype using the craft materials provided. Thus, throughout the practical phase, students are guided to apply engineering principles while progressively experiencing and developing human-centred skills, e.g., leadership, time management, adaptability, and negotiation, to work as a team. At the end of the project design, teams will deliver a group pitch presentation, presenting their design, articulating the rationale for their decisions and reflecting on their experience of working as a team. At the end of the workshop, feedback forms were distributed to students to collect learning experiences and comments for improvement. Based on the feedback, quantitative and qualitative analyses can be conducted on the effectiveness and the overall quality of teaching and learning in the workshop according to the changes in students' perceptions of teamwork. This will support to further identify the shortcomings in the current practice design. The detailed workshop framework is presented in Figure 3.4.

The proposed schedule for the inclusive workshop (for 10 student groups max.):



Notes:

- Workshop facilitator prepare the workshop materials & introduction slides & certificate for the top three best projects and awards.
- Students work in the same group for both activities; students can choose to team up randomly or be grouped by the staff.
- Activity 1: a board game for team building; Activity 2: project/problem-based design + team collaboration + discussions + hands-on work + presentations.
- One pre-quiz survey (Wooclap) about teamwork will be posted in activity 1; one post-activity survey (Google Form) will be posted after activities 1 and 2.

Figure 3.4 The framework of the inclusive game-based teamwork workshop.

3.5.2 Conduct of the workshop

The teamwork workshop has been conducted a total of four times in two universities. The two universities where the workshops took place were the University of Manchester and the University of Sheffield, and the PGT students involved were from Chemical Engineering, Environmental and Energy Engineering and Electrical and Electronic Engineering. The workshops were held over two autumn semesters from 2023 to 2024. Each workshop lasted between two and four hours (course times vary depending on the availability of scheduled course time for the collaborative practice).

Before the start of the workshop, the workshop organisers were responsible for preparing the study materials, game cards, and project design and production materials needed to run the workshop. The workshop organisers were also responsible for communicating with the module lead about the workshop process and the data collection phase before the class began.

Depending on the number of students participating in the workshop, the workshop is usually led by one main instructor and one to three teaching assistants. The students participating in the workshop are usually organised in groups of five, which can be assigned by the course instructor in advance or decided freely by the students at the course site.

3.5.3 Interactive teamwork-building game design

Throughout the workshop design, the most important thing was designing appropriately interactive games to support students' learning in teamwork further. Theoretically, integrating interactive games into education can enhance learning efficacy by fostering engagement, motivation, and active participation. Games encourage collaboration, communication, critical thinking, and responsible learning behaviours, helping students develop essential teamwork and problem-solving skills (Abdulmajed et al., 2015; Rosero et al., 2024).

Designing instructional practices that enhance PGT students' teamwork learning experiences is one of the central objectives of this study. The interactive teamwork-based game design in this study consists of four key stages. The first phase involves preliminary research, focusing on understanding team behaviours exhibited by PGT students in UK engineering programmes during practice-based courses. This stage integrates Belbin's team role theory and classroom observations to examine students' behavioural patterns and potential challenges in teamwork.

Additionally, the interviews were conducted to obtain students' perception of the teamwork experience in depth, laying the groundwork for the next step in constructing appropriate teaching practice content.

The second phase focuses on developing and refining the new instructional practice. Based on Belbin's team role model, along with insights from classroom observations and student feedback, the final team roles used in the teamwork games were categorised into: leader, communicator, idea creator, engineer and calculator. Moreover, the *Lost at Sea* framework was modified and integrated with board game elements to enhance student engagement and gameplay diversity in the teamwork-based learning.

The third phase involves the implementation of the teamwork workshop. The teamwork game applied in the workshop consists of a physical board game containing cards and a game board. The team role simulation game was created and refined based on the traditional business simulation project framework that is frequently applied in business education. The design and development process of both games will be discussed in detail in Sections 3.5.3.1 and 3.5.3.2.

The final phase focuses on practical implementation and feedback collection. The finalised teamwork-based games are introduced in an inclusive teamwork workshop, where they will be tested among master's students, and their feedback will be collected to evaluate their effectiveness and applicability. The development process of the teamwork-based game design is illustrated in Figure 3.5.

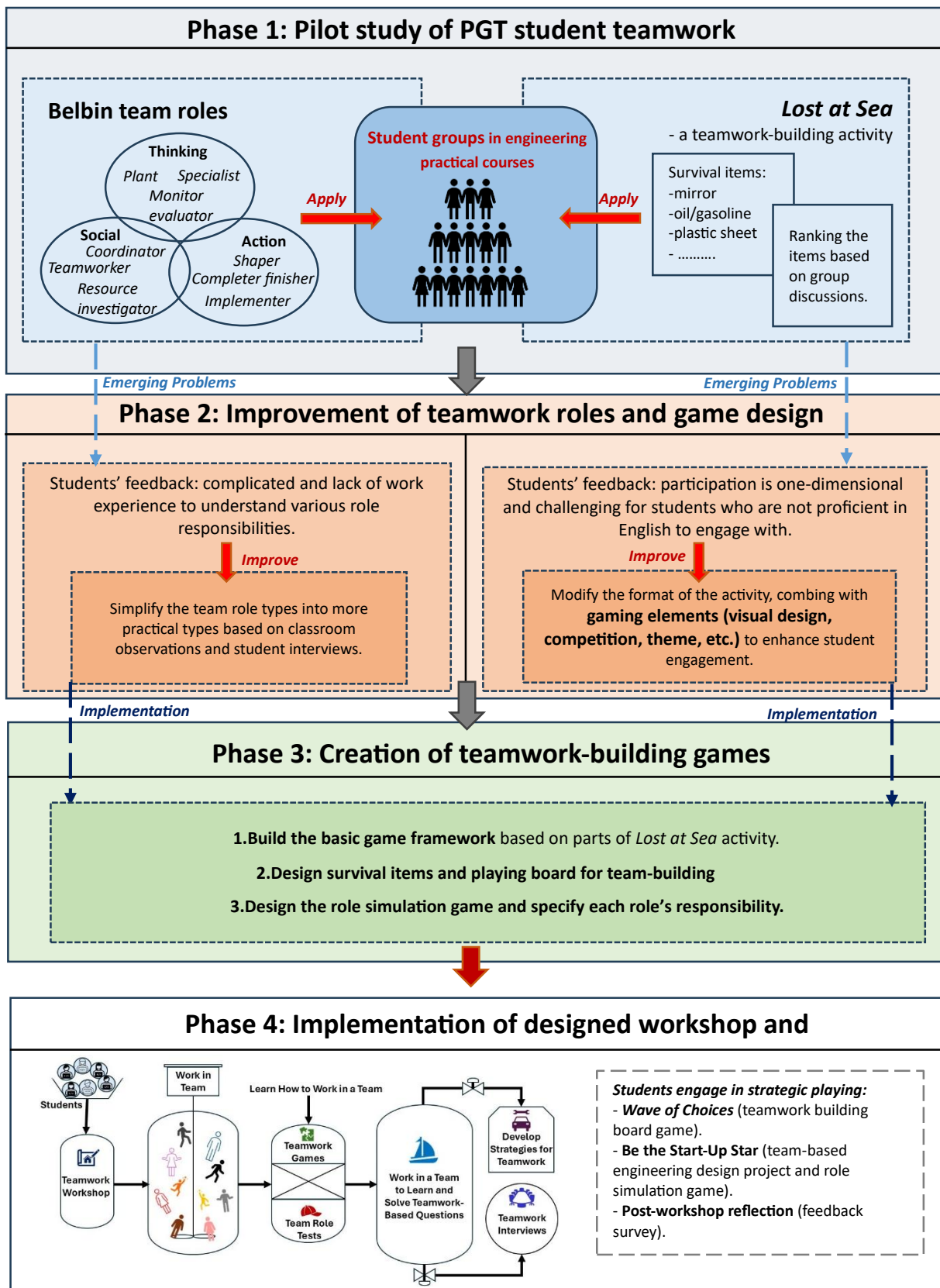


Figure 3.5 Design methodology and flow of the teamwork workshop and games.

3.5.3.1 Teamwork-based board game design (inspired by Lost at Sea) – Wave of Choices

In this study, designing a board game based on enhancing teamwork aims to provide students with a novel and more interactive experiential approach to improving their collaboration skills. The original *Lost at Sea* activity is limited to group discussions, which heavily rely on participants' initiative (e.g., the extent of icebreaking within the group could affect overall engagement) and their proficiency in English communication. For students who lacked teamwork experience, it was often difficult to fully grasp its intended purpose. Thus, in the new game design, the main elements of *Lost at Sea* were still retained, but with more specific information-sharing prompts, images, and interaction story lines added. The newly designed teamwork-building game is called *Waves of Choices*.

The conceptualisation of the board game design was also inspired by the metacognitive training framework guided by Self-Regulation Theory (SRT). Drawing on SRT's (Zimmerman & Schunk, 1989) cyclical model, i.e., goal negotiation - process monitoring - reflection and iteration. Because the instructional practice is designed to achieve the goal of promoting active student engagement and self-learning among students so as to deepen their awareness of teamwork, it is unlikely to achieve the desired learning outcomes if it still adheres to a lecture-based teaching. Therefore, it is necessary to adopt teaching and learning guidance beyond the traditional course model. Gamification is the use of game prompts and staged tasks to decompose metacognitive strategies into modular learning (gaming) steps so that students are empowered to engage in learning in a more immersive way. Using the interactive, visual and goal-oriented nature of gamification, the implicit dynamics of teamwork could be gradually transformed into observable and trainable tangible behaviours, allowing students to progressively understand and develop more complex teamwork skills through participatory experiences.

By combining visual card prompts, team role assignments, stage completion and clear game objectives, the design of this board game aims to create a structured platform that enables students to follow the game more intuitively and to actively participate in and experience the essential stages of teamwork development. The overall goal of the board game design is to allow students to observe, analyse, communicate, discuss, evaluate, negotiate and make strategic decisions to select a specific number of key cards. Previous research has also shown that board games are not only a tool for knowledge acquisition, but also a medium for

developing students' critical thinking, collaboration and communication skills (Noda et al. 2019; Vita-Barrull et al. 2022; Nordin et al. 2024). In addition, it has also been reported that integrating board games into university curricula can enhance experiential learning by actively engaging students in problem-solving and decision-making scenarios that reflect real-world challenges (Zainuddin, 2019; Bayeck, 2020).

Therefore, this study takes advantage of the interactive nature of board games to support students in developing and practising their teamwork skills. Key teamwork components were deconstructed and embedded into game-based steps to facilitate easier and broader participation. For example, task assignment was incorporated through coloured card sets representing different survival responsibilities to manage; communication and knowledge exchange were supported through simple item descriptions paired with visual icons, enabling players to read card information and show what the actual item looked like then trigger discussions; decision-making and critical thinking were promoted using “function cards” that posed targeted questions on items’ features, encouraging players to evaluate and justify both their own and others’ situations; a survival game board allowed teams to visualise their collective progress; and a team scoring rubric for survival item prioritisation drive team-based decision-making about which items to keep or discard to get the highest survival score to win the game. The design components of the entire board game are demonstrated in Figure 3.6 below.

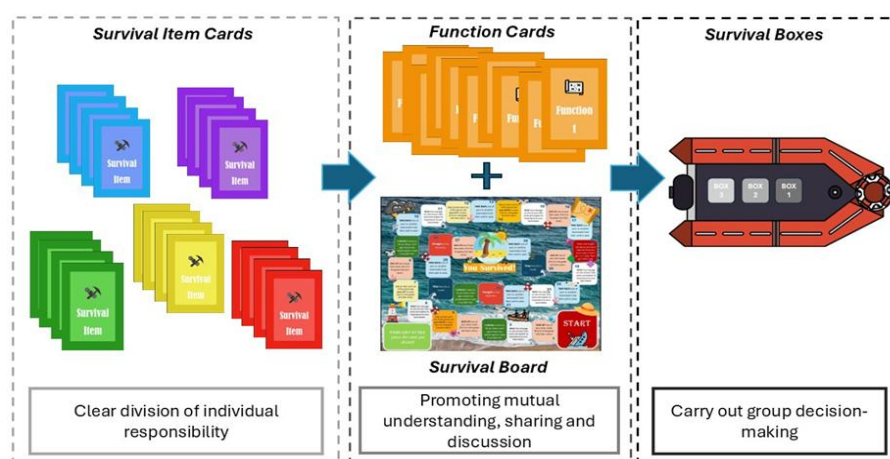


Figure 3.6 Board games designed to promote teamwork in student groups. A complete set of the teamwork board game includes item cards, function cards, playing board and the lifeboat box card.

- Survival item card pack design

The original survival items included in *Lost at Sea* have been modified and converted to a game card format. The descriptive text explaining what each survival item is and its importance in a sea survival scenario has been expanded, and corresponding images of the items have been added. By incorporating visual aids, this adjustment helps non-native English-speaking students quickly understand the items being shown and discussed. Currently, there are 20 survival item cards in total, categorised into five colour-coded groups (red, yellow, green, blue, and purple). Each item card is paired with a corresponding item quiz to help students gain a better understanding of the item. The sample design of the survival item cards is shown in Figure 3.7, while the complete set of 20 cards and quiz sheets can be found in Appendix 3.

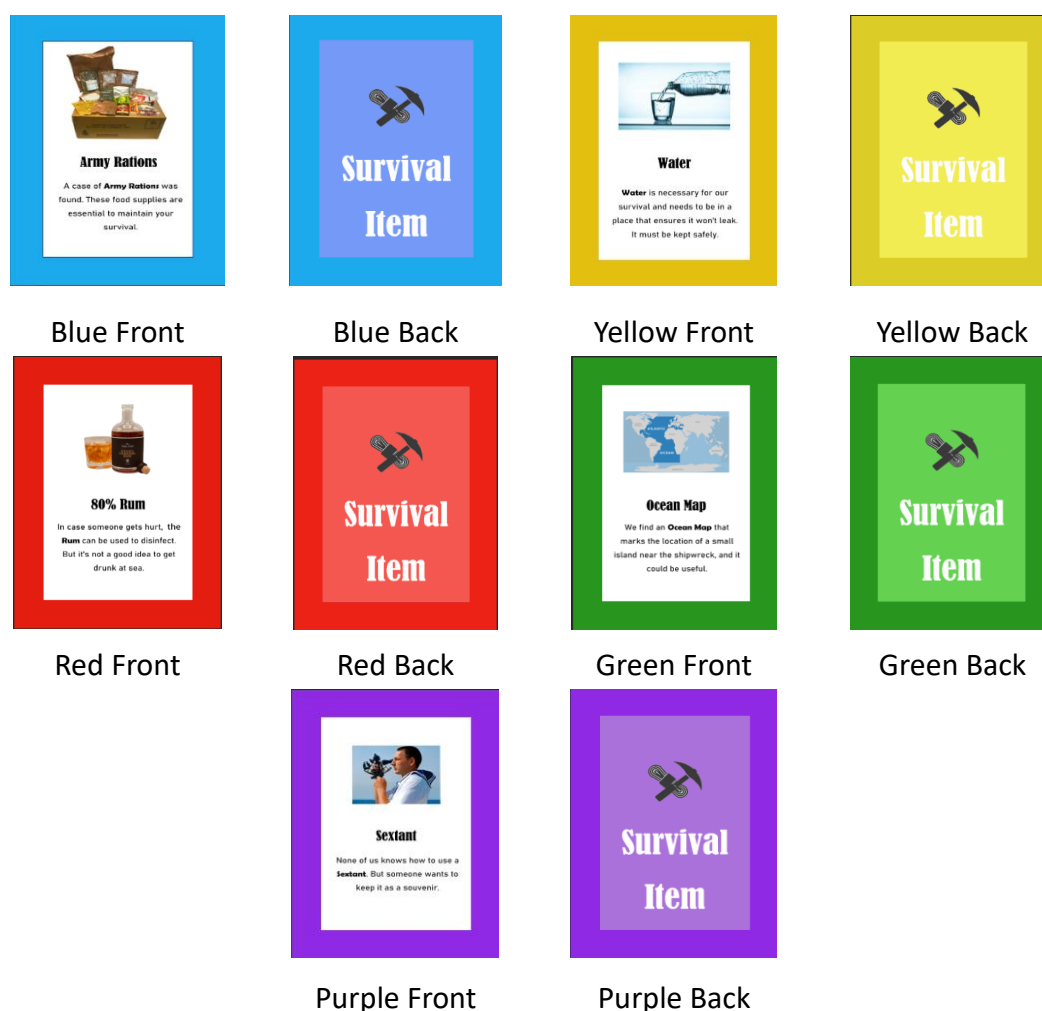


Figure 3.7 The design templates of the survival item cards.

The five colour sets of item cards are set up to make it easier for students to distribute items within groups. There is no hierarchical difference in the ordering of items contained in each colour card.

- Function card design

In addition to the survival item cards, each student group will receive a set of 15 function cards. These cards are designed to help students further analyse and evaluate the importance of the survival items they hold. During each round of the game, one group member reads out the information on a function card, after which all group members respond with either “yes” or “no” based on the question posed on the card. Each player then moves forward on the game board according to their response. The responsibility of reading the function card rotates among all group members. With the aid of the function cards, students are encouraged to collaborate, communicate, and actively listen to one another in order to achieve the game’s objectives. Moreover, the questions on the function cards can be shown to other group members, which to some extent avoids communication misunderstandings due to insufficient English proficiency. A sample design of the function cards is shown in Figure 3.8, while the full set of 15 cards can be found in Appendix 4.

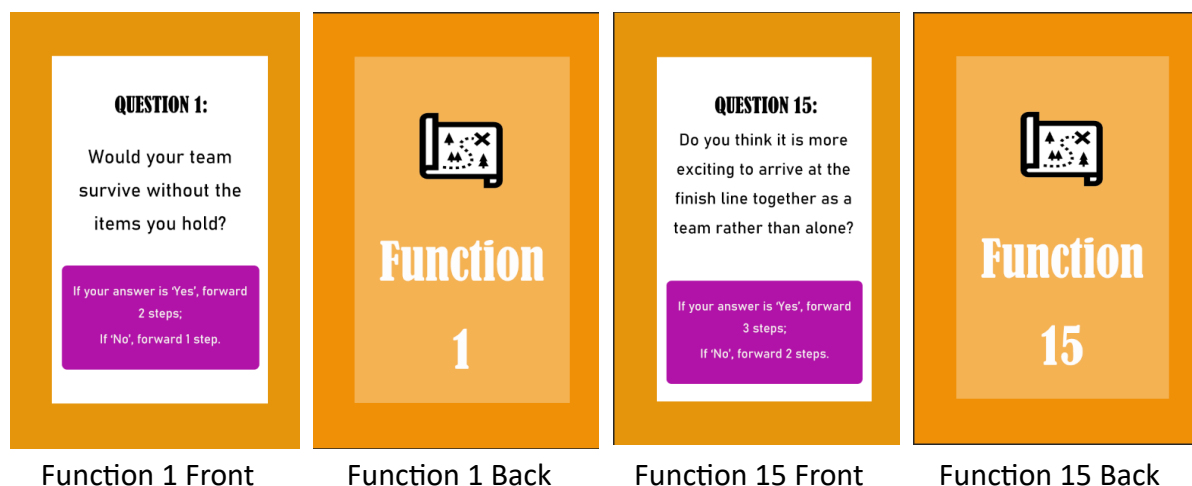


Figure 3.8 The design templates of the function cards.

The function card contains 15 clue-led questions to help students sort out the importance of the survival items.

- Playing board design

To further encourage students to explore teamwork, a game board was designed to facilitate group-based discussion, negotiation, and decision-making. The overall design concept of the board aims to introduce staged group discussions and decision-making processes, helping students filter and select the most suitable survival items to achieve the final game objective.

Each step on the board includes a small task, prompting students to make judgements individually or engage in discussions and even compromises with their peers. Before reaching the endpoint, players must continuously observe, communicate, and interact with other group members. This design ensures equal opportunities for all participants to express their opinions.

The different coloured spaces on the board represent various action tasks, and the number of steps each player moves is determined by their responses to the function card questions. The designed game board is shown in Figure 3.9, while a detailed explanation of the tasks associated with each step on the board can be found in Appendix 5 and 6.



Figure 3.9 The designed playing board.

The current version of the game board consists of 30 squares and a discard area. Each of the different squares has a different task, which requires discussion and decision making based on the task requirement.

- Lifeboat box design

As the ultimate objective of this game, student groups are required to select 9 cards from a total of 20 and place them into the survival item storage box. The items placed in the storage box possess varying levels of importance. The design of the survival item box is illustrated in Figure 3.10. The survival item boxes are numbered 1, 2, and 3, and each box needs to hold

three survival items. However, the items placed in each survival box must be categorised according to their level of importance. The final categorisation and selection of survival items by each group are determined based on the preceding game board and functional card questions. Upon completion of the game's progression on the board, each group must make further choices and decisions, filling the survival item boxes with corresponding items and calculating their group's survival score using the recommended scoring table. In this section, a competitive element is incorporated to foster team unity and bonding among group members. At the end of the board game activity, the three groups with the highest survival scores will be declared the winners of the game. The list of recommended survival item choices and an explanation of why can be viewed in Appendix 7.

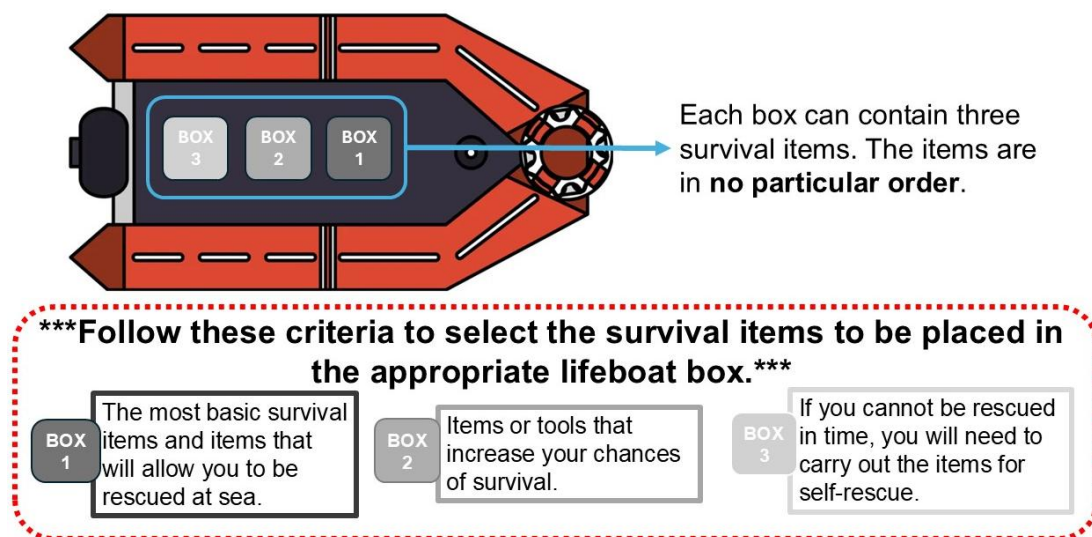


Figure 3.10 The design of the lifeboat survival item boxes and the explanation of the corresponding importance.

For the items to be placed in specific lifeboat boxes can be judged according to the descriptions in the red dashed box in the diagram. Students can use these hints to discuss and make decisions within their groups and make final choices to achieve the game goal.

3.5.3.2 Role simulation with engineering project-based game

Role simulations have emerged as a pivotal pedagogical tool in higher education, by providing immersive and experiential learning opportunities that bridge the gap between theory and practice. According to the available literatures, most of role simulation methods have been applied in business disciplines. Past practice has also shown that the simulations facilitate a deeper understanding of complex business concepts and decision-making processes, thereby

enhancing students' learning outcomes. These are mostly transferable skills, which are necessary for the academic and professional development of students in any discipline. Not to mention that engineering education and careers nowadays require more and more human-centred skills beyond technical expertise.

Past research has also supported that role simulations are effective tools for enhancing students' understanding of professional knowledge through interactive gameplay, also fostering an enjoyable and effective learning atmosphere (Peterková et al., 2022). Similarly, simulations promote deep learning by integrating various business functions, helping students develop critical thinking and strategic decision-making skills (Alstete & Beutell, 2019). This integration is particularly crucial as stakeholders increasingly demand graduates who possess not only theoretical knowledge but also practical competencies. By providing a competence-based learning, project simulations can encourage innovative learning and allow students to apply their knowledge autonomously (Zulfiqar et al., 2021). This also aligns with findings indicating that students improve their understanding of business dynamics through experiential learning cycles inherent in simulation tasks (Capelo et al., 2021). Furthermore, role simulations can facilitate cognitive learning processes by enabling students to organise, synthesise, and apply knowledge gained from lectures, and even the application of professional English in practical scenarios (Dharmastuti et al., 2021). Such practical experiences are vital for developing the skills necessary for success in the workplace. As all students seek career development after graduation, having the opportunity to be involved in real-life situations and issues at the university stage can have a positive impact on their long-term development.

In synthesising the instances above of utilising simulation games to enhance and promote learning efficacy, this study also draws upon and attempts to integrate such group simulation formats into the design of the team-based workshop. However, considering that the primary learning cohort consists of engineering students, the design of project simulation content was originated from engineering expertise. Thus, in the simulation game, in addition to assigning students clear role-specific tasks, they were also required to utilise the basic project design information provided, in conjunction with their previously acquired engineering knowledge and skills, to design and construct an engineering product prototype. The provided

descriptions of the design project, each role's tasks and pitch presentation template can be found in Appendix 8 and 9.

To ensure that the project design simulation could proceed smoothly, the team roles assigned to the students are designed to include the team leader, the idea creator, the engineer, the calculator, and the communicator. The concept of these five roles was based on observations of student groups in previous practical sessions. The leader is responsible for co-ordinating the timing and progress of the project, as well as keeping an eye on each member. The creator is responsible for searching for relevant information and constructing feasible design ideas. The engineer is responsible for visualising the design using handmade materials provided to produce a physical prototype. The calculator is responsible for any mathematical calculations that may be involved in the design of the project, which may include the cost of the design, the rationale, the cost of labour, or even the need for and prediction of future expansion. The communicator gathers and summarises the information presented, found and generated by the group and produces presentation slides for the final group pitch.

Prior to the commencement of the design project simulation, students are required to familiarise themselves with their selected team roles and the project design specifications. Both the team role descriptions and project design briefs outline individual responsibilities and collective team objectives that must be achieved. This structure necessitates that students maintain focus on their personal task progression while simultaneously ensuring effective communication and knowledge sharing within their teams.

During the project design process, students must complete their tasks according to the instructions corresponding to their chosen roles, while simultaneously remaining attention to the actions of other team members. This role simulation game aims to develop students' independent working skills, judgement, time management, strategic decision-making, teamwork and even empathy by engaging them in a variety of role tasks and team interactions. Furthermore, this simulation aims to provide students with an awareness of potential real-world workplace atmosphere and the complex scenarios they may encounter. The fundamental design framework for this engineering project-based simulation game is illustrated in Figure 3.11 below.

Upon initiation of the formal project design phase, students engage in three primary stages of development. The initial stage (Phase 1) involves collaborative discussions, information gathering, and knowledge sharing based on the project requirements, culminating in the formulation and confirmation of their project design concepts. Activities in this phase would be mainly organised by the team leader for discussion and information sharing. The subsequent stage (Phase 2) focuses on the implementation of the design concept and the integration of information. During this phase, while the engineer and the idea creator typically lead and take responsibility for prototype development, other roles actively contribute through assistance and proposal of potential improvements. The final stage (Phase 3) is the group presentation of outcomes, which requires the communicator and the calculator to follow up on the progress of the other team members and to gather information for making the presentation slides. The final format and delivery of the pitch presentation are collaboratively determined by all team members.

Throughout this design simulation process, students, while adhering to their predetermined roles, maintain flexible interaction patterns in response to evolving team progress requirements. As each stage's objectives are accomplished, team members engage in continuous reflection and adjustment of their contributions, ensuring the successful attainment of the collective team goals within the allotted time. This dynamic process fosters both individual accountability and collaborative synergy within the team structure.

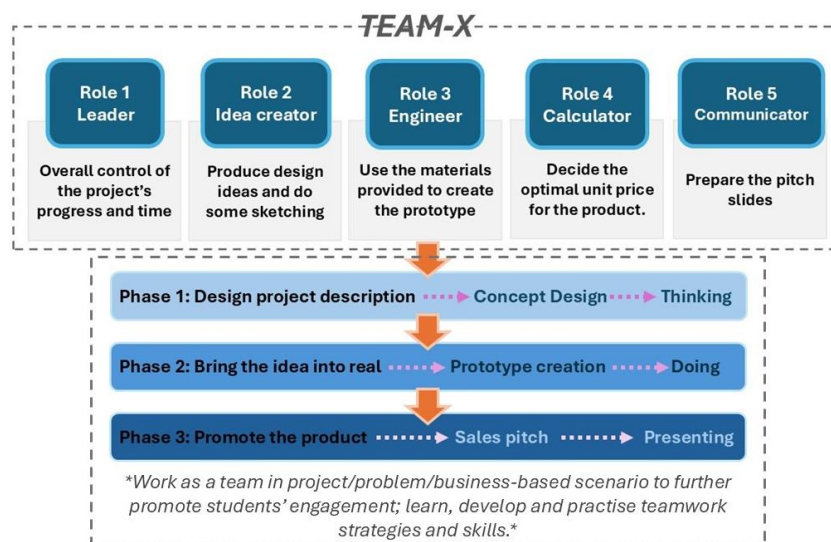


Figure 3.11 Design of the role simulation game.

In each student team, each role will be responsible for completing their own independent tasks as well as participating in collaborative team tasks. The simulation game consists of

three stages: Phase 1-Formation of design concepts, Phase 2-Product prototyping, and Phase 3-Presentation of results.

3.6 Ethical Considerations

Ethical considerations in qualitative research are essential, including informed consent, confidentiality, and the relational dynamics between researchers and participants. In accordance with the thematic content of this study, all studies involving student participants must be grounded in ethical considerations. The primary domain requiring ethical deliberation pertains to data generation and data analysis. Given that the research questions seek to explore the experiences of international students, particularly Chinese students, within engineering courses at UK universities, it is essential that student participants are able to freely and authentically express their viewpoints. Therefore, it was crucial to identify the ethical issues that would arise during the interaction with the participants before commencing the research. This ensures that the research can be conducted as neutrally as possible.

As this study design encompasses two interview studies involving student participants, the ethical approval documents were submitted in 2022 and 2024, respectively, concerning the investigation of the learning capabilities and teamwork competencies of international students. Prior to the commencement of the interviews, participants were provided with a participant information sheet and an informed consent form for reading and confirming. The research information sheet includes the study's introduction, research content and detailed contact information for the researcher. Once participants had read and understood the contents of the research information sheet and the consent form, they were required to sign the consent form to affirm their agreement to participate in the study. The participant consent form contained declarations related to data collection, confidentiality of information, and data publication. The processing and analysis of collected data were strictly conducted in compliance with the qualitative research ethics regulations of the University of Sheffield.

3.7 Chapter summary

This study employs a mixed research methodology, integrating surveys, semi-structured interviews, and classroom observations to enhance data reliability. First, the study establishes a theoretical framework, outlining its philosophical foundations and research aims. In terms

of data collection, learning questionnaires and exploratory working memory tests are used to quantify student learning, while interviews explore students' perceptions of learning, and teamwork, and are analysed through thematic coding. Classroom observations utilise the observation sheet to document group interactions and incorporate the Belbin team roles test to examine PGT students' teamwork preferences as pilot studies. Then, to promote the further development of teamwork skills among PGT students, the inclusive game-based teamwork workshop is developed, featuring two interactive games: the teamwork-based board game - *Wave of Choices* and the team role simulation. Lastly, ethical considerations are rigorously observed, ensuring data transparency and compliance with research ethics. The methodology chapter systematically constructs the theoretical and empirical foundation of the entire study, ensuring data scientific rigour while exploring the practical applications of teamwork in education. In the following Chapter 4, a summary of the data collected at each stage of the study is presented.

CHAPTER 4: RESULTS OF STUDY

4.0 Introduction

This chapter presents the collected quantitative and qualitative data, providing a structured overview of the dataset achieved in this research. The findings and interpretations of these data will be explored in detail in subsequent chapters, aligning with answering the four research questions hypothesised in this paper.

The first part of this chapter (Part I) introduces the quantitative data, covering Chinese students' perspectives on various aspects of learning, including their expectations, practical-based learning experiences, learning behaviours, and teamwork experiences from the pilot workshop.

The second part (Part II) presents qualitative data derived from interviews, detailing the coding and thematic categorisation of the recorded transcripts. The interview data explores engineering students' perceptions of teamwork in general and their feedback on the designed teamwork-building workshop and games.

Part I: The quantitative data

4.1 Chinese students' perceptions of their learning expectations (first-year students, responding ranging from UG to PGR)

This survey investigated the perception of first-year enrolled Chinese students at the University of Sheffield during the 2022/23 academic year (N=72). Over 150,000 Chinese students travelled to the UK to study during this academic year, making it the largest group of international students coming to the UK at that time. This survey is therefore intended to provide a basis for subsequent research and to serve as an update of knowledge about Chinese students' expectations of studying in the UK. The data collected in this section is categorised by Chinese students enrolled on different programmes of study to explore potential reasons for choosing to come to study at a UK university (the University of Sheffield), what these students expect from their current studies in the UK, and what they expect to do in the future after graduation. Despite the relatively small scale, the data is sufficiently rich and contextually grounded to offer useful exploratory findings, which form a foundation for subsequent investigations. The question set used is listed in Table 3.2 (Aspect 2)

4.1.1 Course levels and programmes

From the responses received (see in Figure 4.1), the majority (67%) of these Chinese students are enrolled in postgraduate taught (PGT) (including postgraduate taught-PGT and pre-master's courses) programmes, followed by 26% are enrolled in undergraduate (UG) and foundation programmes, and the least number 7% are enrolled in postgraduate research (PGR) students. Based on the survey results, it can be observed that the top three fields of study chosen by Chinese students for enrollment are engineering (25%), social sciences (24%), and business (22%). In other fields, the proportion of Chinese students who participated in the survey majoring in arts & humanities, science, medicine, and law is less than 15%.

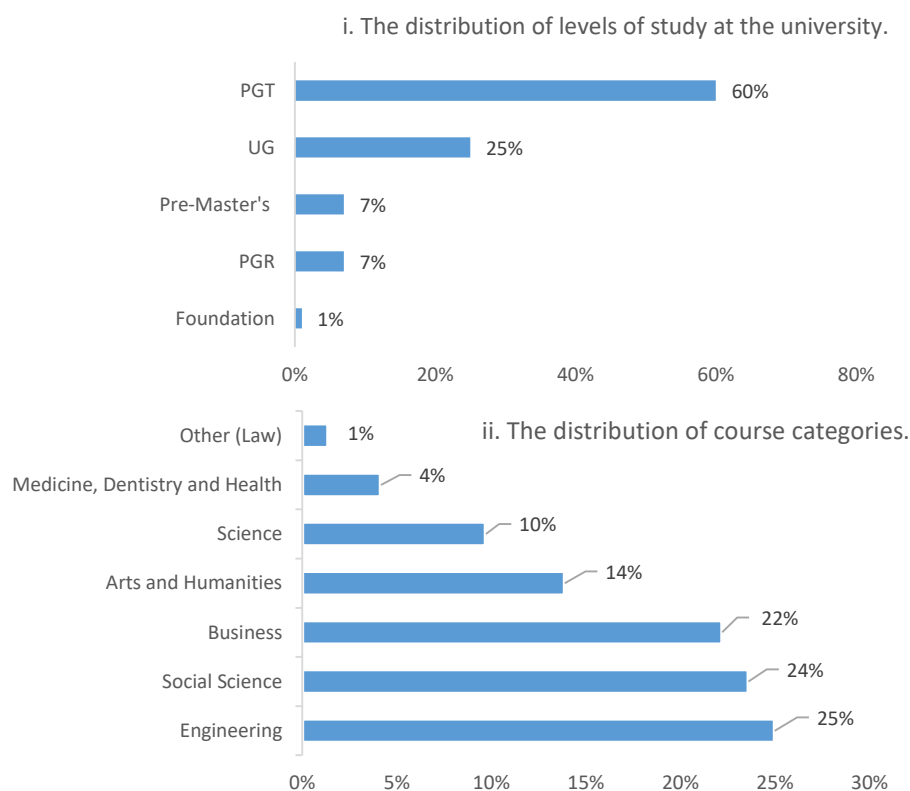


Figure 4.1 The cohort distribution of Chinese students' levels of courses (i) and course categories (ii).

% units in the graph are calculated as a ratio per 100.

4.1.2 The factors influencing Chinese students to decide to study in the UK

As the Chinese students who responded to the questionnaire were studying a wide range of subjects, the subsequent analyses have been divided into broad subject categories to provide

a clearer comparison of the impact of various subjects on their expectations. The reasons why Chinese students chose to study in the UK can be seen in Table 4.1. For most Chinese students (49% of the participants), the primary factor influencing their decisions to study at a UK university is because “they like the programme they chose”. More than half of students in social sciences (60%) and engineering (50%), and 75% of students in medicine and law, decided to come to the UK to study for this reason. Students who study science (43%), arts and humanities (40%), and business (38%) are more likely to be advised by agents to decide their study destinations. In addition, university ranking and facilities are important indicators in students' decision to study abroad. An average of 32% of the students who participated in the survey consider this factor before making the decision. When asked what course of study they were considering, more Chinese students tend to think about their own interests (50%), benefiting future career paths (50%) and bridging their previous studies (41%) when deciding the more specific choice of professional programmes.

Table 4.1 Factors influencing Chinese students to study in the UK (indicated in % of total responses, calculated as a ratio per 100)

	Engineering	Business	Social Science	Science	Arts and Humanities	Others (Medicine, Law)	Average
i. Why did you come to study in the UK?							
I like the programme I choose	50	19	65	43	40	75	49
University ranking and facilities	44	N/A	24	43	30	50	32
Agent recommendation	11	38	24	43	40	25	30
City environment	33	13	24	14	40	25	25
No specific reason	22	31	18	43	10	N/A	21
Local culture	22	6	24	14	10	25	17
Family/friends recommendation	6	6	12	14	10	25	12
ii. Why do you study your current degree programme?							
Personal interests	67	31	41	71	40	50	50
Future career development	56	44	53	86	40	25	50
Bridging my previous study	50	31	29	57	30	50	41
University/programme ranking	11	6	6	14	N/A	N/A	6
Agent recommendation	N/A	6	18	N/A	10	N/A	6

Family/friends recommendation	6	6	6	N/A	N/A	N/A	3

*N/A indicates no responses to the question in this student cohort.

4.1.3 Chinese students' expectations for their current studies

At the time the questionnaire was conducted, the students were already enrolled in their degree programmes, which means that they had experience in various teaching or social activities. Therefore, in this section, the students' expectations of their current studies and their expectations of the university's curriculum and activities are presented.

First of all, most of the Chinese students have the following expectations of their current studies, many of them (43%) are mainly focused on obtaining good academic grades, acquiring professional knowledge and improving their English proficiency. Then, for career purposes, students mainly expect to learn more job skills, find opportunities to start-up businesses, and build a network of contacts while studying. What is noteworthy is that a significant number of students also mentioned expectations in terms of their personal emotional needs. For example, some students felt that students desire to develop emotional relationships with others (e.g., close friendships, mental & physical health, hobbies), and they also expect to maintain good health conditions and hobbies while studying. The results clearly show that Chinese students' expectations of their current studies remain focused on academic advancement (50%). Instead, more students are concerned about their personal feelings (32%) than about future career development (14%) (summarised in Table 4.2).

Table 4.2 Chinese students' expectations of what they can gain from studying in the UK

Learning purpose		Percentage (%,calculated as a ratio per 100)	Ranking (No.)
Academic	Academic achievement	43	1
	Language improvement	7	4
Career	Career development	8	3
	Building a network	6	5
Personal	Personal relationship	21	2
	Mental/physical health	8	3
	Other (e.g., hobbies)	3	6

The results of Chinese students' expectations of their current studies are then summarised in Table 4.3. When it comes to their desired learning activities, the majority of students tended

to choose the activities improving their English language skills (60% responded) and the corresponding skills of their programmes (57% responded) as their primary choice, regardless of their field of study. However, across all student categories, engineering students expressed a greater need to improve their academic writing (33% responded) than students in other disciplines.

In addition to the need to improve their academic skills, finding suitable employment after graduation is another main concern for most students (60% responded). For Chinese students moving to the UK to study, they are not unfamiliar with either the local society or the employment environment. This may make them more likely to seek out information about working opportunities during their studies at the university.

It is also clear from the data that Chinese students are equally concerned about gaining a wider range of skills from studying at university and interacting with the local community. Therefore, the majority of responses (48%) also showed an interest in developing such skills. A significant number of students (38%) were also interested in learning interdisciplinary content. 37% of them expected to develop their English skills not only for study but also for public speaking. In addition to these, a few students (6%) mentioned that they would like to have more opportunities for one-on-one tutoring. The showed tendency indicates that more and more Chinese students become flexible and equip with inquisitive thinking. Thus, to better meet the learning needs of these students means that the university, as providers of education, need to create interdisciplinary, diverse, and inclusive teaching and communication environments.

As for activities other than academic studies, 81% hope to travel to different cities in the UK during their studies. It is also important for these students to have internship opportunities during their studies (64% of Chinese students consider it essential). More than 50% of these Chinese students would like to have more opportunities to experience local culture and customs (e.g., attending culture exchange and local social activities, concerts, etc.). Of course, as students, there is more to their lives than studying, as 33% of the responses were fancy about playing online games with their peers. This also suggests that as Generation Z students, gaming is a way for them to interact with others. This may also serve as a hint to educators and educational policy makers that it is necessary to consider the existing lifestyle and habits of modern students to make up-to-date adjustments to meet their learning needs.

Table 4.3 Chinese students' expectations for learning activities at the university (indicated in % of total responses, calculated as a ratio per 100).

	Engineering	Business	Social Science	Science	Arts and Humanities	Others (Medicine, Law)	Average
i. What additional learning events do you expect the university to offer?							
Improving academic writing	33	63	59	71	60	75	60
Professional training related to my courses	56	69	59	71	40	50	57
Events on finding jobs	56	69	41	71	50	50	56
Transferable skills training	56	50	47	43	40	50	48
Academic seminars on any subject	28	56	41	43	10	50	38
Public Speaking Training	28	25	47	43	30	50	37
Other (e.g., personal mentoring)	6	N/A	N/A	N/A	N/A	N/A	1
ii. What other social activities do you want to participate in here?							
Taking short trips to neighbouring cities	61	69	82	86	90	100	81
Taking an internship	44	75	65	100	50	50	64
Attending culture exchange activities	28	50	59	43	60	75	52
Attending social activities	39	50	65	57	40	50	50
Playing online games	33	38	41	43	20	25	33
Other (e.g., concerts)	11	6	N/A	N/A	N/A	N/A	3

*N/A indicates no responses to the question in this student cohort.

4.1.4 Chinese students' post-expectations for their studies

For all students, it is inevitable that after completing their studies, they will be committed to their career development. Table 4.4 shows the expectations of Chinese students about their future career choices after graduation. For Chinese students studying in the UK, their career choices after graduation are relatively wider. This is not only because of the better degree qualifications they obtain at UK universities, but also because of the wealth of skill sets they are likely to develop in a diverse and international environment. Firstly, as can be seen from the table, the majority of Chinese students studying in the UK now prefer to return to China to seek employment (54%) compared to those who choose to stay and work in the UK (24%) after graduation. In addition to entering the workplace directly after graduation, 29% of

Chinese students would like to go further in their academic studies after completing their current degrees, such as pursuing a master's degree or a PhD after their current courses. Across all disciplines, 67% of those studying engineering are mostly looking to continue their academic studies. In contrast to finding a job and continuing their studies, 10% of Chinese students are considering starting their own businesses, and a very few (2%) are planning a gap year as a break.

Table 4.4 Chinese students' expectations of their future after graduation (indicated in % of total responses, calculated as a ratio per 100)

	Engineering	Business	Social Science	Science	Arts and Humanities	Others (Medicine, Law)	Average
	What do you want to do after graduation?						
Find a job in China	44	44	53	71	60	50	54
Continue in academia (e.g., apply for a PhD)	67	31	29	14	30	N/A	29
Stay and find a job in the UK	28	31	29	43	10	N/A	24
No specific plan	6	13	18	14	20	25	16
Start my own business	6	6	12	14	N/A	25	10
Gap year	N/A	N/A	12	N/A	N/A	N/A	2

*N/A indicates no responses to the question in this student cohort.

In short, these findings above not only address RQ1 by revealing Chinese students' expectations in UK higher education, but also provide a baseline to understand how such expectations may shape their actual learning behaviours (RQ2) and teamwork experiences (RQ3), which are further examined through subsequent surveys, interviews and classroom observations. Thus, the next section, focusing on classroom observations and post-course feedback surveys within practical courses, in turn, offered an external perspective on how students' stated expectations align with or diverge from their actual classroom behaviours.

4.2 International engineering PGT students' learning in practice-based courses

Having established a foundational understanding of Chinese students' learning expectations in the UK, from this section onwards, the main research cohort was focused on postgraduate

taught (PGT) students. This is because students enrolled in PGT programmes constitute the vast majority (65%) of those coming to study in the UK (UK.GOV, 2025). The PGT course, which involves classroom observation and post-course surveys, is the laboratory practice session of CPE6311-Applied Chemical Engineering, a compulsory course for PGT students in the School of Chemical, Materials and Biological Engineering. The main content of this experimental course is to teach students to complete the risk assessment of a gas boiler system and to determine the thermal efficiency of the gas boiler system by recording different real-time data sets (basic working parameters, temperature changes through the system, and exhaust gas ratios) on-site. The majority of PGT students enrolled in this course are international students. The questionnaire was voluntarily answered by students after the completion of the experimental session.

This section focuses on a demonstration of what the students experienced and learnt from the lab-based sessions. The summative findings of the classroom observation form reflect and document students' learning dynamics and performance during lab sessions (the observation form is sampled in Table 3.3). The post lab-survey includes a closed-ended question that primarily reflects students' satisfaction with the teaching, other two open-ended questions reveal further understanding of students' learning of the content. The questions are listed in Table 3.2 (Aspect 1).

4.2.1 Observed PGT students' learning behaviours in the laboratory courses

This section describes the key results of classroom observations in an engineering PGT laboratory course. Based on classroom observations of CPE6311 laboratory courses from September 2022 to September 2024, it is noted that the majority of PGT students enrolled were international students, with a significant proportion of them coming from China (according to the internal admission data, the average annual enrolment rate of Chinese students in this course was 58% from 2022 to 2024). As a practical-based course, each session involves a lead instructor, one or two GTAs, and a group of three to five students. The student groups in each session may mixed with both home and international students or be entirely composed of international students. Based on the dimensions outlined in the observation sheet (section 3.3.3), the observed student learning performance were summarised as follows:

(a) Preparation before class

Across the three years, many Chinese students demonstrated limited evidence of systematic pre-class preparation. A frequent phenomenon was their reliance on digital devices during class to search resources or use translation software for real-time comprehension, instead of referring to pre-read materials. Compared with home students, who tended to bring hand-written notes, Chinese students' preparation was less visible, which in turn influenced their confidence and readiness to participate in learning activities.

(b) Classroom engagement

In 2022–23, when groups were freely formed, the majority of all-Chinese groups (7 out of 12) showed very limited participation in whole-class interaction. Many Chinese students tended to avoid answering instructors' questions, and interaction with teaching staff was minimal. In contrast, home students and other international students were more willing to engage verbally. In later years (2023–25), when groups were assigned by the department, mixed grouping reduced the number of all-Chinese groups and slightly increased Chinese students' participation in class-wide discussions.

(c) Active learning initiative

Overall, Chinese students exhibited a relatively low level of initiative compared to home students. Language barriers often hindered their immediate responses to instructors' questions. However, a small number of highly proactive Chinese students were observed to take on communicative roles. These students actively engaged regardless of English proficiency, and often acted as group representatives in interactions with instructors or other international peers. Yet, their strong presence sometimes reinforced the silence of other group members.

(d) Language use

In all-Chinese groups, communication was predominantly in Mandarin, which facilitated internal collaboration but further limited teacher–student interaction. Instructors' encouragement to use English had little effect in these groups. By contrast, mixed groups created more opportunities for English use. Nonetheless, even in mixed settings, Chinese students frequently relied on translation tools during class, which slowed their engagement.

(e) Teacher–student interaction

All-Chinese groups showed significantly less interaction with instructors compared to mixed groups. In mixed groups, Chinese students engaged more when required to report on behalf of the group, but spontaneous exchanges remained limited. Group composition therefore had a strong influence on the extent of teacher–student interaction.

(f) Peer interaction within groups

Within all-Chinese groups, peer interaction was highly active in Mandarin, with members collaborating closely on tasks. However, this interaction was isolated from broader class engagement. In mixed groups, two distinct patterns were noted: (1) effective collaboration across cultural backgrounds, with higher initiative and positive attitudes; (2) subgrouping by cultural background, where Chinese students mainly interacted among themselves and relied on one representative for external communication.

(g) Teamwork intention

Chinese students generally demonstrated strong task orientation within groups, but less emphasis on intercultural teamwork. In mixed groups, teamwork intention varied: some students embraced collaboration with peers from different backgrounds, while others maintained distance, forming smaller subgroups. The assigned grouping system from 2023 onwards enhanced opportunities for cross-cultural teamwork, although not all students took full advantage of it.

In sum, the three-year observations highlight consistent differences between Chinese students and their peers in UK engineering laboratory courses. Chinese students tended to show weaker pre-class preparation and lower participation in teacher-led interactions. Their reliance on Mandarin in all-Chinese groups and on translation tools in mixed groups further constrained engagement. However, a few highly proactive individuals played a significant role in bridging communication gaps. In all-Chinese groups, Chinese students collaborated effectively in Mandarin but showed little intention for broader teamwork. In mixed groups, collaboration quality might depend on group dynamics, ranging from effective cross-cultural teamwork to culturally fragmented subgroups.

These findings suggest that Chinese students' learning behaviours in UK classrooms are often characterised by cautious participation and selective initiative. Their teamwork shows strong intra-group cohesion but limited intercultural collaboration, unless supported by structured group assignment and teaching intervention. These observations partially address RQ 1 and 2, and provide potential insights for subsequent teaching practice design.

4.2.2 Results of post-course surveys for students' learning experience

- Satisfaction with the teaching and learning

This part outlines the post-lab responses of PGT students' feedback on their learning experiences after attending the CPE6311 laboratory course during the autumn semester from 2022 to 2024. The feedback survey focused on PGT students' satisfaction with the course instruction and their learning in the course. The questionnaire was distributed to students 10 minutes before the end of the session.

Regarding the question on satisfaction, students were asked to choose from a scale of 1 to 5, with 1 being "poor" and 5 being "excellent". Table 4.5 below summarises the changes in course satisfaction among PGT students over the three academic years. In the first year, 54 students completed the questionnaire (with approximately 70 students participating in the course that year, a response rate of 77.1%). In the second year, 76 students completed it (with about 96 students participating in the course that year, a response rate of 79.2%), and in the third year, 43 students completed it (with around 46 students participating in the course that year, a response rate of 93.5%). Over these three years, no students selected the options "2=Not Good" or "1=Poor".

Table 4.5 Comparison of students' satisfaction with the gas boiler lab from 2022-2025

Academic Year	Answered 5 = Excellent	Answered 4 = Good	Answered 3 = Neutral	Response rate	Ratio (per 100 students) of international to home
2022-23 (N ₁ =54)	87.04%	11.11%	1.85%	77.1%	86:14
2023-24 (N ₂ =76)	82.89%	17.11%	N/A	79.2%	92:8
2024-25 (N ₃ =43)	67.44%	30.23%	2.33%	93.5%	67:33

*N/A indicates no responses to the answer in this academic year.

In the 2022-23 academic year ($N_1=54$), 87.04% of students rated the experiment as “excellent-5”, 11.11% rated it as “good-4”, and only 1.85% were “neutral-3, with a ratio of international to home students of 86:14. Although the data are representative, there may be some non-response bias due to the high proportion of a single option.

By the 2023-24 academic year ($N_2=76$), there was a slight decrease in satisfaction, with the percentage of “excellent” falling to 82.89% and the ratio of “good” increasing to 17.11%, with no neutral feedback and with the ratio of international to home students changing to 92:8. Whilst the data is still representative, it is similar to the previous year and may be subject to some bias, lacking of responses from all representative options.

The data for the 2024-25 academic year ($N_3=43$) show significant changes. There was a further decrease in the proportion of “excellent” to 67.44%, but an increase in the proportion of “good” to 30.23%, with 2.33% neutral feedback. This academic year had the highest overall response rate of 93.5% and the most representative data, as the ratio of international to home students was 67:33, which is more balanced than the previous two years.

Overall, PGT students were satisfied with the quality and effectiveness of the lab course (over 98%). The content of the course is analysed in the following section.

- Students’ perception of what they learned and concerns

Except for the question concerning teaching satisfaction, the two open-ended responses in the feedback provided direction for gaining further insight into students' perceptions of the learning content within the practical course. This enabled me to identify which teaching activities and content fostered greater student engagement in learning and encouraged their learning. After looking through the three years of observations and feedback, the overall evolution of the feedback themes mentioned by PGT students is summarised in Figure 4.2 below.

For Practice Needs, the proportion was 22% in 2022–23, dropped to 13% in 2023–24, and rose again to 21% in 2024–25. Curriculum Resources were reported only in 2022–23 (20%), and not mentioned in the following years. In Teamwork Experiences, the percentage increased

from 15% in 2022–23 to 26% in 2023–24, before decreasing to 14% in 2024–25. Safety and Risk Awareness accounted for 9% in 2022–23, rose to 17% in 2023–24, and slightly declined to 14% in 2024–25. The most significant change appeared in Application of Technology and Tools, which was 4% in 2022–23, sharply increased to 40% in 2023–24, and then decreased to 30% in 2024–25. Finally, Integration of Theory and Practice rose from 6% in 2022–23 to 17% in 2023–24, and then decreased to 11% in 2024–25.

The responses have shown a clear change in the students' focus on practical needs. In the first year, student feedback was more related to hands-on activities, whereas in the third year, students mentioned more the possibility of learning more complex equipment and industry skills during practical-based teaching, suggesting that students' expectations of learning may be shifting from “quantity” to “quality”. In addition, as the teaching of risk assessment has been strengthened over the years, students' awareness of the content has increased significantly after completing the laboratory course. The use of technical tools was also consistently cited as a key element of the course, especially the various sensors used in the experiments and how to draw a process and instrument diagram (P&ID) of the system. Surprisingly, the focus on the ability to work in a team was also mentioned constantly by the students (average 18%).

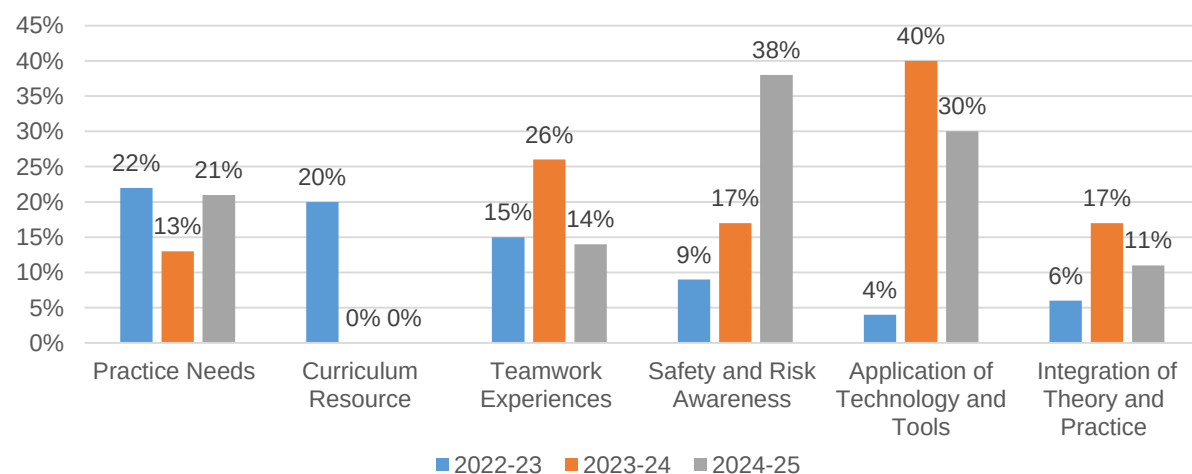


Figure 4.2 Changes in the theme of PGT students' concerns about participation in laboratory-based courses over the three academic years.
% in the graph represents how often the keyword appeared in the overall response.

In summary, the responses highlight how PGT students' perceptions of practical courses evolve over time. These findings speak directly to RQ2, as they reveal not only the behavioural

emphasis students place on practical engagement but also how their expectations shape what they value in learning activities. Importantly, teamwork emerged consistently as a meaningful aspect of the course. This data partially guides me in the direction to explore RQ 3 by illustrating that students' experiences of collaboration are not peripheral but integral to how they engage with learning content. These insights also informed the design of the subsequent practice on teamwork learning (RQ4), suggesting that fostering teamwork within inclusive and practice-based settings can further enhance Chinese students' skills development and overall learning experience in UK engineering education.

4.3 Examining Chinese engineering PGT students' learning capacity

Having established a basic understanding of how PGT students learn in practical courses, subsequent research further focused on the Chinese student cohort. As there have been few definitive findings on their ability to learn at UK universities, this section presents the initial exploratory findings of an investigation into the working memory capacity (WMC) of Chinese engineering students at the University of Sheffield. The main purpose of this study was to observe and investigate whether there are significant differences in Chinese students' WMC in processing information between Chinese and English. As an exploratory experiment, a simple Ospan test was designed and applied, aiming to further clarify whether the use of different languages may have an impact on Chinese students' learning ability in an English teaching environment. Although a limited sample of data was obtained from this study (N=17), its primary purpose was to eliminate linguistic interference factors from my current research hypotheses. Further replication is required for other studies.

The participants included 12 PGT and five PGR students enrolled in the University of Sheffield's Faculty of Engineering during the academic years 2022-24 and 2023-24. The proportion of female participants was higher than that of male participants (13:4). The results of this study may not be broadly representative due to the limited sample size, but they still provide the opportunity to discuss the inter-individual differences in WMC among the Chinese student cohort. The results of this study can be used to optimise the design of subsequent experiments and applied to larger samples to further validate these findings. The processed Ospan MIS scores for all participants are summarised in Table 4.6, and the statistical analyses of the MIS score data for the different Ospan tests and the two student groups are presented in Table 4.7.

Table 4.6 MIS scores of Chinese students completing the Ospan test for memorising Chinese and English Items

Participant No.	Gender	Study level	Chinese MIS score	English MIS score
1	Female	PGT	1.00	0.21
2	Female	PGT	0.14	1.00
3	Male	PGT	1.00	0.29
4	Female	PGR	0.83	1.00
5	Male	PGT	0.43	0.83
6	Female	PGT	0.43	0.36
7	Male	PGT	0.29	0.29
8	Female	PGT	0.12	0.36
9	Female	PGR	0.43	0.50
10	Female	PGT	1.00	0.29
11	Male	PGR	0.86	0.57
12	Female	PGR	0.79	0.79
13	Female	PGT	0.86	0.71
14	Female	PGT	0.21	0.50
15	Female	PGT	0.71	0.48
16	Female	PGT	0.29	0.14
17	Female	PGR	1.00	0.86

Table 4.7 Results of statistical analysis of Chinese students' MIS scores

Ospan type (N _{total} =17)	Mean	Standard Deviation	Min.	Median	Max
Chinese MIS	0.61	0.33	0.12	0.71	1.00
English MIS	0.54	0.28	0.14	0.50	1.00
Analysis of significance (t-test) between Chinese and English MIS					
t-statistic	0.7008				
p-value	0.4935				
Participant cohort (N _{PGT} =12, N _{PGR} =5)					
PGT-Chinese	0.52	0.32	0.12	0.43	1.00
PGR-Chinese	0.78	0.22	0.43	0.83	1.00
PGT-English	0.46	0.26	0.14	0.36	1.00
PGR-English	0.74	0.24	0.57	0.79	1.00
Analysis of significance (t-test) between PGT and PGR cohort					
p-value (Chinese)	0.085				
p-value (English)	0.030				

According to the statistical results, the mean MIS score for Chinese is 0.61 (SD= 0.33), with a range from 0.12 to 1.00 and a median of 0.71; while the mean MIS score for English is 0.54 (SD= 0.28), ranging from 0.14 to 1.00 with a median of 0.50. The paired t-test results show a t-value of 0.70 and a p-value of 0.493. Since the p-value > 0.05, indicating that there is no statistically significant difference between the two groups of MIS scores. Based on the statistical analysis, although the MIS scores of the Chinese Ospan test are slightly higher than the English test (a difference of approximately 0.07), due to the small sample size of the test population, this difference may be caused by random factors rather than systematic influences.

The data is further analysed according to the groups of participating students (PGT vs. PGR), it can be found that in the Chinese test, the mean score of the PGR group (0.781) is higher than the PGT group (0.522), but the difference is still not significant ($p=0.085$). Whereas in the English test, the PGR group (0.743) is significantly higher than the PGT group (0.455) with $p=0.030$. The two groups show significant differences in distribution: the median of the PGR group is close to the mean (Chinese 0.833 vs. Chinese mean 0.781; English 0.786 vs. English mean 0.743); while the median of the PGT group is significantly lower than the mean (Chinese 0.428 vs. Chinese mean 0.522; English 0.357 vs. English mean 0.455), which is due to the presence of some extreme high scores (1.00) pulling up the mean, while the majority of participants scored low (ranging from 0.14 to 0.50).

Preliminary data results suggest that the PGR group can perform more consistently in bilingual tests, especially showing a significant advantage in the English test, which may be related to their academic background or language proficiency; whereas the PGT group shows higher score volatility, with individual high scores (such as a perfect score of 1.00) potentially masking the overall underperformance. Additionally, there is a difference in sample size between the two student groups (PGR group $n=5$ vs. PGT group $n=12$), which may affect the final test efficacy.

Based on the preliminary data, it can be inferred that Chinese students maintain a relatively stable level of working memory (WM) across different language Ospan tests. Their learning ability is not significantly affected by the change in language used. However, due to the small sample size obtained in this study, further research is needed to verify its credibility, and the sample size needs to be increased to improve statistical power.

4.4 Investigating Chinese engineering PGT students' learning behavioural preferences

Further building on the initial understanding of Chinese students' learning abilities obtained from the above investigations, this section explored the tendency of learning behaviours (including study engagement, English language use and learning mode preference) towards their study of engineering subjects at UK universities. The data collection was conducted in the form of an online questionnaire with 18 responses (N=18). Although the sample size is limited, these data, to some extent, reflect students' genuine experiences and provide valuable insights and reference points for subsequent teaching practice design. This included undergraduate, PGT and PGR students studying at the University of Sheffield's Faculty of Engineering during the 2022-24 and 2023-24 academic years. The question set for this part is listed in Table 3.2 (Aspect 3).

4.4.1 Participants' background

The general background of the Chinese engineering students who participated in answering the questionnaire is summarised in Table 4.8. The sample collected was dominated by PGT (66%), PGR (28%), and UG (6%) students, with a higher proportion of female participants (60%). The majority of the participants were under 30 years old (only 10% of the students were over 30 years old). Furthermore, around 65% of the students indicated that they had other overseas study experience prior to starting their current course in the UK.

Table 4.8 Demographics of participants (% units in the table are calculated as a ratio per 100)

Dimension	Range	Percentage of participating students
Age	21–25	35%
	26–30	55%
	Above 30	10%
Gender	Male	40%
	Female	60%
Course level	Postgraduate Taught (PGT)	66%
	Postgraduate Research (PGR)	28%

Dimension	Range	Percentage of participating students
Other overseas learning experience before current studies	Undergraduate (UG)	6%
	Yes	65%
	No	35%

4.4.2 Learning status

To gain a comprehensive understanding of Chinese students' current learning status, this section was designed to investigate their study time allocation, academic performance and expectations, as well as the challenges they encounter in their studies (see Table 4.9). Learnt from the results, 50% of the students spent 5-15 hours per week on independent study, 20% invested more than 20 hours, and 30% studied less than 5 hours. For the obtained coursework grades, 56% of the PGT and UG students were in the range of 60-69 (moderate), and 17% were in the range of 50-59 (low). Following, with regard to expectations of final grades, the vast majority (66%) of Chinese students (predominantly PGT students) would like to achieve at least 60 or more, and nearly half (28%) of these students would also like to achieve above 70 for a first-class degree. In the open-ended questions discussing the learning difficulties they encountered in their current studies, language barriers (e.g. listening, reading, and academic writing) were presented with the highest percentage (40%), followed by time management and lack of personal motivation to study (35%), and communication problems with tutors (25%).

Table 4.9 Participants' engagement and self-assessment of their learning at the current stage of study (% units in the table are calculated as a ratio per 100)

Dimension	Range	Percentage of participating students
Weekly self-directed learning time	5–15 hours	50%
	More than 20 hours	20%
	Less than 5 hours	30%
Current academic grade	60–69	56%
	50–59	17%
	Not applicable (PGR)	28%

Dimension	Range	Percentage of participating students
Expected final grade	Above 70	28%
	60-69	38%
	50-59	6%
	Not applicable (PGR)	28%
Biggest Learning barriers perceived by students	Language barriers	40%
	Communication with others	25%
	Time management / Collaboration with others	35%

4.4.3 English proficiency

To further explore Chinese students' English proficiency and their approaches to coping with language-related challenges, this part of the survey was conducted to complement the classroom observations, thereby providing a more comprehensive understanding of how language use influences their learning experiences (see Table 4.10). As shown in the table, 80% of the Chinese considered English to be "very important" to their current studies, but their actual self-perceived English proficiency varies significantly. 45% of the respondents rated their ability to fully comprehend English lectures in the range of 7 to 10 (moderate), 35% as 8-9 to 10 (good), and 20% as 5-6 to 10 (weak). In terms of reading strategies, about 39% of the students indicated that they needed to translate from English to Chinese at first sight to assist their comprehension, while another 28% still needed to translate from English to Chinese for comprehension after a few times of reading. In addition, 40% of students used AI tools (e.g., ChatGPT, Claude) several times a week to assist with writing, 15% used them rarely, and only 10% did not use them at all. Then, when the students were asked to self-assess their current English proficiency, 55% thought they were relatively proficient in one part of listening, speaking, reading, and writing. While only 11% could answer very proficient, and 28% thought that they were currently very unskilled in their English use, and even 6% thought that their English proficiency was on the decline.

Table 4.10 Participants' perception of their English proficiency in learning (% units in the table are calculated as a ratio per 100)

Dimension	Range	Percentage of participating students
The importance of English as perceived by students in influencing the effectiveness of their current studies	Very important	80%
	Important	20%
What is your first reaction when you read a question in English?	Read it once and understand the English meaning straight away.	33%
	Read it once and translate it into Chinese for understanding	39%
	Read it several times and I can basically understand English questions, but if not I will translate them into Chinese.	28%
Frequency of using technology tools such as AI or translation App in learning	Sometimes (monthly)	35%
	Often (weekly)	40%
	Rarely	15%
	Never	10%
Level of understanding of the English heard in the classroom	7/10 (Average)	45%
	8–9/10 (Good)	33%
	4–6/10 (Weak)	22%
How do you self-assess your current level of English proficiency?	Partially proficient	55%
	A bit deficient	28%
	Very proficient	11%
	Insufficient (even backwards)	6%

4.4.4 Learning method preferences

Building on the previous sections that examined Chinese students' learning status and English proficiency, this part of the survey focuses on their learning methods and preferences. The purpose is to provide a more targeted understanding of how Chinese students approach different aspects of learning in UK universities, while also supplementing classroom

observation findings, thereby offering exploratory insights into their learning tendencies and characteristics. The categorised results are shown in Table 4.11.

In terms of information memorisation, the majority of students (60%) preferred to memorise information in visual forms (such as pictures), 25% opted for textual descriptions, and an even lower proportion (15%) favoured hands-on (tactile) learning. This trend may indicate that visual information plays a crucial role in aiding Chinese students in memorising information.

Regarding information recall, the data showed that 60% of students tend to recall information by reading aloud, 25% chose to write it down for verification, and only 15% assisted their recall by tracing letters in the air. This may suggest that auditory and visual methods are more favoured by Chinese students to retrace information.

When it comes to acquiring new knowledge, 50% of students preferred self-directed learning, indicating a preference for independent exploration; while 40% tended to learn through demonstrations, explanations, or the use of applications and internet resources. The proportion of students who mix various methods was relatively low, at only 10%. This could reflect that, in the process of acquiring new knowledge, Chinese students have both a need for independent exploration and a reliance on external assistance.

For solving complex problems, Chinese students' responses revealed a more diverse range of strategies: 33% actively looked for advice from experienced individuals, 28% chose repeated study and practice, another 28% preferred to list steps and draw flowcharts for systematic planning, while the proportions of those who directly engaged in hands-on practice and those who adopt mixed methods are both 5.5%. This distribution suggests that, when faced with complex problems, students may prefer guided or structured approaches, avoiding reliance solely on intuition or unplanned operations, which could affect learning efficiency.

Finally, when completing practical projects, 55% of students preferred guidance from professionals, 22% learnt by watching demonstrations or instructional videos, 17% depended on protocols to complete projects independently, and only 6% used mixed methods. This trend highlights the importance of professional guidance to Chinese students during practical operations, as well as the need for clear operational steps, and outcomes.

Table 4.11 Participants' learning preferred methods (% units in the table are calculated as a ratio per 100)

Dimension	Range	Percentage of participating students
Preferences for information memorisation	Visual (a picture)	60%
	Textual (text description)	25%
	Tactile (Through field exposure, experience)	15%
Preferences for recalling information	Spell aloud	60%
	Write down to check	25%
	Trace letters in the air	15%
Learning approach for new things	Self-directed learning	50%
	Learn from others (demonstration/explanation/collaboration)	40%
	Hybrid approach	10%
Approach to solve complex problems	Seek advice from someone with experience	33%
	Repeat learning then practise	28%
	Straight, to practise	5.5%
	Make a list, write a step-by-step and a flow chart to solve the problem	28%
	Hybrid	5.5%
Approach to complete hands-on projects	Receive instruction from a professional person	55%
	Watch a demonstration or instructional video	22%
	Complete it independently based on the protocol	17%
	Hybrid	6%

From the overall analysis of the learning preference survey results, it is evident that Chinese students studying at UK universities possess certain pre-existing international background characteristics, but the primary challenge they faced still is their deficiency in English. Although Chinese students are aware of the importance of English proficiency for studying at

UK universities, the prevalence of numerous digital tools may lead to their reliance on translation tools and AI applications during studies. However, it is also clear observed from this survey that Chinese students exhibit a preference for visual and practical learning methods. Whether in memorising or recalling information, the high proportion of 60% indicates that visual and direct oral expression methods are more readily accepted by these students, which may be related to their shortcomings in English proficiency and the widespread use of multimedia methods in contemporary higher education modes. It can be further argued that Chinese students tend to learn better orally, but their limited English proficiency is compromising their studies at UK universities (the teaching and learning is fully conducted in English). If Chinese students are not able to make a “quality” development in their English acquisition in a short period of time, it is important from an educator’s point of view to provide these students with more engaging and inclusive teaching methods.

Furthermore, when engaging in more complex learning, Chinese students prefer self-directed learning and seeking professional guidance (relying on teacher involvement). This may suggest that Chinese students have a stronger inclination towards structured lectures and independent learning. The above results would further reflect that the different preferences formed by Chinese students in their previous and current studies can impact their overall learning effectiveness. Therefore, more exploration in teaching design to integrate diverse and inclusive teaching methods will be able to meet the varied learning needs of these students.

4.5 Chinese PGT students’ teamwork learning

Upon the previous analysis of PGT students’ learning performance, abilities and preferences, this section delved deeper into the design of specific practices that can influence PGT students’ learning performance. Based on earlier sections’ findings, it can be inferred that Chinese students’ learning of technical content is not significantly affected by their English language proficiency, and that most Chinese students have a high level of willingness to engage in practical-based learning. But their limited academic English still has an impact on their overall learning experience at UK universities. This phenomenon led me to further infer that the factors influencing Chinese students’ learning are not rooted in their inherent abilities but are more likely due to their unfamiliarity with and lack of the learning modes prevalent in UK

universities, especially in project-based learning and practical activities conducted in teams within UK universities.

Therefore, after excluding the influence of individual learning abilities, the design core of this study and how inclusive teaching practice can be developed to promote teamwork skills among international PGT students is described below. This practice design study took three years from the pilot study to the final establishment of the inclusive workshop framework and teamwork learning games. Based on a phased approach to observe and investigate PGT students' teamwork behaviours, a game-based teamwork workshop framework and gamified activities were ultimately established, and student feedback was collected after their participation to evaluate the effectiveness of these applications in an engineering course. The evaluation questions are listed in Table 3.2 (Aspect 4)

In the first year, a preliminary experimental practice was conducted using the Belbin team role test to establish a foundational understanding of teamwork behaviours among PGT students. The observations and insights gathered from this phase informed the design of subsequent teamwork learning workshops and games.

Then in the second year, the first version of the teamwork workshops and games was implemented and tested with students from the Environmental and Energy Engineering programme. Feedback and data collected during this phase were used to refine and improve the design of the workshops.

In the final third year, the scope of the study was expanded to include PGT students from two engineering programmes at the University of Sheffield—Environmental & Energy Engineering and Electrical & Electronic Engineering—as well as a cohort from the Chemical Engineering programme at the University of Manchester. After participating in the workshops, students' feedback was collected to evaluate the effectiveness of the interventions and further enhance the workshop design.

4.5.1 Pilot study of PGT students' teamwork preferences (based on Belbin team role test and first trial of the inclusive teamwork workshop)

Before fully designing the new game-based teamwork workshop, a pilot workshop study of applying the Belbin Theory and Belbin Team Role Self-Perception Inventory (BTRSPI) (See

Appendix 12) was conducted amongst PGT engineering students studying the Chemical Engineering taught module (CPE6311 Applied Chemical Engineering). The workshop was held in the autumn semester of academic year 22/23 and lasted 4 hours. A total of 61 students participated, 52 of whom completed the Belbin Team Role Test prior to the course (31 Chinese and 21 others). During the workshop, participants were divided into two different groups at different stages. For the first grouping type, participants decided and chose their groups freely according to their own ideas, which is called self-selected groups. For the second type, the instructor formed groups based on the students' BTRSPI results, considered each student's first and second role choices, and formed the most balanced groups based on Belbin's role theory and team formation (Aritzeta, et al., 2007; Van de Water et al., 2008), which is engineered groups. Figure 4.3 illustrates an example of a balanced selection of roles for an engineered group.

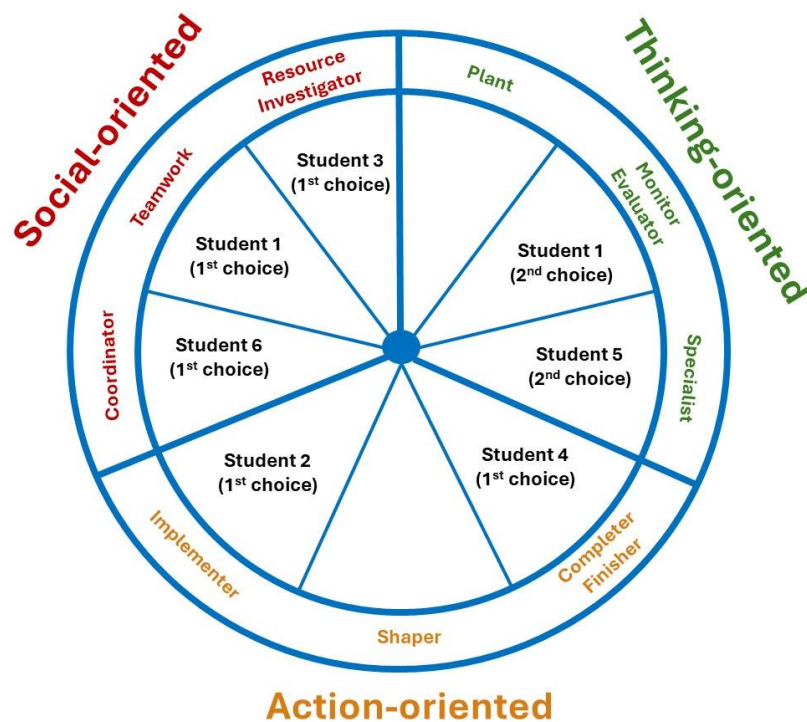


Figure 4.3 Belbin team role-balanced group circle was applied in the pilot teamwork workshop for grouping students.

This figure is modified from the following source:

<https://www.belbin.com/resources/articles-directory/thinking-social-action>.

4.5.1.1 The pilot workshop design

The workshop teaching was divided into two parts. The process of implementing the pilot workshop is described in Chapter 3, Section 3.3.4. The two activities included in the workshop were:

Part 1: Learning teamwork and team roles: the instructor introduced students to how to function effectively as a team and conducts a team-building activity called *Lost at Sea* in which students could experience group-based discussion and become familiar with each other. In this part, students worked in self-selected groups.

Part 2: A chemical engineering project design: Students were asked to design a desalination plant and calculated the associated parameters for the system. In this part, students worked in Belbin engineered groups.

To evaluate changes in students' perceptions of teamwork at different stages, they were required to complete a Self-Assessment Form (SAF) at the end of each part (which is designed and applied in the CPE6311 module evaluation for years, see Appendix 13). The scales used in the SAF included leadership, cooperation, initiative, attitude, and effort. Students needed to rate themselves on a scale from 0 to 10 and the group performance in different settings on the same scale. The two different team feedback forms completed by the students can then be used as a basis for observing and inferring PGT students' teamwork behaviours.

4.5.1.2 Belbin team roles frequency showed among engineering PGT students

Since Belbin team roles were used as the basis in this study, the trend of Belbin team role performance among engineering PGT students became one of the focuses. The frequency of team role orientation of PGT students who completed the BTRSPI in this pilot teamwork workshop is shown in Table 4.12. In addition, 67% of the PGT students who completed the Belbin role test were Chinese students, thus the differences in team role orientation between Chinese students and other students (including home students and other international students) are also shown and compared in the table. Each role frequency was calculated based on the results of students' BTRSPI. The data shows that the majority of Chinese students (49%) intended to be social-oriented roles, compared to other students who preferred more to be action-oriented roles (37%). While the number of PGT students who chose to be the thinking-

oriented role was below 20% in either cohort, which is a small proportion of the three main role categories in the Belbin team.

Table 4.12 Differences between the team role orientation of Chinese students and students from other countries

Belbin team role orientation	Frequency (%)	
	Chinese (N=31)	Others* (N= 21)
Thinking-oriented roles	19%	13%
Action-oriented roles	24%	37%
Social-oriented roles	49%	27%

* The range of students of “Others” nationalities mentioned in this table includes Home students, European students, Middle Eastern students, and Other Asian students (except Mainland China).

4.5.1.3 PGT students’ performance change in different Belbin groups

Beyond examining Belbin’s role tendencies, this study primarily focused on the potential behavioural characteristics and changes in teamwork among PGT students. The SAF scores returned by the PGT students for the five different team activity factors in the different groups are shown in Table 4.13 (a total of 35 fully completed SAF forms were returned). Independent t-tests were conducted on the scores derived from the two different grouping methods, and the results indicated that scores of two grouping types were not statistically significant ($p > 0.05$).

The data revealed that for four self-assessment indicators—leadership, initiative, attitude, and effort—the average scores of the Belbin-engineered groups were higher than those of the self-selected groups. These findings suggest that working in Belbin-engineered groups, with a more rational and balanced allocation of role tasks, may better facilitate individual participation and further motivate and encourage students to engage more actively in group activities, thereby enhancing both individual and overall team performance.

However, in terms of cooperativeness, the self-selected groups (mean = 7.57) outperformed the Belbin-engineered groups (mean = 7.23). Additionally, the overall team performance rating of the self-selected groups (mean = 8.69) was higher than that of the Belbin-designed groups (mean = 8.26). One possible explanation for this overall score decline is that in Belbin-designed groups, most students were reassigned to work with unfamiliar peers, requiring time to establish rapport and adapt to each other. Their relative unfamiliarity with one another’s

working habits may have resulted in reduced cooperation within the group, ultimately affecting the overall experience. Therefore, these results may suggest that incorporating specific role requirements into team tasks could have a positive influence on Chinese students' individual team behaviours to some extent, though it may have limited impact on overall team efficiency (particularly if students are unfamiliar with specific team working methods and behaviours).

Table 4.13 Performance difference between the self-selected groups vs. the Belbin engineered groups

Dimension	Self-selected group (N=35)				Belbin-engineered group (N=35)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Leadership	6.23	1.50	3	10	6.54	1.38	3	9
Cooperation	7.57	1.40	5	10	7.23	1.72	2	10
Initiative	6.74	1.69	5	10	7.23	1.61	2	9
Attitude	7.51	1.27	5	10	7.54	1.40	4	10
Effort	7.09	1.36	5	10	7.40	1.35	4	10
Overall group performance	8.69	1.43	5	10	8.26	1.38	5	10

4.5.1.4 PGT students' perceptions of the importance of key factors in teamwork

After gaining an understanding of PGT student teamwork through the Belbin role and trial on the initial design of the teamwork workshop, in the autumn of the 2023-24 academic year, the second workshop session was held to further test the feasibility of the workshop amongst PGT students (N=83, of which 87% are Chinese students) enrolled in the CPE6311 module. The framework of this workshop was consistent with the process described in section 3.5, with the exception of the card design, which remained unrefined. The questions on students' participation in teams were developed with reference to prior research, which highlights communication, cooperativeness, goal setting, leadership, and personal expertise as core dimensions of team-based work (Riebe et al., 2010; Salas et al., 2014; Tarricone & Luca, 2011; Gantasala, 2015; Freedman & Somech, 2021; Xyrichis & Ream, 2008). The data collected in this workshop was the main categorisation of the task roles that the students took on in their teams and the elements of teamwork that they perceived to be carried out.

- Team roles and task allocation

Firstly, based on the questionnaire feedback collected during the workshop sessions, the main team tasks and role categories that students perceived themselves to be responsible for during group work can be seen in Figure 4.4. 47% of respondents believed they were primarily responsible for communication and coordination, indicating that the majority assumed the role of information communicators or collaboration facilitators within the team. Secondly, 28% perceived themselves as leaders of the team, implying a proportion of members who actively took on organisational and decision-making responsibilities. Additionally, 21% focused on completing individual tasks, suggesting that these students might excel at executing technical tasks, with their focus on assisting with the implementation and achievement of team objectives. Finally, 6% reported that they primarily observed others in the team, which might indicate a lack of awareness or initiative in actively participating in teamwork among some students.

This data reflects students' fundamental understanding of different role allocations in team collaboration. Moreover, students can clearly recognise their own role preferences within a team context, acknowledging that their contribution to team functioning relies not only on individual capability but also on interdependent interaction and coordination among members, rather than merely task execution. These findings also provide a reference for defining role types in subsequent game design.

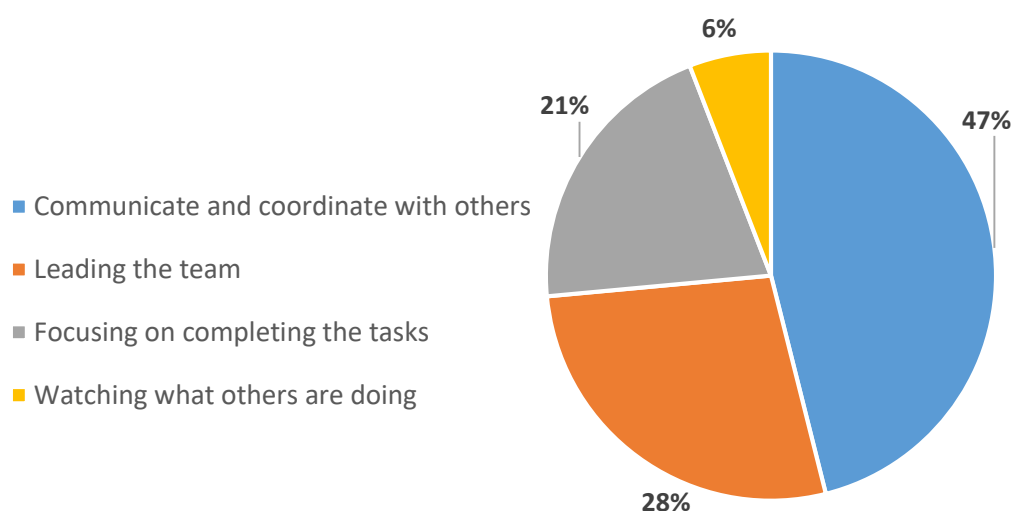


Figure 4.4 Students' self-perception of the main task they do in the team.

- Self-perception of teamwork

When answering the open-ended question about what they considered effective teamwork, international students and home students shared a consensus on the core principles of effective teamwork but exhibited some differences in specific emphases. The detailed themes and keywords mentioned are listed in Table 4.14. The open-ended survey responses were analysed using thematic analysis (Braun & Clarke, 2006). Through iterative coding, six recurrent themes were identified that reflected students' perceptions of teamwork: communication and discussion, division of labour and responsibilities, team cohesion, efficiency and implementation, equality and inclusion, and innovation and flexibility. To illustrate the relative salience of these themes, frequency counts were employed as a heuristic device, indicating how often each theme was mentioned by students (Vaismoradi et al., 2013).

The results showed that the majority consistently emphasised the importance of communication and active listening in teamwork, believing that clear, frequent communication and respect for diverse perspectives are crucial for ensuring smooth collaboration. Additionally, team tasks should be fairly distributed, with each member taking on corresponding responsibilities and applying their strengths to collectively achieve team goals. Furthermore, most respondents believed that efficient execution and rational discussions can help reduce unnecessary conflicts, ensuring that tasks progress more smoothly. Respect and inclusivity were also regarded as key factors for successful teamwork, especially in multicultural settings, where understanding and accepting different perspectives and working styles can foster a more open and safe collaborative environment.

Despite this consensus on core principles, home and international students came up with some differences in task implementation procedures. Home students tended to emphasise open discussions and information transparency, believing that all members should freely express their opinions and actively engage in communication to ensure intellectual exchange and decision-making quality. However, this could pose challenges for international students with limited English proficiency. Additionally, home students particularly valued equitable contributions from team members, advocating for tasks to be allocated based on individual capabilities and expecting balanced participation and shared responsibility. They also preferred resolving conflicts quickly, believing that disputes should not hinder task progress, and thus consensus should be reached promptly to maintain team efficiency. Moreover, they

generally acknowledged the importance of having a designated leader and believed that clear role allocation could enhance overall collaboration efficiency. In terms of team atmosphere, local students viewed teamwork not only as a means to achieve efficiency but also as an opportunity for a dynamic and informative experience, providing a positive learning and exchange environment for members.

In contrast, international (mainly Chinese) students placed greater emphasis on real-time and continuous communication, believing that team members should share ideas consistently to avoid misunderstandings or inefficiencies caused by insufficient communication. This focus on continuous communication may originate from language and cultural differences, prompting them to ensure consistent understanding among team members throughout the collaboration process. Furthermore, while international students also particularly emphasised the timely completion of tasks, reflecting a strong focus on progress control. In terms of teamwork dynamics, they tended to follow the leader's instructions rather than adopting a fully egalitarian approach, which may be influenced by their cultural backgrounds and past teamwork experiences. When addressing conflicts, international students preferred resolving issues through rational discussions, emphasising that collaboration should be guided by mutual understanding and shared goals to minimise unnecessary disputes and conflicts. Regarding team atmosphere, they placed greater importance on each individual's experience during the collaboration process, viewing teamwork not only as a means to accomplish tasks but also as an enjoyable and rewarding experience.

Table 4.14 Classification of PGT students' perceptions of effective teamwork (% in the table represents how often the keyword appeared in the overall response)

Theme	Percentage of international students	Percentage of home students	Keywords (international)	Keywords (Home)
Communication and discussion	33%	26%	"share opinions", "listen to others", "effective communication"	"discuss together", "express opinions"
Division of labour and responsibilities	24%	30%	"division of labour", "assigned by strengths"	"complete own part", "finish work on time"
Team cohesion	21%	19%	"help each other", "build friendships"	"work as one team", "resolve conflicts"
Efficiency and implementation	10%	15%	"follow a leader", "fast efficiency"	"simultaneous work", "quick decisions"

Theme	Percentage of international students	Percentage of home students	Keywords (international)	Keywords (Home)
Equality and inclusion	9%	7%	"respect differences", "equal expression"	"equal responsibility", "kindness"
Innovation and flexibility	3%	4%	"mind storm", "competitive inspiration"	"lively discussion", "flexible solutions"

Overall, home students focused more on efficient and clear division of labour and leadership, while international students were more concerned with continuous communication, time management and overall cooperative atmosphere. The emphasis from international students on communication may also stem from their unfamiliarity with Western teamwork practices and concerns about misunderstandings arising from imprecise language expression. These differences reflect the various expectations of teamwork in different cultures and provide important insights into team management and cross-cultural cooperation. Understanding and balancing these differences in a multicultural team environment can help build a more efficient and harmonious mode of cooperation.

4.5.2 PGT students' feedback and reflections on engaging in the teamwork workshop and games

This section summarises the outcomes of the designed teamwork workshop and games implemented among PGT students. To obtain a comprehensive evaluation of the workshop's effectiveness, the practical sessions were conducted at two UK universities. Participating students were enrolled in the 24-25 academic year in Chemical Engineering-related programmes at the University of Manchester (Manchester CE), Environmental and Energy Engineering programmes at the University of Sheffield (Sheffield CMBE), and Electrical and Electronic Engineering-related programmes at the University of Sheffield (Sheffield EEE). A total of 145 participants attended, with 110 valid feedback questionnaires collected (N=110). The proportion of Chinese students who completed the feedback form was 71%. The workshop framework and team game settings were entirely consistent with the methodology described in Chapter 3, Section 3.5. The proportions of home and international students among the three participating student cohorts are shown in Figure 4.5.

Observed from the figure, it is evident that among the three engineering-related PGT programmes, only Manchester CE had a proportion of Chinese students below 50%. While in the two Sheffield student groups, Chinese students constituted the majority (above 50%). Notably, in the Sheffield EEE group, almost the entire cohort (93%) consisted of Chinese students. This also suggests that students currently studying PGT engineering programmes at UK universities are predominantly from mainland China.

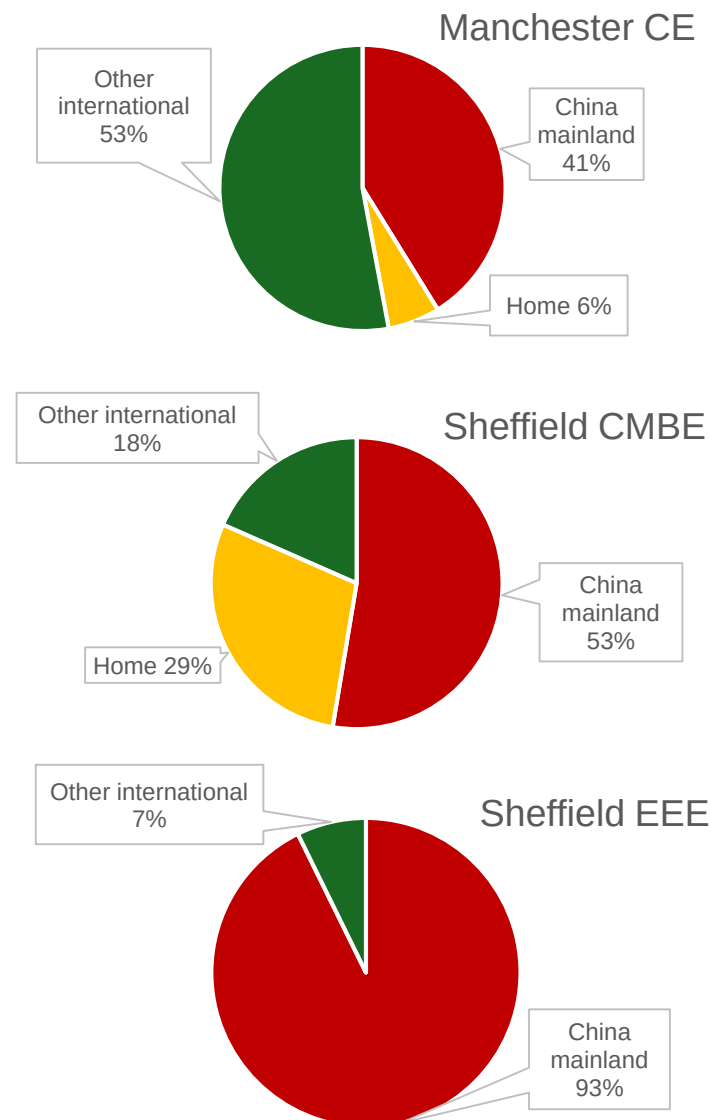


Figure 4.5 Distribution of home, Chinese and other international students who completed the post-workshop feedback among the three student cohorts.

4.5.2.1 Students' assessed improvement in teamwork perceptions and abilities

In order to quantitatively analyse whether the design workshop made an influence to Chinese PGT students' perceptions of teamwork, the self- and peer- assessment of the overall team

performance were included in the post-course feedback forms to further observe and assess the effectiveness of the workshop. Below is a summary of the percentage distribution of responses across the five-point scale for self and peer evaluations across three cohorts (see Figure 4.6 and 4.7).

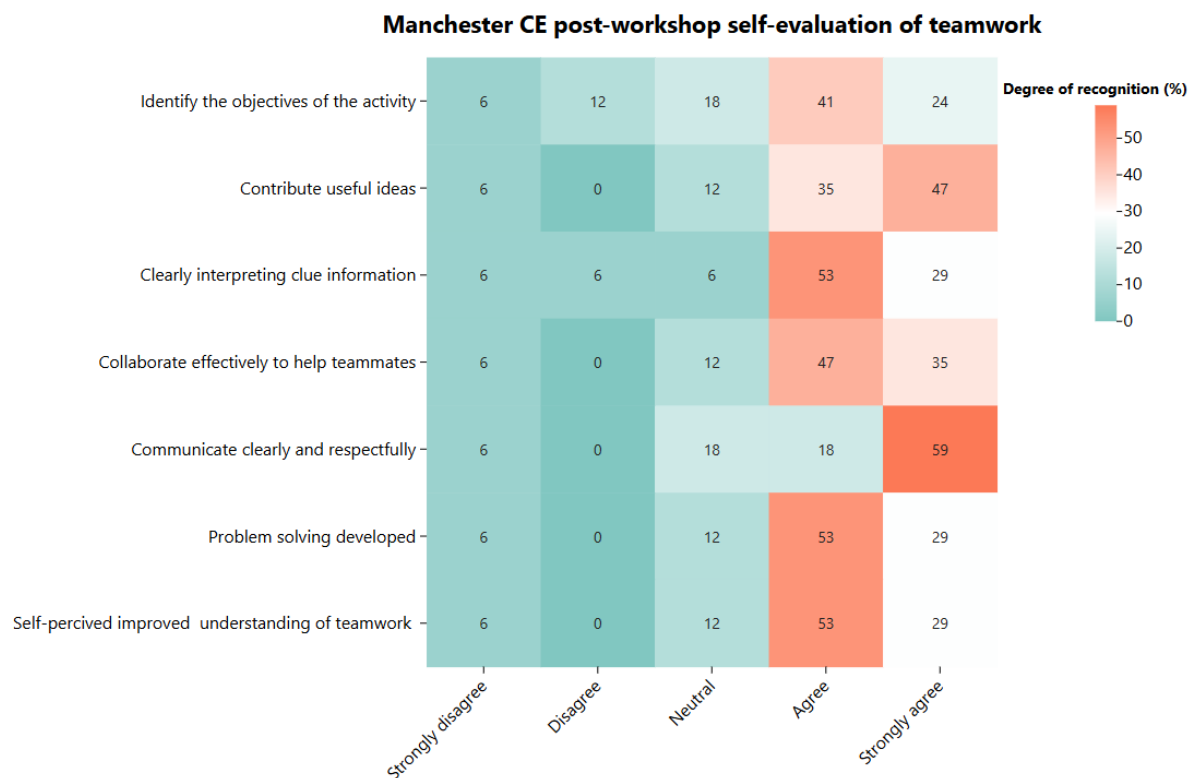


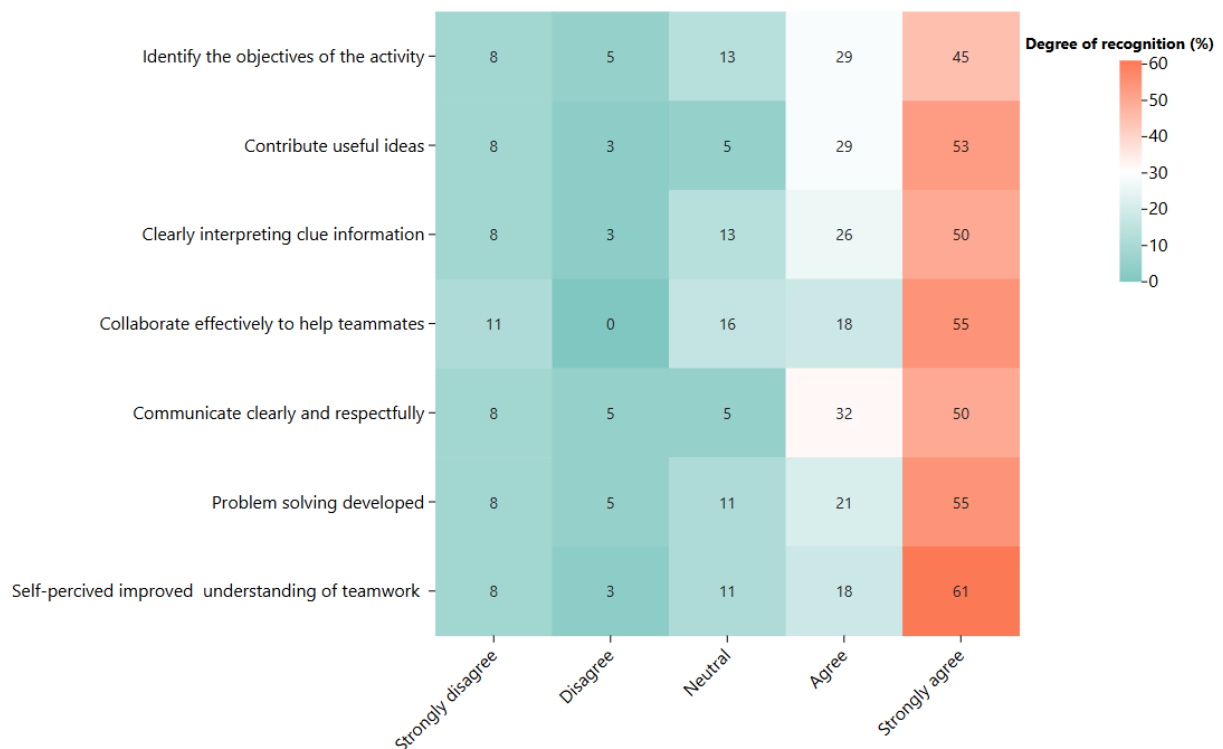


Figure 4.6 Heatmap of three PGT student cohorts' evaluation of their teamwork performance after the workshop (% , calculated as a ratio per 100).

Manchester CE post-workshop peer-evaluation of teamwork



Sheffield CMBE post-workshop peer-evaluation of teamwork



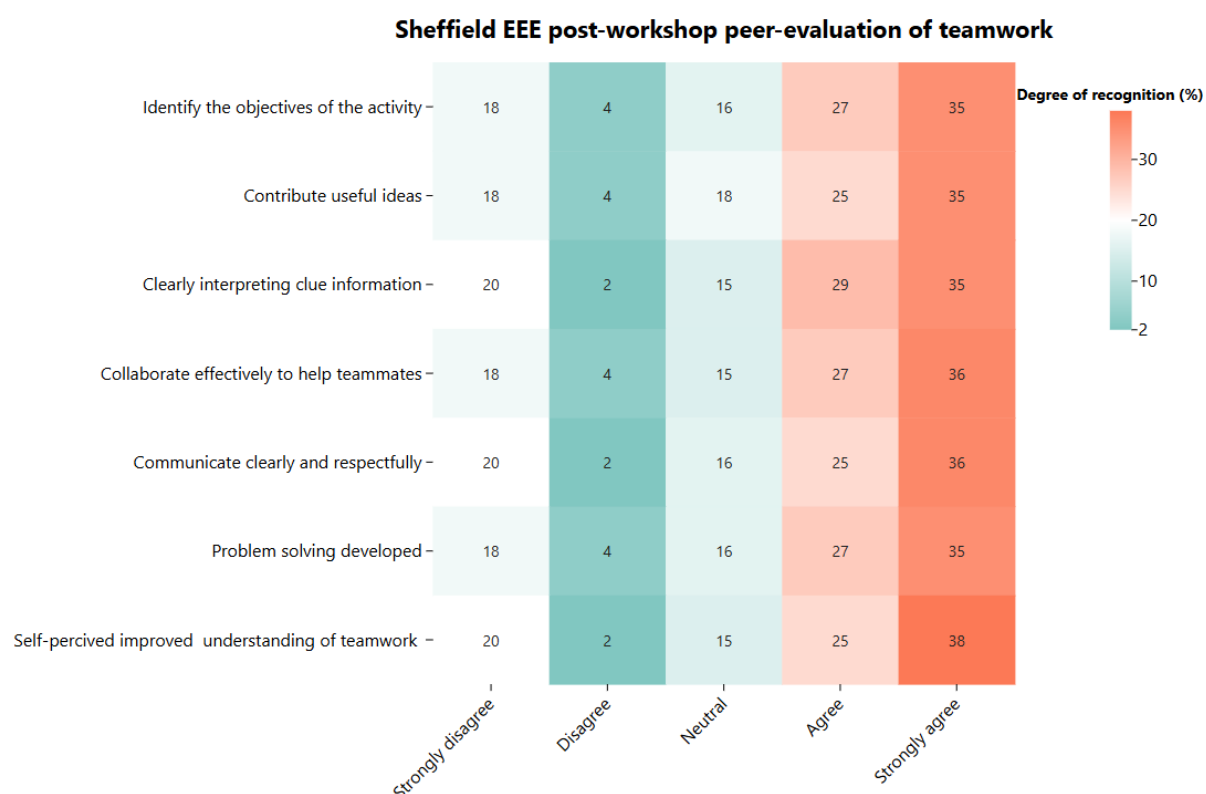


Figure 4.7 Heatmap of three PGT student cohorts' evaluation of their peers' teamwork performance after the workshop (% calculated as a ratio per 100).

As shown in the two figures above across three cohorts, in general, Manchester CE students' self-assessments were generally higher than those of their peer assessments, especially in the dimensions of “improved problem-solving skills” and “improved understanding of teamwork”. For example, 82% of students rated themselves as positive (4-agree or 5-strongly agree) on the improvement of problem-solving skills, compared to 65% of peer ratings. In addition, peer evaluations tended to be more neutral in their feedback, for example, 29% and 18% of peer evaluations were neutral on the dimensions of “identifying goals for the activity” and “contributing useful ideas”, respectively, which were significantly higher than the 12% and 6% on the self-assessments. This difference suggests that students may have overestimated their actual performance in the team, while their peers' feedback was more critical. In the area of communication and collaboration, students' self-assessments show a higher level of confidence. For example, 59% of students rated themselves as having the highest score (5-strongly agree) for “clear and respectful communication” compared to 41% of peer ratings. However, recognition of collaborative skills was more consistent: 82% of students rated themselves as good at “collaborating to help teammates” in their self-assessment, and 71%

of peer ratings were positive. It is worth noting that there is a large cognitive gap in the dimension of “contributing useful ideas”, with 82% of self-assessed positive attitudes but only 59% of peer-assessed positive attitudes, suggesting that the students' actual contributions may have deviated from their self-expectations. However, some dimensions showed potential shortcomings in teamwork. For example, 47% of the peer ratings for “defining the goals of the activity” were neutral or negative (3-neutral and below), compared to 24% of the self-assessments, suggesting that the clarity of the team's goals may have fallen short of the members' expectations. In addition, the percentage of positive attitudes towards “problem-solving skills” was significantly lower in the peer ratings (65%) than in the self-ratings (82%), suggesting that the students' improved problem-solving skills may not have been adequately reflected in the actual collaboration.

In the Sheffield CMBE student cohort, students' self- and peer-assessments were both highly positive, but self-assessment was also significantly higher than peer feedback on some dimensions. For example, in “Improvement in problem-solving skills” and “Improvement in understanding of teamwork”, the self-assessed positive attitudes (4-agree and 5-strongly agree) were 82% and 81% respectively, compared to 76% and 79% in the peer assessments. It is worth noting that the proportion of “strongly agree” was generally lower in the peer evaluations than in the self-assessments, but the proportion of “agree” was relatively balanced. For example, on the dimension of “communicates clearly and respectfully”, 68% of the self-assessed ratings were “strongly agree” compared to 50% of the peer-assessed ratings, but 32% of the peer-assessed ratings were “agree” compared to 32% on the self-assessed ratings, which is a much lower percentage than the self-assessed ratings. However, the 32% of peer-rated “agree” complements the 13% of self-assessment, suggesting that peers are more inclined to express their approval with a conservatively high score. In terms of collaborating to help teammates, there is a high degree of consistency in positive attitudes between self-assessment and peer-assessment (82% for self-assessment and 74% for peer-assessment), and the proportion of “strongly agree” in the self-assessment reaches 63%, compared to 55% in the peer-assessment, suggesting that both parties have positive attitudes towards the practical effects of collaborative skills. In terms of perceptions of contributing useful ideas to group work, the proportion of positive attitudes in the self-assessment was as high as 82% (5-strongly agree 61%) compared to 79% in the peer assessment (5-strongly agree

53%), which is a relatively small difference, indicating that the students' ability to contribute was more highly recognised by their peers. Then, when setting goals for the activity, 76% of the self-assessments were positive compared to 74% of the peer evaluations, but 26% of the peer evaluations had neutral or negative feedback (3 or less), significantly higher than the 24% of the self-assessments, suggesting that there may be a slight cognitive bias in the team's goal-setting.

Last for Sheffield EEE, students expressed high confidence in their teamwork skills in self-evaluations, particularly in collaborative and communicative aspects: 53% strongly agreed they could “collaborate effectively to help teammates” and 55% strongly agreed they “communicated clearly and respectfully.” Self-perceived strengths also extended to problem-solving skills (51% strongly agreed), with minimal disagreement across all categories ($\leq 16\%$ strongly disagreed). In contrast, peer evaluations revealed more measured assessments. Peers were less emphatic in their praise, with only 36–38% strongly agreeing on collaboration and communication skills. Notably, peers assigned higher rates of neutrality (14–16% for problem-solving and interpretation of clues) and stronger disagreement (20% strongly disagreed with “clearly interpreting clue information”), suggesting gaps in perceived clarity during teamwork. Then, a key discrepancy emerged in Sheffield EEE’s self vs. peer comparisons: students consistently rated themselves higher than their peers did. For example, 49% of students strongly agreed they “contributed useful ideas,” compared to 35% in peer evaluations. Similarly, self-assessments of “interpreting clue information” showed 16% strongly disagreeing, while peers reported 20% disagreement, highlighting potential overconfidence in students’ self-awareness.

4.5.2.2 Students’ reflection on engaging in the game-based teamwork workshop

In the post-feedback, the open-ended responses were also collected from the students regarding their best and worst experiences in the workshop. These open-ended answers were also counted using thematic analysis, and the proportions of the key positive and negative teamwork experiences are presented in Figure 4.8. The responses were examined using thematic analysis (Braun & Clarke, 2006), which involved iterative reading, coding, and categorisation of the data. Through this process, recurring patterns were identified and

grouped into themes that captured students' perceptions of positive and negative teamwork experiences. To indicate the relative prominence of these themes, frequency counts of the responses assigned to each theme were also calculated (Vaismoradi et al., 2013). This analytic procedure resulted in seven themes: conflict, time management, game interaction, communication, communication (misunderstanding), task completion, and teamwork.

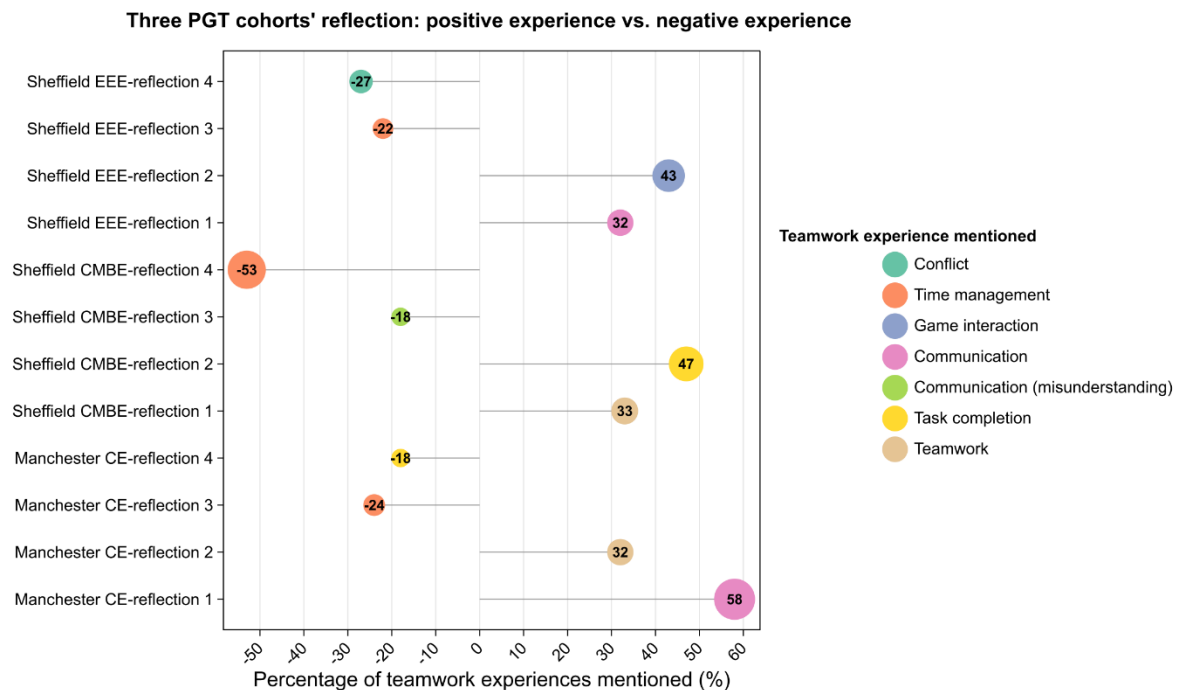


*Figure 4.8 Summary of PGT students' reflections after the workshop.
Percentage of teamwork experiences mentioned by students, on the x-axis: positive values are positive, negative values are negative.*

As presented in the figure above, regarding the positive (best) experiences, Manchester CE students valued communication and teamwork the most, with 58% mentioning "communication and coordination" as their most satisfying aspect, while 32% considered the teamwork experience of "achieving common goals." Sheffield CMBE students, on the other hand, focused more on task completion, with 47% citing the "design project" as their most satisfying aspect and 35% highlighting the teamwork experience of "completing the presentation together." In contrast, Sheffield EEE cohort leaned more towards interactive games and cross-cultural communication, with 43% mentioning the "survival game" as their most satisfying aspect and 32% emphasising the cross-cultural communication experience of "discussing with teammates." These differences reflect the varying needs of team experiences

based on cultural backgrounds, with home students prioritising task completion and outcome presentation, while international students enjoyed interactivity and cross-cultural exchange.

Then, regarding the negative (worst) experiences, Sheffield CMBE students complained the most about time pressure, with 53% perceiving "difficulties in time management" as their least satisfying aspect, and 18% mentioning "communication misunderstandings." Sheffield EEE students highlighted conflicts more, with 27% citing "differences in opinions" as their least satisfying aspect and 22% mentioning "time constraints." Manchester CE students expressed dissatisfaction with time constraints and task failures, with 24% citing "insufficient time" and 18% mentioning "selecting incorrect items." These worst experiences highlight common challenges in teamwork, particularly in time management and communication.

Moreover, to provide a more specific assessment of the effectiveness of the teamwork workshop, the three-cohort students were also asked to reflect on the teamwork-related skills (Riebe et al, 2016; Xyrichis & Ream, 2007; Salas et al., 2014; Tarricone & Luca, 2011; Van Horne & Rakedzon, 2024) they believed they had improved after participating (see Table 4.15).

Table 4.15 Teamwork-related skills or aspects of teamwork that students self-identify as having improved as a result of engaging in the workshop and games

Teamwork-related skills or aspects of teamwork perceived to have improved	Percentage of responses
Communication	70%
Collaboration	58%
Problem-solving	53%
Friendship	45%
Time management	41%
Decision-making	41%
Patience	37%
Organisation	36%
Self-reflection	35%
Goal-setting	34%
Leadership	34%
Adaptability	32%
Negotiation	31%
Integrate and analyse information	31%
Conflict resolution	19%

According to the table, students reported improvements in multiple teamwork skills and other related areas after participating in the workshop. Communication, collaboration and problem-solving were the top three skills mentioned as having improved, with each accounting for

more than 50% of the total responses. This indicates that the workshop achieved moderate success in enhancing individual students' communication, collaboration and problem-solving abilities, which are definitely regarded as core competencies in general teamwork.

Following closely were friendship at 45%, time management, and decision-making at 41% of. The improvement in these skills may reflect students' enhanced ability to manage time, and make effective decisions when faced with complex tasks, also building close relationships with each other.

Patience, organisation, introspection, goal setting, leadership, adaptability, negotiation and information analysis then accounted for between 31% and 37%. These results suggest that students not only improved their practical key skills related to teamwork but also strengthened self-awareness, goal-oriented and flexible capabilities through the team interaction. However, conflict resolution was the least mentioned skill, with only 19% of the responses accounting for it. This may suggest that the practical settings were relatively insufficient in fostering conflict resolution skills, and future teaching design of the workshop will include more training and guidance in this aspect.

Finally, although the game-based teamwork workshop still has shortcomings in its implementation and content design, it received promising feedback from the three PGT student groups (see Table 4.16). When asked whether they would like to participate in similar activities in future teaching, 88% of Sheffield CMBE students, Sheffield EEE 82%, and Manchester CE 94% expressed a strong willingness to continue participating. This also demonstrates that the combination of gamified teaching, teamwork learning, and technical skills application provided students with a more enriching and positive learning experience.

Overall, the workshops were notably effective in improving students' core teamwork skills such as communication, collaboration, problem solving and time management. However, there is still potential for improvement in lesser-mentioned skills such as conflict resolution. Future workshops could incorporate targeted training to further strengthen students' overall teamwork skills.

Table 4.16 Students' self-reflection of teamwork learning outcomes from the workshop and expectations for future participation in game-based teaching

Cohort	Willingness to participate in similar game-based teaching activities in the future
Shen CMBE	88%
Shen EEE	82%
Man CE	94%
Average	88%

Part I summary

The five strands of empirical investigation presented in this chapter should be understood as a coherent and progressive inquiry rather than as separate analyses. Collectively, they demonstrate how the study addresses the rationale and aims outlined earlier. The exploration of Chinese students' initial learning expectations (4.1), alongside their observed classroom behaviours and subsequent reflective feedback (4.2), provided a foundational understanding of their learning capacities, study orientations, and adaptation challenges, thereby contributing directly to RQ 1 and 2. The investigation of working memory differences when using English and Chinese (4.3) also further illuminated the cognitive dimension of their learning behaviours (RQ 2), offering additional depth to the interpretation of how language influences their academic engagement. Building on this, the examination of Belbin team role distributions in collaborative workshops (4.5.1) offered insight into how Chinese students engage in teamwork within a cross-cultural educational environment, thereby addressing RQ 3. Finally, the implementation and evaluation of gamified teamwork workshops (4.5.2) provided empirical evidence of the potential of innovative pedagogical interventions to enhance teamwork skills and engagement, thereby directly contributing to RQ 4.

Taken together, these interconnected findings illustrate a stepwise progression: from mapping students' learning expectations and behaviours, through understanding their teamwork roles and cognitive challenges, to trialling and evaluating pedagogical innovations. This progression demonstrates how the study holistically responds to its stated rationale and aims, while also generating exploratory insights into the ways Chinese students adapt to UK engineering education and how inclusive teaching practices might be further developed to support them to overcome the "adaptation lag".

Part II: The qualitative data

In this study, in addition to collecting and analysing quantitative data to observe and capture students' learning in engineering practical courses, qualitative data research was also employed to enrich and complement issues that were not highlighted in the quantitative data.

4.6 Preparation of interview data for analysis

Effective qualitative research relies heavily on the careful preparation of interview data before analysis. This process ensures the data is accurate, well-organised, and ready for systematic exploration. The initial step involves transcribing interview recordings, which allows researchers to immerse themselves in the data and facilitates accurate analysis (Doody & Noonan, 2013; Stuckey, 2014). Subsequently, employing a structured analytical framework, such as thematic analysis or content analysis, aids in organising and interpreting the data effectively.

Thus, in this study, the first step in preparing interview data is organising all materials systematically. This involves gathering all audio recordings, transcripts, and any field notes taken during the interviews. Each interview has been assigned a unique identifier, such as "CH1" (representing Chinese students), to maintain consistency and ensure anonymity. A structured folder system is also essential, with subfolders for raw data, cleaned transcripts, coding, and analysis notes.

Once the interviews are organised, transcription becomes the next critical step. Accurate and detailed transcripts form the foundation of qualitative analysis. To process the interview transcripts, the automatic transcription tool (iFlyrec) was first used to speed up the transcription of the interview recordings. When all the text was transcribed, I also did manual verification to ensure accuracy.

After transcription, the data also needs to be cleaned and formatted for consistency. Standardising the format across all transcripts ensures clarity and ease of reading. This includes using uniform speaker labels, such as "Chinese Interviewer (CHI)" and "Student Participant (STP)," as well as maintaining consistent paragraph spacing and timestamps where

necessary. Additionally, any identifying information has been removed with pseudonyms to maintain confidentiality and comply with ethical requirements.

4.7 The interview coding output

This section provides an overview of the codes and themes for the five broad categories explored qualitatively in the present study. In sub-sections 4.8.1 and 4.8.2 represent the different numbers of themes and codes that emerged from the thematic analysis process for two independent interview studies.

The data were analysed using Braun and Clarke's reflexive thematic analysis (Braun & Clarke, 2006; Braun & Clarke, 2019). This approach was chosen because it provides a systematic yet flexible method for identifying patterns of meaning while acknowledging the researcher's interpretive role. The analysis followed six phases: (1) familiarisation with the data through repeated reading of transcripts; (2) initial coding of meaningful segments; (3) searching for potential themes by grouping related codes; (4) reviewing themes against the dataset to ensure coherence; (5) defining and naming themes regarding the research questions; and (6) writing up the analysis with illustrative quotes. Codes were first generated inductively from the data, then iteratively refined through comparison with existing literature (Riebe et al, 2016; Johnson et al., 2014; Laal & Ghodsi, 2012; Colbeck et al., 2000; Oakley, 2004; Pfaff & Huddleston, 2003). To ensure rigour, a coding framework was developed and applied consistently, with themes representing interpretive patterns rather than topic summaries. NVivo 14 software was used to support data management and analysis.

All interviews were conducted in Mandarin Chinese, allowing participants to express their experiences in a language they felt most comfortable with. The audio recordings were transcribed verbatim in Chinese. Initial coding and theme development were carried out in Chinese to preserve the cultural and linguistic nuances of participants' accounts. Only after the themes had been established were they translated into English for the purpose of reporting in this paper. This process minimised the risk of misinterpretation during the early analytical stages, but we acknowledge that translation inevitably involves some loss of meaning and subtlety (Van Nes et al., 2010). As such, we recognise language transfer as a limitation of the study and encourage readers to consider this when interpreting the findings.

4.7.1 Chinese students' perception of teamwork

In order to gain a more in-depth understanding of Chinese students' individual experiences of teamwork in UK universities, the interviews with 23 UG, PGT and PGR students studying at four UK universities were conducted. After analysing the 23 transcripts thematically, four major themes emerged: Chinese students' understanding of the basic functioning and composition of teamwork (Team dynamics), the process and factors involved in teamwork (Team processing), the results of teamwork (Team outcome), and the impact of teamwork skills on career development (Career impact). The detailed coding points collected and summarised under these four themes are presented in Table 4.17 below. The set of questions used in the interviews can be found in Appendix 1.

Table 4.17 Developing themes and codes for Chinese students' perception of teamwork learning in UK engineering courses

Theme	Description	Number of cited files	Number of sentences/items cited
1. Team dynamics	How did students understand the basic concepts of teamwork?	23	43
1.1 Communication pattern	What are the most used communication methods for the student team?	6	11
1.2 Encountering conflicts	Describe problems or challenges students have had within previous teamwork experience.	2	2
1.3 Diversity	Whether the team involve students from different professional areas, countries or genders?	8	9
1.4 Roles and responsibilities	The most recognised team roles and main task content	23	45
1.5 Team formation	How does the student team form like self-selecting or pre-assigned by academic staff?	14	27
1.6 Team size	How many people are usually in a team?	20	24
2.Team processing	What are the key elements and steps students will experience when they work with others?	20	32
2.1 Team atmosphere	Whether students think the team atmosphere is good or bad?	6	9

2.2 Encountering challenges	What students will do when there is a challenge emerging in the team	19	29
2.3 Resolving conflicts	Describe how students deal with issues and any experience they have with working in a team to solve problems.	9	13
2.4 Coordination	The element of teamwork is most often mentioned by students.	19	49
2.5 Decision-making	Clear statement for someone or the whole team to make a decision at a time point.	1	1
2.6 Performance evaluation	Students' perceived ways of evaluating the results of teamwork, such as group assignments and supervisors' comments.	4	7
2.7 Setting goals & planning	Do students set goals or plan carefully before starting the work, for example, have regular group meetings?	11	14
2.8 Leadership	Do students realise that they or someone else is acting as a team leader whether or not they are explicitly assigned to do so?	13	23
2.9 Personal efforts	Describe the tasks and contributions in a team.	7	10
2.11 Respect and fairness	Whether students feel that work is distributed well and that everyone is treated with equal respect.	4	6
2.12 Time limits	Time restriction impact on teamwork	5	5
2.13 Curricular interventions	Does the course they are currently taking emphasise or require teamwork in any way?	22	40
3.Team outcomes	Students' physical achievements like a team report, design product or any personal takeaways and reflections after working as a team.	23	23
3.1 Further improvements	Skills, perceptions, or insights that students would like to see themselves improve in teamwork in the future.	18	20
3.2 Learning and development	Growth and gains for students after experiencing teamwork.	10	15
3.3 Performance (quality and efficiency)	Students' personal evaluations of their own and the whole team performance. Like do they get a good course grade or win a prize in a competition?	20	23

3.4 Satisfaction (self and team satisfaction)	Whether students are comfortable with teamwork and would like to participate in more teamwork?	19	26
4.Career impact	Whether students are aware of the importance of teamwork skills in their future careers.	13	16
4.1 Connection between academia and industrial	Do students find a connection or a difference between teamwork in universities and the workplace, for those with some work and internship experience?	5	8
4.2 Industry requirements for teamwork	Are students aware of the need for teamwork skills in the workplace?	7	9
4.3 Personal endeavour	Have students paid special attention to and enhanced their teamwork skills for personal pursuits to meet the demands of their future careers?	5	6

4.7.2 PGT students' perception of the designed teamwork workshop and games

Further to gain more specific understanding and review of the implementation of the designed teamwork workshop and games, seven participating students were invited to participated in the follow-up interviews to gain a more targeted understanding of their individual perceptions during the workshop. These interviews were designed to assess the effectiveness of the practice design from the perspective of students who had experienced it. After collecting and transcribing the six interview transcripts, a thematic coding analysis was conducted, resulting in three main themes: students' overall impressions and evaluations of the workshop, the impact of participating in the workshop on their ability to work in a team, and students' expectations of suggestions for improvements and optimisations to the workshop design. The specific coding categories and summaries for each theme are detailed in Table 4.18 below. The set of questions used in the interviews can be found in Appendix 2.

Table 4.18 Developing themes for student feedback on the designed game-based teamwork workshop and games

Theme	Description	Number of cited files	Number of sentences/items cited
1.Overall perception of the workshop and games	Students' feelings about how good or bad the whole workshop and games were.	7	9
1.1 Novelty	Whether the workshop or game is a different experience for the students from the rest of the course.	4	5
1.2 Positive experience	Whether the workshop activities were fun, had a good team atmosphere and helped students to improve their self-awareness of teamwork.	7	18
1.3 Negative experience	Whether the workshop activities are too difficult or too easy, or the time schedule is not reasonable or creates any barriers for the team.	6	12
1.4 Overall satisfaction	Whether the workshop activities allow students to achieve the learning goals or increase participation in similar courses.	5	9
2.Impact from the workshop and games on teamwork	Regardless of any aspect of teamwork, did students feel that playing the game in some way promoted their sense of teamwork or co-operation or reflection.	7	16
2.1 Collaboration	By playing the game, did the students have a clear division of roles or tasks, demonstrating mutual support and team co-ordination among the team members?	7	16
2.2 Communication	Did the students take the initiative to express their views, listen and understand, or negotiate and compromise during the game? Or how they talk to each other?	5	17
2.3 Decision making	Did students engage in brainstorming or shared decision-making in the workshop?	4	4
2.4 Individual growth	Any individual growth experienced after the course, e.g. increased sense of responsibility, self-awareness or improved sense of teamwork.	7	10
3.Suggestion for improvement	Students mentioned suggestions for future courses and game design, improvements to the content, processes, and materials.	7	8

3.1 Content design	Add new game contents, simplify rules, add backstory, and enhance the connection to the technical curriculum.	6	10
3.2 Organisation	Better time and process management, detailed instruction and guidance on different time points.	3	4
3.3 Long-term impact	Whether students' interest in participating in similar teamwork will increase in the future?	5	8

4.8 Chinese students' perception of teamwork in UK engineering courses

In this study, semi-structured interviews were conducted with Chinese engineering students studying at four UK universities (Sheffield, Manchester, Cambridge and Warwick) during the 2023-2024 academic year. The interview recordings, lasting between 20 and 60 minutes, were anonymised and transcribed. All Chinese texts were translated and proofread by the principal researcher (native Chinese speaker).

4.8.1 Interviewee respondents

A total of 23 Chinese engineering students (UG: 4%, PGT: 61% and PGR: 35%) participated. The gender ratio of the participants was male 43: female 57. The interviews were conducted in Chinese to allow these Chinese students to express their views more comprehensively and be able to provide frank insights into their perception and experience in learning Engineering courses at UK universities. The following brief criteria were used in recruiting visitors: (a) studying an engineering-related course at a UK university, and (b) having experience of working in a team, either in their current or previous study experience. A brief profile of the interview respondents is presented in Table 4.19.

Table 4.19 Interviewee profile of participants in the interview investigating Chinese students' teamwork experience in UK universities

Interviewee ID	Gender	Course level	Degree programme	University
CH-1	Male	PGT	Environment and Energy Engineering	The University of Sheffield
CH-4	Male	PGT	Environment and Energy Engineering with Industrial Management	The University of Sheffield
CH-5	Female	UG	Civil Engineering and City Plan	The University of Sheffield

CH-7	Male	PGT	Environment and Energy Engineering	The University of Sheffield
CH-8	Female	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-9	Male	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-10	Male	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-12	Female	PGT	Environment and Energy Engineering with Industrial Management	The University of Sheffield
CH-13	Male	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-14	Female	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-15	Female	PGR	Engineering Education	The University of Warwick
CH-16	Female	PGR	Computer Science	The University of Cambridge
CH-17	Male	PGR	Electrical and Electronic Engineering	The University of Sheffield
CH-18	Female	PGR	Mechanical Engineering	The University of Sheffield
CH-19	Female	PGT	Biochemical Engineering	The University of Manchester
CH-20	Female	PGR	Chemical and Biological Engineering	The University of Sheffield
CH-21	Male	PGR	Robotics	The University of Sheffield
CH-22	Female	PGR	Translational Biomedical Engineering	The University of Cambridge
CH-23	Female	PGR	Mechanical Engineering	The University of Sheffield
CH-28	Female	PGT	Education Technology	The University of Sheffield
CH-29	Female	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-30	Male	PGT	Electrical and Electronic Engineering	The University of Sheffield
CH-31	Male	PGT	Electrical and Electronic Engineering	The University of Sheffield

4.8.2 Interview results

4.8.2.1 Chinese students' perception of teamwork dynamics

Firstly, in terms of basic understanding of teamwork, the majority of Chinese student participants perceive teamwork as involving a small group of individuals who collaborate to accomplish tasks assigned to each member, with communication playing a key role in determining whether the team's ultimate goal can be achieved through complementary individual efforts. Since all interview participants were current students, most respondents' views on teamwork revolved around their school experiences, such as completing coursework, laboratory projects, and design assignments. Two respondents summarized the general perspective as follows:

"My understanding of teamwork is more about fully utilizing everyone's talents and organizing their contributions as efficiently as possible to produce an outstanding result. When I think of a word to describe teamwork, I would say 'making the best use of everything.' I hope that everyone's work and efforts are reflected in the outcome of the teamwork so that each person can feel the value of their contribution to the team." (CH-7, Male, PGT)

"Basically, for almost everything, whether in society or in the academic tasks assigned in school, I believe that many of these larger tasks cannot be accomplished by one person alone. Apart from those tasks that assess individual skills, larger projects require a collective effort. In the process of collaboration, everyone plays to their strengths and combines their efforts to successfully complete a major project or assignment." (CH-15, Female, PGR)

Through their experiences of team-based learning in school, most Chinese student respondents also noted that communication, team diversity, and team roles influence their learning experience in a team setting. They recognised that their language proficiency could impact the effectiveness of communication. One respondent mentioned:

"When I worked as a GTA, we had many Chinese students; it was quite challenging because they had issues like cultural differences and language barriers. As Chinese students, they usually don't engage in detailed English conversations and listening to others speak is considered a form of respect or acknowledgment. So sometimes they hesitate to interrupt or share their thoughts smoothly. There are a few who may speak up, but most of them feel a bit shy." (CH-17, Male, PGR)

Furthermore, communication within groups fully consisting of Chinese students can also be hindered by differing personalities. The following comment vividly illustrates this point:

"There was one team member who had good grades and was also Chinese, who often acted as if he wasn't really discussing with us. Instead, he was just conveying his ideas, and if you didn't agree, he would argue once or twice. If he couldn't convince you, he would lose his temper. Generally, I found it difficult to communicate with him." (CH-20, Female, PGT)

From this student's perspective, we can see that even in student group collaborations where there are no language barriers, effective communication can still be hindered by differing understandings of the team task's objectives or personal targets. Another respondent, who had participated in a team made up of students from different nationalities, noted that interaction between native English speakers and international students was limited because:

"Communication, I think, is always the biggest problem. People are often too shy to talk, especially non-native English speakers. Native English speakers tend to talk more with each other, which can sometimes create a subtle exclusion or bias. It's not that they don't want to talk to us; it's just that talking might be too exhausting for them, so they'd rather avoid it." (CH-12, Female, PGT)

Clearly, communication in group work is one of the most significant factors affecting teamwork for Chinese students studying at UK universities. The communication challenges they encounter are often due to the diversity within teams. Most of the Chinese respondents were

master's students, and many of the PhD respondents had also completed a master's program at a UK university. Some respondents who had worked in culturally diverse teams remarked:

"From my personal experience, I feel that ideas can be very different across different cultures, and we share and discuss those ideas with each other. Sometimes I might make a mistake with the language, which makes me feel a bit embarrassed, but aside from that, I really enjoy the process of interacting with classmates from different countries, languages, and cultural backgrounds." (CH-28, Female, UG)

"For the whole group, everyone's understanding of a task can offer more choices and a wider perspective on the problem. Then we can discuss it together, sharing different viewpoints. For example, cultural exchange allows you to see a problem from another person's cultural background, which brings new and different insights." (CH-7, Male, PGT)

It is precisely through interactions with students from diverse cultural backgrounds, whether from the same country or different countries, that teamwork enables students to explore and identify their roles within the group. Based on the feedback from the majority of respondents, Chinese students in teams tend to assume supportive, coordinating, or *technical roles*:

"In most team activities, I'm the type of person who first observes what is needed, and then steps in to help. I'm not the kind of person who has to take on a specific role—I'm flexible. I'll watch what others want to do, and if there's a gap somewhere, I step in to fill it." (CH-18, Female, PGR)

"I'm usually more of an executor, not a leader. I'll join in the discussions, but I don't take the dominant role." (CH-16, Male, PGT)

"I typically take on a role similar to a technical provider, doing things like writing or creating something. I'll write things or make a PowerPoint presentation." (CH-22, Female, PGR)

Furthermore, I encouraged the participants to recall and share their past experiences of team activities, as well as to reflect on the roles they tended to carry within teams. The results revealed that students primarily identified with three key roles: team leader, communicator, and task implementer. Among the 23 participants, 52% mentioned that they often served as task implementers, focusing on solving specific technical problems. This preference could be due to the cultural/language barriers that prevent them from communicating freely or taking the lead in a team. Then, 26% identified themselves as communicators, facilitating interactions among team members; and another 26% indicated that they frequently took on the role of team leader. These findings suggest that Chinese students' role preferences within teams are relatively consistent and closely aligned with their individual abilities, personalities and the needs of the team.

4.8.2.2 Chinese students' understanding of the teamwork process

For the process of team development, most Chinese students believed that when participating in team activities, they would first agree on the setting of action goals:

"I think setting goals is the focus of a team because everyone needs to find a common direction to work towards, otherwise it's like an analogy in China, it's a lot of swans pulling a boat, if they're going in different directions the boat can spin in place, if they can find a common direction it can move forward very well, I think so goals are important." (CH-12, Female, PGT)

"The second one I ranked was setting goals because I think if a group co-operation is a headless kind of flying around with no goals and no purpose, they are unable to finish the project no matter how strong they are individually." (CH-14, Female, PGT)

With certain goals in mind, routines of collaborative behaviours in the group would develop, driving student teams to seek out possible collaborative interactions and communication:

"I think when goals are set, for example, every time we have a group meeting to set the requirements, like what we do this week. If the goal is set, our whole advancement will be smoother and more efficient, so I think it's important to set goals ..." (CH-8, Female, PGT)

Expect setting goals, the students also realised that goals are a driving force that can promote collaboration and that having goals forces students to think and behave appropriately as a team:

"Collaborative, people have their own tendency to say what they like to do, and what they don't like to do. When you go into a team it's not possible to say that everything you're assigned to do is what you want to do, it all requires a part of compromise, you can't just look at it from your own point of view, but you have to be considerate and think about the bigger picture, we're all in it for each other. There are times when you may not be doing your favourite thing, but maybe for the sake of the team how is it better, it's connected to the goal, it's about what is it that I need to do if it's for that goal, not that I want to do something." (CH-18, Female, PGR)

Communication, in turn, will be a signal for students to realise that they are beginning to work as a team. In student groups, communication is also being considered as a technical way of establishing teamwork. Communication is a way to make students realise whether it is possible to continue to work with each other, clarifying the difficulties to be overcome and the goals to be reached, and even warn of conflicts:

"Communication is essential. Because a project is more or less difficult when it is done by a single person. This difficulty is a problem for you, but for someone who already understands before, then it may not be a difficulty. While everyone communicates and exchanges ideas then they can talk about the areas they are not good at, and then another person who is good at it can give some guidance." (CH-10, Male, PGT)

"Communication is also very important because everyone has different ideas, and then we need to keep communicating to achieve a better outcome for everyone and put the best result into our project, which is the meaning of teamwork. Whether it's a different schedule, different content in the middle, an innovative idea, or a flashpoint (breaking point), we need to keep communicating to align our schedules and ideas, which is the equivalent of getting the group members to work together." (CH-14, Female, PGT)

For international students, they also realise that communication doesn't have to be about talking, but can be any form of peer interaction to ensure teamwork and co-operation:

"Within teamwork, it doesn't matter what your role is, but you should be able to work with other people and able to do a good, mutual, written or verbal, that kind of a communication exchange, this is important." (CH-15, Female, PGR)

For some participants were comparing cooperativeness and communication, they would tend to think that the two factors were equivalent:

"Collaboration and communication can be a same issue, if everyone has a co-operative mind, we can still get the job done, but I also think communication is more important because if we can communicate well, the team atmosphere will be good, and then if we just have collaboration without communication, although we can get the job get the work done, but I don't feel so comfortable in my heart." (CH-12, Female, PGT)

"Since it's a teamwork, we can't fight alone, so I think communication and co-operation is an interactive process between people." (CH-5, Female, UG)

In addition to the three most important teamwork factors above, student participants gave more diverse interpretations of leadership in a team. For most Chinese students, leadership is indeed an integral part in a group work. However, when it comes to what they understand leadership to be, most of them still refer to a specific persona and more likely someone who fits in well with the team:

"Because from my experience, everyone has their own ideas, they may not want one person to control the whole situation, what we need more is to be put on an equal level and angle to communicate..... I think to have leadership is ok if there's one person who is capable to lead a team, it can play a role as a supervisor." (CH-14, Female, PGT)

"From my experience, the leaders that I prefer are not really the ones that have a strong personality or a strong competence. For example, the kind of leader (I prefer) who is very

capable, but they don't show it on purpose, they don't lead in a forceful way. It's more like they understand the strengths and weaknesses of their team members, and then give them the right tasks, and especially they play a role as a liaison, which is the kind of leader that I like more.” (CH-18, Female, PGR)

There were also some students who suggested that in student groups, leadership or leader is more of an influence and that it is not just one person all the time, but can be rotated among team members depending on the situation:

“Although now there are many forms of leaderless groups, but I think more or less in a team, there is always one or two people play a leading role, here I mean that may not be a very clear image of the leader, but a kind of decision-making power and influence in the moment to drive and give guidance to the direction.” (CH-19, Female, PGT)

“It means that no matter who has what kind of ability, the leaders can be interchangeable, kind of like you can be everyone who has one of these abilities, and at different stages the equivalent of the leader is interchangeable.” (CH-21, Male, PGR)

While conflict resolution and individual professional competence in the six key features were ranked lower by most respondents. For most students, conflict resolution is a relatively rare occurrence at school, so they were unable to give a clear description, but they would like to have the opportunity to learn more about team conflict resolution skills in the future. In terms of individual competence, most students agreed that deficiencies in individual competence in a team can be complementarily enhanced through teamwork:

“Individual professional competence, that is, in teamwork, I don't think it's that important because some people definitely know more or less, the most classic of the team is Journey to the West, there must be a character like Piggy, otherwise the whole team won't be successful.” (CH-10, Male, PGT)

“Individual professional ability, because it is a group, so I think individual professional ability may not seem so important, maybe even if some members have a lack of ability, but other members can help him or teach him to make up for the lack of personal professional ability, or that kind of level of everyone is average, but you can learn together and work together. “(CH-12, Female, PGT)

In addition to the six elements that we selected in the interview questions, there were three other different important factors for teams that were mentioned by the students. To achieve effective student teamwork, members should also maintain an attitude of mutual equality and respect:

“Equality and respect, I think these are important at the beginning of teamwork because some people always want to stand out and think they should be the leader, acting as if they are a level above everyone else. I think this affects the team atmosphere... I feel it's more about giving everyone a chance to contribute their efforts in the team. In the end,

teamwork doesn't necessarily guarantee a successful outcome, but good teamwork should always involve a harmonious and pleasant process. Everyone should gain something from it, and no one should be left out." (CH-19, Female, PGT)

Furthermore, the establishment of an effective organisational structure promotes students' understanding and execution of teamwork:

"For a team to function well, an organisational structure is a key guiding principle. Without it, there's no difference between a team and an individual. So, the organisational structure is at the core of teamwork, and once it's in place, there also needs to be leadership in organising the team and ensuring it runs smoothly under the structure... Task allocation is only one aspect; organizational structure also involves understanding and breaking down the teamwork tasks. It's not just about dividing tasks but refining them." (CH-7, Male, PGT)

Similarly, no matter what kind of team task is to be carried out, there should be a clear system of responsibility and division of labour, otherwise it is likely to lead to free-rider in the team and affect the progress of the team's work:

"My top choice is the system of responsibility. I think this is crucial because if responsibility isn't assigned to individuals, people are less likely to have the initiative or motivation to complete the group work. They might try to rely on others or take shortcuts." (CH-14, Female, PGT)

From the respondents' feedback, it is evident that Chinese students have developed understanding of the effective operation of teamwork and recognise that each key factor is interconnected. Regarding their experience with teamwork in the UK educational environment, they also acknowledged many challenges. While communication is viewed as the most important factor in teamwork, it is also seen as one of the biggest obstacles:

"The most difficult part is probably communication because sometimes the team members aren't familiar with each other. For example, someone on their side might delay something, and without it, you can't continue your part." (CH-13, Male, PGT)

Apart from the communication, it is also a challenge for the students to break the ice before the communication starts or to keep the communication going:

"Another challenge in communication is when you want to initiate a conversation, but the other person is unwilling. That's the most difficult part. Sometimes it feels like you're trying too hard, only to be met with indifference—it's like giving a warm face to a cold shoulder." (CH-17, Male, PGR)

"In terms of the communication, you want to communicate with them but they don't want to communicate with you about it. Or they promise verbally that they will do it, but doesn't actually do it." (CH-23, Female, PGR)

Additional challenges in teamwork perceived by Chinese students include language skills, cultural differences, personalities, attitudes among team members, lack of professional competence, too many ideas from members, unnecessarily rigid processes and fairness.

4.8.2.3 Chinese students' perception of teaching and learning teamwork in Engineering Education

In this section, the interviews attempted to explore questions that required participants to review their teamwork learning experiences in their academic life. Firstly, it was found that most of the interviewees' responses indicated that if they had completed their undergraduate studies in China, they felt that Chinese universities did not emphasise the teaching of teamwork. As one PGT student said as follows:

"In the current (Masters) programme, it will make learning teamwork a mandatory course. In one of our MSc modules, we are required to work as a team. But like the undergraduate we had in China, it doesn't have such a mandatory requirement, and it probably defaults to teamwork being an already known thing for everyone." (CH-8, Female, PGT)

However, for students who came to the UK to study at Master's and Doctoral level, they could clearly feel the requirement for teamwork in their study life, both in the curriculum modules and in the lecturers' personal teaching guidance. It is also helpful for these students to have business strategy and operations related courses in their engineering modules:

"We had an innovation course last year called Strategy Innovation, and then we were looking at the strategies of different companies, their strategies in the marketplace, and then the goals, and then what strategies we were going to set for ourselves to achieve that goal. It was useful." (CH-4, Male, PGT)

"Like the course I was just talking about, it introduced a 4-step approach to setting up a project, and then it was all about what to do at this stage, and then the social ethics and morals to consider, and then the life cycle of business. It's actually quite useful." (CH-10, Male, PGT)

As well as targeted courses dedicated to teamwork, they can help students with little experience of teamwork to better gain basic awareness and skills of teamwork:

"The first lesson introduces you to what a team is. Then in the second lesson are about the roles of teamwork, what types of people are in the team, like what the leader is, etc.

Then in the third lesson you're given a test to assess your abilities, and the lecturer assigns us to the team.” (CH-13, Male, PGT)

In addition to the specific curriculum, teamwork learning guided by the instructor also promotes an understanding of teamwork:

“The teacher would intersperse teamwork workshops or seminars into the content of the module he was teaching. The teacher gave us about five or six questions to answer in groups. The way of grouping was very interesting. Because there were a lot of students, and we normally sat with our friends or familiar people, but he wanted us to separate and talk to different people, so he labelled each student ABCD in order, and then divided them into a group of students sitting together, like group B sitting together, group C sitting together...and then discussing with each other, and encouraging each other.” (CH-28, Female, PGT)

Therefore, on the basis of the students' experience of teaching teamwork, we also invited the respondents to further visualise how they expected to improve the practice of teaching and learning teamwork. Learned from insightful suggestions of the respondents' answers, we can see most of them expect to expand with teamwork practical content that is integrated with our physical world:

“For example, experiencing some very extreme and complex scenarios (related to courses), and then let's try to solve professional and technical problems in this scenario.” (CH-6, Female, PGR)

“I think it's better to take real projects as an example. Our current courses are all assumptions, there's nothing really good about the outputs, it's just an economic analysis or a feeling of whether it can be achieved or not. So to get a better experience of teamwork or project management, I think we should work with an outside company, with a real project, and then give it to different groups to see which group's solution is the best, it can be from any industry.” (CH-10, Male, PGT)

“We can start from the usual life problem or do some field activities, some interesting activities, start from the small things. After all, making a life is everything. Based on the consciousness of life then to reflect the consciousness of academic learning, and then it will make us learn faster of teamwork.” (CH-31, Male, PGT)

Moreover, students mentioned that the magnitude and complexity of projects in engineering disciplines made it imperative to consider teamwork in their studies, and that it could not be ignored:

“Without teamwork, my project would not have worked. Because I don't have the extra budget to buy a very expensive equipment, but it's necessary for the project. So I have to ask someone else and then co-ordinate to work together...Also, some of my ideas

came out of talking to other people, I could talk to other PhD students and other professors, and these processes had a great effect on my growth.” (CH-21, Male, PGR)

In terms of the Chinese engineering students who participated in our study, we also found that they showed a tendency to be more passive and introverted, and were not born with strong social skills:

“With five members in our group, we were all actually rather introverted, and we just contacted each other when we were almost on the deadline of submitting our team's contract form.” (CH-7, Male, PGT)

“I think less people will be more relaxed. If there are more people, everyone's personality is not very outgoing. It would require more communication with each other, which I wouldn't be used to.” (CH-9, Male, PGT)

“The girl I was teamed up with, neither of us had any experience. She's a Brit and then she was sort of introverted and shy. Then I wasn't sort of particularly lively and outgoing as well.” (CH-18, Female, PGR)

On the other hand, considering the language and cultural barriers international students face when they start studying at a UK university for the first time, if they are to be guided with concrete guidance, strategies or demonstrations incorporating hands-on practices rather than a single lecture, which would help them develop a better sense of teamwork:

“I think another way to do it is, especially the students who don't know anything about teamwork, to show them what a better and harmonious teamwork looks like, and there will be a guideline. We cannot come up and get it when everyone doesn't quite know what it's about, or they will be deliberately slacking off. So show them how others do it, like a role model.” (CH-18, Female, PGR)

“It starts with introductions to break the ice, gradually going over what each person is good at, and doing some funny group activities so that everyone can trust each other more. After that, we can have a common topic, and the topic itself is the best way to let everyone play their own strengths, and get everyone involved, then we may slowly transition to the big project.” (CH-21, Male, PGR)

Chinese students also realised that the introduction of teamwork-related teaching and learning at university is necessary for their future career development. Firstly, gaining teamwork experience at university will help them to better integrate into the future workplace:

“In fact, most of the work environment will require soft skills. No matter doing research or work, they may look at your personal abilities and whether your values are a good fit with the company. When you apply for a job in a company, they will test your professional inclination or whether you have the ability to work in a team before they

look at your technical skills through an interview. So for real, teamwork ability is a big part of the job. ” (CH-17, Male, PGR)

“You have the opportunity to get in touch with how team works early, then you will know what is important inside this team, which will definitely be helpful for the future workplace. I would say in the university we're already partially stepping into society and industry, we cannot just learn lifeless knowledge from books. ” (CH-30, Male, PGT)

While, some students still felt that a rational setting is needed to design the teaching and learning about teamwork at the university level to avoid unreasonable workload affecting their learning outcomes:

“There is a not so good situation is that if teamwork has too much influence on our studies or if the score is too heavily weighted on it, it's actually a big burden because it means that the grade you get at the end is not based on your own efforts but on the efforts of other people. ” (CH-14, Female, PGT)

Furthermore, it has always been the view of the students that the teamwork they learnt at university should be combined with real-life workplace scenarios, and there should be a reasonable link between academia and industry:

“I feel that being taught (of teamwork) in the classroom is more inclined to academic, the actual work may be simplified... if you design a programme, the actual work will skip some non-essential steps, whereas in the classroom everything is taught step-by-step. ” (CH-10, Male, PGT)

Undoubtedly, academic learning should, to some extent, prepare students for their future professional roles. Engineering students, in particular, recognise the importance of developing teamwork skills for both their studies and career growth. Although cultural differences between China and the UK may lead to varied understandings of teamwork, most students agree that communication and collaboration skills are essential in any context, as all tasks fundamentally involve interpersonal interactions.

4.9 PGT Students’ feedback on designed teamwork workshop and games (*Wave of Choices* and team role simulations)

This part of the interview study was conducted to gain a more comprehensive understanding of the effectiveness of the implementation of the designed teamwork workshop, and to obtain critical insights of the overall quality of the workshop teaching and learning from the perspective of the student experiencers. The more specific and targeted qualitative data obtained could be a supplement to the quantitative results.

4.9.1 Interviewee respondents

In order to gather PGT students' perceptions in depth after participating in the designed workshop, seven participants were invited to conduct an interview. These students included Chinese (43%), home British (14%) and other international (43%) PGT students. The gender ratio of the participants was male 71: female 29. They were enrolled in the PGT engineering courses at the University of Sheffield during the 2024 - 2025 academic year. The brief profile of the interview respondents is presented in Table 4.20.

Table 4.20 Interviewee profile for participants in teamwork learning interviews

Interviewee ID	Gender	Nationality	Degree programme
ST1	Female	Chinese	Environment and Energy Engineering
ST2	Male	Chinese	Electrical and Electronic Engineering
ST3	Male	Indian	Electrical and Electronic Engineering
ST4	Female	British	Environment and Energy Engineering
ST5	Male	Indonesian	Electrical and Electronic Engineering
ST6	Male	Nigerian	Environment and Energy Engineering
ST7	Male	Chinese	Electrical and Electronic Engineering

4.9.2 Students' insights on improving the design of the workshop and games

This section focuses on gathering feedback from the student participants who experienced the designed teamwork workshop and games. Interviews were conducted one to two weeks after the course had taken place based on students' availability. This ensured that students retained a clearer memory of the content and process of their participation and allowed some time for reflection. All interviews were conducted about 30 minutes. The main purpose of these interviews was to gain a more comprehensive and direct understanding of the participants' real experience of the teamwork workshop. The feedback from these students included both positive and negative comments, whether or not they had gained anything from the course practice, as well as suggestions for improvement from a participant's view.

4.9.2.1 Students' overall perception of the designed team workshop and games

In response to the students' evaluation of the teamwork workshop and games, the interview questions started with their overall feelings about the practical course, and it was clear from

the students' feedback that almost all of them had positive feelings about the game-based practical course. In particular, the unique format of the course was a positive influence on the students' mutual understanding and participation in group work. When students recalled their participation, most of them said:

"For example, like in our class, although we were all sitting together, chatting, and then this was a very joyful thing, so it was really helpful in promoting connections within the group." (ST2)

"I think it is very exciting and I also think that it kind of helps me bond with my team together because it was a bit difficult to communicate with each other before (the class)." (ST5)

"The workshop was actually fun. And it's a gaming form which actually builds a relationship between everyone, (I mean) everyone not just each group but the students of all in the course." (ST6)

Then, in terms of the students' personal feelings, the teamwork workshop and games gave them additional individual and team experiences, such as the students mentioned about the playability of the games:

"I haven't been to a class like this before, I found it quite useful and fun By playing the game in such an accessible way, I just followed the game and I felt quite able to get myself just engaged." (ST1)

"I think the atmosphere is quite good because it's the first time I've been to this kind of event over here and I'm actually quite inclined to take part in this event, and I wish there were more of these courses." (ST2)

"I thought it was quite fun, especially when I first got my hands on this, it is more interesting than other teaching activities." (ST7)

"I would probably say fun because it's something that I don't find a lot (before). I'd say even the undergraduate level of university teaching is an expectation that everything is going to be very dry and very sort of clinical. Whereas it's quite nice to go into a session to be told this isn't assessed. This is just for you to bond with your teammates." (ST4)

The feedback from the PGT students was that the workshop was a refreshing experience for the students and facilitated them to work in groups through a combination of visual presentations, Wooclap quizzes, graphic game elements, and role simulations. There were also some suggestions from the students regarding the integration of these learning elements. They felt that the overall flow and the teaching content should involve more descriptive details, and more consideration for different learning paces of individual students. The current shortcomings in the design of the workshops and games were further clarified by some negative feedback from students:

"I think it was probably at the beginning. It was a bit of a surprise because I am not expecting it to be like this, and the English (materials) wasn't very familiar so I couldn't keep up with the pace at the beginning." (ST1)

"I think it could be a little bit better if a clearer goal was given like tell us we will win a prize, because I am not knowing what the whole goal was, or if you gave a more specific general background of the game story." (ST2)

"I don't think I actually got that point to learn in the session because the teacher was taught on something completely different before, and I didn't really know what he was focusing on before. So if suddenly to join in the activity, it was a bit of difficult, I need more information about what to start with. But then by engaging in the games I understand slowly that everything was about teamwork." (ST7)

From the above points, it can be seen that most of the students' negative feedback came from being unfamiliar with the type of the practical course. Because the majority of the student cohorts enrolled in the course are international students, language proficiency, cultural and personality differences are also issues that need further attention in future lectures. In addition, as the workshop is independently developed and not based on any existing course module, there are some issues with the integration between the previous and the previous programme. It also creates problems with students not being able to adapt.

4.9.2.2 Impact from the workshop and games on students' awareness of teamwork

During the interviews, in addition to seeking feedback from student participants on the effectiveness of the workshop and games, another critical aspect of evaluation was whether

participating in the practice had influenced their awareness of teamwork. Therefore, when analysing students' feedback on this dimension, the focus was primarily on assessing whether students had become aware of the fundamental elements of teamwork, such as collaboration, communication, and decision-making, during the workshop, as well as their perceptions of their own roles in team settings.

According to the students' overall feedback, it is evident that engaging in the workshop and games, through both the game elements and experience, had a certain effect in promoting group-based collaboration. By playing games and solving problems together, and gradually working towards the final game objectives, students developed a deeper understanding of teamwork. However, the extent of this understanding also depended on the participants' prior teamwork experience. For students with limited prior team experience, the interaction within the group undoubtedly provided additional valuable insights:

"This course, I think it emphasised teamwork as the core, so subconsciously, I kept reminding myself not to focus only on myself. I also needed to quickly understand others, their thoughts, and what they were trying to do." (ST1)

"It absolutely does give me a lot of insights honestly, because by participating in workshops like it broadens your horizon in ways to learn about various ideas that you previously don't have a lot of knowledge about." (ST3)

Obviously, for students who have had some prior experience of teamwork, either in their previous studies and in the workplace, participation in such practices can also be a way of reflecting on or reinforcing their own developed sense of teamwork.

"I've done a lot of group work before...I found that it was quite nice to let someone else take the lead for a bit. I am a little bit guilty of trying to take the lead in everything. But what I found is that when I let another member kind of take over for a bit, did actually they'll go all right. Maybe that's something I should try applying to general life as well." (ST4)

"I think teamwork in academia and at work are two different things. I worked for two years in a tech company. From the company's perspective, if you don't do this, you will

definitely suffer losses. But honestly, at university, there might not be such direct results."

(ST7)

Based on these views from such students, it has also made me think further about the applicability of the design to meet the needs of a wider range of people. However, the current framework is primarily aimed at students who lack real-world teamwork experience. This is because the majority of participants in the PGT practical sessions are international students. This group of students' learning is affected by the differences between their own learning styles and the UK teaching methods, which can impact their learning outcomes. Therefore, in addition to deepening students' understanding of teamwork, this course aims to help international students gradually adapt to the UK teaching methods through an accessible approach, such as active collaboration in group work and freely exchanging ideas. This is also reflected in the perspectives of international students:

"This class gave me more opportunities to understand my teammates. It also allowed me to observe how other groups approach teamwork... Because there was a clear goal, everyone was quite proactive in interacting, asking each other what to do and how to do it." (ST1)

"I've been pushing others to participate, because it's probably not good if there's no one in a group to push. We actually have a guy in our group who doesn't participate too much, but I've been urging him on and also because this game goes in a loop, and by going in a loop it prevents someone from being left behind, and then it's a new understanding of teamwork for me." (ST2)

"...the games, it's kind of like reminded me of work in the workplace. There are a different set of people in their own professionals. So it's actually helped me improve learning to meet new sets of people." (ST6)

Undoubtedly, for some of the international students, the language in communication was still a factor that mainly affected their teamwork, but the students did their best to overcome it in their own way:

"The problem is conversational issues most of the time we are facing, but we are still able to converse...The group is like for five members, only me is Indian and rest are

Chinese. Just one Chinese guy understands my English well. He translates whatever I speak in English into Mandarin and so that the others can understand it.” (ST3)

“I think because most of my group members is Chinese, I don't mean any no. But I'm the only non-Chinese member in my group and I did notice that the Chinese students talk in Chinese.... So I have one of my group members who is more fluent in English and helps me translate my words into Chinese. I also notice that most of my team members wanna say something, but it's too difficult to directly express it into English. Language is a bit depressed issue.” (ST5)

Whilst language remains a challenge for many international students studying at UK universities, applying teaching methods that use games and practical activities as a mediating platform may better mitigate communication hesitations and timidity caused by language barriers for these students. Especially for PGT programmes, the teaching and learning period is very limited. If students are unable to adapt quickly to the teaching mode of UK universities, it will undoubtedly have an impact on their academic performance and reduce their motivation to participate in further learning. In addition, with the motivational elements of games, students' interactions and decision-making were not completely limited by how well they express themselves in English, which allowed them to focus more on teamwork. As the students experienced:

"I think it was when moving on the board and considering whether to remove someone else's card. In such moments, if we were close friends, it would be more like a joke to 'take out' the other person and take their cards. But in the groups during this class, it wasn't as straightforward to just take the cards." (ST1)

"The rule that we needed to have nine cards to pass the game that made us think more during playing. Think about the rules, it encouraged us to think more strategically, so we didn't just randomly eliminate or give up." (ST7)

“I think especially on the task at the end of the board game where it got you to put your remaining resources into those boxes. My team massively disagreed on what should go in each box.” (ST4)

It is indeed that just one practice session cannot have an absolute impact on the students' full understanding of teamwork skills, but this framework can be used as an opportunity to guide the PGT students to focus further on the all-round development of their necessary interpersonal skills in addition to their professional knowledge. As mentioned by the following students:

"I think I can still be a leader because I find that I'm still willing to be the one to break the ice when everyone is out of ideas, or silent..." (ST1)

"I've actually been learning how to act more like a leader, but there's always been one issue: I tend to avoid those with poor communication skills and a lack of self-motivation, and I'm unsure how to motivate them. But this time I'm trying to change." (ST2)

"When you start to learn how to work in groups, your brains start to understand various ways of working that you previously couldn't make out." (ST3)

"I realise that everyone in my group is very competent, which is a nice thing. So it showed me that I don't need to try and control every aspect of the thing because the people around me, we can actually can help (each other)." (ST4)

"I think the aspect I learned is listening to my team.... I do notice that having a second opinions does help me." (ST5)

The feedback given by the students is an insightful overview of the effectiveness of the teamwork workshop practice. Although the overall design is not yet perfect, and there are many technical issues that arose in the field practice cannot be ignored, requiring further improvements. However, in sum from the students' experience, the design of the teamwork workshop did facilitate students' learning and thinking about the elements and processes of teamwork to a certain extent.

4.9.2.3 Suggestions for further improvement on the workshop and games

Finally, the last key of this interview study was to gather students' suggestions for improving the design of the practical activities. This is aimed at facilitating iterative optimisation in subsequent design research. Students' improvement suggestions primarily centred on the workshop flow and time allocation, detailed explanations of game objectives and rules, the

design of specific board game cards, and the lack of integration with professional course modules. Regarding the overall process, students commented:

"I feel that when there are specific activities for us to do, time passes very quickly. I even felt that the second part was a bit rushed. If, for example, the course could be split over two days, I think it would be better." (ST1)

"My group members couldn't understand it clearly like how we are supposed to progress in it at the beginning. Actually we asked our GTAs. He gave us a rough idea." (ST3)

Concerning the specific design of the board game, students provided inspiring suggestions based on their experiences to further enhance the playability and engagement of the game:

"Given a background and a goal, such as surviving for a certain number of days, and then encountering various challenges along the way. For example, by the fifth round, you could introduce an additional scenario to re-engage everyone, as attention tends to drift over time." (ST2)

"Let us to play it twice, maybe like the first is to practice it, then the second time to know it better. But change the items." (ST6)

"If there are more people playing the game, the number of cards might need to be increased. Otherwise, it's easy to run out the cards by the end... For example, I might pick up a sextant, but I've never used one before, and I don't know how it works. My first reaction would be to look up what it's for. Having a more detailed explanation of the item's purpose would be better." (ST7)

Finally, all students also expressed their anticipation and willingness to participate in more similar teamwork practices in the future. This certainly reaffirms the effectiveness of the current teamwork workshop design and suggests that it has the potential for wider application in disciplines that emphasise and require the use of teamwork skills. It can stand as a viable and effective approach to helping students develop and understand teamwork effectively in an inclusive and easy-accessible format.

Part II summary

The qualitative interview data in this part was been viewed as a complementary strand that enhances and validates the findings drawn from quantitative surveys and classroom observations. The first set of interviews, which explored Chinese engineering students' perceptions and experiences of teamwork learning, provided deeper insights into how they make sense of collaboration in the UK higher educational context, while also supporting the patterns performed and observed in previous studies. This directly reinforces RQ 3 by contextualising teamwork learning and engagement within these students' lived experiences. The second set of interviews, which evaluated the effectiveness of the gamified teamwork workshops, offered interpretive evidence that supplements the questionnaire findings and captures nuanced aspects of students' perceived skill development. In this way, the interviews substantively contribute to RQ 4 by illustrating how pedagogical innovation can influence teamwork awareness and practice. In sum, these qualitative findings not only substantiate the quantitative results but also enrich the overall explanatory power of the study, thereby ensuring a more holistic response to its research aims.

4.10 Chapter summary

This chapter presents a comprehensive analysis of the learning experiences and teamwork perceptions of international PGT engineering students in the UK. It synthesises both quantitative and qualitative findings, attempting to offer insights into students' expectations, learning behaviours, and teamwork engagement. In the following chapters 5-7, the results corresponding to each of the research questions posed in the study will be interpreted in order to further draw valuable conclusions.

CHAPTER 5: ANALYSIS & DISCUSSION for RQ 1 & 2: Chinese Students' Perspectives on Their Studies in UK Universities

5.0 Introduction

This chapter focuses on the first research question: “What are Chinese students' learning expectations in UK higher education?” and the second research question: “What are the learning behaviours of Chinese students studying in UK engineering practical courses?”, combined with the data presented in the previous chapter sections 4.1 to 4.4 of the previous chapter, provide a comprehensive discussion of the learning behaviours, characteristics and preferences of international taught postgraduate students (PGTs) studying at UK universities. In particular, the learning behaviours of Chinese engineering students are reviewed.

5.1 Key findings of the Chinese students' expectation survey on investigating the perspective of their learning experience at the University of Sheffield

The purpose of education is to facilitate the enhancement of individuals' skills or cognition, thereby promoting personal development. Such development not only contributes to the transmission of existing knowledge but also enables innovative exploration on the basis of what is already known. In primary education, the focus is more on the construction of a fundamental cognitive framework for individuals. In higher education, however, teaching objectives should be more flexible: while expanding personal cognition and knowledge is essential, it is equally important to cultivate independent and collaborative learning skills. This is because, after completing their studies, individuals will enter society and become active participants within it. For society as a whole, education ensures the continuity of knowledge systems while providing a constant driving force for social development. For individuals, education not only offers a platform to access vast amounts of existing knowledge but also equips them with a life-long development competency to adapt to a changing world. Therefore, as the primary participants in education, students' expectations of education stem from the ideal goals that education aims to achieve.

In this study, data on the expectations of first-year Chinese students at the University of Sheffield about their current university studies and future development after graduation were collected through a questionnaire survey. Chinese students studying in UK universities were

chosen not only because of its increasing numbers in recent years but also in an attempt to re-examine the quality of the UK university education system and its potential limitations and challenges from the perspective of a non-mainstream student group.

Firstly, in terms of why Chinese students choose to study at UK universities, it is evident that more Chinese students now consider their interests when deciding to study in the UK, whereas they prioritised university rankings or locations (Cheng & Agyeiwaah, 2022; Counsell, 2011; Dearden et al., 2019; Xiang & Shen, 2009). Combined with an interest in subjects, Chinese students can learn with high motivation and engagement, which may drive more self-determined learning participation and input. From this point, it can be inferred that when students choose a major based on their personal interests, it indicates that they already possess a certain level of understanding of the field, rather than relying solely on ratings or recommendations from established teaching quality evaluation systems (e.g., QS rankings, Times Higher Education rankings, etc.). This also suggests, on the other hand, that Chinese students have certain expectations regarding the quality of teaching in their chosen courses before they begin their studies. Thus if, after starting their courses, students find that the actual teaching content and methods fail to meet their expectations, their motivation to learn will gradually diminish, and their engagement in exploring the subject will decrease. Of course, for a small number of students with exceptionally strong self-directed learning abilities, external teaching models may not significantly impact their motivation. However, for the majority of Chinese students who may have chosen a field of study only out of temporary interest, maintaining their learning motivation requires more effective and inclusive pedagogical guidance.

In addition, Chinese students also felt that it would be best to choose a programme that would bridge their previous studies (this was mainly the case for students choosing a PGT programme) and provide better career prospects. These factors also became important for students in deciding where and what to study. Meanwhile, the resources and promotions offered by educational agencies in China had a certain influence on students' decision to study abroad. Obviously, Chinese students overwhelmingly prefer the services of study abroad agents when choosing to study abroad, as they consider that agencies can provide more comprehensive information about universities and professional advice on choosing courses (EOL, 2016; Yang & Hu, 2016). But where agencies have partnerships with certain UK

universities, this may lead to students being deliberately guided by the agent when making their decision to study abroad and invisibly affect their expectations (Baker, 2021; Yang et al., 2022). This reliance on educational institutions also reflects a broader trend in Chinese students' decision-making process in deciding whether to study abroad or not, which is ultimately driven by their pursuit of academic and professional development.

This reliance on agency guidance and decision support is closely linked to the overall educational aspirations of Chinese students. Their motivations for studying abroad are deeply rooted in traditional academic values and career-oriented goals, which shape their expectations and experiences in foreign education systems. For Chinese student, whether they choose to study abroad or stay in their home country, the primary goal of learning is to enhance their professional knowledge and skills. This is because it is an asset for them to achieve success in their careers in the future. Most of the responses in the survey study expressed their desire to improve their academic performance by studying in the UK universities. In traditional Chinese education, there has always been a strong emphasis on academic performance and examination results (Brown & Gao, 2015; Davey et al., 2007; Hannum et al., 2011; Qian & Walker, 2011). Therefore, regardless of where they are studying, the primary expectation for most Chinese is to achieve good academic grades. Because of the influence of traditional Chinese culture and education, obtaining high scores generally means better development opportunities and resources (Tsegay & Ashraf, 2015; Tsegay & Ashraf, 2016). Apart from academic achievements, as Chinese students studying abroad, improving their English language skills also remains one of their top academic priorities to consider (Zhai & Cao, 2022). This is not only due to the fact that English proficiency is required to study at UK universities, but also probably because in many Chinese and multinational corporations, English is considered a basic employment requirement (Huang & Turner, 2018, Zhao & Cox, 2022). Also in the survey it was found that in addition to academic and career development, they also have expectations of establishing personal relationships and focusing on well-being and interests while studying. The responses in this aspect were surprising, and suggested that modern students' perceptions of self-development are not limited to stereotypical academic or professional accomplishments, but are beginning to emphasise the holistic development of the "human being."

Beyond striving for academic excellence and career readiness, Chinese students also recognise the importance of broader personal and social development during their studies in the UK. In students' view, the most direct expectation of academic learning is the academic performance and outcome. However, if students are judged only by their grades, this does not really give a full picture of their competencies. Hence, more and more students are beginning to realise that apart from classroom learning, they need to enhance their overall performances through other means to be better equipped for future academic and career challenges. In the UK, universities usually offer training and enhancement courses, seminars or workshops to enhance students' academic skills and employability. For Chinese students, choosing to participate in extracurricular activities related to their degree programmes was an extra approach they perceived to improve their academic performance. Among various extracurricular activities, academic writing, professional skills, and career training were the ones that most Chinese students were interested in getting involved. Obviously, engaging in academic writing courses can have a significant impact on the student's academic abilities. Through writing exercises, students can gradually develop critical thinking and logical reasoning skills for writing scientific papers, which are lacking in Chinese high schools and higher education (Pan, 2019; Zhang et al., 2011). Participating in such academic and professional skills training events can also help students better adapt to the challenges of the real world and reinforce the knowledge learned from textbooks through practice and application. Moreover, students' abilities in analysis, problem-solving, teamwork, leadership, and communication can be boosted via participating in employability training., preparing them to be competent in the labour market.

In parallel to looking forward to engaging in academic activities, Chinese students also indicated a willingness to experience local social events. These activities can provide opportunities for international students to interact with local people and communities, helping them broaden their horizons, enhance cross-cultural understanding, and improve communication skills. Through appropriate involvement in social networking, students can further gain confidence in time management and organisational strategies to achieve a balance between academics and personal life, which would be beneficial to their physical and mental health while studying abroad.

Finally, in regard to the expectations upon completion of their UK studies, the number of Chinese students expecting to return to China to work after graduation was almost doubled compared to those who wanted to find work in the UK or continue their academic pursuits. The differences in expectation can further reflect the Chinese students' attention, confidence and identification with the recent socio-economic development of their own country. China has made tremendous economic and social progress in the past few decades, and its status and influence on the global stage continue to rise. Therefore, more Chinese students believed that China can provide more career and development opportunities to achieve their career goals. Besides, for many Chinese students, obtaining a degree from a UK university is one of the most important qualifications for their future career development in China (Tsegay & Ashraf, 2015; Pires & Duarte, 2019). Moreover, according to the statistics of China's domestic job market in recent years, the proportion of students returning to China after studying in the UK in 2022 for example is 41.4 %, which is the highest proportion among the US, UK, and Australia (ZhaopinLtd, 2023).. Furthermore, returning and working in China also allows students to maintain a stronger connection with their family and cultural background. It can be seen that a clearer and more definite understanding of their own life planning and personal desires among Chinese students.

In short, Chinese students' main and immediate expectation of studying in the UK is finding a job after completing their studies. However, in reality, obtaining an academic degree doesn't mean to secure a job position. The desire to secure a good job motivates students to make choices in their studies that favour the development of employability. However, in most higher education institutions, the cultivation of students' human-centred skills within existing curricula is often limited (Bishop, 2017; Padhi et al., 2022; Querol-Julián & Díez-Ramírez, 2021; Caggiano et al., 2020; Vykhliaiev et al., 2022). In modern society, a student's employability is not solely defined by academic performance. With the continuous advancement of technology, individual learning and development have become more diversified, extending beyond the confines of the classroom. Thus, the development of society and enterprises requires talents with human-centred skills beyond hard academic competencies. Comprehensive personal development is not merely about meeting the demands of potential employers but also about cultivating stronger adaptability and transferable skills to navigate unpredictable career trajectories.

The key findings from the expectation survey in the study are visualised in Figure 5.1 below.

Chinese Student Learning Expectations at the UK universities



The infographic presents the key results and findings from the survey of Chinese student learning expectations in Sheffield.

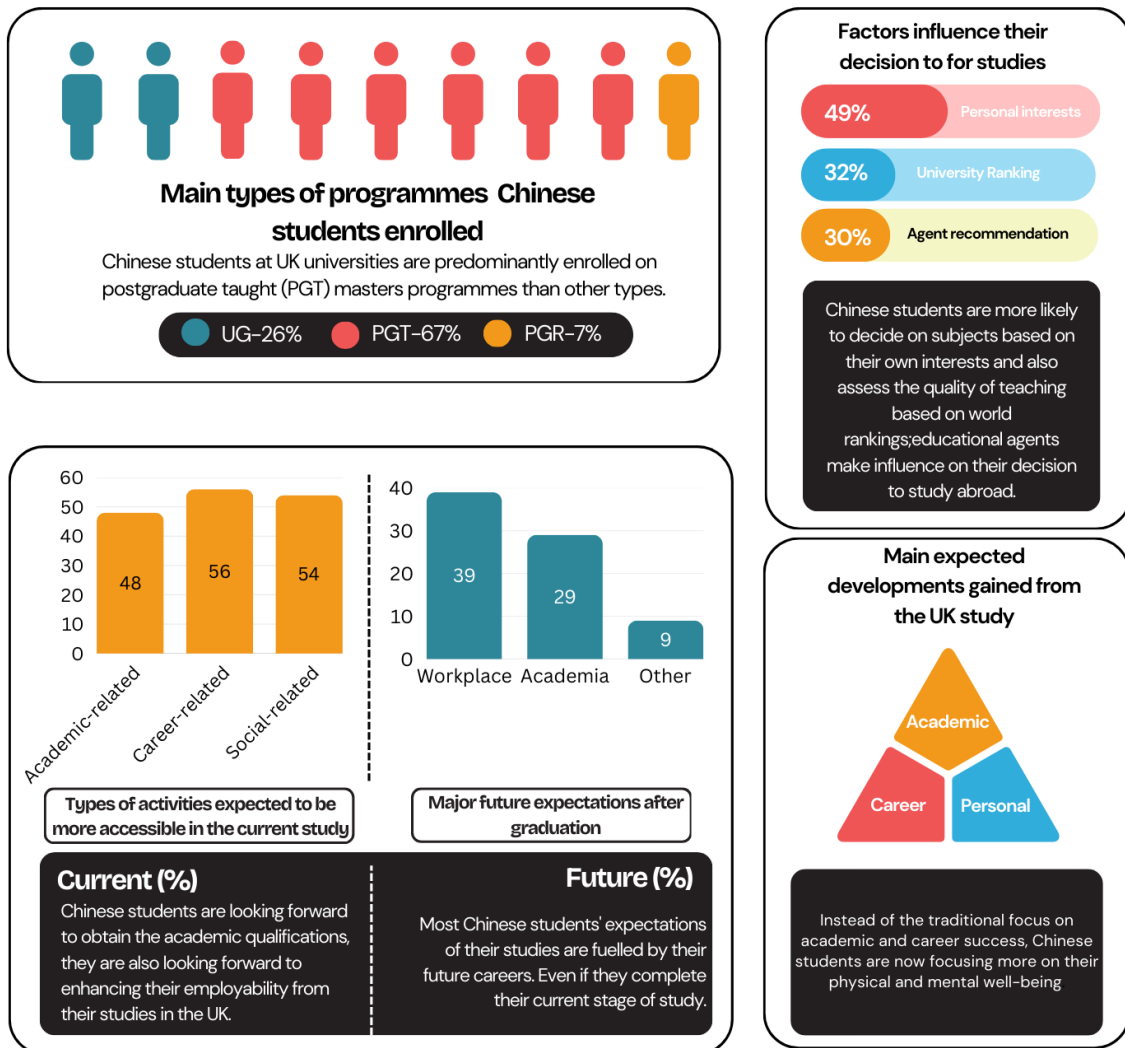


Figure 5.1 Chinese student expectations of their studies in the UK.

5.2 Key findings from classroom observations of Chinese students' learning in lab-based engineering courses

5.2.1 Observed learning behaviours of Chinese students

After understanding Chinese students' expectations of studying at a UK university, this section discusses the observed behaviour of Chinese students in real classrooms. The observations,

combined with the post-lab feedback forms, not only further clarified the students' behaviours and characteristics during the course, but also helped instructors to reflect on the dynamics and culture of the course that support active learning methodologies (Shahid et al., 2022; Van Beek & McCahan, 2021; Sølvik & Glenna, 2021).

Firstly, the observed learning performance of Chinese PGT students shows that the language barrier (English language proficiency) remains the main challenge they face and have to overcome. There has been an ongoing debate about the English language skills of international students studying at UK universities (Chew & Chen, 2021; Wang et al., 2018; Hanifa, 2018). Although they are required to provide proof of language proficiency qualification such as the International English Language Testing System (IELTS) test, before entering a UK university, passing such a general English language proficiency test may not fully represent that an overseas student has the academic English skills to conduct professional learning and research in academia (Clark & Yu, 2020; Quan & Reilly, 2024; Liu, 2012). Based on classroom observation, the reality is that the English level of Chinese students participating in practical labs varies significantly. For instance, some students were able to express themselves to the instructor and UK counterparts fluently in English, but some remained hesitant to answer a simple question like "Can you tell us what you have completed for the pre-lab activity?" Such hesitation in answering simple questions and participating in classroom interactions may stem from anxiety caused by unfamiliarity with the teaching environment and methods (Chiu, 2014; Frith et al., 2022; Wang, 2023). Through post-class conversations with some Chinese students, it is evident that they find the teaching model in UK universities unfamiliar. Moreover, they did not participate in any preparatory courses designed to help them adapt to the UK teaching approach before starting their studies (Quan & Reilly, 2024). This unfamiliarity, combined with limited language proficiency, further restricts their engagement in the classroom.

Limited language proficiency not only hinders interaction between students and instructors but also restricts communication between Chinese students and their non-Chinese peers. In practical courses, interactions among participants significantly influence the final learning outcomes (Gormally, 2017; Wei et al., 2018). Observations suggest that in courses with a high proportion of international students, interactions depend not only on language ability but also on whether students possess strategic skills for collaboration. For instance, some Chinese

students actively attempt to communicate with others in English or sought opportunities to communicate with their UK teachers despite limited English fluency, even if they were assigned to a group composed entirely of Chinese students. In an English language teaching and learning environment, fluent language skills positively enhance the effectiveness of team-based practical learning to some extent, but they may not be considered as the conclusive factor hindering learning outcomes. However, if individuals possess strong teamwork, communication, and interaction skills (e.g., mutual support among team members), their learning could also be improved gradually through team interaction. Therefore, this highlights the necessity of emphasising the cultivation of key human-centred skills such as teamwork in higher education.

It is well known that individuals need to interact with others daily in society; this does not mean they naturally develop the ability to work effectively and collaboratively with others. As for the instructors, students' limited English proficiency and interaction may restrict the ability to teach complex concepts and conduct technically specialised discussions to students. Students may also struggle with the progress of the course delivery due to the inability to accurately articulate their questions, which can lead to further attainment gaps, affecting classroom engagement and the learning experience, and ultimately lowering the effectiveness of the teaching and learning. Affected teaching and learning efficiency means that they may not be able to reach the full UK university programme requirements (Nightingale et al., 2022; Nortcliffe et al., 2019; Dai, 2023). Additionally, most Chinese students come to UK universities to pursue one-year master's programmes. One of the main reasons these UK PGT degree programmes attract Chinese students is their short duration. However, this advantage can also become a disadvantage, affecting students' learning outcomes if educators fail to create supportive and inclusive environments to enhance the learning experience. To help international students better adapt to the teaching practices of UK universities within a limited time, educators must not only teach and guide students to learn and practise the corresponding knowledge and skills but also flexibly adapt teaching methods and design more suitable strategies based on students' characteristics. For example, as proposed in this study, incorporating team-based interactive activities and tasks, clarifying the responsibilities of each group member, and implementing tiered teaching through easily understandable phased tasks to enrich students' practical experience.

Thus, to help students improve their practical learning outcomes, it is essential for instructors to provide clear learning guidelines and identify achievable learning objectives in teaching. This is because the proactive teaching behaviours of instructors significantly impact classroom learning outcomes (Van Beek & McCahan, 2021; Zhang et al., 2022). Also through rational design and effective use of instructional resources can affect students' participation and engagement in the classroom (Shahid et al., 2022; Sølviik & Glenna, 2021; Chen, 2022). Furthermore, students' learning outcomes are further collected and analysed through post-class feedback forms (Pokorny et al., 2010; He et al., 2024). Therefore, in the practice and development of experimental courses, effective strategies to promote student engagement can be further refined and implemented based on different students' learning demands, as illustrated in Figure 5.2.

Observed PGT students' learning in the lab course and future teaching improvements

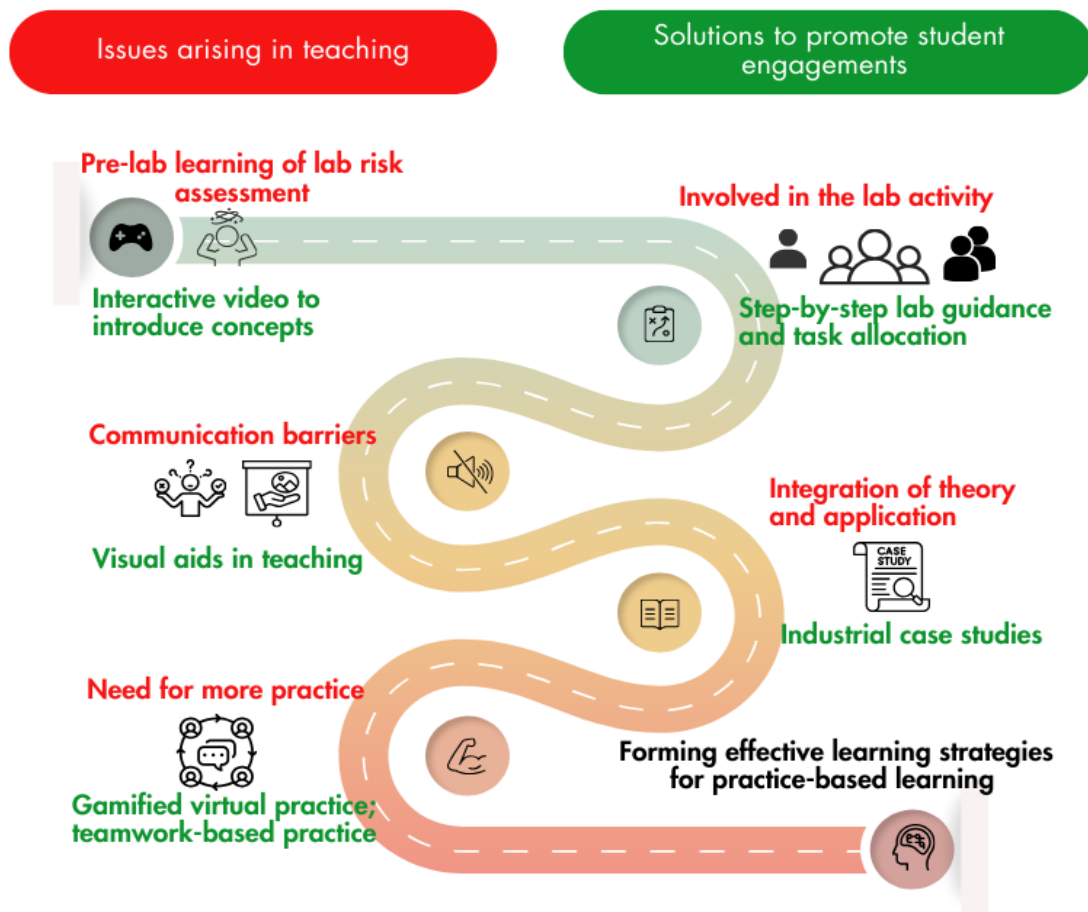


Figure 5.2 Learning and teaching in the PGT lab course.

5.2.2 Students' feedback on the learning outcome of the lab course

Through a comprehensive analysis of students' post-class feedback, both a deeper recognition of PGT students' learning and a more detailed understanding of the current shortcomings in experimental teaching and potential areas for improvement were investigated. Overall, students' feedback on this experimental course primarily falls into three key areas: (1) the need for hands-on learning with actual equipment and tools (including teamwork); (2) the assessment of risks in practical engineering operations; and (3) the integration of theory and practice to enhance understanding and facilitate future professional applications.

Over the three-year observation, a clear shift has been observed in students' learning demands for practical engagement, from a focus on quantity (e.g., increasing the number of laboratory hours) to an emphasis on quality (e.g., mastering the operation and application of advanced derivative equipment). This shift indicates that students are no longer solely seeking opportunities for experimentation but are increasingly focused on developing a deeper understanding of relevant technical skills. Additionally, this trend may reflect the continuous improvement of teaching practices, enabling students to move beyond merely completing coursework and be more likely to correlate theoretical attempts with practical applications. Therefore, in future teaching practice, attempts will be made to incorporate additional equipment operation modules that could further support students' skill development and help bridge the gap between theoretical knowledge and practical application (Wang et al., 2023; Puffelen et al., 2018; Nadeem & Mahgoub, 2014).

Another noteworthy finding is the emphasis on teamwork skills, as suggested by the student groups themselves. This phenomenon suggests that the practical-based learning approach provides students with more opportunities for team-based practical engagement, not only aiding in their acquisition of technical knowledge but also fostering a deeper understanding of their peers. In addition, the emphasis on teamwork allows students to take advantage of the collective classroom environment and start with simple tasks to develop and shape their own teamwork styles and sharing of responsibility. Therefore, future practical-based teaching can place greater emphasis on team-based problem-solving and task allocation to encourage peer interaction, critical thinking, and communication skills, thereby fostering a more

dynamic learning environment and a culture of continuous learning development (Scheepers et al., 2018; Herrman et al., 2022; Deressa et al., 2022).

Then, the awareness of risk assessment is taught annually in the course. The emphasis on this aspect in teaching is not only reflected in the learning materials but also revisited through interactive discussions during practical sessions. The combination of students' pre-class preparation and on-site teaching forms a concrete approach to integrating theory with practice. Feedback results show that the proportion of students who recognise and remember this learning content is increasing annually. This is likely due not only to students' deeper engagement with the course materials but also to the inclusion of real-world industrial application cases explained by instructors. By combining real cases with explanations of laboratory equipment and environments, students gain a better understanding of the importance of risk assessment (Álvarez-Chávez et al., 2019; Camel et al., 2020). In future teaching practices, it is planned to help students familiarise themselves with risk assessment of laboratory operations and the use of relevant detection technology in a controlled setting through interactive videos.

Finally, the integration of theory with practical technical tool operation has always been a core focus for students. Their feedback in this area has gradually shifted from “general application” to “precise mastery”. This shift reflects modern students' expectations for learning, which have moved beyond mere understanding to a desire for opportunities to apply and develop their knowledge in practice. This trend suggests the need for tiered teaching in future courses, such as embedding corporate case studies to strengthen the connection between theory and practical engineering applications. By incorporating industry-related scenarios, students can gain a deeper understanding of how technical skills are applied in professional environments, which not only enhances their comprehension of technical knowledge but also boosts their motivation and career readiness (Turner, 2012; Bilgin et al., 2015; Tomasik et al., 2014).

5.3 Key findings of the learning ability (working memory capacity) of Chinese students in engineering courses

5.3.1 Does working memory capacity affect Chinese students' learning in English?

In this study, the Math-Item-Sequence (MIS) scores of Chinese students in Chinese (CN) and English (EN) Ospan tasks were explored to investigate the differences in their working memory across different language environments. Although individual data analysis revealed a certain difference in MIS scores between the two language environments (L1: 0.61 vs. L2: 0.54), this difference was not statistically significant ($p = 0.49$). This may be caused by the small sample size and the lack of control over participants' English proficiency.

Overall, the Ospan experiment results indicate no significant difference in the working memory capacity of Chinese students when memorising content in Chinese versus English. Previous research suggests that recall tasks in a second language (L2) typically place higher demands on working memory, as individuals require additional phonological conversion processes when processing L2, which may affect the efficiency of information storage (Miyake & Friedman, 2013). However, the results of this study show that although the MIS scores for EN tasks were slightly lower than those for CN tasks, this effect may not be significant. This could be because participants have studied and lived in UK universities for some time, achieving a certain level of English proficiency, thereby reducing the cognitive load of language switching.

Additionally, according to cognitive load theory, individuals may need to allocate more cognitive resources to semantic and syntactic processing in L2 tasks, which could also affect their working memory performance (Sweller et al., 2011). However, for Chinese students studying at UK universities, immersive methods such as attending technical courses and participating in various activities have improved their English proficiency. Particularly for PGR students, who have spent a longer time studying and living in the UK, the cognitive load of using English is less impactful, resulting in generally higher performance in EN tasks compared to PGT students. This aligns with previous research indicating that individuals with higher L2 proficiency typically perform better in working memory tasks than those with lower proficiency (Linck et al., 2009). However, since this WM experiment did not control for participants' L2 proficiency (e.g., by classifying participants using standardised tests such as

IELTS or TOEFL), variations in English proficiency among participants may have reduced the differences in MIS scores, thereby affecting the overall significance of the analysis results.

Beyond the potential differences in individual cognitive abilities among the Chinese students participating in the study, another possible influencing factor is their learning environment. For international students studying in UK universities using English, the load on working memory may affect their storage and comprehension of information (Brehmer et al., 2012). This is because they may require additional cognitive resources to interpret instructors' explanations, thereby reducing the cognitive resources available for note-taking or problem-solving. Therefore, comparisons based solely on individual physiological functions in the experiment may not accurately reflect changes in the learning abilities of Chinese students in an English-taught environment. Additionally, past research has found that the impact of L2 load may be more pronounced in STEM courses, as these subjects often require simultaneous processing of linguistic and symbolic information (Paas & Sweller, 2012). Therefore, in the subsequent instructional design of this study, more visually-based information displays (e.g., images, diagrams) were incorporated and combined with gamified teaching methods, attempting to reduce language load and enhance the utilisation of cognitive resources among international students during learning.

To summarise, based on the experimental results of working memory capacity tests conducted on Chinese students, their working memory capacity does not appear to be significantly affected by language switching. This may be attributed to their improved English proficiency through their study experiences at UK universities. It can be inferred that the introduction of more inclusive and supportive instructional designs in teaching could further enhance these students' learning outcomes in skills that are not directly influenced by language.

5.3.2 Chinese students' learning preferences in UK universities

Based on the previous findings, the influence of English language proficiency on Chinese students' learning in UK universities can be provisionally excluded in this study. This suggests that individual cognitive efficiency may not solely depend on the immediate capacity of

working memory but is also closely linked to long-term learning habits. For instance, it is similar to the relationship between hardware and software in computing, where working memory functions as the "hardware" of cognition, whereas learning habits serve as the "software." To achieve optimal learning outcomes, both the immediacy of working memory and the long-term nature of learning habits should be considered in the development of teaching and learning to ensure a complementary effect.

In this study on learning behaviours, most Chinese participants were postgraduate students or above, suggesting that they have likely developed relatively stable learning preferences through their prior academic experiences. Furthermore, the majority of them had an international education background, indicating a degree of familiarity with Western educational systems. This may have further facilitated the development of a blended learning approach during their studies at UK universities, making them more receptive to diverse teaching methods.

Regarding study engagement, the findings reveal that 50% of students dedicated between 5 and 15 hours per week to independent learning. However, their academic performance feedback showed that 60% of students scored within the mid-range (60–69%). This result challenges the common assumption that study time and academic performance exhibit a linear positive correlation. The observed discrepancy may be attributed to variations in learning efficiency. For Chinese students studying at UK universities, academic achievement cannot simply be assessed based on study hours alone. Chinese students often encounter language barriers (e.g., 65% identified language and communication as their greatest challenges) or may employ ineffective learning strategies (predominantly by individual study), which hinder the conversion of study time into tangible academic outcomes. Additionally, among students who reported studying for more than 20 hours per week (20% of respondents), their grades did not significantly surpass those in the mid-range category. This could be due to excessive but ineffective study efforts leading to fatigue or cognitive overload (Kirschner et al., 2018). These findings further suggest that, beyond simply acquiring technical knowledge, international students may benefit more from learning and applying effective study strategies, such as scientific time management and collaborative learning, to enhance their academic performance.

Undoubtedly, for international students, the fluency of English significantly impacts their learning engagement, but it is not always the critical factor to determine their final learning outcomes. In all aspects of English—listening, speaking, reading, and writing—Chinese students generally report insufficient proficiency. Although 80% of Chinese students highly recognise the importance of English proficiency in their studies, in practice, 45% rate their listening comprehension as only 7/10 (moderate level), and 50% still rely on artificial intelligence (AI) and translation tools for writing and reading assistance. This phenomenon aligns with the “instrumental motivation” theory (Gardner & Lambert, 1972), which suggests that students may over-rely on supporting tools (e.g., AI and translation software) for utilitarian short-term goals (such as passing exams), neglecting the development of deeper language skills. Such reliance on tools may mask the genuine language deficiencies of Chinese students and weaken their active mastery of grammatical rules and academic expression (Hyland, 2016). Particularly for engineering students, who also need to learn and familiarise themselves with interdisciplinary terminology, this complexity exceeds the scope of general English training and may result in their feeling overwhelmed in professional scenarios.

Then, in terms of learning methods and practices, 60% of Chinese students prefer visual and auditory methods for recalling information. This preference aligns with the dual-coding theory (Paivio & Clark, 2006)—the synergistic encoding of visual and linguistic systems enhances information storage efficiency. When learning new knowledge, 50% of Chinese students prefer independent study, while 40% choose to acquire information through collaboration and communication with others. This suggests that Chinese students' learning patterns remain predominantly independent. Thus, when engaging in complex learning and practical tasks, visual memory and independent execution may be Chinese students' primary learning strategies, but they will also seek external support to strengthen cognition if they have enough resources to do so (on average, 44% of students seek advice from experienced individuals). Seeking external support indicates that, in unfamiliar learning environments, collaborative learning can promote deeper understanding of information (Vygotsky, 1978). This not only enhances learning outcomes but also helps Chinese students explore and develop effective and diverse learning strategies in unfamiliar environment.

The overall analysis of Chinese students' learning behavioural preferences highlights that UK universities may currently be inadequate in meeting the learning needs of international students. Existing teaching strategies may not be effective in bridging the gap between teaching and learning experienced by Chinese student cohort. For example, for international students, participating in English language training courses undoubtedly helps improve their academic English proficiency. However, most courses continue to separate language training from subject-specific learning, making it difficult for students to transfer their language skills to contexts that correspond to their technical programmes. For instance, engineering students must comprehend and apply numerous technical formulas and process diagrams, yet they may struggle to articulate their complex ideas clearly in English. Furthermore, it is also worth noting that with the rapid advancement of technology, the use of AI tools in education has become inevitable. In future education, AI should be positioned as a "collaborative partner" rather than a "replacement." Thus, guiding students to use and engage with these technical tools critically could be a more important focus in teaching practice.

In summary, the relationship between Chinese students' academic engagement and their performance at UK universities is influenced by factors originating from themselves and the educational environment. For Chinese students, their current learning difficulties at UK universities fundamentally reflect a conflict between instrumental and competence rationality. In order to fulfil the academic requirements in UK universities, Chinese students tend to rely on short-term study aid tools to solve their immediate needs, such as completing assignments, while neglecting the deeper development of metacognitive learning skills. This makes it impossible to reconcile the gap between their learning styles and the teaching modes in UK universities. Ultimately, they are unable to achieve the desired learning outcomes. Therefore, from an educational point of view, to help these students to change or develop more effective learning patterns or overcome potential "adaptation lags", it is more important to optimise the interplay between learning efficiency, language competence, and targeted practice design. By implementing inclusive pedagogical measures to ensure that students' learning inputs can be translated effectively into actual achievement as much as possible.

In summary of the key points of Chinese student's learning behaviours, a visual representation of Chinese students' learning behaviour tendencies in UK universities, refers to Figure 5.3.



Figure 5.3 Chinese students' learning preferences. Key findings from the learning preference survey are summarised in the five dimensions

5.4 Chapter summary

In this chapter, the research data on learning expectations and behaviours of Chinese students studying in UK universities are analysed in an attempt to describe and reflect the characteristics of Chinese student learning. The findings can provide references for the subsequent design of teaching practices to facilitate the learning experience of these international students. While the small sample size inevitably limits the generalisability of

these findings, their exploratory nature can still provide valuable insights into Chinese students' learning expectations and behaviours in UK engineering education. The data reveal emerging trends in their study orientations, classroom engagement, and language-related challenges, which directly address RQ 1 and 2. More importantly, these findings serve as a necessary foundation for the subsequent investigations in this study, including the qualitative exploration of teamwork experiences and the evaluation of game-based interventions. Thus, although the validity and reliability cannot be extended to broader populations at this stage, the findings nonetheless offer indicative evidence that informs both the interpretation of later results and the design of future research with larger and more diverse samples.

CHAPTER 6: ANALYSIS & DISCUSSION for RQ 3: Chinese Students' Perception of Teamwork in Engineering Education

6.0 Introduction

This chapter builds on the data from previous chapter sections 4.5.1 and 4.8 to address the third research question, “How do Chinese students perform and experience teamwork in UK engineering courses?” It aims to reveal the potential behavioural characteristics and perceptions of teamwork in team-based teaching and learning activities among the Chinese student population studying in UK universities. The students' perspectives are also provided to identify the current status and problems of human-centred skills teaching and development in engineering education practice.

6.1 Key findings of the surveys on PGT students' learning of teamwork within the postgraduate taught engineering teamwork-based workshop

In the engineering industry, human-centred skills such as teamwork are essential employability attributes for graduates. Therefore, by applying team dynamic theories such as the Belbin team roles and integrating them into project design-focused engineering workshops, students can deepen their understanding and development of teamwork and collaboration skills while applying technical knowledge in practice. Additionally, as problem/project-based learning (PBL and PjBL) methods are increasingly used in engineering education, students' learning patterns become more based on team-based learning and research (Barrows & Tamblyn, 1980; Larmer & Mergendoller, 2015; Evensen & Hmelo-Silver, 2000).

Past research findings indicate that incorporating Belbin team roles into teaching can, to some extent, enhance students' performance and participation in group work (Zarzu et al., 2013; Aranzabal et al., 2022). But in this study, the implementation of the Belbin theory did not fully achieve its intended outcomes to support Chinese students further clarify their adaptability to their team roles and how they could develop further. This may be due to insufficient teaching resources and untimely feedback during the initial attempts, which resulted in students losing motivation and clarity of purpose during the co-operation process, hindering

deeper engagement and interaction between team members. In addition, classroom observations and post-course feedback revealed that there were challenges in fully understanding and practising Belbin's team theory for students enrolled in the one-year PGT programme. If Belbin's theory is to be utilised to help engineering students improve their team skills, a step-by-step introduction to the theory needs to be developed in the curriculum. However, this requires more lecture planning, staff work load and teaching resources, which is certainly challenging for a programme with a limited teaching period. This situation also reflects a wider dilemma for the teaching of human-centred skills in engineering programmes, which is also true for other professional programmes: although the need for these skills has been emphasised in the teaching objectives, there is still a lack of effective ways of integrating them into the teaching of technical knowledge in practice.

In this exploratory game-based teamwork workshop teaching, another key research focus was understanding the potential teamwork performance of engineering students in team/practical-based learning. From student feedback on awareness of their team roles, it is evident that most students chose to “collaborate to complete” tasks, with some considering themselves in leadership roles and others opting to independently complete their assigned work. It was also found through on-site classroom observations that most student groups operated without a clearly designated leader and more often functioned in a leaderless manner (Tigre et al., 2024; Jiang et al., 2023; García-Galán et al., 2024; Magrane et al., 2018). This type of group functioning model requires the involvement of every member rather than just a few to ensure effective communication and collaboration. Moreover, the observed interactions between students also revealed that when group members include individuals from different countries, differences in cultural backgrounds and habits can affect the perceptions of teamwork and effective communication among members. For example, members from high-context cultures (e.g., China, Japan, Taiwan) tend to rely on indirect expression and contextual interpretation (Li et al., 2024; Halford et al., 2018; Langaas & Mujtaba, 2023; Guo & Cionea, 2017; Li et al., 2020), while those from low-context cultures (e.g., Europe, USA) depend more on explicit verbal information (Liu, 2016; Vélez-Calle et al., 2021; Leal et al., 2018). Such cognitive differences could lead to information decoding biases. Whereas, if students' English proficiency is limited, the bias is likely to be further deepened, thus affecting the overall team-based learning experience. Therefore, teaching human-

centred skills such as teamwork in engineering PGT courses (with a predominantly international student cohort) should consider the use of intuitive teaching methods that require less language proficiency, such as visual aids and gamified instructional design, to minimise information translation errors due to linguistic cognitive differences.

Additionally, cultural differences in perceptions of decision-making authority can also be identified from observations and feedback. For instance, team members from Eastern Asian countries that respect authoritative leadership tend to wait for instructions from superiors rather than actively participate; whereas team members from European and American countries prefer equal discussions and relationships (Mukherjee, 2010; Göçen, 2021; Hudson et al., 2020).

For most international students entering UK universities for the first time, they need to have opportunities to interact with others to make observations and adapt to new teaching and learning patterns. Practical courses that focus on teamwork are therefore great opportunities that can facilitate their social- and human-centred experience. Moreover, international students' learning at UK universities can be considered as a dual-track model: they need to excel academically while optimising their learning strategies. But to achieve both in a short period of study time, relying on their own initiative alone is undoubtedly challenging for most of them. Therefore, it becomes necessary to adopt suitable inclusive practical teaching methods to help them adjust and adapt more quickly and efficiently to new educational environments, compared to traditional classroom teaching (Majoko, 2019; Pappas et al., 2018; Méndez et al., 2022; Shafaei & Razak, 2016).

In addition to the above observations, student feedback further revealed that in students' cross-cultural team collaboration, communication and collaboration skills formed the foundational support system for teamwork: communication serves as the neural network for information exchange, ensuring cognitive alignment, while collaboration acts as the mechanical framework for resource integration, driving task progression. The quality of communication and collaboration directly determines the upper limit of team effectiveness. However, for students lacking practical experience, more challenges may lie in the fact that project simulations without well-defined goal-achieving requirements may weaken the recognition of potential cultural differences, and the academic pressures lead students to prioritise personal success over group objectives (Johnson & Johnson, 2014; Laal & Ghodsi,

2012). Therefore, a design project simulation with clear team objectives and task requirements for each member was applied in an attempt to go beyond the traditional lecture-based teaching to engage students more actively in learning and independent exploration.

The key findings of Chinese PGT students' teamwork behaviours and learning in practical-based courses is presented in Figure 6.1 below.

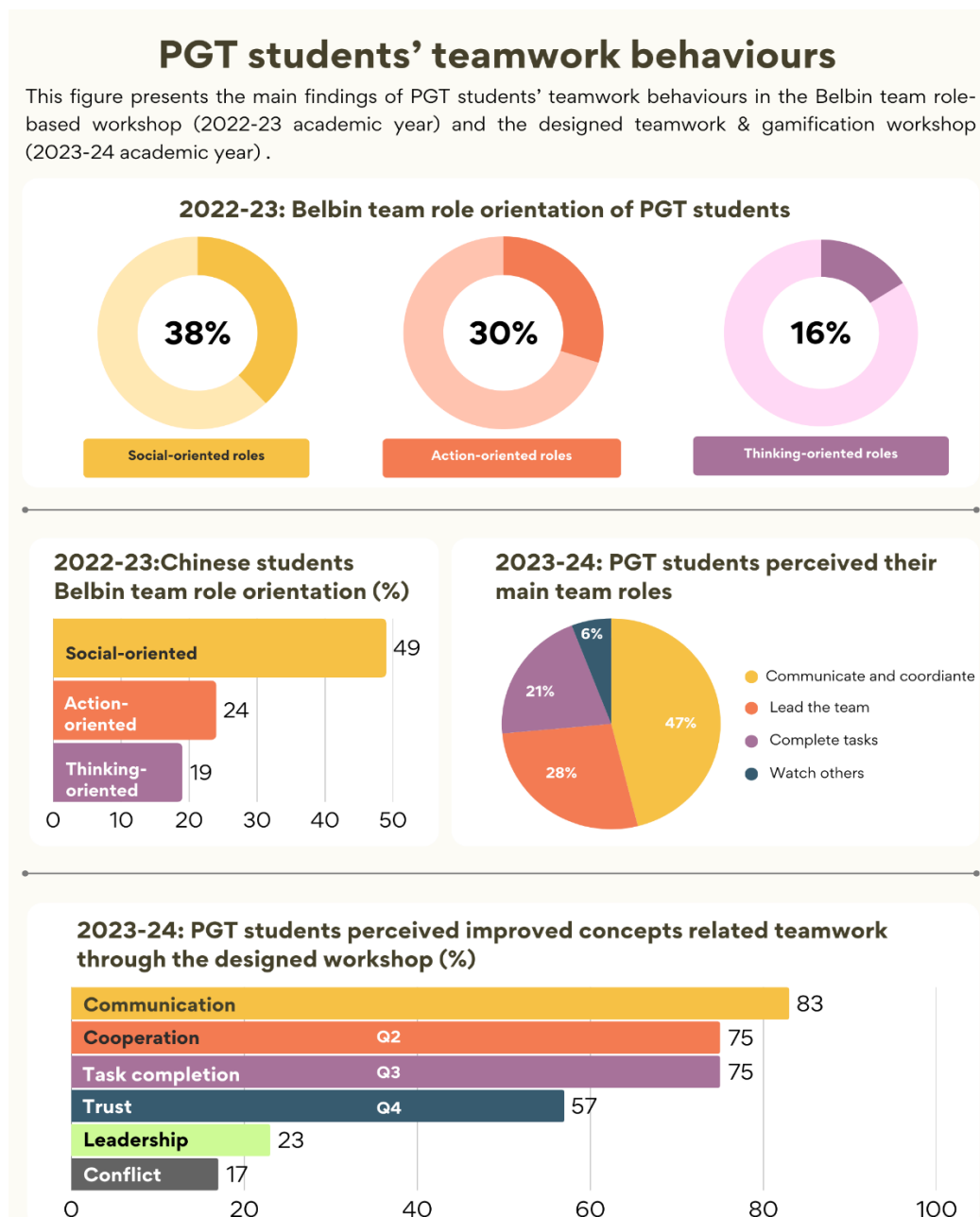


Figure 6.1 Summary of PGT students' teamwork behaviours and learning in the game-based teamwork workshop.

6.2 Key findings of the interview on international (Chinese) students' experiences of teamwork in engineering programmes studied at UK Universities

Having established an initial understanding of the teamwork behaviours of PGT students in practical courses, an interview study was conducted to gain a deeper insight into the teamwork experiences of Chinese engineering students in UK universities. The aim was to explore how these experiences may contribute to their learning and growth beyond technical knowledge, and to gain insights from students' views to design the teamwork-based teaching practice. Overall, the results of the study highlight the following key findings:

1. Clear teamwork cognition: Most of the Chinese students interviewed demonstrated a clear understanding of the value of teamwork in their studies, particularly in the context of engineering disciplines. Most students were clear about their place and role in the team and realised what they were expected to do in the team. This awareness not only increased their receptiveness to teamwork but also motivated them to actively seek opportunities to practise and learn within a team setting. It has also been found from previous studies that students' teamwork awareness and skills can be positively promoted when appropriate instructional guidance and interventions are employed in diverse teaching and learning environments (Riebe et al., 2010; Fathi et al., 2019; Morbitzer et al., 2021; Lorenz & Kikkas, 2024).

2. Positive feedback on teamwork experience in UK universities: When evaluating their teamwork experiences, students generally expressed a positive outlook, noting that teamwork offered multiple growth opportunities beyond classroom knowledge. These included enhancements in cross-cultural communication, workplace adaptability, and interpersonal skills. Most students reported that working in teams helped them gain a better understanding of cultural differences, particularly benefiting their cross-cultural sensitivity when collaborating with international peers. This also highlights that incorporating appropriate contextual and culturally instructional settings in team development for students can also be more effective to enhance their problem-solving competencies (Cohen et al., 2019; Grocutt et al., 2020; Pellissier et al., 2022).

3. Challenges and need for adaptability: Although most students viewed teamwork experiences positively overall, they also identified challenges, especially in effectively integrating teamwork with practical problem-solving in engineering contexts. Many students

emphasised that teamwork-based activities made them realise their own limitations in areas such as communication, problem-solving, and team management. These challenges were not only due to language barriers but also originated from interpersonal differences, even when working with peers of the same nationality. Additionally, several students noted significant differences in the structure and atmosphere of teamwork between China and the UK's engineering programmes. In China, from the beginning of their primary education, Chinese students have been emphasised more on independent learning (Chan et al., 2015). Studying at UK universities, on the other hand, there is a greater emphasis on teamwork, which requires them to adjust their learning habits and strategies, but most of them are not very clear about exactly how to do this appropriately and effectively. This therefore highlights the need for effective interventions in the UK engineering programmes to support them to adapt to the UK educational environment and to ensure their learning outcomes during the transition phase.

Moreover, student interview feedback indicates that teamwork experiences during studies are still largely confined to completing course assignments during their current studies. Although students generally demonstrated an understanding of core teamwork concepts, they remained limited in grasping actual teamwork skills and application. Notably, some students had prior work experience before coming to the UK, and they would spontaneously place greater emphasis on the facilitating role of teamwork in their studies. This difference in perception may suggest that teamwork activities should be more closely integrated with real-world industry contexts to enhance practical relevance. Many students also expressed a desire for more real-world problem-related cases to be included in the teaching, indicating that teamwork teaching and learning at the university level should not be limited to group-based written projects but should include more contextualised tasks based on industry-relevant issues.

Building on these findings, three key insights can be identified: first, integrating teamwork-based activities into UK engineering education will be beneficial in promoting positive learning experiences for Chinese students and the wider international student cohort. Teamwork skills not only enrich students' disciplinary learning experiences but also foster their interaction and collaboration across interdisciplinary contexts. Second, students expect that improvements in activities designed to develop teamwork skills could be more aligned with industry-relevant tasks rather than simply assigning group coursework. In addition to adding diversity in

teamwork education, structured guidance and specific team tasks can lead them to adapt their learning strategies efficiently, especially for students with limited teamwork experience. Finally, one unexpected finding was that students' personal characteristics may also influence their teamwork effectiveness. Many engineering students who participated in the interviews perceived themselves as somewhat introverted. A previous study has also shown that students studying engineering subjects tend to exhibit introverted personalities (Capretz, 2003).

Undoubtedly, there has been a significant amount of research on teamwork instruction in higher education, but most studies focus on the design and implementation of general instructional and module contexts (Ghannam & Ahmad, 2020; Ghannam et al., 2021; Huerta et al., 2024; Giroto & Oliveira, 2022), with relatively few examining the teamwork experiences of international students studying in UK universities. This study, therefore, seeks to fill this gap, especially in light of the trend towards internationalisation of higher education, as universities are evolving beyond being just classrooms for knowledge transfer, but rather incubation platforms for developing well-rounded individuals who can drive the technological age. The UK universities are also becoming an international academic stage where students from diverse backgrounds can master concrete technical expertise and develop essential employability and transferable skills for life-long development. Thus, developing better teamwork experience not only supports engineering students in becoming well-rounded professionals but also cultivates their interpersonal competencies to work harmoniously with others in the workplace. As one of the students put it:

"Everyone goes to a university, then you're always going to have teachers and classmates. Then there will be group work happening. The current learning environment should correlate with the future work environment. When you go into society to work, whether it's with clients or colleagues, it's always a teamwork scenario that exists. So I think that the team experience that I have experienced here is something that will be useful for me in the future."

This comment evidently suggests that the current university educational environment should be inspired by and relevant to workplace environments, connecting the education with the physical world. The teamwork experience gained from university education could have the

potential to play a key role to students' success, offering a baseline for students' employability skills development.

To summarise, understanding teamwork experiences within a cross-cultural research context allows educators and researchers to observe, with greater clarity, the diverse expectations and adaptation patterns of students from different cultural backgrounds to the UK engineering curricula. Chinese students studying in the UK generally view their teamwork experiences positively. Compared to their experiences in Chinese educational institutions, the teamwork practices in the UK Higher Education system have led them to develop a deeper understanding of the essence and value of teamwork. While this conclusion may vary based on the characteristics of different student groups, the integration of teamwork into engineering education is undeniably well-received and welcomed by students. Overall, the experiences and perceptions of teamwork among Chinese students, especially during their UK university studies, were not only derived from the accumulation of prior experiences, but also more from the actual teaching intervention received.

6.3 Further discussions on how engineering education can transform engineering students into future engineers: what makes all-around engineers?

The above research on Chinese students' teamwork is all aimed at clarifying the future direction of engineering education for enhancing students' learning experience. Undoubtedly, in the future, society will not only need a technician, but also a well-rounded engineer with both technical expertise and human-centred skills.

For all-round engineers, the core of the profession is a strong foundational expertise in mathematics, physics, and engineering principles, enriched by interdisciplinary knowledge, and further developed hands-on abilities through laboratory training, prototyping, and project-based learning (Bell, 2010). But beyond technical mastery, these engineering professionals should excel in problem-solving via design thinking and systematic analysis, for example, balancing innovation and sustainability in broader engineering projects (Kunrath & Ramanujan, 2021; Zhao et al., 2020; Beckman et al., 2007; Rosano & Biswas, 2015). At the meantime, they also should be able to work in teams, with the ability to collaborate, interpersonal skills, leadership awareness and project management (Johnson & Johnson, 1994;

Cohen & Bailey, 1997; Goleman, 1998; Northouse, 2018; Kerzner, 2017). Thus, engineers are not just task performers, they are also innovative drivers of society and technological development.

Synthesising the above, it is clear that becoming a well-rounded engineer requires more than just technical excellence but also relies on human-centred skills. From the engineering educational perspective, shaping engineering students by incorporating non-technical level skills into the curriculum ensures that they not only grow to be technically proficient professionals, but are also more than capable of metamorphosing into ethically grounded and agile problem solvers. While this is of course the most desirable outcome of engineering education's development, there are some key gaps in actual practice: while project/problem-based learning is widely adopted, formal and systematic training curricula in teamwork skills such as leadership, conflict resolution, and collaborative strategies still spares.

In most contemporary engineering education practices, a technology-first educational paradigm is still adopted, which reflects some deep-seated cognitive biases: reducing engineers to mere technical execution tools while neglecting their essential role as drivers of social change. When curriculum design overly focuses on imparting skills at the material level, it essentially alienates engineering education into a void, training detached from the social context. Therefore, engineering educators should clearly recognise that every detail of engineering design impacts the organisational structure of human communities—these decisions are far from purely technical judgments but rather the interplay of technical rationality and humanistic values. It is therefore important not to lose sight of the incorporation of non-technical knowledge learning in the design of engineering teaching practices. If human-centred skills such as teamwork, ethical awareness, and cross-cultural communication continue to be relegated to secondary status, the education system risks cultivating a generation of “technologically excellent but socially blind” individuals. The innovation of engineering education not only relates to the upper limits of individual career development but also shapes the ethical baseline for future societal technological advancement.

6.4 Chapter summary

This chapter highlighted the findings of RQ 3 to explore Chinese engineering students' teamwork performances. Main findings revealed the potential teamwork behaviours and perception of learning and collaboration of the Chinese student cohort in the UK universities, and established a starting point for better design and adoption of team-based teaching and learning initiatives in future engineering education development. Although the relatively small sample size limits the generalisability of the findings, the data nonetheless reveal indicative patterns of potential teamwork behaviours and perceptions within this cohort. These exploratory insights provide a valuable reference point for understanding how Chinese students approach collaboration in cross-cultural engineering contexts. Importantly, the findings not only complement the earlier analyses of students' learning expectations and behaviours but also establish a foundation for the refinement of game-based teamwork teaching and learning initiatives. Further research with larger and more diverse samples is required to strengthen the validity of these conclusions.

CHAPTER 7: ANALYSIS & DISCUSSION for RQ 4: Enhancing Chinese Students' Learning Experience

7.0 Introduction

This chapter combines the data from previous chapters 4.5.2 and 4.9 to address the final research question: “To what extent can an inclusive workshop, incorporating teamwork games, enhance Chinese students’ teamwork learning skills and experiences in UK engineering programmes?” The findings are analysed to gain valuable insights for current issues and future development of the designed workshop and games. This chapter presents the students' pre- and post-workshop feedback, which suggests a positive response to their participation in the workshop in terms of understanding, learning and developing skills related to teamwork. The main student cohorts involved in this chapter are two engineering PGT programmes at the University of Sheffield (Sheffield CMBE and EEE) and one at the University of Manchester (Manchester CE).

7.1 Key findings of PGT students’ perception of engaging in game-based teamwork teaching and learning

7.1.1 PGT students’ experience of teamwork learning through the workshop

Teamwork has become an integral teaching and learning element in modern engineering education. With the increasing complexity of engineering projects and the increased need for interdisciplinary collaboration, engineering education needs to not only impart professional knowledge, but also develop students' human-centred skills, for example, teamwork and collaborative competencies. In response to this pedagogical trend, which is not limited to the field of engineering education, this study aims to help PGT students, especially international students, to enhance their teamwork knowledge and skill building by engaging them in a game-based teamwork workshop practice. In this practical design, game elements, problem-based learning (PBL) & project-based learning (PjBL) and role-playing were incorporated to guide the students to collaborate as teams. Then, the effectiveness of this practical design and the impact of teaching on students' perception of teamwork were explored via a post-workshop feedback form and semi-structured interviews.

In terms of student composition, Chinese students make up over 40% of the three student cohorts, and over 50% of the students on the two programmes at the University of Sheffield. Particularly in the Sheffield EEE cohort, 93% of the students are Chinese. These demographics therefore suggested that Chinese students remain the main source of students for PGT engineering programmes in the UK (Huang & Turner, 2018; Holliman et al., 2023).

The impact of this designed teamwork-based workshop teaching on the learning experience across the three student groups is analysed below.

7.1.1.1 PGT students' overall perception of the workshop

Across three cohorts' feedback on their overall team performances, self-evaluations consistently yielded higher proportions of "Strongly agree" responses compared to peer assessments, which may indicate a pervasive self-enhancement bias (Beylat et al., 2024; Ghaljeh et al., 2021; Maas et al., 2018). For instance, within the Sheffield CMBE cohort, self-rated agreement for communicating clearly and respectfully reached 68%, surpassing peer evaluations by 18% (-50%). Similarly, in the Sheffield EEE cohort, self-assessments for problem-solving developed (+51%) exceeded peer ratings by 16% (-35%). These disparities suggested students may overestimate their communicative clarity or problem-solving efficacy due to self-perception bias, whereas peers prioritised observable outcomes or tangible behavioural changes (Mann et al., 2019; Salas et al., 2018; Strode et al., 2022). Also, for Manchester CE, they rated their problem-solving developed at 53% in self-evaluations, while peers assigned only 35% to this category. These phenomena may suggest that PGT students tended to overestimate their communicative clarity and problem-solving efficacy, potentially due to introspective biases or a lack of external benchmarking.

Further analysis revealed that students are particularly divided on subjective competencies. Sheffield EEE's self-assessment of self-perceived improved understanding of teamwork (53% - Strongly agree) exceeded peer ratings by 15% (-38%), implying students may be confusing participation with deeper conceptual grasp, whereas peers evaluated tangible behavioural changes, for example, whether peers were engaged in the discussion. Similarly, Manchester CE's self-evaluation of collaborating effectively to help teammates (35%) diverged from peer assessments (41%), possibly reflecting differing interpretations of "collaboration" - self-

perceived level of effort versus what their peers expected to achieve were different. In contrast, evaluations aligned more closely with observable actions. For example, Sheffield CMBE's peer and self-ratings for collaborating effectively showed narrower gaps (peer: 55% vs. self: 63%), suggesting shared recognition of collaborative behaviours.

In addition to the potential intrinsic factors affecting students' competence in conducting evaluations, differences in the results of self and peer evaluations may be due to cultural norms within collaborative settings, such as hesitancy to critique peers openly, which may suppress critical feedback, further widening the gap (Brahmasrene & Suwannarat, 2021; Dulaimi & Hariz, 2011; Stahl & Maznevski, 2021). For instance, Sheffield EEE's lower peer ratings for problem-solving developed (35% vs. self: 51%) might reflect peers' reluctance to acknowledge others' problem-solving contributions in competitive tasks, whereas students credited themselves more generously.

What's more interesting to note is that evaluations aligned relatively closely with collaborative actions than with subjective competencies. All cohorts showed relative consensus in collaborating effectively to help teammates (Sheffield CMBE peer: 55% vs. self: 63%; Sheffield EEE peer: 36% vs. self: 53%; Manchester CE peer: 41% vs. self: 35%), suggesting observable teamwork behaviours are evaluated more consistently than abstract skills.

Overall, the positive impact of the teamwork workshop on increasing student participation in collaborative learning can be identified from the students' self- and peer-assessments, but the observed self-assessment gap still highlights the complexity and efficiency of assessing intangible teamwork skills among student cohorts. Inferred from the findings, it can also be inferred that when teaching students non-technical knowledge, the approach should not be restricted to the written or didactic format, but rather the integrate and translate these human-centred skills into specific executable tasks. The results of the present phase also showed that integrating game-based teaching into task-specific practice (e.g., gamification and role simulation) is able to help students experience and develop teamwork awareness and skills in a more experiential way.

7.1.1.2 Best and worst experiences of the workshop

Furthermore, in the feedback, when the question was asked about the best and worst experiences of attending the workshop, the focus differed among the three cohorts. For the Manchester CE cohort, the highest-rated best experiences centred on communication (58%) and teamwork (32%), suggesting that role simulations and collaborative tasks requiring frequent information exchange and collective problem-solving resonated strongly with this cohort. This consistency may reflect the application of structured communication frameworks, such as reading clue cards and scenario-based design tasks, which may enhance the demand for students to communicate clearly and coordinate with each other. Instead, the main challenges they faced were time constraints (24%) and task completion (18%), which could be due to the limitations of the course hours and the challenging design tasks requiring them to prioritise depth over efficiency.

For Sheffield CMBE, they prioritised task completion (47%) and teamwork (35%) as their best experiences, probably indicating a preference for outcome-driven, goal-oriented collaboration. However, their dissatisfaction with time constraints was also high (53%), suggesting that there may be a mismatch between the complexity of the task and the amount of time allotted (mainly due to course time constraints). In addition, this cohort mentioned communication misunderstandings (18%), which further hints at gaps in role clarity or feedback mechanisms during the collaboration phase.

While Sheffield EEE's feedback diverged markedly from the previous two cohorts, with game interaction (43%) and communication (32%) dominating their best experiences. The prominence of game-based engagement highlighted the effectiveness of dynamic, interactive pedagogies for this cohort, likely driven by competitive simulations or gamified scoring systems that heightened motivation. Their worst experiences were conflict (27%) and time constraints (22%) again. Conflict may stem from unclear role tasks and scoring mechanisms, while time pressure, while not as pronounced as in other cohorts, still impacted their ability to conduct the task efficiently.

The disparities in experiences across cohorts underscore the influence of task design and disciplinary inclinations. Manchester CE's communication-centric satisfaction aligns with simulations emphasising dialogue and coordination, while Sheffield CMBE's task-oriented

focus mirrors their preference for structured outcomes. Sheffield EEE's engagement with gamification highlights the value of interactive methods but also exposes the risks of competition-driven friction. All cohorts identified time constraints as a significant challenge. This is because the current implementation of the workshop practice is conducted independently and has not yet been integrated into the formal teaching schedule. Therefore, each session requires coordination with collaborators to confirm available teaching time, limiting the practice to 2-4 hours. During the workshop, if students fail to plan and manage task progress effectively, it is likely that tasks will remain incomplete, which in turn affects their overall participation and the learning outcomes.

7.1.2 PGT students improved teamwork skills

Following participation in the game-based workshop, most participating students exhibited a hierarchical pattern of skill development, with communication (70%), collaboration (58%), and problem-solving (53%) emerging as the most prominently enhanced competencies. This outcome aligns closely with the structural logic of the game-based design. For instance, gamified elements such as role-play simulations and time-constrained collaborative tasks immersed students in scenarios necessitating intensive interaction, ranging from simulated crisis management to role-specific team challenges. These activities, incorporating mandatory communication phases and open-ended problem-solving frameworks, compelled participants to rely on dialogue, negotiation, and collective decision-making, thereby naturally reinforcing the understanding of core teamwork concepts and experiencing the teamwork development process. Concurrently, gamification mechanics (e.g., reward-based scoring systems) lowered participation barriers for culturally diverse cohorts (Alsawaier, 2018). In cross-cultural student groups, simulations of multicultural scenarios (e.g., cross-cultural negotiation exercises) fostered inclusive collaboration within low-risk environments, enabling learners to navigate implicit challenges posed by linguistic or value-based differences.

Among moderately improved skills, time management and decision-making (both 41%) demonstrated comparable progression. Teams operating under temporal constraints must simultaneously coordinate task workflows and consensus-building, the dual demand that tests both students' abilities of time allocation and analytical prioritisation. In contrast, leadership (34%) and adaptability (32%) exhibited slower development among

students. This may be due to fixed role assignments (e.g., persistent adherence to implementers rather than leadership roles) limiting opportunities for students to engaging in leading projects. Also in cross-cultural teams, linguistic insecurities or apprehensions regarding cultural friction might also hinder their proactive attempts to be a leader (Tenzer et al., 2013; Voss et al., 2014). It is worth to note that conflict resolution (19%) ranked lowest, suggesting that competence in directly resolving disagreements remains under-trained among students, which is related to insufficient targeted teaching in the curriculum.

Therefore, based on the above discussion, the use of gamification mechanisms and dynamic role tasks/prompts to promote cross-cultural understanding and exchange will be considered in future research to further optimise teaching and learning outcomes. The role task design will more explicitly point out the alternation of leadership at different stages of the project design to break the role rigidity and expose students to multifaceted responsibilities. An attempt will also be made to introduce a conflict resolution module based on real industrial case studies, which can engage students in a conflict scenario to explore tools and skills to mediate disputes. In addition, the overall project design will be further optimised in terms of reasonable time planning, specific tasks in the execution and reflection phases (make them explicit as gaming elements or written guidance). These improvements aim to address the perceived skill gaps of the PGT students and to gradually improve the formation of an inclusive and supportive learning system, thus ultimately improving the overall teamwork capabilities of engineering students. The content of the designed teamwork workshop and the impact on PGT students' development of teamwork are shown in Figure 7.1 below.

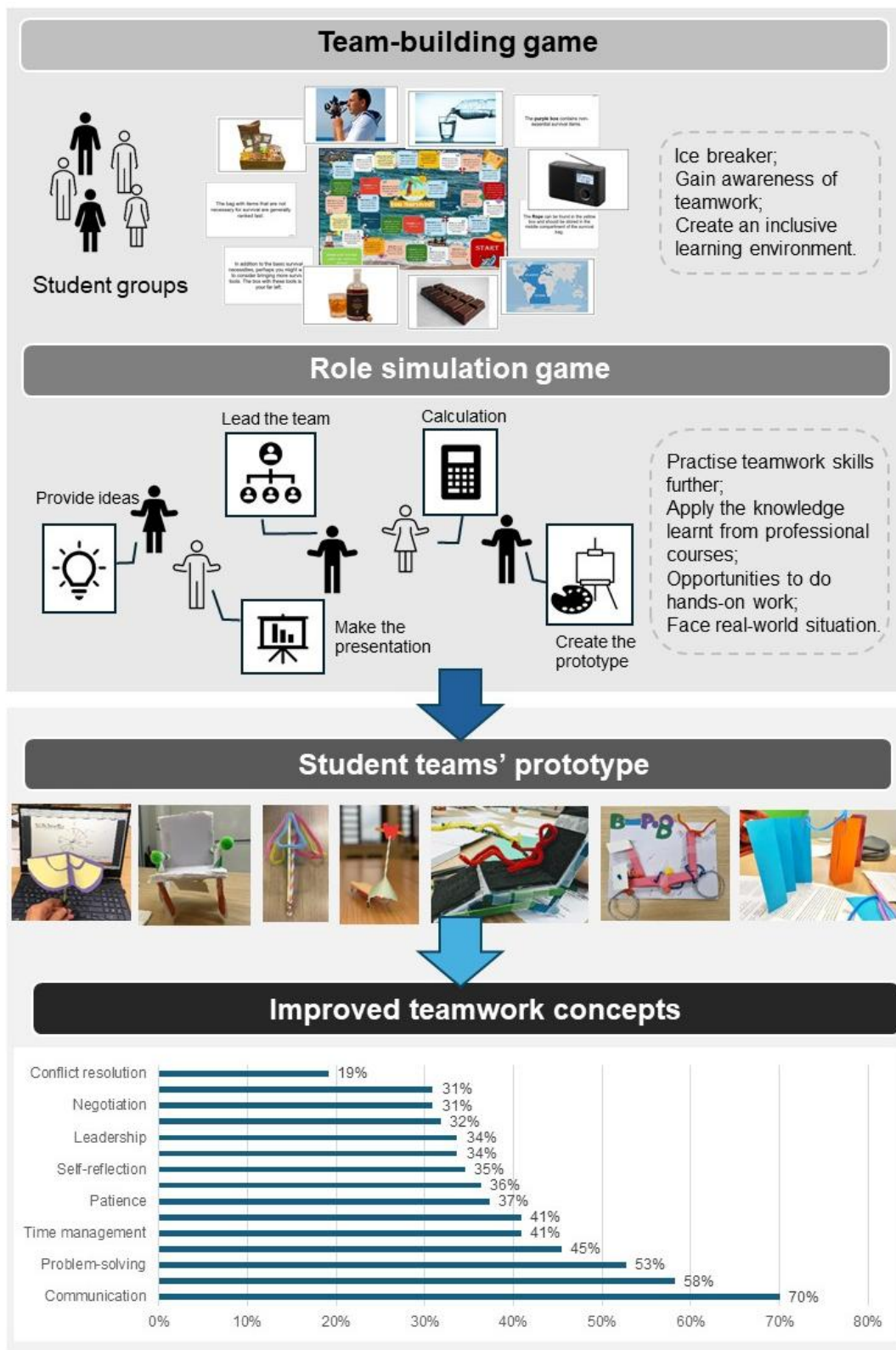


Figure 7.1 Schematic flow of the game-based teamwork workshop content and impact on PGT students' learning, practice and teamwork behaviours.

7.1.3 Problems and future improvements in the teamwork games and workshop

This section summarises the post-workshop interviews conducted with PGT students to reveal their specific experience of the workshop. Firstly, most PGT students provided positive feedback on the course design, particularly praising the course's fun factor and the fresh experience brought by its "gamified" format. This design broke away from the traditional "one-way transmission" teaching model, creating a relaxed and enjoyable communication environment that significantly enhanced peer connectivity and engagement. Students generally felt that this interactive design encouraged their active participation and involvement, offering a stark contrast to the often "dry" university lectures they were accustomed to.

However, some students still experienced confusion or struggled to keep up during the initial stages of the workshop, especially those unfamiliar with the game rules or lacking background information. Additionally, language barriers and cultural differences posed significant challenges for international students, particularly non-native English speakers like Chinese students, affecting their understanding and participation (Byrne et al., 2019; Motavas et al., 2018; Singh & Jack, 2021; Susandi et al., 2023; Tan et al., 2018).

Overall, the positive feedback indicates that gamification and interactive design significantly enhanced the classroom experience, breaking the stereotype of traditional engineering courses and fostering a sense of team belonging, which reduced communication barriers in "stranger groups" (Salvadori et al., 2022; Templeton et al., 2023). Instead, the negative feedback also highlights the need for improved initial guidance, clearer rules, and enhanced language support during teaching and learning, particularly for a diverse international student body. This "adaptation difficulty" reflects the current shortcomings in international curricula regarding multicultural and language support (Adisa et al., 2019; Birch & Rienties, 2013; Ramachandran, 2011; Wingate et al., 2011).

For the aspect of the impact on students' understanding of teamwork, most students reported gaining a deeper understanding of teamwork through the course. They became more aware of the importance of listening to and understanding others' perspectives, experienced the value of "active individual participation in facilitating team collaboration," and recognised the differences between real-world workplace collaboration and academic group assignments. For students with more prior teamwork experience, this experience served more as a

reflection and validation of their existing teamwork skills. In contrast, students with limited teamwork experience found the course to be a valuable hands-on opportunity.

Last, for the students' suggestions for the workshop Improvement, PGT students generally suggested that the course should provide more detailed explanations of the game rules and objectives to reduce the initial confusion. They also recommended extending the course duration to avoid an overly fast pace. Additionally, students felt that incorporating background stories or diverse challenges into the game could enhance immersion and sustain interest. Some also focused more on the rationality of the game design itself, such as the number of cards or the explanation of item functions, while others were concerned about the lack of integration with technical courses.

Overall, from the students' feedback, it is evident that the workshop had significant positive effects: the innovative design broke the monotony of traditional classrooms and effectively promoted understanding and collaboration among PGT students. Cultivating teamwork skills is not merely about imparting skills but also about guiding cognitive and behavioural habits. In addition, the improvement of the workshop design is clear: future iterations could further optimise game mechanics, enhance rule clarity, increase language and cultural adaptation support, and even embed subject-specific content. This teamwork-based practice design, therefore, offers valuable insights for future inclusive engineering education: gamification and task-driven designs are effective for international and multicultural student groups. The summarised PGT students' feedback on the teamwork workshop is presented below in Figure 7.2.

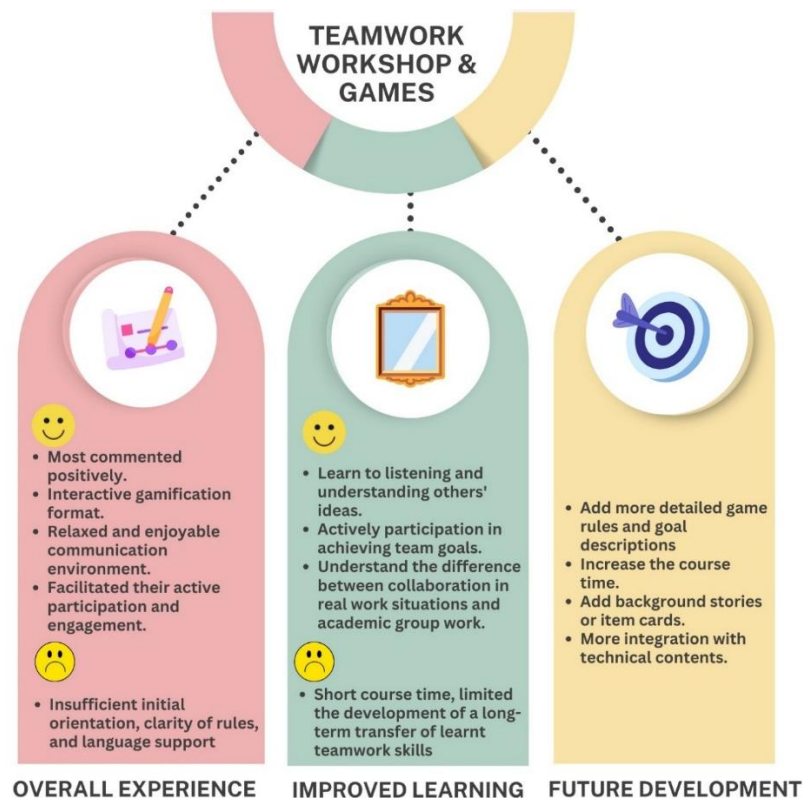


Figure 7.2 PGT students' overall experience of the teamwork workshop and games, the impact on their learning of teamwork and suggestions for further improvement.

7.2 Chapter summary

This chapter outlines and discusses the findings of student feedback obtained after the implementation of the teamwork-based practices designed with three different PGT engineering student cohorts. The positive feedback from students has directly answered RQ 4. By analysing and discussing the students' self-perceptions of their learning through the workshop, it helps to assess the pedagogical effectiveness and identify remaining shortcomings of the current practice design, to further improve and optimise the framework and content of this practice design, and to provide valuable references for other researchers who are exploring the similar research. Through the findings, it is evident that participating in this game- and teamwork-based practice allows students to clearly recognise two key factors influencing team effectiveness: first, team member competence (Right People)—whether team members possess the knowledge and skills to complete tasks; and second, team norms and collaboration (Sound Structure)—whether team members can collaborate effectively and adhere to team norms (Hackman, 2002).

CHAPTER 8: IMPACT CASE STUDY on the implementation of the game-based teamwork workshop in the University of Manchester (Manchester CE cohort)

8.0 Introduction

This chapter provides an impact analysis of the effects and adaptation of conducting the game-based teamwork workshop practice at the University of Manchester. The course at the University of Manchester was a guest lecture. This attempt demonstrates the scalability and sustainability of the current design of the teamwork workshop and games in the wider field of engineering education.

8.1 Discussions on the impact of applying an inclusive teaching approach to enhance diverse students' learning experience in engineering education

Following the pilot implementation of the game-based teamwork workshop at the University of Sheffield during the academic year 2023-24, the results of the study were presented as a poster at the ChemEngUKDay conference 2024. As a result, the research team received an invitation from the University of Manchester to pilot the same approach in their *Employability and Transferable Development module*, which is open to PGT students on chemical engineering-related programmes. This invitation itself reflects the emerging impact of our innovative teaching practice of promoting teamwork awareness and skills, demonstrating recognition and interest from more institutions in adopting this method to address similar pedagogical challenges.

By trialling the same practice design across more institutional teaching and analysing impacts, it is also possible to ensure that the impact described is both credible and representative of the institution's wider mission (Jensen et al., 2022). Additionally, understanding the impact of the designed practice can motivate more researchers and institutions to focus on socially relevant issues and address real-world problems (Dunlop, 2018). Thus, the successful adaptation of the teaching practice and positive post-workshop outcomes achieved at the University of Manchester not only validate the broader applicability of this experimental teaching method but also mark a meaningful step toward embedding innovative pedagogical practices across institutional boundaries.

8.1.1 Background

The experimental teaching practice was originally developed and piloted at the School of Chemical, Materials and Biological (CMBE), the University of Sheffield to address challenges in student engagement, teamwork, and collaborative problem-solving within practical courses. The method incorporated elements of gamification, structured team-based tasks, role simulations, reflective surveys, and an emphasis on engineering-related project design scenarios.

Initial implementation at the Sheffield CMBE cohort demonstrated significant positive outcomes, including improved student participation, enhanced teamwork awareness and skills, and greater engagement with course content. Student feedback indicated increased motivation and better understanding of collaborative processes. Based on the data collected from the initial workshop conducted during the 2023-24 academic year, 77% of students perceived improved their awareness and skills of teamwork in self-evaluation and 79% in peer evaluation. These results positioned the method as a potentially transferable model for other institutions facing similar pedagogical challenges of teaching professional skills alongside the need to enhance the learning of human-centred skills.

8.1.2 Recognition and cross-institutional adoption

As a direct result of the positive outcomes of the teamwork workshop implemented at the University of Sheffield, the research team was invited by teaching staff in the University of Manchester to adapt and implement the same experimental teaching approach within their Employability and Transferable Development module in the Chemical Engineering Department. The invitation itself represents an early indicator of the impact and recognition of the practice design beyond its initial context.

In the University of Manchester, similar issues were identified within their engineering PGT curriculum — a high proportion of international students, limited student interaction during practical courses and challenges in fostering effective teamwork among diverse student cohorts. Thus, the goal of the cross-institutional implementation was to test the adaptability

and effectiveness of the designed teamwork workshop in a different academic and student conditions, as well as to assist more institutions in addressing similar pedagogical challenges.

8.1.3 Implementation in the University of Manchester

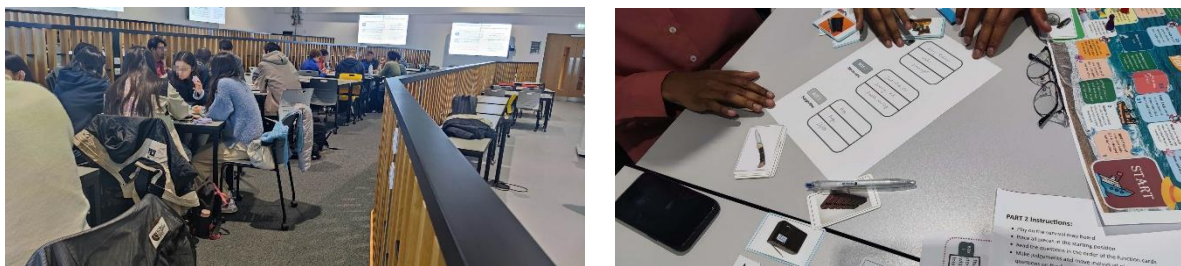
The teaching practice was delivered at the University of Manchester for one course session 2.5 hours (four hours of teaching time was the ideal setting). In order to be able to comply with the course hour limitations of the university teaching and to maximise the pedagogical impact of the practice, the flow of the workshop was appropriately adapted, but still ensured that key pedagogical elements and practical activities were implemented. Key teaching components included general introduction of teamwork principles, the team survival board game *Wave of Choices*, decision-making on survival teams, introduction to role simulation projects and self/peer evaluation to reflect on collaborative learning.

8.1.4 Evidence of impact

As described and analysed in Chapter 7 to discuss the effectiveness of the teamwork workshop, the peer evaluation results indicated that students acknowledged the effectiveness of the workshop in promoting their perceptions of teamwork. Specifically, 41% of students strongly agreed that they were able to collaborate and communicate effectively with teammates during the tasks. Similarly, an average of 47% of student strongly agreed in their self-evaluations that they were able to collaborate and communicate effectively through activities. Negative responses (disagree/strongly disagree) across all teamwork indicators remained consistently low, confirming that most students experienced productive teamwork dynamics.

Further, when asked about their ability to adapt and solve problems, a significant majority—88.2% of students—reported feeling more capable of finding solutions as part of a team than working alone. After experiencing the workshop, over 40% of the students felt that their knowledge of key teamwork skills such as problem-solving, communication, decision-making, leadership and self-reflection had improved. These findings highlight the workshop's success in enhancing students' confidence in collaborative problem-solving, particularly in challenging situations. Pictures of the site held the workshop, student participation, and models of the designed products can be seen in Figure 8.1 below.

Student engagement



Students' outcome



Figure 8.1 On-site PGT students' participation and prototypes of students' design project.

The positive effect of the workshop was also recognised with the teaching staff via a follow-up chat, with feedback stating that classroom dynamics had changed markedly and that students were more actively engaged in their learning and peer interactions. The survival team decision-making activity (part of *Wave of Choices*) was highlighted as particularly impactful in strengthening the relationship and trust between team members.

8.1.5 Sustainability and broader collaboration

The successful implementation of the teamwork workshop at the University of Manchester has demonstrated its transferability and scalability. The project has led to ongoing potential collaboration between the two institutions to refine and integrate this practice into the undergraduate curriculum.

The joint publications are being drafted, and the conference poster presentation has been accepted in the ChemEngUKDay 2025 to disseminate findings. One more academic staff member from Canterbury Christ Church University has also expressed interest in collaborating

to implement the teamwork workshop. This case study provides evidence that well-designed inclusive teaching practices can generate meaningful educational impacts across institutional contexts, supporting broader goals of enhancing student engagement and collaborative learning in higher education.

8.1.6 Reflection, next steps and future impact

The cross-institutional implementation of this experimental teaching method represents a significant milestone in its impact trajectory. Evidence from the University of Manchester confirms the method's capacity to enhance student engagement and understanding of teamwork in practical engineering education. Building on this success, the research team aims to conduct a longitudinal study to assess the long-term impact on the development of students' teamwork skills and academic performance. The design of the next phase will further consider how best to integrate and implement this practice into the technical modules that engineering students are studying. Other improvements will also be made to improve the overall workshop teaching quality by providing introductions before the class and preparing online learning resources so that students can understand the aims of the workshop in advance. This would also enable students to get into the teaching and learning flow more easily and quickly during the session. The possibility of converting teamwork games to digital formats will also be explored to make them easier to distribute to a wider audience and community.

8.2 Chapter summary

This chapter presents an impact case study to evaluate the effectiveness and versatility of the cross-institutional implementation of the designed game-based teamwork workshop. Quantitative data from Manchester students' self and peer assessments after the participation indicated positive perceptions. The results showed the workshop helped them to deepen their understanding of teamwork. The outcomes of this study therefore confirm that the designed game-based teamwork workshop is transferable to different institutional settings, highlighting its potential for broader implementation in engineering education and other disciplines.

CHAPTER 9: CONCLUSION

9.0 Introduction

This is the conclusion chapter of this thesis. In this chapter, the innovative contributions of this study, the core implications for the future development of the inclusive engineering education practice, the limitations of the study, and the recommendations for future research are elaborated based on the previous methodology, data, and discussion chapters.

9.1 Original contribution of the study

Currently, in the broader context of globalisation, there is increasing emphasis on the development of human-centred skills beyond technical knowledge, but systematic and effective pedagogical practices of these skills are still lacking in engineering education. Additionally, given the high enrollment proportion of international students (mainly from China) in engineering programmes at UK universities and their limited English fluency, some traditional teaching paradigms successfully implemented in UK universities before may not be fully applicable to international students' learning needs. Therefore, this study begins by understanding and recognising the learning and teamwork behaviours and characteristics of Chinese engineering students, then combines the observed data to gradually lay the foundation for a new game-based practice design. Ultimately, based on the observed students' learning characteristics and challenges, an inclusive workshop framework and games were designed, aiming to improve the learning experience of these students in team-based learning.

This study contributes two original advancements to the development of engineering education practices. The first contribution is a comprehensive analysis of the teamwork-based learning characteristics and preferences among Chinese engineering students studying in the UK. This provides relevant background information for researchers and educators in international engineering education, assisting them in better understanding and recognising the team-based learning behaviours and challenges of Chinese students in future teaching. The second contribution is the design of a game-based teamwork workshop framework and team-building games to promote students' acquisition and experience of teamwork skills. This teamwork teaching practice includes the establishment of workshop flows, the design of teamwork-building board game and the role simulation game for engineering-related projects,

and their implementation among PGT student groups at different universities. Finally, through collected student feedback, the development of PGT students' awareness of teamwork skills through this practice design and implementation were confirmed. The impact of this practice design was also validated through collaboration with more institutions. The specific innovations and their corresponding categories of this study are summarised in Table 9.1.

Table 9.1 Main contributions of this study

Contributed aspect	Established phase	Further development
Information update on Chinese students' learning experience and behaviours studying in UK universities.	PhD Thesis and research papers	Follow-up surveys
New game-based teamwork workshop framework in engineering education.	Established the initial framework of the game-based teamwork workshop and implemented it with the three engineering student cohorts.	Expanding the practice within broader educational communities.
New game-based and role simulation teaching approaches.	Create the prototype of the teamwork-building games.	Iteration of the game designs.

9.2 Implications of the study

The ultimate significance of this study lies in its aim to explore and establish a dynamic bridge between the “ideal ought” and the “actual is” of the educational system through the design of appropriate teaching practices. Because in engineering education, research on teaching practices is not merely about updating teaching content but rather about continuously deconstructing and reconstructing teaching approaches to equip students with the cognitive abilities, response mechanisms, and operational systems needed to navigate future uncertainties.

The new generation of students expects a university education to provide them with a ticket to the workplace (e.g. a degree qualification), but the real workplace typically requires much more from employees than what a printed degree certificate can represent. Contemporary higher education institutions serve many different purposes, but one of the key purposes should eventually be the creation and retention of human capital, which is the basis for the global economic growth and innovation (Yeo, 2018; Lepik & Sakarias, 2023). However, as the outside society and technology continues to evolve, higher education institutions are also

under increasing pressure from both industry and students, requiring to provide “usable” knowledge that can resolve evolving challenges.

In today's society, knowledge acquisition is no longer confined to traditional classroom settings (Hattie, 2009; Bates & Sangra, 2011). With the rapid advancement of communication technologies and social media, how individuals learn is continuously being influenced and reshaped. Thus, it may no longer be sufficient for higher education institutions to rely solely on traditional pedagogical methods to address the complexity of real-world problems and challenges. This has further led to the need to re-evaluate and reconstruct pedagogical paradigms in higher education to ensure the integrity and coherence of taught knowledge whilst integrating more closely with real industry dynamics, thereby meeting students' evolving needs.

Furthermore, considering the context of the accelerating replacement of procedural skills by AI, developing students' interdisciplinary thinking and value judgment competencies will be at the heart of what needs to be emphasised in the aims of higher education in the future. For example, the Chinese Ministry of Education's research report on *Core Competencies for Chinese Student Development* – 2016 noted that over 67% of employers believe modern graduates lack the ability to integrate knowledge systematically (MOE, 2016). Taking engineering education as an example, when classroom teaching is difficult to cover the complexity of the real world, students' learning becomes limited, and even the knowledge they acquire becomes outdated. Therefore, what university education really is in the future technology-driven society, or what value universities can provide for students to pursue in a rapidly developing world, will be a question for future university educators and stakeholders to reflect.

In this context, engineering education faces the dual challenge of keeping pace with technological advancements while ensuring that students develop the competencies necessary to navigate real-world complexities. As engineering disciplines are inherently rooted in real-world applications, educators must consider not only the transfer of knowledge, but also ensure that teaching content remains consistently relevant to the real-world scenarios.

The increasing use of project/problem/challenge based learning and teaching methods in engineering education also shows that both educators and students expect a shift from a “knowledge transfer” paradigm to a “competence development” paradigm in future higher education. In other words, students’ learning in universities is about building active learning trajectories in controlled “trial-error-correction” pedagogical environments, leading to further development of cognitive mechanisms and competencies that meet the demands of the ever-changing social life and industrial work. Thus, in the future development of engineering education, it is essential to clearly define the core question of what to teach in practical courses, ensuring that classroom instruction fosters a progressive learning chain of “knowledge-practice-competence”. As established by this study, the game-based teamwork workshop practice can provide an inclusive learning platform for international (Chinese) engineering students to learn, experience and develop teamwork skills progressively, while also learn how to apply technical expertise in a safe and controlled environment.

9.3 Limitations of the study

In terms of limitations, firstly, data collection and observations were mainly conducted within one engineering PGT programme at a single UK university, making the homogeneity of the sample a key limitation. As the students involved in the study were mostly from one university, the findings may lack broad representation. Thus, future research can seek cross-university collaborations to obtain broader student feedback and establish an effective follow-up assessment mechanism to systematically track students’ long-term learning development.

Additionally, there was insufficient data from home and other international students in the engineering PGT programmes where the study was conducted to enable valid parallel comparisons. This constraint limits the comprehensiveness of the evaluation regarding different student groups' learning experiences and may also lead to biased evaluations of the overall effectiveness of the designed practice.

Regarding the design of teaching practices, as the limited course duration did not allow for an in-depth investigation of students’ long-term development of teamwork skills. At the current stage, the assessment of the teamwork workshop at this stage relied on a single post-workshop assessment form and post-workshop interviews, without a systematic assessment

of students' long-term skill development. Moreover, as the assessment was only carried out for a single course intervention, this may have compromised the examination of the validity and accuracy of the overall practice design. Thus, future research will focus on developing an in-class assessment mechanism to examine the effectiveness of teaching and learning in a timely and comprehensive manner. Another shortcoming was that this study focused entirely on students' perceptions of engaging in the practice and neglected feedback from teaching staff. Therefore, in future research, feedback from teaching staff on their perceptions of the implementation of this workshop can also be collected.

9.4 Recommendations for future research

Future research will primarily focus on further optimising and refining the design and implementation of the existing game-based teamwork workshops and games. At present, this teaching practice is mainly conducted within one university. Although it has also been trialled at another university, the scope of the implementation is still limited. Moreover, systematic research into the development of interdisciplinary teamwork skills between different groups of students in UK universities remains limited to date. This suggests that if the practice design is to continue to be optimised, there is a need to seek cross-institutional collaboration to implement it more widely and to examine its pedagogical effectiveness.

At present, the study primarily draws data from PGT students, with limited insights from UG, PGR students, or industry professionals. Also, because the teaching core of this workshop practice is to enhance individuals' learning and understanding of human-centred skills that are not exclusive to university students but are essential in professional and everyday contexts. It may also be expanded as a means of promoting public engagement between scientific community and the public. Future research will seek to incorporate a broader range of participants to enhance the comprehensiveness and generalisability of the findings.

Additionally, given that this study is currently based on a single case within a UK university, future research could adopt a comparative case study approach, examining similar student groups across different institutions. Expanding this teaching design to a wider range of educational communities would not only validate its effectiveness but also foster inter-

institutional collaboration, facilitating the knowledge exchange of best practices and strengthening the role of human-centred skills development within engineering education.

While this inclusive workshop framework and games were initially designed for engineering education, their fundamental structures are highly adaptable. It can be adapted to the requirements of the curriculum for the specific teaching contents involved in the implementation. So in future practice, it could also be experimented with to be applied to teaching teamwork in humanities or social science majors.

Finally, specific improvements of the practice design could focus on: first, balancing competitive and cooperative relationships in games by applying cooperative scoring mechanisms, such as rewarding cross-team supportive behaviours. Second, strengthening the complementarity in the team simulation between team roles, making clear the interdependence of roles in the game. Third, establishing a structured reflection mechanism to guide students to understand and review their teamwork performance at the different stages of teaching and learning.

9.5 Conclusion

This thesis comprises nine chapters that explore the learning behaviours of Chinese students studying engineering at UK universities and presents a teamwork-based teaching practice designed to enhance their learning experience. This study is driven by four key research questions and conducted as action research with mixed research methods. The primary research participants were Chinese engineering students, the majority of whom were enrolled in one-year PGT programmes.

This research makes two key contributions: firstly, it provides an up-to-date reference of the learning behaviours of Chinese students in UK higher education; secondly, it introduces an inclusive and effective game-based teamwork teaching practice design. Eventually, this study is hoped that the findings offer valuable insights and practical recommendations for the broader audience, including engineering educators, researchers, administrators, and students, supporting further improvements in the development of learning, teaching delivery and curriculum design in international engineering education.

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Appendix

Appendix 1

List of interview questions about Chinese students' perceptions of teamwork

- Can you please briefly describe what you understand about teamwork (What is the meaning of teamwork to you?).
- How many teamwork experiences do you have to date? A lot, some or limited?
- Can you describe a teamwork experience that you thought was good or bad?
- What role do you feel you usually play when working with others?
- In your experience, how many people make up a team?
- What do you find most difficult when working in a team?
- Do you enjoy working in teams? Yes or no, why?
- Has a lot of teamwork been required in your current or previous studies?
- In your previous and current studies, was there a course that specifically taught teamwork? If so, please describe how this was done.
- In what way would you like teamwork to be taught to you?
- Have you ever worked with a (international) group of students from different countries? If so, how do you feel about teamwork? Is it a good or bad experience?
- Can you tell any difference between the teamwork you are experiencing in your current studies and what you have experienced before?
- Let's look at some key factors of teamwork, such as communication, leadership, etc. Can you list and rank the key teamwork elements you know according to your own experience, from the most important to the least important? Also, you can put the ones that you think are equally important side by side.
- Please explain briefly the reasons why you make the ranking in this way.
- Which of the factors mentioned above do you think you would like to learn more about and improve further?
- In your experience, do you think teamwork is important for you to learn engineering courses? Is it important or not important and why?
- What kind of tasks do you need to complete while working in a team for the technical course learning?
- Assume this: do you feel that the teamwork skills you gain in the university will have some impact on your future career? If yes or no, please specify?

Appendix 2

List of interview questions about PGT students' post-workshop perceptions of the effectiveness of the teamwork workshop

- What are your overall feelings about this workshop?
- During the workshop, were there moments when you felt uncomfortable or confused? If so, could you share specific examples?
- How would you describe the atmosphere of the workshop? Did it help you feel engaged in the activities?
- How do you think the teamwork went during your interactions with group members?
- Do you think the workshop's schedule was reasonable? Did the designed content meet your expectations?
- If you had to use one word to describe your overall experience, what would it be and why?
- Do you think the design of the games was interesting or engaging?
- Were there any parts of the games that particularly stimulated your thinking of teamwork?
- Were there any parts of these games that you found particularly difficult or uncomfortable? If so, could you provide more details?
- Did you find anything new about yourself or your team members during the games?
- Do you think the games provided enough challenge or interactivity?
- We are still working on improving the game design. If you could, what aspects would you most like to see improved?
- Do you feel that participating in the workshop gave you new insights or perspectives on teamwork?
- Did you discover any ways to improve your performance in team collaboration?
- Through working with your group, were you aware of any teamwork skills or strategies you had previously overlooked?
- Did the workshop help you better understand your own team personality or collaboration style?
- After the workshop, do you feel more confident or willing to participate in future team projects?
- Can you summarise your biggest takeaway from the workshop in one sentence? Or anything you want to say about teamwork?

Appendix 3

20 complete survival item card designs:

Red pack

 Oil/Gasoline Similar to water, a can of Oil/Gasoline mixture is important for our survival. This can be used as fuel for heating or signaling.	 80% Rum In case someone gets hurt, the Rum can be used to disinfect. But it's not a good idea to get drunk at sea.	 Floating Cushion We've checked with each other that we all know how to swim, but a Floating Cushion will be a useful tool if someone falls overboard.	 Flashlight The Flashlight requires extra batteries and can short-circuit at sea, but it may be useful as a backup signaling and lighting tool.

Blue pack

 Army Rations A case of Army Rations was found. These food supplies are essential to maintain your survival.	 Fishing Kit Some of us are very good at fishing so the Fishing Kit will be very useful.	 Mosquitoes Netting There are no mosquitoes in the middle of the Atlantic, but maybe the Mosquitoes Netting can be used for another purpose.	 Compass If we never get rescued, then we need a Compass for navigation or finding a safe location to save ourselves.

Green pack

 First Aid Kit To better ensure everyone's safety and health and the emergency treatment of wounds, a First Aid Kit with medical supplies is definitely needed.	 Ocean Map We find an Ocean Map that marks the location of a small island near the shipwreck, and it could be useful.	 Chocolate Bars Luckily, 2 boxes of Chocolate Bars were found. They can be our basic food supply.	 Radio In the middle of the Atlantic, there's a very small chance we can use a Radio to contact other ships.

Yellow pack



Rope

The **Rope** can help us tie up loose items and can also be used to make and secure tools. It will be useful at sea and on land.



Shark Repellent

If we are unfortunate enough to meet a shark and lost in the middle of the Atlantic, we may need to bring **Shark Repellent**.



Water

Water is necessary for our survival and needs to be in a place that ensures it won't leak. It must be kept safely.



Lighter

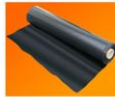
Fire is essential for warmth, cooking, and water purification. So, the **Lighter** can be useful.

Purple pack



Shaving Mirror

A **Shaving Mirror** must be kept in the most accessible place so that it can be used immediately for signaling in case of emergency.



Plastic Sheet

In case we run out of food and water, then a piece of opaque **Plastic Sheet** will be useful and essential.



Folding Knife

Whether we're drifting at sea or arriving on an island, we'll need a **Knife** to cut food, make tools, and even self-defence.



Sextant

None of us knows how to use a **Sextant**. But someone wants to keep it as a souvenir.

Quiz questions corresponding to the item cards

Flashlight

Scene 1: Drifting on the Lifeboat - Using the Flashlight at Night

Description

While drifting at sea during the night, visibility is extremely low. The only light source comes from the moonlight overhead and the occasional flash of lightning from distant storm clouds. Among the items found from the wreckage is a flashlight, which seems to be in working condition. Someone suggests, "We should use the flashlight to signal for help and to improve visibility on the lifeboat during the night."

Question 1: Is it a good idea to use the flashlight to signal for help and improve visibility at night?

True ☐

False ☐

Scene 2: On the Lifeboat - Saving the Flashlight Battery

Description

After several days at sea, the team is growing tired and desperate. The flashlight you found is crucial for night-time visibility, but its battery is running low. Someone says, "We should save the flashlight's battery for emergencies only and rely on other means, like natural light or reflection, whenever possible."

Question 2: Is it OK to save the flashlight's battery for emergencies and limit its use to preserve power?

True ☐

False ☐

Floating Cushion

Scene 1: Drifting on the Lifeboat - Using the Floating Cushion for Additional Buoyancy

Description

While drifting at sea, the team is feeling the effects of exposure and fatigue. You have a floating cushion in the lifeboat. The lifeboat is small and crowded, and some members are

struggling to stay afloat. One person suggests, "We should use the floating cushion to provide additional buoyancy and support for those who are struggling."

Question 1: Is using the floating cushion to provide additional buoyancy and support for struggling members a beneficial strategy?

True ☐

False ☐

Scene 2: Floating Cushion as a Safety Measure - Using It for Emergency Situations

Description

After drifting at sea for several days, the weather has worsened, and the lifeboat is taking on more water. You have the floating cushion. Given the rough conditions, someone says, "We should keep the floating cushion ready to use as an emergency flotation device in case someone falls overboard or the lifeboat capsizes."

Question 2: Is it reasonable to keep the floating cushion ready for use as an emergency flotation device?

True ☐

False ☐

Oil/gasoline

Scene 1: Drifting on the Lifeboat - Using Gasoline for Fire

Description

After days at sea, you have five litres of gasoline found from the wreckage. The nights are cold, and someone suggests, "We should use the gasoline to start a fire for warmth and signalling."

Question 1: Is it a good idea to use gasoline to start a fire for warmth and signalling?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Using Oil for Signalling

Description

While drifting on the lifeboat, someone spots a distant ship but has no flares left for signalling. At this point, you see the rest of the gasoline left in a bottle. One team member shouts out, "We should pour the oil onto the water and light it to create smoke for signalling the ship."

Question 2: Is using the oil to create smoke signalling a reasonable plan?

True ☐

False ☐

80% Rum

Scene 1: Drifting on the Lifeboat - Using 80% Rum as a Disinfectant

Description

While drifting at sea, one of the team members sustains a deep cut on their leg, and you are worried about infection. Among the survival supplies is a bottle of 80% rum from the wreck. Someone suggests, "We can use the rum to clean and disinfect the wound since it's high in alcohol."

Question 1: Is using the 80% rum as a disinfectant for the wound a good idea?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Drinking 80% Rum to Stay Warm

Description

As the nights grow colder while drifting at sea, the whole team begins to feel the effects of the dropping temperatures. Someone says, "We should drink the 80% rum to warm up our bodies and fight off the cold."

Question 2: Is drinking the 80% rum a good way to keep your body warm in cold conditions?

True ☐

False ☐



Army rations

Scene 1: Initial Survival - Army Ration Distribution

Description

After surviving a shipwreck, your team reached a deserted island. You find two boxes (with 24 pieces) of military rations (designed to provide high-calorie meals for soldiers in the field) from the ship's storage bay. The team comprises several healthy adults and a few older individuals who are less physically capable. Someone says, "We should distribute the rations equally among everyone, so we all have an equal share."

Question 1: Is it a good idea to distribute the military rations equally among everyone in this situation?

True ☐

False ☐

Scene 2: Prolonged Survival - Ration Consumption Rate

Description

After a few days on the island, the team starts to run low on military rations. The rations provide around 3,000 calories per day, but with limited food sources on the island, some members of the team suggest cutting the daily intake in half to make the rations last longer. "If we eat only half a pack each day, we can extend our food supply until we find more food."

Question 2: Is it a reasonable survival strategy to halve the daily consumption of military rations to make them last longer?

True ☐

False ☐

Compass

Scene 1: Drifting on the Lifeboat - Using the Compass to Navigate

Description

While drifting at sea after the shipwreck, you and your team have limited supplies and no clear idea of your location. Among the survival items found is a compass. One of the team members suggests, "Let's use the compass to steer our way toward land. We can pick a direction and follow it to find help."

Question 1: Is it a good idea to use the compass to navigate and pick a direction to steer the lifeboat?

True ☐

False ☐

Scene 2: On the Island - Using the Compass to Explore

Description

After drifting to a deserted island, you and your team decide to explore further inland to find freshwater and higher ground for a better view of the surroundings. You still have the compass. Someone says, "We should use the compass to help keep track of our direction and avoid getting lost while we explore."

Question 2: Is using the compass a good strategy to navigate the island and avoid getting lost?

True ☐

False ☐

Fishing Kit

Scene 1: Drifting on the Lifeboat - Using the Fishing Kit Immediately

Description

After escaping the shipwreck, you and your group are drifting on a lifeboat with limited food and supplies, including a fishing kit found from the wreck. After a few hours of drifting, someone suggests, "We should start using the fishing kit now to catch some fish, just in case we get hungry later."

Question 1: Is it good to start using the fishing kit right away to catch fish while still drifting?

True ☐

False ☐

Scene 2: On the Island - Using the Fishing Kit for Sustained Food Supply

Description

After reaching a deserted island, your group finds minimal food on land, but you still have the fishing kit. The surrounding waters are calm, and you can see fish swimming near the shore. Someone suggests, "We should use the fishing kit to catch fish regularly for a sustainable food source."

Question 2: Is using the fishing kit to fish regularly near the shore a reliable way to maintain a food supply?

True ☐

False ☐

Mosquito Netting

Scene 1: Drifting on the Lifeboat - Using the Mosquito Netting for Protection

Description

While drifting at sea, you and your group are exposed to the elements, including the hot sun during the day and cooler temperatures at night. Among your supplies, you find mosquito netting from the wreck. Someone suggests, "Let's set up the mosquito net now to protect ourselves from the sun."

Question 1: Would it be a good idea to use the mosquito net as sun protection while drifting at sea?

True ☐

False ☐

Scene 2: On the Island - Using the Mosquito Netting for Shelter

Description

After reaching a tropical island, you and your team set up a basic camp near the beach. The island is hot and humid, and you notice mosquitoes and other insects are active, especially near the water. One person says, "We should use mosquito netting to create a barrier around our sleeping area to protect us from insect bites at night."

Question 2: Is it better to protect yourself in the tropical forest by using a mosquito net while asleep?

True ☐

False ☐



Chocolate bars

Scene 1: Drifting on the Lifeboat - Distributing Chocolate Bars

Description

While drifting at sea, your team has been relying on limited food supplies. You found two boxes (with 20 pieces) of chocolate bars. The team is feeling exhausted and hungry. Someone says, "We should distribute the chocolate bars equally among everyone now to boost morale and energy."

Question 1: Is distributing the chocolate bars equally among everyone a good approach to improving morale and energy?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Saving Chocolate Bars for Future Use

Description

After several days at sea, the team is growing weak and low on energy, and you only have one box of chocolate bars left. Someone suggests, "We should save the chocolate bars for later, as we might need them more when we are in greater need or if our situation worsens."

Question 2: Is it wise to save the chocolate bars for future use instead of consuming them now to address immediate energy needs?

True ☐

False ☐

First aid kit

Scene 1: Early Stages of the Shipwreck - First Aid Kit Distribution

Description

After your ship sinks, your team drift to a deserted island. Fortunately, you find a first aid kit containing some basic supplies: bandages, antiseptic, painkillers, and a few common medications. Due to the limited resources in the first aid kit, you must decide how to distribute them. Someone suggests, "We should each take some medicine and bandages now, just in case of an emergency later."

Question 1: Is it reasonable to immediately distribute the first aid kit supplies to everyone?

True ☐

False ☐

Scene 2: Daily Survival - Wound Care

Description

After days of drifting at sea, your team arrives at a deserted island. While surviving on the island, one of your team members accidentally cuts their arm while chopping wood. The wound is deep but not life-threatening. There are only bandages and a few antiseptics left in the first aid kit. Someone suggests, "We should just bandage the wound without using too much antiseptic or ointment to save resources."

Question 2: Is it reasonable to save antiseptic and ointment by directly bandaging the wound in this situation?

True ☐

False ☐

Ocean Maps

Scene 1: Drifting on the Lifeboat - Using the Ocean Map to Plan a Course

Description

While drifting at sea, your team finds an ocean map among the survival items from the shipwreck. The map shows various islands and potential routes across the sea. Someone says, "We should use the map to plot a course towards the nearest island to increase our chances of finding land and help."

Question 1: Is using the ocean map to plan a course toward the nearest island a practical strategy for finding land and help?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Conserving the Ocean Map

Description

After several days at sea, people in the team become tired and anxious. You've been looking at the map and trying to find a course, but you've never met another ship, and the map is somewhat damaged by the salty sea. Someone suggests, "We should avoid using the map too frequently to conserve it and prevent further damage. We can rely on other methods for navigation and only use the map when absolutely necessary."

Question 2: Is it a good idea to conserve the ocean map and limit its use to prevent damage?

True ☐

False ☐

Radio

Scene 1: Drifting on the Lifeboat - Using the Radio to Call for Help

Description

While drifting at sea after the shipwreck, you look through the survival items found on the ship, and among them is a radio. The radio appears to be in working condition. Someone proposes, "We should use the radio to send a distress signal immediately. It might reach nearby ships or rescue services."

Question 1: Is it advisable to use the radio to send a distress signal as soon as you find it?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Saving Radio Battery for Future Use

Description

After several days of drifting on the lifeboat, your team has managed to conserve your food and water supplies. The radio, while functional, has limited battery life. One person says, "We should save the radio battery and not use it for distress signals now. We might need it later if we spot a ship or aircraft."

Question 2: Is it a good strategy to conserve the radio battery and delay using it for distress signals?

True ☐

False ☐

Lighter

Scene 1: Drifting on the Lifeboat - Using the Lighter to Signal for Help

Description

After escaping the shipwreck, you are drifting on a lifeboat with limited supplies, including a lighter found in the wreckage. It's night, and you notice the distant lights of what could be a ship. Someone suggests, "We should use the lighter to create a flame or signal, hoping the ship might see us."

Question 1: Is it a good idea to use the lighter to create a signal in hopes of attracting attention from the distant ship?

True ☐

False ☐

Scene 2: On the Island - Using the Lighter to Start a Fire

Description

After drifting for several days, your team reaches a deserted island. You are cold, hungry, and in need of a fire for warmth and cooking. You have the lighter. Someone says, "Let's use the lighter to start a fire and cook the food we've gathered."

Question 2: Is it a good idea to use the lighter to start a fire on the island for warmth and cooking?

True ☐

False ☐

Rope

Scene 1: Initial Survival - Rope Usage for Shelter

Description

After surviving the shipwreck, your team make it to a deserted island with a few survival items, including a long rope. The team decides to build a temporary shelter using branches and leaves. Someone suggests, "Let's cut the rope into smaller pieces and use it to tie the branches together. It will make building the shelter easier."

Question 1: Is it a good idea to cut the rope into smaller pieces for building the shelter?

True ☐

False ☐

Scene 2: Climbing to Higher Ground

Description

A few days after arriving on the island, you spot a high cliff that might provide a better viewpoint to survey the surroundings or spot rescuers. The cliff looks steep but climbable with the help of the rope. One team member suggests, "We should tie the rope to one of us and have them climb up first. If they slip, we can hold the rope and pull them to safety."

Question 2: Is it safe to use the rope in this way for climbing the cliff?

True ☐

False ☐

Shark Repellent

Scene 1: Initial Survival - Using Shark Repellent Immediately

Description

After the shipwreck, you are still floating near the shipwreck, and the water appears calm, with no visible signs of sharks. You found a canister of shark repellent among the emergency supplies and someone suggests, "We should use the shark repellent now, just in case sharks are nearby."

Question 1: Is it a good idea to use the shark repellent immediately?

True ☐

False ☐

Scene 2: Crossing Open Water - Applying Shark Repellent

Description

A few days after reaching a small island, the team decides to explore another nearby island, believing it may have more resources. To get there, you will have to swim across a stretch of open ocean. The water appears deep, and there are occasional sightings of marine life. Someone suggests, "Before we start swimming, we should apply the shark repellent to reduce the risk of an attack."

Question 2: Is it a good idea to use the shark repellent before swimming across the open ocean?

True ☐

False ☐

Water

Scene 1: Initial Survival - Water Distribution

Description

You found two cases of drinking water from the wreck and brought them to the lifeboat. Each box contains 12 bottles of water, and your survival team consists of five people. Given the uncertainty of when you'll find another source of fresh water, someone suggests, "We should each drink one full bottle of water now to stay hydrated and then worry about finding more later."

Question 1: Is it a good idea for each person to drink a full bottle of water immediately?

True ☐

False ☐

Scene 2: Water Rationing for Physical Activity

Description

A few days after being stranded on the island, the team is getting low on water from the two cases you brought from the ship. Some team members suggest a plan to explore further inland for a freshwater source. Someone argues, "Since we'll be doing more physical activity today, we should drink more water in the morning to avoid dehydration during the search."

Question 2: Is it wise to drink extra water before engaging in physical activity during a survival situation?

True ☐

False ☐

Folding Knife

Scene 1: Drifting on the Lifeboat - Using the Folding Knife to Cut Fishing Line

Description

The team has been trying to catch fish for food while drifting at sea. After a few hours, a fish is finally hooked, but the fishing line gets tangled around the boat. Someone says, "We should use the knife to cut the fishing line and catch the fish before it gets away."

Question 1: Is it a good idea to use the folding knife to cut the tangled fishing line?

True ☐

False ☐

Scene 2: On a Deserted Island - Using the Folding Knife for Shelter

Description

After drifting for days, the team finally reaches a deserted island. With nightfall approaching, the team needs to build a temporary shelter. One person suggests, "We can use the folding knife to cut branches and vines to construct a shelter for the night."

Question 2: Can the folding knife be effectively used to cut branches and vines to construct a shelter?

True ☐

False ☐

Shaving Mirror

Scene 1: Drifting on the Lifeboat - Using the Shaving Mirror for Signalling

Description

After several days of drifting, your team spots a distant ship on the horizon. The only reflective object among the survival items is a shaving mirror. One person in the group suggests, "We can use the shaving mirror to reflect sunlight and signal the ship."

Question 1: Can you effectively use the shaving mirror to signal a distant ship by reflecting sunlight?

True ☐

False ☐

Scene 2: On the Lifeboat - Using the Shaving Mirror for Self-Monitoring

Description

While drifting at sea, the team is exposed to the sun for extended periods, and some

members are starting to show signs of sunburn and dehydration. The only reflective object is the mirror. Someone says, "We should use the mirror to inspect ourselves for signs of sun damage and injuries in areas we can't easily see, like the back of our necks."

Question 2: Is it useful to use the shaving mirror to inspect your body for sunburn or injuries that may be hard to see?

True ☐

False ☐

Plastic Sheet

Scene 1: Drifting on the Lifeboat - Using the Plastic Sheet to Collect Rainwater

Description

After several days at sea, the team is running low on drinking water. Dark clouds gather, signalling the possibility of a storm. Among your survival supplies is a large black plastic sheet. One member suggests, "We should use the plastic sheet to collect rainwater so we can replenish our water supply."

Question 1: Is it a good idea to use the plastic sheet to collect rainwater?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Using the Plastic Sheet as an Insulator

Description

As temperatures drop during the night, everyone grows cold and tired. One team member suggests, "We should use the plastic sheet to cover ourselves and stay warm."

Question 2: Is using the plastic sheet to stay warm an effective strategy?

True ☐

False ☐

Sextant

Scene 1: Drifting on the Lifeboat - Using the Sextant Without a Horizon

Description

After days of drifting at sea, the skies have been cloudy for days, and there's no clear horizon view. A team member suggests, "We should still try to use the sextant to determine our location and navigate."

Question 1: Can you use the sextant to accurately determine your location without a clear view of the horizon?

True ☐

False ☐

Scene 2: Drifting on the Lifeboat - Using the Sextant Without a Nautical Chart**Description**

The team is feeling lost at sea after several days of drifting. Among the survival items is a sextant, but you don't have any maps or charts. Someone suggests, "We can still use the sextant to navigate and figure out where we are, even without a nautical chart. At least we tried."

Question 2: Is it good to use the sextant to help you navigate and find your location in this situation?

True ☐

False ☐

Appendix 4

15 complete function card designs:

QUESTION 1: Would your team survive without the items you hold? If your answer is 'Yes', forward 2 steps; If 'No', forward 1 step.	QUESTION 2: Do you hold one or more items that are very basically necessary to keep your team surviving for seven days? If your answer is 'Yes', forward 2 steps; If 'No', forward 2 steps.	QUESTION 3: Are there items you hold that require someone with specific skills to use them? If your answer is 'Yes', forward 3 steps; If 'No', forward 2 steps.
QUESTION 4: Do any of your items have multiple purposes to use? If your answer is 'Yes', forward 3 steps; If 'No', forward 2 steps.	QUESTION 5: Is one or more of the items you hold easy and light to carry? If your answer is 'Yes', forward 3 steps; If 'No', forward 2 steps.	QUESTION 6: Do you have one or more items that can increase your survival chances when the basics are consumed? If your answer is 'Yes', forward 3 steps; If 'No', forward 1 step.
QUESTION 7: Do you have items that may pose a threat to the safety of your and others' lives? If your answer is 'Yes', forward 2 steps; If 'No', forward 3 steps.	QUESTION 8: If you only use the items in your hand now, can you ensure that the team survives? If your answer is 'Yes', forward 1 step; If 'No', forward 3 steps.	QUESTION 9: After seven days, you have not been rescued. Do you still hold any items that will ensure your continued survival? If your answer is 'Yes', forward 2 steps; If 'No', forward 1 step.

QUESTION 10:

Do you have any items that can help defend or protect you from harm?

If your answer is 'Yes', forward 2 steps;
If 'No', forward 1 step.

QUESTION 11:

You have been floating at sea for three days. Do you still hold more than three item cards?

If your answer is 'Yes', forward 2 steps;
If 'No', forward 1 step.

QUESTION 12:

You've been floating at sea for five days. Did you help others get their item cards back?

If your answer is 'Yes', forward 2 steps;
If 'No', forward 1 step.

QUESTION 13:

On the seventh day of floating, if you had one chance to exchange items with others, would you be willing to do so?

If your answer is 'Yes', forward 2 steps;
If 'No', forward 1 step.

QUESTION 14:

After seven days of ocean floating, you have arrived at an isolated island. Do you still hold items that will help you survive on the island?

If your answer is 'Yes', forward 2 steps;
If 'No', forward 1 step.

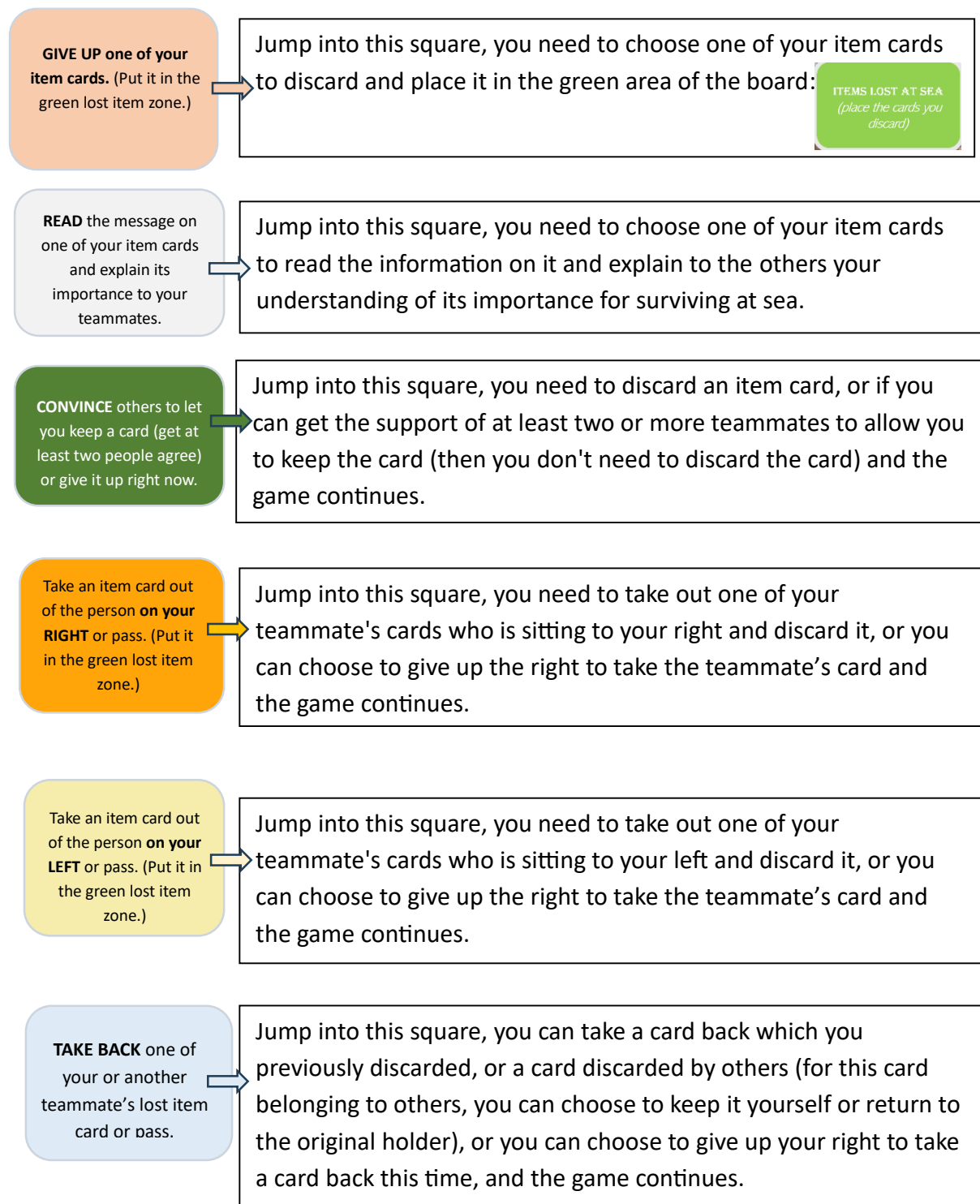
QUESTION 15:

Do you think it is more exciting to arrive at the finish line together as a team rather than alone?

If your answer is 'Yes', forward 3 steps;
If 'No', forward 2 steps.

Appendix 5

The board square task description



Teams vote to give one person priority to reach the finish line now or pass. ("Vote" go **GREEN** way, "Pass" go **PURPLE** way)

Jump into this square, your group needs to take a group vote: choose one person to reach the finish line directly (if you choose to vote, take the green arrow path); or give up the chance to vote (if you don't vote, take the purple arrow path), and the game continues.

Stop here for a round.

Jump into this square, you need to stay in this square for one more round without going forward, while the rest of the players continue to move forward as instructed by the next function card.

Straight to the finish line.

Jump into this square, you can move the pieces to reach the end directly.

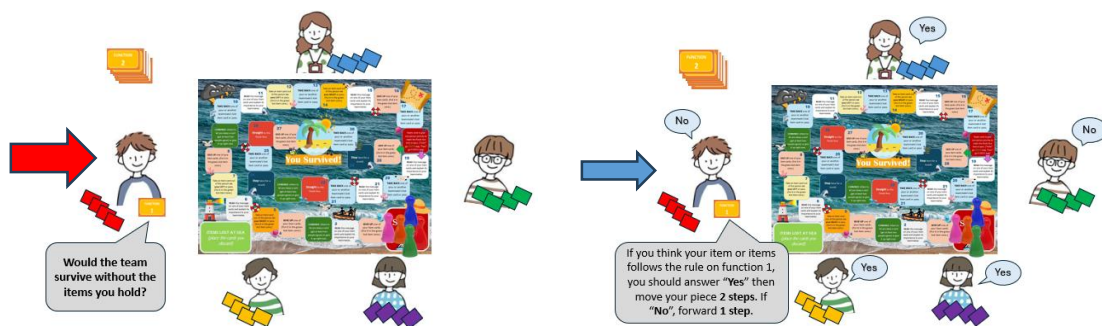
Appendix 6

The playing instruction of the teamwork-building board game:

1. You have:
 - A Map Board
 - Five game pieces
 - 15 Function cards
 - Each person also holds four item cards.
2. Start:
 - Place all your game pieces at the starting point on the map board



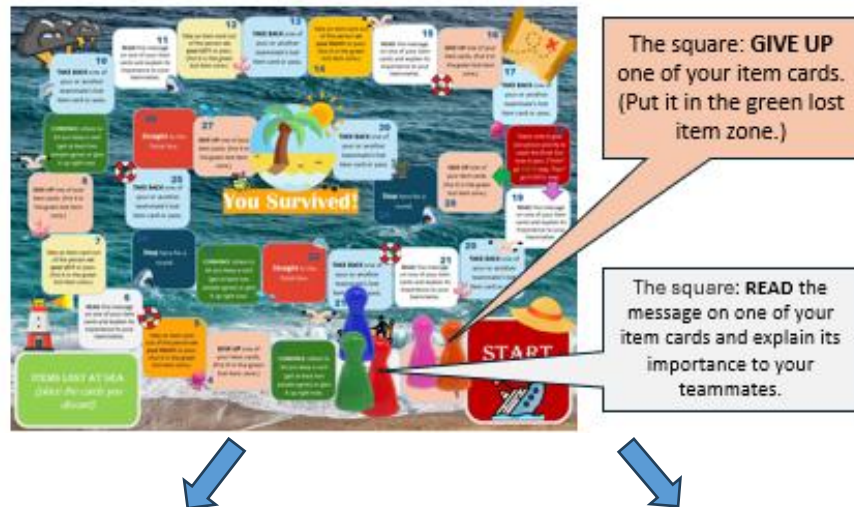
- One person reads out a FUNCTION card each round (in order), and all people judge whether the items yourself hold are eligible based on the information on the function card.



- Move your pieces according to the instructions on the function card

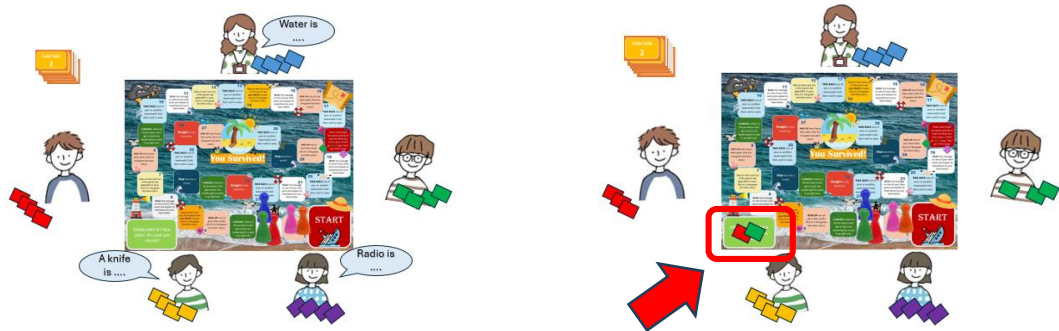


- Read, discard or retake the cards as required by the square your piece stands (check the action required in the square)

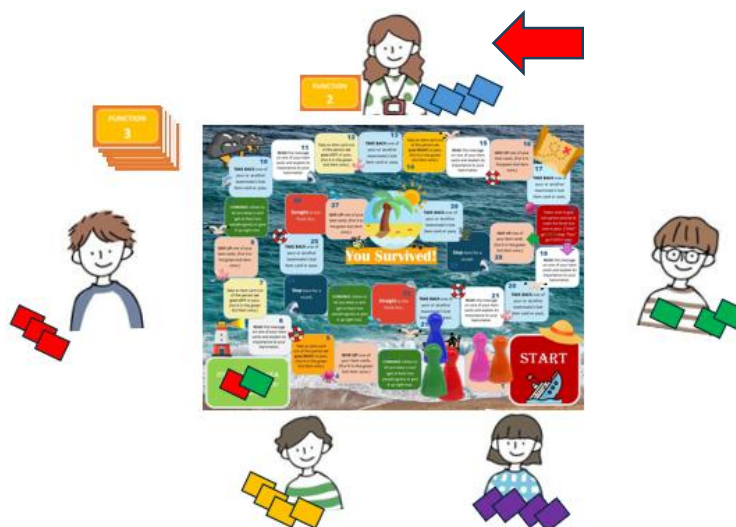


Read one of your item card's information cards

Discard one of your item

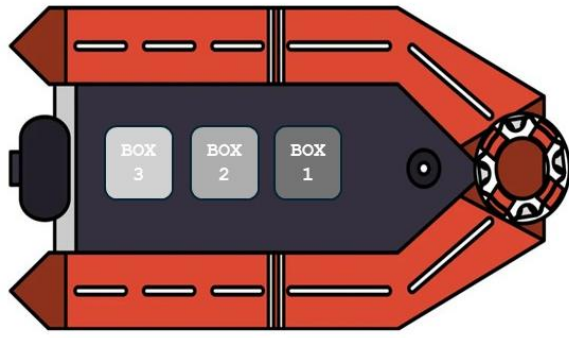


- Proceed to the next round of the game in the same manner. Each person takes a turn reading the function card.



Appendix 7

Recommended survival item selection list:



The diagram shows a red lifeboat with a black interior. Inside the lifeboat, there are three boxes labeled BOX 1, BOX 2, and BOX 3. BOX 1 is on the right, BOX 2 is in the middle, and BOX 3 is on the left. To the right of the lifeboat, there are three lists of survival items corresponding to each box.

BOX 1 Most Needed for surviving:

Water
Army rations or Chocolate bars
Plastic sheet

BOX 2 Necessary for increasing your survival chance:

Mirror
Oil/gasoline or Lighter
Floating cushion

BOX 3 For self-rescue:

First aid kit
Folding knife
Fishing kit or Rope

Survival scores calculation:

- BOX 1** The correct items to put in **Box 1** are worth **10 points** each.
- BOX 2** The correct items to put in **Box 2** are worth **5 points** each.
- BOX 3** The correct items to put in **Box 3** are worth **3 points** each.

*****The total survival score of all the right survival items placed in the right lifeboat boxes is **54 points!****

Why choose these survival items? -- Coastguard Expert Analysis

1st Rank Items	Coastguard Reasoning
Shaving mirror	It is the most powerful tool you have for communicating your presence. The reflected sunbeam can even be seen beyond the horizon.
Army rations or Chocolate bars	Your basic food intake
Water	The most basic life-supporting resources
2 nd Rank Items	
Lighter	Build fires to provide warmth, cook food, and purify water, etc.
Plastic sheet	Can be used to collect rainwater and shelter from the wind and waves.
Oil/gasoline	This is also a critical item for signalling. The mixture will float on water and can be ignited if any of you bring a lighter.
Floating cushion	Useful as a life preserver if someone fell overboard.
3 rd Rank Items	
Fishing kit	Ranked lower because there is no guarantee you will catch any fish. But it is a survival tool.
Rope	Can be used to lash people or equipment together to prevent being washed overboard. There are a variety of other uses to survive.
First aid kit	For treatment of wounds and medical emergencies to prevent infection or deterioration.
Folding knife	Multi-purpose tools for cutting, tool making, self-defence, etc.
Other Items	
Shark repellent	To repel sharks to save your lives, of course!
Rum	Contains 80% alcohol, which means it can be used as an antiseptic for injuries, otherwise of little value. Not for drinking! It would cause the body to dehydrate.
Radio	Unless there's a radio station near you.
Ocean Maps	Worthless without navigation equipment.
Mosquito netting	There are no mosquitoes in the middle of the Atlantic Ocean.
Sextant	Useless without the relevant tables and a chronometer.
Compass	Critical for navigation, but limited use, as the lack of fixed landmarks or references at sea.
Flashlight	Provides light at night, useful for signalling, but it requires extra batteries.

Appendix 8

The design project's description in the role simulation game:

New Eco-friendly Energy Applications



After discovering the powerful energy resource on the island, your group has invented a new **eco-friendly energy storage device/material to store and utilise the energy**. The new device has an energy density of 350 up to 400 Wh/m³, and the unit cost per m³ is £30. This device can be flexible, foldable and durable (it can be produced in the form of deformable sheets, fabrics or membranes). The unit weight of the energy device/material is 300 to 400g per m². In addition to its high performance, another key feature of the energy device is that it can be charged via power cables and solar, serving as both a charging panel and storage device.

Now you're going to design some derivative products based on this new energy device. There is an investment bank that is very interested in your business, and they want to invest in derivative products in the energy industry. The bank's portfolio includes **new energy-related products, sustainable environmental development and healthcare** investments. You are given an opportunity to pitch your design to the senior executives of the investment bank. In the pitch, you are going to present **the basic idea** of your design and present **a prototype** and a **market forecast** (use the Google Slide template).

Notes:

- Your design should be sustainable and suitable for a wide range of customers (e.g., kid-friendly, elder-friendly, disable-friendly, etc.).
- Your design should have the potential to be commercially applied and produced (e.g., outdoor supplies, clothes, transport vehicles, e-bikes, portable medical devices, detectors, recycling devices, etc.).

Appendix 9

The five roles' descriptions in the role simulation game:



Team leader tasks:



Your tasks:

- I) After all group members have familiarised with their roles, ensure there are no problems/confusion and that everyone has the information they need.
- II) Throughout the activity, you need to ensure all the tasks are being undertaken and that everyone is kept informed of progress.

So you can

- **Keep an eye on the completion of individual tasks and time management:** familiarise yourself with the different group members' tasks and ensure that things are progressing well and on time. If any tasks are completed ahead of time, the group member should be invited by you to help others. You also should be a flexible member to help others when they need it.
- **Organise group meetings when needed:** Arguments are always unavoidable when working together in a group. That's why you, as the leader, need to keep an eye on your group's dynamics and act in the event of a dispute. In meetings, you need to give every group member an equal opportunity to speak and share.
- **Organise to practise the pitch presentation:** before the pitch presentation, you should organise your group to practise to ensure that you can finish the pitch within the time (3 mins maximum).
- **Be the presentation opener!**

Generating product ideas:



Your tasks:

- I) Initiate a group discussion on potential product ideas.
- II) Actively listen to other teammates' opinions and generate the final product idea.

So you can

- **Think about the product name:** all the group members should be the inventors of the product. While you are giving your own opinions, you should also actively listen to others. Think of a commercial product name that can highlight the main features of the product.
- **Draw a logo for your product:** draw a simple logo representing your product.
- **Be clear about the basic product design and target market:** be able to explain why people should buy your product.

Hands-on work:



Your tasks:

- I) Your job is to create and construct a simple physical model (prototype) of your product after your group has the idea (using the handcraft materials supplied to create). The model you create can be a scaled-down or scaled-up version of the actual product size.
- II) Be able to explain the main features of the product you designed in the pitch.

So you can

- **Draft and construct the physical model of the product:** you need to work with the group to discuss the designed structure and materials to make the model. Before you start making the model, you need to agree on the final look and design of the product with the group.
- **Be clear about the designed structure and key features:** collaborate with your teammates who are responsible for editing the slides to summarise and write down the key features.

Calculating:



Your tasks:

- I) Give a reasonable estimate of the unit price of your product.
- II) Consider the potential cost of producing your product.

So you can

- **Determine the cost per unit of your product:** you need to have a group discussion to decide the direct costs per unit: raw materials, processing costs, labour costs, etc.; indirect costs: research and development costs, marketing costs, logistics costs, equipment depreciation, etc.; and profit margin: to meet the revenue requirements of investors or shareholders, a certain percentage (estimate 45%) of profit should be added to the total cost.

$$\text{Unit Price} = \text{Total cost per product} + \text{Target profit}$$

$$\text{Target profit} = \text{Total cost} * \text{Profit rate (\%)}$$

- **Analyse the prices of similar competitors and determine your positioning in the market (high, medium or low-end):** Research the pricing range of similar products in the market to find out a reasonable pricing range. Have a group discussion to determine the market position of your product and make a reasonable price increase or reduction.

Preparing pitch slides:



Your tasks:

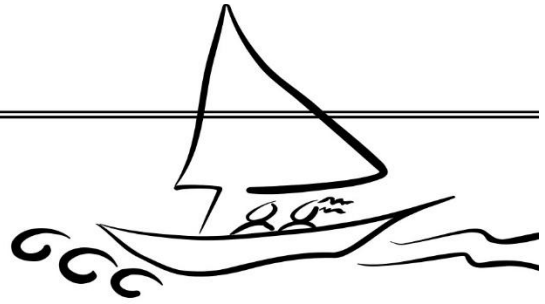
- I) Complete your group product slides (use the Google Slide template).
- II) Gather information from other teammates.

So you can

- **Find the right person to get the right information:** talk to different teammates to gather information and edit it in the slides.
- **Think about an advertising slogan:** your slogan should be a short and catchy phrase. You can create as many slogans as possible, as long as each slogan fits the scenario of using your product. (For example, Nike – Just do it; McDonald's – I am lovin' it.)

Lost at Sea

Situation



You are adrift on a private yacht in the South Pacific. As a consequence of a fire of unknown origin, much of the yacht and its contents have been destroyed. The yacht is now slowly sinking. Your location is unclear because of the destruction of critical navigational equipment and because you and the crew were distracted trying to bring the fire under control. Your best estimate is that you are approximately one thousand miles south-southwest of the nearest land.

Below is a list of fifteen items that are intact and undamaged after the fire. In addition to these articles, you have a serviceable, rubber life raft with oars large enough to carry yourself, the crew, and all the items listed below. The total contents of all survivors' pockets are a package of cigarettes, several books of matches, and five one-dollar bills.

Your task is to rank the fifteen items below in terms of their importance to your survival. Place the number 1 by the most important item, the number 2 by the second most important, and so on through number 15, the least important. You will do this twice: once alone (10 min.) and once as a group (20 min.).

Items	Step 1	Step 2	Step 3	Step 4	Step 5
	Your Individual Ranking	Your Team Ranking	Coast Guard Ranking	Difference between Step 1 & 3	Difference between Step 2 & 3
Sextant					
Shaving Mirror					
Mosquito Netting					
25 liter container of Water					
Case of Army Rations					
Maps of the Pacific Ocean					
Floating Seat Cushion					
10 liter can of Oil/Petrol mixture					
Small Transistor Radio					
20 sq. ft. of opaque Plastic Sheeting					
Can of Shark Repellent					
One bottle rubbing alcohol					
15 ft. of Nylon Rope					
2 boxes of Chocolate Bars					
An ocean Fishing Kit & Pole					
TOTALS				Your Score	Team Score

INSTRUCTIONS

Lost at Sea

- 1) Provide a Lost at Sea ranking chart for every member of your group.
- 2) Ask each person to take 10 minutes to decide their own rankings, and record the choices in the left-hand **Step 1** column.
- 3) Invite everyone to get into teams of 3-5. Encourage the group to discuss their individual choices and work together to agree on a collaborative list. Allow 20 minutes for this section. Each group records their rankings in the **Step 2** column (team rankings).
- 4) The correct answers were suggested by the US Coast Guard. Display the 'expert' rankings on the PowerPoint presentation, whiteboard or photocopy. Have groups list the scores in **Step 3**.
- 5) Groups compare individual and group answers with the correct answers and determine a score. For each item, mark the number of points that your score differs from the Coast Guard ranking and then add up all the points. Disregard plus or minus differences. The **lower** the total, the better your score.
- 6) As the groups work together, sharing thoughts and ideas, this should produce an improved score over the individual results. Discuss with your group why the scores were different. What changed their minds? And was this enough to survive.

Expert Analysis

According to the “experts,” the basic supplies needed when a person is stranded in mid-ocean are articles to attract attention and articles to aid survival until rescue arrives.

Articles for navigation are of little importance since even if a small life raft were capable of reaching land, it would be impossible to store enough food and water to survive for that amount of time. Without signaling devices, there is almost no chance of being spotted and rescued.

Item	Coast Guard Ranking	Reasoning
Sextant	15	Useless without the relevant tables & a chronometer.
Shaving Mirror	1	Of all the items, the mirror is absolutely critical. It is the most powerful tool you have for communicating your presence. In sunlight, a simple mirror can generate five to seven million candlepower of light. The reflected sunbeam can even be seen beyond the horizon.
Mosquito Netting	14	There are NO mosquitos in the middle of the ocean.
25 liter container of Water	3	Vital to restore fluids lost through perspiration. Quantity will supply rations for your group for several days.
Case of Army Rations	4	This is your basic food intake.
Maps of the Pacific Ocean	13	Worthless without navigation equipment
Floating Seat Cushion	9	Useful as a life preserver if someone fell overboard.
10 liter can of Oil/Petrol mixture	2	2 nd most critical item for signaling. The mixture will float on water & can be ignited using the matches.
Small Transistor Radio	12	You would be out of range of any radio station.
20 sq. ft. of opaque Plastic Sheeting	5	Can be used to collect rain water & shelter from wind & waves.
Can of Shark Repellent	10	Obvious!
One bottle of Rubbing Alcohol	11	Can be used as an antiseptic for any injuries. Not to be ingested as it will cause dehydration.
15 ft. of Nylon Rope	8	Could be used to lash people or equipment together to prevent being washed overboard. There are a variety of other uses but non high on the list for survival.
2 boxes of Chocolate Bars	6	Your reserve food supply.
An ocean Fishing Kit & Pole	7	Ranked lower than chocolate as there is no guarantee you'll catch fish. Pole could be used as a tent pole.

Survival Scores

00 - 25	Excellent	You demonstrated great survival skills. Rescued!
26 - 32	Good	Above average results. Good survival skills. Rescued!
33 - 45	Average	Seasick, hungry and tired. Rescued!
46 - 55	Fair	Dehydrated and barely alive. It was tough, but rescued!
56 - 70	Poor	Rescued, but only just in time!
71+	Very Poor	Oh dear, your empty raft is washed up on a beach, weeks after the search was called off.

Appendix 11

The list of survey questions and options designed for the study:

For Post-practical course feedback

1.1 Are you satisfied with today's session (today's lab met your expectations and you find the content useful)? Rates from 1-5, 1=poor, 5=excellent

- 1-Poor
- 2-Not good
- 3-Neutral
- 4-Good
- 5-Excellent

1.2 Which part of today's session did you find most useful? (for example, e-resources on BlackBoard, hands-on activities, demonstrations from instructors, etc.)

Answer: (_____)

1.3 Can you recall one point you remember in today's lab?

Answer: (_____)

For learning expectations

2.1 Why did you choose to study in the UK? (Select all that apply)

- I like the programme I chose
- University ranking and facilities
- Agent recommendation
- City environment
- No specific reason
- Local culture
- Family/friends recommendation

2.2 Why did you choose to study the degree course? (Select all that apply)

- Personal interests
- Future career development
- Bridging my previous study

- University/programme ranking
- Agent recommendation
- Family/friends recommendation

2.3 What activities would you like to take part in more besides studying? (Select all that apply)

- Improving academic writing
- Professional training related to my courses
- Events on finding jobs
- Transferable skills training
- Academic seminars on any subject
- Public Speaking Training
- Other (Please specify: _____)

2.4 If the university offers additional post-course workshops/seminars, etc., what would you like these activities to be about? (Select all that apply)

- Taking short trips to neighbouring cities
- Taking an internship
- Attending culture exchange activities
- Attending social parties
- Playing online games
- Other (Please specify: _____)

2.5 What are you most looking forward to gaining in the following academic year?

Answer: (_____)

2.6 What would you like to do after graduation?

- Find a job in China
- Continue in academia (e.g., apply for a PhD)

- Stay and find a job in the UK
- No specific plan
- Start my own business
- Gap year to travel around
- Other (Please specify:_____)

For learning preferences

3.1 Before your current course, have you studied at other overseas universities/institutions?

- Yes
- No
- Other (Please specify:_____)

3.2 How many hours per week do you volunteer to study? Except for the scheduled teaching time at the university.

- Below 5 hours
- Around 5 to 15 hours
- Over 20 hours
- Other (Please specify: _____)

3.3 What is your average grade for the most current assignments and exam?

- Above 70
- 60-69
- 50-59
- Below 50
- Prefer not to say
- Not applicable
- Other (Please specify: _____)

3.4 What is your expected grade for the whole study?

- Above 70
- 60-69
- 50-59
- Below 50
- Prefer not to say
- Not applicable
- Other (Please specify: _____)

3.5 Do you think it is important to be proficient in English in your current studies?

- Very important
- Important
- Neutral
- Not important
- Not important at all

3.6 What is the frequency of using software/Apps during your studies, such as DeepL or ChatGPT, to improve/revise your writing?

- Very often (once every day)
- Often (a few times per week)
- Sometime (a few times per month)
- Rarely (once per month)
- Never

3.7 How much do you think you can understand when listening to lectures / seminars / tutorials?

- Select from the scale 0 to 100 %.

3.8 What is your first reaction when you read a question in English?

- When I read it for the first time, I immediately translated it into Chinese in my mind.
- Understand the meaning of the English text when first reading.
- When I first read, I cannot fully grasp the meaning; I shall need to read it several more times. After rereading, I will translate the English into Chinese for comprehension.
- When I first read, I did not fully grasp the meaning; I needed to read it several more times. After rereading it, I can understand its English meaning directly.
- Other (Please specify: _____)

3.9 How do you self-evaluate your current level of English proficiency?

- Highly proficient in listening, speaking, reading and writing.
- Relatively proficient grasp of certain aspects of listening, speaking, reading and writing.
- My listening, speaking, reading and writing skills remain at the same level as when I first enrolled in the course.
- I feel my listening, speaking, reading and writing skills are somewhat underdeveloped.
- I feel that my listening, speaking, reading and writing skills have even declined somewhat.
- Other (Please specify: _____)

3.10 If you are required to remember a river right now, which of the following would be easier for you to remember?

- Text
- Picture
- Sound
- Tactile
- Other (Please specify: _____)

3.11 What are you most likely to do to spell out a complex word?

- write it down
- Spell it out
- Fingerspelling in the air

- Other (Please specify: _____)

3.12 What's the best way for you to learn about something new (like a phone App or a video game)?

- Learn from others and let them demonstrate it to you.

- Read relevant materials

- Play with it without instructions.

- Other (Please specify: _____)

3.13 What do you find most helpful when solving a complex problem (e.g., no obvious solution and may involve wide-ranging steps, and you may need to be creative and use different resources)?

- Repeat the learning and practise step by step.

- Draw charts or flowcharts for the whole process.

- Create a list outlining the steps to resolve the issue.

- Seek methods through practice alone.

- Seek advice from those with experience.

- Other (Please specify: _____)

3.14 What do you find most helpful when working on a hands-on project?

- Receive guidance either in advance or on-site.

- Check demonstrations or instructional videos in advance or on-site.

- When you arrive at the site, you will independently complete the project according to the operating procedures.

- Go to the place to seek others and collaborate on completing the project.

- Other (Please specify: _____)

For teamwork learning

4.1 You've worked with your group, so your preference for the group work is:

- Leading the team
- Communicate and collaborate with others
- Focusing on my own task
- Watching what others are doing
- Other (Please specify: _____)

4.2 How well do you know your current teammates?

- We are all friends
- Some of them are my friends
- I know someone in the team, but we are not friends.
- We never met before
- Other (Please specify: _____)

4.3 What is effective teamwork you think?

Answer: (_____)

4.4 When faced with uncertainty in the workshop, do you feel you can adapt and find solutions better and more quickly in the team than working alone?

- Definitely yes
- Fairly yes
- Neutral
- Fairly no
- Definitely no
- Other (Please specify: _____)

4.5 After attending this workshop, do you feel that you would be more willing to engage in team-based activities?

- Definitely yes
- Fairly yes
- Neutral

- Fairly no
- Definitely no
- Other (Please specify: _____)

4.6 What was your best experience at the event?

Answer (_____)

4.7 What was your worst experience at the event?

Answer (_____)

4.8 Self-evaluation: I clearly understood the objectives of the activity.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.9 Self-evaluation: I actively contributed useful ideas to play the game.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.10 Self-evaluation: I read and explained the clue information clearly and helped others understand it.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.11 Self-evaluation: I effectively collaborated with my teammates, helping them survive in the game.

- 1- Strongly disagree

- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.12 Self-evaluation: I communicated clearly and respectfully with my team.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.13 Self-evaluation: I actively engaged in solving problems during the workshop.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.14 Self-evaluation: I learned something new and improved my understanding of teamwork from the workshop.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.15 Group evaluation: All team members understood the objectives of the activity.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.16 Group evaluation: Every team member contributed useful ideas to play the game.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree

- 5- Strongly agree

4.17 Group evaluation: Every team member read and explained the clue information clearly and helped each other understand it.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.18 Group evaluation: Every team member worked well and respectfully with others and helped each other.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.19 Group evaluation: Every team member communicated effectively and respectfully.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.20 Group evaluation: Every team member was actively involved in solving problems during the workshop.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.21 Group evaluation: Every team member demonstrated learning improvement and good teamwork during the workshop.

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

4.22 What kind of aspect do you think you improved after the workshop? (Select all that apply)

- Decision-making
- Communication
- Collaboration
- Leadership
- Goal-setting
- Problem-solving
- Friendship
- Time management
- Conflict resolution
- Patience
- Organisation
- Self-reflection
- Adaptability
- Negotiation
- Integrate and analyse information

Reliability (Cronbach's Alpha) Analysis of Self- and Peer-evaluation Scales (Question 4.7 – 4.19):

Scale	Number of Items	Cronbach's Alpha
Self-evaluation	7	0.991
Peer-evaluation	7	0.992

For Self – evaluation:

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Self_Q1(4.7)	24.10	63.283	.924	.992
Self_Q2 (4.8)	23.95	62.888	.962	.990
Self_Q3(4.9)	24.04	62.989	.967	.990
Self_Q4(4.10)	23.95	62.456	.977	.989
Self_Q5(4.11)	23.88	62.490	.969	.990
Self_Q6(4.12)	23.95	62.713	.981	.989
Self_Q7(4.13)	23.97	62.375	.979	.989

For peer-evaluation:

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Peer_Q1(4.14)	22.80	67.042	.965	.991
Peer_Q2(4.15)	22.68	67.742	.924	.993
Peer_Q3(4.16)	22.70	66.340	.982	.989
Peer_Q4(4.17)	22.69	66.289	.970	.990
Peer_Q5(4.18)	22.71	66.300	.972	.990
Peer_Q6(4.19)	22.72	66.241	.984	.989
Peer_Q7(4.20)	22.65	66.066	.974	.990

Appendix 12

Belbin Team Role Self-Perception Inventory (BTRSPI)

The Team Role Inventory Test

Department of Chemical & Biological Engineering

Please enter here 

Name:	Click & Type your name
Registration No.:	

What I Believe I Can Contribute to a Team:

I think I can quickly see and take advantage of opportunities.		You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish. Points Remaining: 10 YOU HAVE NOT USED ALL OF YOUR POINTS YET Click Here To Proceed To Part II
I can work well with a very wide range of people.		
I can usually sense what is realistic and likely to work.		
My capacity to follow through has much to do with my personal effectiveness.		
My ability rests in being able to draw people out whenever I detect they have something of value to contribute to group activities.		
My technical knowledge and experience is usually my major asset.		
I can offer a reasoned case for alternative courses of action without introducing bias or prejudice.		
Producing ideas is one of my natural assets.		
I am ready to face temporary unpopularity if it leads to worthwhile results in the end.		

If I Have a Possible Shortcoming in Teamwork, It Could Be That:

I am not at ease unless meetings are well structured and controlled and generally well conducted.

My objective outlook makes it difficult for me to join in readily and enthusiastically with colleagues.

I find it difficult to lead from the front, perhaps because I am over-responsive to group atmosphere.

I am apt to get too caught up in ideas that occur to me and so lose track of what is happening.

My colleagues tend to see me as worrying unnecessarily over detail and the possibility that things may go wrong.

I am sometimes seen as forceful and authoritarian if there is a need to get something done.

I am inclined to be generous towards others who have a valid viewpoint that has not been given a proper airing.

I am reluctant to contribute unless the subject being discussed deals with an area I know well.

I have a tendency to talk too much once the group gets on to new ideas.

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To Part III](#)

When Involved in a Project with Other People:

I can be counted on to contribute something original.

My general vigilance prevents careless mistakes and omissions being made.

I have an aptitude for influencing people without pressurizing them.

I am keen to look for the latest in new ideas and developments.

I try to maintain my sense of professionalism.

I believe that my capacity for judgements can help to bring about the right decisions.

I am always ready to back a good suggestion in the common interest.

I am ready to press for action to make sure the meeting does not waste time or lose sight of the main objective.

I can be relied upon to see that all essential work is organized.

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To Part IV](#)

My Characteristic Approach to Group Work is That:

I have a quiet interest in getting to know colleagues better.

While I am interested in all views, I have no hesitation in making up my mind once a decision has to be made.

I am not reluctant to challenge the views of others or to hold a minority view myself.

I think I have a talent for making things work once a plan has to be put into operation.

I have a tendency to avoid the obvious and come out with the unexpected.

I am ready to make use of contacts outside of the group itself.

I bring a touch of perfectionism to any job I undertake.

I can usually find a line of argument to refute unsound propositions.

I contribute when I know what I'm talking about.

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To Part V](#)

I Gain Satisfaction In a Job Because:

I enjoy analysing situations and weighing up all the possible choices.

I feel that I am using my special qualifications and training to advantage.

I like to find a field that stretches my imagination.

I feel in my element when I can give a task my full attention.

I am interested in finding practical solutions to problems.

I like to feel I am fostering good working relationships.

I can meet people who may have something new to offer.

I can get people to agree on a necessary course of action.

I can have a strong influence on decisions.

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To Part VI](#)

If I Am Suddenly Given a Difficult Task with Limited Time and Unfamiliar People:

I tend to read up as much as I conveniently can on the subject.

I would retain a steadiness of purpose in spite of the pressures.

I would open up discussions with a view to stimulating new thoughts and getting something moving.

I believe that I would keep cool and maintain my capacity to think straight.

I would find some way of reducing the size of the task by establishing what different individuals might best contribute.

I would feel like retreating to a corner to devise a way out of the impasse before developing a line.

I would be prepared to take a positive lead if I felt the group was making no progress.

My natural sense of urgency would help ensure that we did not fall behind schedule.

I would be ready to work with the person who showed the most positive approach.

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To Part VII](#)

With Reference to the Problems to Which I Am Subject in Working in Groups:

I am apt to show my impatience with those who are obstructing progress.

I hesitate to get my points across when I run up against real opposition.

I am inclined to feel I am wasting my time and would do better on my own.

I am conscious of demanding from others the things I cannot do myself.

I am tend to get bored rather easily and rely on one or two stimulating members to spark me off.

My desire to ensure that work is properly done can hold up proceedings.

Others may criticise me for being too analytical and insufficiently intuitive.

I find it difficult to get started unless the goals are clear.

I am sometimes poor at explaining and clarifying complex points that occur to me

You have ten (10) points to distribute amongst the statements on the left, depending on how much you agree with each of them. Statements you disagree with or are indifferent to will be awarded zero points. You may not give negative points to any statement, nor are you allowed to award fewer than ten points in total. You may distribute points as you wish.

Points Remaining: 10

YOU HAVE NOT USED ALL OF YOUR POINTS YET

[Click Here To Proceed To the Results Page](#)

Results:

Scores for Each Section:

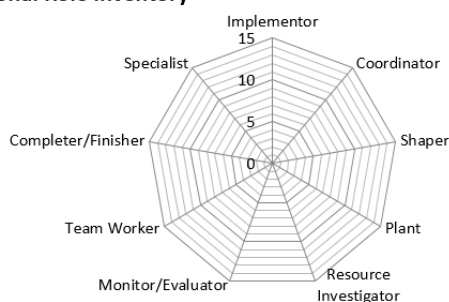
Section	Total									
I	0	0	0	0	0	0	0	0	0	0
II	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	0	0	0	0
IV	0	0	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0	0	0
VI	0	0	0	0	0	0	0	0	0	0
VII	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

Your Team Role is :

==>	Implementor	0
==>	Coordinator	0
==>	Shaper	0
==>	Plant	0
==>	Resource Investigator	0
==>	Monitor/Evaluator	0
==>	Team Worker	0
==>	Completer/Finisher	0
==>	Specialist	0

[Click Here to Complete the Test](#)

Personal Role Inventory



Team Role	Contribution	Allowable Weaknesses
Plant	Creative, imaginative, free-thinking. Generates ideas and solves difficult problems.	Ignores incidentals. Too preoccupied to communicate effectively.
Resource investigator	Outgoing, enthusiastic, communicative. Explores opportunities and develops contacts.	Over-optimistic. Loses interest once initial enthusiasm has passed.
Co-ordinator	Mature, confident, identifies talent. Clarifies goals. Delegates effectively.	Can be seen as manipulative. Offloads own share of the work.
Shaper	Challenging, dynamic, thrives on pressure. Has the drive and courage to overcome obstacles.	Prone to provocation. Offends people's feeling.
Monitor evaluator	Sober, strategic and discerning. Sees all options and judges accurately.	Lacks drive and ability to inspire others. Can be overly critical.
Teamworker	Co-operative, perceptive and diplomatic. Listens and averts friction.	Indecisive in crunch situations. Avoids confrontation.
Implementer	Practical, reliable, efficient. Turns ideas into actions and organises work that needs to be done.	Somewhat inflexible. Slow to respond to new possibilities.
Completer/ Finisher	Painstaking, conscientious, anxious. Searches out errors. Polishes and perfects.	Inclined to worry unduly. Reluctant to delegate.
Specialist	Single-minded, self-starting, dedicated. Provides knowledge and skills in rare supply.	Contributes only on a narrow front. Dwells on technicalities.

Appendix 13

Self-Assessment Form (SAF) used in pilot Belbin Teamwork Workshop

Peer Assessment for Group Work

Name _____

Please enter a score from 0 (worst) to 10 (best) in each row, for yourself and for your team members. If you enter uniform scores across the board, I know you haven't taken this assessment seriously. A 10 should be an unusual score!

Enter your initials in the first column and those of the members of your group in the remaining columns.	<i>me</i>				
Leadership 10 Very strong leader, provided direction, inspired and encouraged others. 5 Willing follower, took directions easily. 0 Frustrated the group, blocked progress, and criticized others.					
Cooperation 10 Worked readily with others, outstanding contributor, anticipated requests. 5 Cooperated with occasional prompting. 0 Rarely contributed or cooperated, worked alone, had to be coerced.					
Initiative 10 Produced good ideas which helped others, "went the extra mile". 5 Accepted other's ideas and improved on them. 0 Criticized other's ideas, never contributed original ideas.					
Attitude 10 Positive, enthusiastic, encouraging others to work better. 5 Neutral, worked with the group without either enthusiasm or grumbling. 0 Negative, complained about the project, worked unwillingly.					
Effort 10 Worked hard on assigned tasks, independently and cooperatively. 5 Worked reasonably hard, also socialized a lot. Occasional prodding needed. 0 Didn't contribute much at all, tasks were unsatisfactory.					
Grade You have 100 points to divide among your team members. Distribute the points in an equitable manner, where each score reflects effort and contribution, (which aren't always the same.)					
Assessment of the group 10 Best group I've ever worked with, the project was fun as a result. 5 Group sometimes worked well together, with occasional problems. 0 Worst group I've ever worked with (or not); this was a miserable experience.					

Who in your group took most of the leadership for this project?

Is your group functioning better, worse, or just differently than at the beginning of the session? Explain.