Personalised e-Learning

Using Social Networks and Personal Learning Environments with Secondary Schools Teachers

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A thesis submitted in the fulfilment of the requirements for the degree of Doctor of Education.

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October 2016

Acknowledgements

I would like to thank Dr Tim Herrick for his continuous encouragement and feedback throughout the duration of my dissertation especially with his excellent support in helping to shape this thesis. I would also like to thank all the Higher Education academics at the School of Education at University of Sheffield, as well as all those involved with the smooth running of the EdD.

This work would not have been possible without the understanding and love of my family and close friends.

Abstract

This thesis proposes to add value to the traditional e-learning systems by personalising the content being presented. The personalisation process was brought together through the amalgamation of crowdsourcing techniques, explicit with learners' interests, and learner profiling technologies. A prototype called iPLE, intelligent personal learning environment, was developed and tested within an empirical study where participants experienced and compared the proposed iPLE with a static e-learning environment and a standard face-to-face delivery. A number of data collection instruments have been integrated within the empirical study to accumulate participants' feedback. The results were fully documented and analysed using a combination of quantitative and qualitative data analysis tools that generated essential assessment information. An indicative improvement was reported following the data analysis and evaluation of results that led to the conclusion that even though there is plenty of room for further development and research, the combination of the proposed techniques does help and assist in rendering e-learning more effective.

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List of Abbreviations

API	Application Program Interface
CSS3	Cascading Style-Sheets version 3
e-Learning	electronic Learning
F2F	Face-to-Face
HCI	Human-Computer Interaction
ICT	Information Communications Technology
iPLE	intelligent Personal Learning Environment
LMS	Learning Management System
PHP	Pre-processor for Hypertext
PLE	Personal Learning Environment
PLN	Personal Learning Network
PLP	Personal Learning Portfolio
TAM	Technology Acceptance Model
VLE	Virtual Learning Environment
Web 2.0	Second generation Web technologies
WWW	World-Wide Web

Glossary of Terms

Adaptive Learning Theory – A learning theory that conceptualises the use of technology to customise and tailor educational resources to accommodate the specific and unique needs of each learner.

Connectivism – A theory first put forward by Siemens (2004) presupposes that in the digital information age knowledge is the product of influences from a number of sources, both human and non-human. When an individual is able to reconcile all the connections from the various information sources in a meaning-making exercise, learning happens.

e-Learning – Is learning on Internet Time, the convergence of learning and networks. e-Learning is a vision of what corporate training can become. E-Learning is to traditional training as eBusiness is to business as usual. (Cross, 2004)

Learning Technologies – Different media, technology-based applications and tools that can be used to facilitate and support learning. Learning technologies also include the 21st century digital practices that would require a specific set of skills and attitudes.

Pedagogy – The art and science of teaching. In this thesis it is assumed that such a concept is not to be taken for granted and that teaching requires specific skills and experience.

Personal Learning Environment – Electronic personal learning spaces that are traditionally made up of two components, namely, a personal learning network and a personal learning portfolio.

Personal Learning Network – A virtual and informal network of friends and resources that a learner can interact with and from which information and knowledge is extracted for personal use. A personal learning network usually forms part of a personal learning environment.

Personal Learning Portfolio – A compendium of academic works that act as educational evidence of a particular learner. It is commonly part of a personal learning environment and is used to assess the learner, keep an academic record, and act as feedback to the learner.

Self-Determinism – A learning theory that promotes the motivation of the self within a learning environment. Deci & Ryan (1985) initial theory about intrinsic and extrinsic motivation and basic psychological needs applied to the educational domain.

Social Constructivism – A theory posited by Vygotsky (1997) that describes how meaning making can be aided by the social context in which the learner is found. Therefore, community and collaborative activities become an important influence on the learning.

Social Networks – This term refers to the connections between individuals in a community. Christakis and Fowler (2011) define this as "*an organised set of people that consists of two kinds of elements: human beings and the connections between them…Real, everyday social networks evolve organically from the natural tendency of each person to seek out and make many or few friends, to have large or small families, to work in personable or anonymous workplaces*" (p. 13).

Technology Acceptance Model – Based on the Davis (1993) theory of reasoned action it models how learners come to accept, usefulness and ease of use, a system like an e-learning environment.

Virtual Learning Environment – This term broadly encompasses virtual spaces that are used for learning. Such environments can include Learning Management Systems (LMS), Multiuser Virtual Environments (MUVEs), Virtual Worlds (VWs), and Serious Games.

Web 2.0 – O'Reilly (2005) coined this term to demarcate a phase within the evolution of the WWW whereby websites allow user-generated content thus encouraging web user to author, contribute, share, and distribute their own and others material. Social media were a direct result of this particular phase that also has dynamic characteristics in contrast to previous static read-only counterparts.

World-Wide Web – The massive knowledge base of information spread over the global network of servers known as the Internet.

Chapter 1

Introduction

The motivation that triggered off this original work initiated during a research project that focussed mainly on ways of how to optimally make good use of web resources while concurrently pursuing another personal research area and passion, e-learning within the higher education domain. E-learning, as initially coined by Jay Cross, refers to "eLearning is learning on Internet Time, the convergence of learning and networks" (Cross, 2004, p.104). A relatively new research topic, crowdsourcing, emerged through a societal need to control the information overload that the Internet was inevitably imposing but also due to a combination of academic enthusiasm coupled with paranoia for completeness not to miss out on any relevant information, trivial as it may be. As this was not enough, there still needed other elements to the formula to accomplish and fulfil a comprehensive e-learning solution. Previous work that was personally performed fifteen years earlier into the next generation search engines, the employment of user profiling and personalisation techniques was successfully employed. This research reports on how these techniques, that evolved since then, in combination with crowdsourcing promise to enhance e-learning effectiveness and so the potential of the

added-value prospects renders it academically and pedagogically appealing to investigate and enquire. This research could potentially initiate an educational praxis whereby mutually exclusive techniques independently valid and well founded could be operationally merged together to enhance the services offered by e-learning providers.

The learning environment proposed combines the application of crowdsourcing via social networks and the use of Web 2.0 technologies, together with personalised customisation through the use of the learners' interests, and learner profiling through computer science techniques. The combination of such techniques is required to be analysed, researched and evaluated well to determine whether it is effective or not. This encapsulates what this research work is all about which understandably entails a number of challenging yet gratifying endeavours that needed to be tackled and resolved. Nonetheless the entire task, the different techniques and the exhilarating research undertaking could potentially have a considerable and lasting impact on e-learning in general.

The rest of this chapter is organised as follows. The next section formally highlights the problem being addressed together with a brief run-through of how the three proposed practices address this problem thereby setting the scene for this thesis. The theoretical underpinnings together with the research methodologies adopted, reflecting my own epistemological standpoint, are addressed in the following section. The research question is posed in Section 1.3 accompanied by the main hypothesis and three challenges that emerge from the hypothesis. Each of these challenges is expanded in some detail, as they constitute the basis of the work encapsulated within the empirical study. A summary of results that emerged from this research, as well as, a full summary of the contributions of this work to the area of e-learning is presented in the next two sections. Finally a chapter-by-chapter outline of this thesis is given to further assist the reader while reading through the details of this research study as part fulfilment of my Ed.D. within the higher education stream.

1.1   *Problem Definition & Setting The Scene*

In an effort to enhance e-learning effectiveness three of the most common e-learning challenges, identified by several e-learning researchers amongst which are O'Donoghue, Singh, & Green (2004), Olson, et al., (2011), and Noesgaard & Ørngreen (2015), gave

rise to a composite problem definition whereby isolation, motivation and being impersonal feature highly. Each of these e-learning issues was separately tackled and addressed to set the scene for the rest of the thesis. In an effort to address the compound problem, the empirical study was designed accordingly in line with three corresponding learning theories and associated approaches applied as part of the learning environment.

Isolation refers to the learner's lonely experience during an e-learning course without any contact whatsoever with other learners or educators. Bousaaid, Ayaou, Afdel, & Estraillier (2015) investigate this phenomenon and conclude that the simple act of participating within a network of like-interested persons within a social network assists e-learners and renders the entire process more effective. They argue that latest Web 2.0 technologies actually promote even more communal practices whereby learners are able to collaborate, share and communicate freely with others. Similarly Davies & Merchant (2009) highlight the ability of Web 2.0 to enrich and transform the educational experience. Web 2.0 (O'Reilly, 2005) is considered to be a phase, or the second generation, of web technologies that promote "*user-generated content coupled with mechanisms that enable and enhance user interaction*" (Davies & Merchant, 2009, p. 4). The authors identify four distinguishing characteristics to illustrate how web users can exploit Web2.0, namely, through being present, the ability to modify and generate content, and finally by partaking in social activities. These features, apart from reducing the isolation problem, go further and promote the individuality of the users while establishing a personalisation element. The learning theory adopted to address this issue was Connectivism which, together with the approach and associated implementation, are addressed in the following chapters.

Learner motivation, which is the second e-learning issue being addressed, could be affected by a number of issues but the lack of enthusiasm usually results from either learners who lack determination, or simply are not interested in the subject matter. Attempting to engage learners with the educational content by rendering it relevant to them and relate it as closely as possible to their own interests has been investigated by Tang & McCalla (2004) where they highlight the importance of learner feedback in order to offer in return course materials that motivate further individual students based on their personal profile. Motivation is an important issue in every learning situation but in regards to e-learning the need for learners to be self-determined is even greater. In this

respect the self-determination learning theory has occasionally been coupled with the corresponding learner profiling approach to address this particular issue.

Finally, the third e-learning problem identified in the previous section, that of being impersonal is addressed through the dynamic and adaptive nature of Web 2.0 features mentioned earlier. The adaptive learning theory is associated to this particular issue in tandem with personalisation techniques as part of the solution that this study attempts to address, propose a solution, and investigate the outcome.

The personalisation of the learning experience online featured as one of the top six trends in the 2013 Horizon report (Johnson, et al., 2013), as well as one of the top six significant challenges within the same report as the existent teaching tools and methodologies do not assist and support academic personalisation. The report highlighted the predicament of a one-size-fits-all teaching methodology that intensified the need for customised e-learning that addresses the student's needs. This in turn triggers the development and use of novel online technologies that enable differentiated education through individual learner choice and control. A year later personalised e-learning featured again in the 2014 report (Johnson, et al., 2014) as an innovative pedagogical practice as it explicitly states that "*part of engaging students in deep learning across online environments is personalizing the experience*" (p.19).

These online environments are also known as VLEs (Virtual Learning Environments) that have been subject to numerous research projects like Pearson, Gkatzidou, & Green, (2009) who investigated the adaptation of the VLE to support learners' needs and preferences. Similar projects like those reported by Brusilovsky & Peylo (2003), Canales, Peña, Peredo, Sossa, & Gutiérrez, (2007) and Peredo, Canales, Menchaca, & Peredo, (2011) investigated the use of artificial intelligent techniques to adapt web-based educational systems and tailor them to the learners' needs, interests and preferences. The use of personal learning environments (PLE) in conjunction with VLEs have also been subject to investigation (Wilson, Liber, Johnson, Beauvoir, Sharples, & Milligan, 2006; Attwell, 2007a; Schaffert & Hilzensauer, 2008; Pearson, Gkatzidou, & Green, 2009) as the value of personalistion at the level of learning management systems is considered crucial and instrumental. A personal learning environment according to Morrison (2013) incorporates a personal learning portfolio (PLP) together with a personal learning network (PLN). These are expanded further in Chapter 2 but the concept of a personal

environment facilitates further the customisation process as it allievates the issues of isolation, motivation and being impersonal.

The advent of Web 2.0 technologies brought about a new aspect to customisation as learners' contibutions can potentially put together a more complete picture of the their needs and interests. Studies related to the adoption of Web 2.0 and social networks in academia (Davies & Mechant, 2009; Grosseck, 2009; Chatti, Agustiawan, & Jarke, 2010; Dabbagh & Kitsantas, 2011; Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012; Miranda, Isaias, Costa, & Pifano, 2013; Hew & Cheung, 2013; Karvounidis, Chimos, Bersimist, & Douligeris, 2014) have rekindled new interest in adding value to e-learning by personalising and tailoring the learning experience. Web 2.0 also gave rise to a simple practice of making use of the collective knowledge of potential contributors to tackle a shared problem or to accomplish a specific mission. Such a practice is commonly known as crowdsourcing and has been applied and functionally proven within industry (Cox, 2011). The contextual reference to crowdsourcing in this work is a direct reference to the numerous web resources being academic material in addition to multitudes of contributions performed by educators and domain experts within blogs, reports, proceedings and other online publications. This thesis reports on the use of crowdsourcing in combination with other practices to add value to e-learning. My interpretation of crowdsourcing in this respect is specifically the application and practical use of data provided over social networks to the domain of education.

This study aims to investigate the theoretical and practical educational connotations with regard to methodology, pedagogy and effectiveness, of all the three practices mentioned above. Their combined use within a personal learning environment encapsulates the learner's needs and interests, enhanced with Web 2.0 techniques, and complemented with the collective feedback of fellow learners, can potentially contribute to a novel and added-value e-learning experience.

1.2 *Theoretical Underpinnings and Research Methods*

The combined use of the trio of techniques that collectively assist in the accomplishment of this research project, namely, crowdsourcing through Web 2.0, personalisation through the profiling of individual learners, and adaptation through personal learning

environments, it stands to reason that e-learning is the principal area of focus and research, particularly within the higher education field. Specifically this work investigates in depth the arrangement and blending of three independent yet compatible research areas in their own right to the mission of enhancing the effectiveness of e-learning. The main emphasis of this EdD thesis is purely educational, specifically to enhance by adding value to the e-learning experience. This focus can be evidenced in the fact that this study investigates the pedagogical ramifications of the combination of established techniques rather than the three underlying practices in isolation. The proposition here is to employ different methodologies that have been derived from other different research areas to exploit the availability of educational content made available through numerous online educators and information providers as well dynamic knowledge-bases populated through the social media, in an effort to personalise the academic material and the learning experience to the the specific requirements of each single learner. As a result such a motivation impelled this research project to move towards the iPLE, a personal learning environment that is intelligent, composed of mainly two components, namely, the Personal Learning Network implemented through crowdsourcing and Web 2.0, together with the Personal Learning Portfolio implemented through the personalisation of the content to enhance and improve e-learning effectiveness. Realistically this research project deployed an online e-learning platform that tailors the content and environment to the specific learner's academic needs and generic interests. The personal network avails itself of the massive web knowledge-base as crowdsourced sources are collected and collated using appropriate techniques and instruments in an endeavour to personalise content to fit the individual learner's profile that evolves along the way. Epistemologically my post-positivism views influence and effect the decisions taken and implemented as the context and circumstances of each of our experiences online holistically affect and impinge on the global outcome of what and how much we take away at a personal and intellectual level. The facilitating learning medium determines the amount and quality of the academic content that is customised and which is being investigated. Personal insights and attitudes regarding e-learning in general have an effect on the system as well as the content delivered that this thesis reports upon. In this respect another established theory of this study lies within the self-determination approach as this novel environment is being proposed, which also addresses the 'motivation' issue introduced earlier. Deci & Ryan (1991) distinguish between various kinds of motivation in their self-determination theory, founded on diverse motives or objectives that trigger

off an action. Human motivation is imperative in the effectiveness of e-learning, be it intrinsic as in doing something simply because it is intrinsically appealing and pleasing, or extrinsic as it leads to a separable outcome.

The integration of Web 2.0 techniques is also be an important contributing factor in this proposal thereby bringing in the connectivism theory that asserts the existence of a solid association amongst education, working knowledge, and information. Gurzick & White (2013) argue that through connectivism Web 2.0 technologies connect knowledge workers to their online personal networks for information exchange, informal learning, and social support, thereby supporting the notion of a personal learning network (PLN) and a concrete way of dealing with isolation, identified earlier as the second e-learning issue that this thesis addresses.

Last but not least is the adaptive learning theory that completes the set of three theories at the foundation of this study. This theory is imperative to the concept of customisation and the benefits extracted from personalising knowledge and academic resources to the specific learner requirements, interests and needs. This addresses the third and final issue that caters for the impersonal nature of e-learning systems. The combination of these theories is expanded later in the next chapter as they jointly justify my epistemological stance regarding the reasoning behind this research. In the next section I seek to formalise the proposed research through the main research question and measurable hypothesis.

1.3 *The Research Question and Main Hypothesis*

In this section the main hypothesis encapsulates the aforementioned vision about e-learning effectiveness and the combination of techniques in an attempt to enhance it. The hypothesis is based upon the main research question around which this thesis is organised. A series of sub-questions that unpick the themes within the main question can be considered as the main challenges that address all the issues related to the expected outcome that are quantitatively measured and evaluated. Qualitative data analysis also forms part of this thesis as a mixed approach is adopted. Details about the data collection and analysis methods used are expanded in Chapter 3.

The central research question is:

Does the combination of crowdsourcing, learner profiling and

personalisation render e-learning more effective?

Following the main research question it is now possible to state the hypothesis of this thesis from which the main challenges are extracted. The hypothesis of my thesis is the following:

It is possible to enhance the effectiveness of e-learning at a higher education

level through the combination of three techniques, namely:

- *extracting content from social networks,*
- *personalising content to the learner's needs and interests,*
- *persistently evolving the learner's profile.*

This extensive hypothesis gives rise to a number of challenges that are now individually expanded and clarified.

i.   *Does personalisation render the learning process more effective?*

Research studies conducted to investigate the effect of personalisation are very common in Computer Science especially in the area of Artificial Intelligence. Studies by Pazzam & Billsus (1997), Fisk (1996), Davies & Weeks (1998), and Idris, Yusof, & Saad, (2009) are just a few examples of how personalisation can be successfully applied to enhance an automated process as the task is tailored and shaped on a model of the same human user. Similar studies related to e-learning (Dolog, Henze, Nejdl, & Sintek, 2004; Brusilovsky & Peylo, 2003; Brusilovsky & Millán, 2007; Adler & Rae, 2002; Corrado, Castiello, & Fanelli, 2008; Mencar, Castiello & Fanello, 2008a) have also investigated how the personalisation process can be applied to e-learning contexts. The main issue that this

particular sub research question is addressing goes beyond the emphasis of these studies, and rather than focussing on learner profiling technique itself and the relation between learner profiles and pedagogical resources, it specifically converges on the overall effectiveness of employing such a process. The data collected during the empirical study specifically addresses this question and the results are evaluated and discussed in the final chapters.

ii.   How effective is the use of personal interests within an e-learning environment?

Use of personal interests to model the content presented can effectively enhance the learning process according to my hypothesis, and so this sub-question specifically addresses learner interests and how these interests, implicit or explicit, can have a positive effect on the overall effective outcome of e-learning. A number of studies like Liang & Lai (2002), Seo & Zhang (2001), and Crabtree & Soltysiak (1997) have investigated the possibility of modelling different systems according the user interests. Explicitly stated interests are usually collected beforehand during registration to a new service or an application like in Stermsek, Strembeck, & Neumann (2007), while implicitly stated interests are either extracted from user activities (Kim & Chan, 2008), or through the interaction with tagged objects (Carmagnola, 2007). The empirical study also includes instruments to collect data about the effect of using learner interests as part of the e-learning environment. Additionally, the way the user interests contribute to create a learner profile and how they are employed within this research study is elaborated in Chapter 2 and Chapter 3 respectively.

iii.   Is an adaptive dynamic learning environment beneficial to e-learning?

The final sub-question addresses the proposed learning environment as a whole. Numerous academic projects (Gooren-Sieber & Henrich, 2012; Leone, 2013; Manouselis & Sampson, 2002) have investigated the advantages of using personalised learning environments especially in relation to higher education and lifelong learning. Pearson, Gkatzidou, & Green, (2009) examine how personalisation and learning environment adaptation can assist in the special needs and specific preferences of disabled learners.

The authors propose an adaptable model that is learner centric that focuses on accessibility, personalisation and flexibility. They conclude that although they "*may not be able to guarantee an improved experience in all cases*", a more inclusive educational setting that adapts to the learners' requirements and interests is possible. The learner centric approach can possibly "*offer maximum potential for wider adoption not only by disabled learner groups but within the mainstream community*" (p. 756). This study and this specific sub-question attempts to address these same issues within the mainstream of higher education that Pearson, Gkatzidou, & Green, (2009) only refer to. Data collected during the empirical study is analysed to shed light on this sub-question and drive conclusions and comparisons to similar studies.

The research question, main hypothesis and the sub-questions have been stated to clarify exactly what this research sets out to achieve. It is my belief that the overall effectiveness of e-learning can be improved by integrating content from social networks with the main education material, while at the same time addressing the learners' interests within a personalised learning environment.

The specific sub-questions were derived directly from the main hypothesis in an effort to fragment e-learning effectiveness into measureable quantities and evaluate the validity of the same hypothesis. A summary of results and contributions now follow to briefly underline the overall outcomes together with the validity of my hypothesis as well as the supported end result to the main research question.

1.4   *Summary of Results*

The main focus of this thesis is to personalise e-learning in an effort to enhance the effectiveness of e-learning. The idea is to combine the use of the learners' personal interest with material content from social networks to tailor and customise the educational material presented. The learner interacts with the personal learning environment that in turn uses the learner's feedback and interaction to adjust the content for the next interaction. Chapter 4 describes exactly how the intelligent Personal Learning Environment or iPLE works.

Three learning theories form the theoretical basis of this work together with my epistemological stance, as a result of which the methodology, design and eventually the implementation of this research were determined. The first of these learning theories is sometimes referred to as the digital version of the socio-constructivism learning theory (Kop & Hill, 2008) in a way that learners build their own knowledge acquisition structures through their surroundings and other learners, while the traditional educator is transformed into a facilitator. Connectivism takes this learning theory a step forward and employs the online community as the environment and medium for such constructive learning to happen. Siemens (2004), who originally coined the term connectivism, states, *"A community is the clustering of similar areas of interest that allows for interaction, sharing, dialoguing, and thinking together."* The online accessibility of knowledge and information, as well as the ease to participate and benefit from online communities like social networks render this key learning theory highly relevant and essential.

The second learning theory, that in my opinion complements the previous learning theory, is the self-determination learning theory. One of the principles of connectivism (Siemens, 2004) is that learning in itself is a personal decision-making process that each individual chooses what to learn. Self-determination learning theorists like Deci & Ryan (1985) and Deci, Vallerand, Pelletier, & Ryan (1991) argue that much of the learning process is controlled by the learner depending on the individual interest in learning. This theory promotes the valuing of education by the learners themselves in combination with a strong confidence in their own personal capacities and educational attributes. If a learner refuses outright to learn, shutting down any possible communication medium or enabling environment, then the learning process has limited to no chance of succeeding. The point being that self-determination, especially in open and self-controlled learning environments, is a quintessential factor that lies at the basis of this study.

The final learning theory that contributed to the theoretical foundations of this research which in turn shed interesting results on the same theory, is the adaptive learning theory. Even though an educator can potentially adapt and adjust to the different requirements and interests of each specific student, the process is not easy or straight forward, and eventually becomes impossible to maintain as the number of learners keeps on increasing. For this reason this theory lends itself very well, similar to the connectivism learning theory, to the digital age and e-learning. The underlying understanding with adaptive systems is that a tailored or personalised experience is more effective and beneficial to

the user (Brusilovsky & Peylo, 2003; Oxman & Wong, 2014; Peredo, Canales, Menchaca, & Peredo, 2011). The results discussed in detail in Chapter 5 shed further insights about these learning theories that characterise the nature and foundations of the study itself.

The research methodology has been totally motivated and inspired by the underlying learning theories mentioned above, as a result of which a new and innovative methodology has been proposed and implemented. It is based on the integration of a number of methods that mutually fit together to present a coherent learning environment. The techniques used reflect the pedagogical techniques adopted and as a result of which an interesting and novel e-learning environment has been proposed and put forward for rigorous testing and evaluation. First among the techniques used involved the use of social networks as they played an important role to supplement the educational material with related content that has been provided by the online community. The term crowdsourcing refers precisely to the aggregation and collation of information provided by online contributors that a web-based system can potentially use (Ramakrishnan & Halevy, 2011) and productively take full advantage of (Casal, 2011; Fitt, 2011). Such a concept is possible through the realisation of Web 2.0 technologies (Sclater, 2008), whose potential has already been investigated within schools (Davies & Merchant, 2009) and the higher education arena (Weld, et al., 2012). Another technique integrated within the resulting e-learning environment involved the creation of an electronic profile of each individual learner that made use of the environment. Every learner had a personal profile created the first time s/he made use of the intelligent personal learning environment, and subsequently tweaked, adjusted and refined every time the same learner interacted with the iPLE web-based application. This is commonly referred to as user profiling (Gauch, Speretta, Chandramouli, & Micarelli, 2007) and subscribes to the notion of the adaptive learning theory mentioned earlier.

The empirical study in itself is another result of this thesis that brought together all the above results into a tangible web-based learning environment that was used with a number of participants to generate a series of test results. The outcome and its detailed interpretation are reported in Chapter 5 and Chapter 6 respectively giving a complete picture of the full set of results and pedagogical interpretations. Such results were extracted through a series of data collection instruments that were designed and integrated as part of the learning environment itself. A mixed method approach was

adopted when it came to data collection. Quantitative data was collected considering a hypothesis has been stated earlier and had to be tested, together with qualitative data collected prior, during, and following the empirical study. Results emerging from this collected data were made possible through a thorough data analysis process using well-established electronic tools, namely Excel, SPSS and NVivo. The evaluation of these results and the contributions emerging from this study have been summarised in the following section.

1.5 *Summary of Contributions*

The research question and the main hypothesis that led to the investigation of the pedagogical effects of personalising e-learning made it possible to generate a number of results, summarised in the previous section, that factored in a number of interesting contributions which I am proud to summarise and defend. The first three contributions mainly refer to the methodology employed throughout the study, while the final two contributions can be attributed to the outcome of this thesis.

i. The research question stated in Section 1.3 led to a multi-faceted hypothesis within the same section that brought together a combination of techniques or technological methods. The concept of employing these methods together to productively attempt to optimise the effectiveness of e-learning is a major contribution in itself. The hypothetical setup of this attempt has already been accepted as contribution within the research domain when it was presented at both the one-day research conference on Higher Education in the Globalised Age at the University of Sheffield (Montebello, 2014b), and at the 7th International Conference on Education, Research and Innovation (ICERI 2014) in Spain (Montebello, 2014a). A full journal paper including the other four contributions has been submitted for review at the Journal of Educational Technology & Society entitled "Evaluating the effectiveness of an intelligent e-learning environment as opposed to conventional e-learning and traditional face-to-face: A three-way comparison". This three-way comparison is expanded further below when the fourth contribution is presented.

ii.   Another contribution of this study falls within the domain of educational learning theories. As summarised in Section 1.4 three founding learning theories, namely, connectivism, self-determination, and adaptive learning theories have been merged together as an theoretical basis for a multi-faceted research project due to the nature of its hypothesis. Such a combination of learning theories, even though they have distinct differences, they are not mutually disjointed and it has been shown that it is possible to fuse and bring together different learning theories to reach and support the main research hypothesis. Connectivism (Siemens, 2004) lends itself to the pedagogical benefits of online connections especially through the use of social networks, the self-determination learning theory (Deci, Vallerand, Pelletier, & Ryan, 1991) highlights the importance that learners need to be motivated especially when it concerns their needs and interests to seek information and supplement their knowledge while dynamically refining their learning profile, and the adaptive learning theory (Oxman & Wong, 2014) that maintains that personalisation of educational content is imperative to ensure the individual educational needs of learners are addressed accordingly. This thesis amalgamates and addresses all three ideologies that reflect my own personal epistemological beliefs about knowledge and education.

iii.   The environment used to perform the empirical study during this research, referred to as the intelligent personal learning environment or iPLE, is the third contribution that tangibly brings together the previous two contributions. The iPLE follows a serious of personal learning environments reported in academic journals and conference proceedings that have been developed to similarly collect data, produce results and draw educational conclusions. Chapter 2 extensively refers to these earlier environments and their conclusions, but none of them brings together such a combination of techniques and learning theories in an effort to enhance e-learning effectiveness. As specified earlier the iPLE is at the centre of a journal paper submitted for review as it epitomises all the work done and all the research performed together with the results and conclusions. This contribution fits nicely within the literature of PLEs as it addresses a specific niche area that intensified its impetus these last couple of years as evidenced in the annual Horizon reports by Johnson, et al., (2013) and Johnson, et al., (2014) mentioned earlier. Other numerous researchers have contributed to the PLE research area and Fiedler & Väljataga (2013) have investigated how these researchers have tackled this specific

area. In their comprehensive review the authors point out that there exist two major conceptual strands of personal learning environments research that characterise the evolution of PLE over these last years. On one side lie pragmatic PLE researchers who investigate the integration of the environment with existent academic institutional platforms, and on the other side the theoretical or conceptual researchers who are concerned with the learners' development of disposition, self-regulated learning and informal education. This study falls within the second category of PLE as it subscribes to the self-regulated concept of the PLE as clearly argued by Tu, Yen & Sujo-Montes (2015). The authors insist that these environments (PLEs) need finer personalisation while requiring greater technological input as well as maintaining a design based on a sound pedagogical framework. Wheeler (2012) had earlier outlined the close connection of PLEs to self-regulated learning as he contextualised self-regulated learning within social learning environments, while highlighting the fact that some aspects of the PLE are characterised by collaborative and social networking tools.

Additionally, during the write-up of this thesis, the 2015 and 2016 Horizon reports indicated a clear focussing shift towards personalising learning and adaptive learning technologies (Johnson, et al., 2015). In particular the latest of these reports (Johnson, et al., 2016) identified '*Keeping Education Relevant*' and '*Personalizing Learning*' as considerable hurdles encumbering the uptake of technology in HE, and 'Learning Analytics' and 'Adaptive Learning' as imperative steps forward in higher education technologies. It is worth pointing out that the Horizon reports are a major source of information regarding global emerging technology uptake in regards to academic and innovative investigation (NMC, 2016).

iv. The first of the two contributions attributed to the outcome of this thesis is the unprecedented three-way comparison that is fully documented in the discussion chapter towards the end of the thesis. Comparing a newly proposed learning environment to the traditional face-to-face modality is common practice and expected as part of the literature. The fact that the iPLE is an additional layer above the static e-learning platform creates a precedent whereby the empirical study was planned and designed to accomplish a unique comparison between three teaching modalities, namely, face-to-face (F2F) or the traditional teaching mode;

virtual learning environment (VLE), which represents the static e-learning platform; and the intelligent personal learning environment (iPLE). The comparison was essentially different from the normal comparisons found in e-learning systems literature because of the dual fact that the iPLE was proposed as a potential enhancement over the static e-learning medium, while concurrently required a control comparison to the classical F2F that is customary to perform. Such an arrangement provided an interesting setup during the actual study, described in full in Chapter 3, where the participants were divided into three groups, attending the same part of course in parallel using the three different modalities, for three weeks in sequence. No study of which I am aware of has ever been setup in such a way to ensure that all the participants are exposed to all the material, subjected to all the modalities, and alternating three times in a cycle to ensure ethical and academic impartiality. As mentioned earlier in the first contribution a journal paper highlighting this three-way comparison has been submitted for review at the *Journal of Educational Technology & Society*.

v. The final contribution refers to the outcome of the main research questions itself and the conclusion of this thesis. Chapter 7 draws a number of conclusions following a thorough discussion of the results in the previous chapters, but converges on answering the research question set initially in this chapter. An indicative improvement was reported following the data analysis and evaluation of results that led to the conclusion that even though there is plenty of room for further development and research, the combination of the proposed techniques does help and assist in rendering e-learning more effective. This is the result of the collective contributions that characterise this thesis.

1.6 *Thesis Outline*

This chapter sets the scene for the entire thesis by underlining the research area under consideration and setting the main research question together with the hypothesis and a number of related sub-questions. A summary of the results and the main contributions is given followed by a short description of each chapter. This provides a comprehensive outline of the thesis giving a coherent narration of the process being documented, as well as assisting the reader to comprehend the bigger picture of my work.

Chapter 2 presents a literature review of the main underlying technologies, concepts and learning theories that characterise this thesis, as well as provide the necessary background information to the reader to be in a better position to appreciate the work performed.

Chapter 3 gives details of the methodologies employed during the study. These include details of the empirical study together with theoretical underpinnings that characterise the entire process, as well as, issues about data, ethics, validity and reliability.

Chapter 4 is all about the online environment that was purposely developed for this empirical study whereby a combination of techniques were merged together to create a personalised learning environment. Apart from the obvious webpage development tools and techniques required to create an online portal, other techniques have been included due to their contribution to the study at hand.

Chapter 5 presents the various results that were collected during the study. These include information about the participants and their patterns, data collected from questionnaires, focus groups, surveys and evaluation forms.

Chapter 6 offers a comprehensive discussion and critical evaluation of the research question posed earlier in this thesis. This chapter brings all the previous chapters together as a collective perspective is given on the entire study from its initial conception, design, underlying rationale, data collection, and significance of the results.

Chapter 7 brings the thesis to a close with a thorough revisit to the research question to critically evaluate the overall project performance, as well as underline and justify any limitations of this research, while recommending future work and directions.

Chapter 2

Literature Review

In this chapter I present a literature review of the main underlying technologies, concepts and learning theories that characterise this thesis. This provides the necessary background information to ensure that the reader is aware of all the essential literature required to better appreciate and position the research study presented. Four subsections now follow to deal with the main areas that characterise this study and its underlying research aspects, followed by another subsection that delves into a number of case studies. The first of these subsections highlights the combination of the three approaches adopted within the project and that form part of the underlying conceptual framework. Their ultimate goal is to personalise e-learning and enhance effectiveness but the way they are brought together is incrementally introduced by independently expanding each one of them. These individual methodologies are justified and well-founded within respective learning theories that are presented in the next subsection. The characteristic properties of the different learning theories are presented together with the way they theoretically coalesce into a functional e-learning environment that

could potentially add value and enhance effectiveness to current state-of-the-art online educational portals. The third subsection specifically tackles potential issues related to e-learning effectiveness as this features within the main question, stated in the previous chapter, as well as within the sub-questions. It is therefore imperative that all the aspects related to effectiveness of e-learning are investigated, clarified and later on employed to evaluate the set objectives.

2.1 *Approaches Adopted*

The particularity of this research study is primarily due to the adoption and application of a number of approaches in a strategically-designed combination of individually applied techniques, namely, personal learning networks, learner profiling and personalisation. These are eventually coupled in the next section with associated learning theories, namely connectivism, self-determination, and adaptive learning respectively. The inception of combining a number of techniques originated from the educational relevance and use of a Personal Learning Environment (PLE). The reason for adopting the use of personal learning environments is entirely due to their capability of personalising the learning process and creating an environment within which the student can be truly immersed. A Personal Learning Environment, which, in contrast to a course-centric learning management system, such an environment is student-centric, and predominantly constitutes an academically tailored environment (Sclater, 2008). A personal learning environment, as shown in Figure 2.1, has two dimensions to it, namely, a Personal Learning Network (PLN) and a Personal Learning Portfolio (PLP). Personal learning networks are traditionally considered to encompass the online communities learners are registered with, and with whom they engage with to contribute and exchange information (Leone, 2013). On the other hand, personal learning portfolios are considered to be a collection of works that reflect a student's academic efforts, progress and accomplishments (Gooren-Sieber & Henrich, 2012). These two dimensions, the PLN and the PLP, together with the outcome of their combination, the personal learning environment, underline the three approaches adopted and the associated learning theories, that in theory are being investigated to address the three e-learning issues highlighted in Chapter 1.

PLE: A framework that uses Web 2.0 tools that allows learners to take control of and manage their own learning

PLN: A dimension of the PLE, where the learner develops professional relationships that are based upon a common interest, project
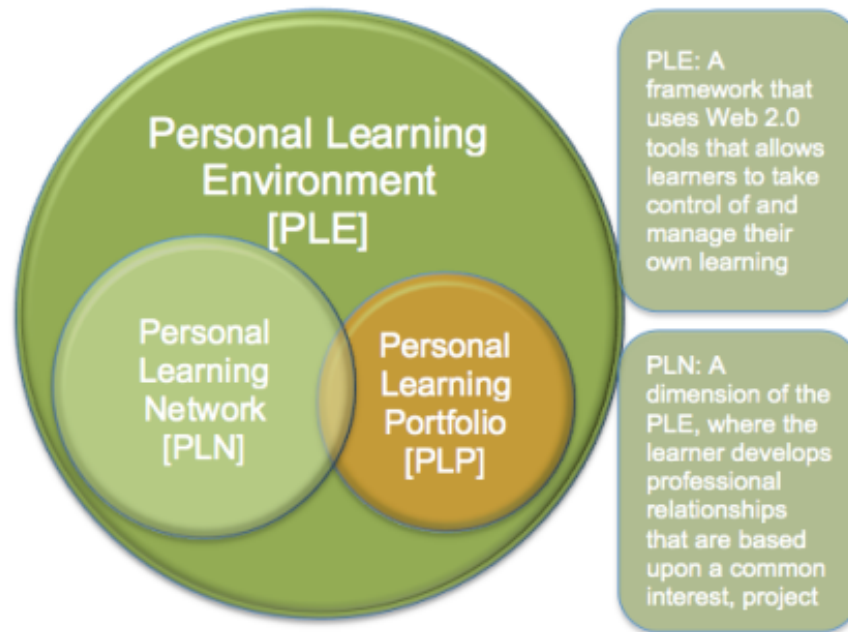
Figure 2.1 – A visual representation of a Personal Learning Environment system (Morrison, 2013).

a) *Personal Learning Networks and Crowdsourcing*

As highlighted earlier Leone (2013) emphasises the importance of a learner support system made up of social connections and online resources. This learning network is unique to individual learners as it evolves over time and through continuous interaction that eventually contributes to the personal and professional development and knowledge. Personal Learning Networks (PLNs) are firmly set within the connectivism learning theory, that is expanded later in Section 2.2, and their ultimate goal is to empower learners and educators by building a personal community of peers and knowledge providers online in a way to share, collaborate and source information, ideas and knowledge. The potential of having a massive online knowledge base at one's fingertips is intense and overwhelmingly powerful that is sometimes overlooked and not taken advantage of. To build such a network a person needs the adequate tools, social networking tools, to be able to connect and interact with other web users who likewise are developing their own personal network. Every individual can decide on the way to go about extending one's network while at the same time defining the way to learn, what to learn, and at which pace. Such networks automatically promote collaboration and sharing thereby fostering a communal sense of belonging and non-isolation. Developing a private learning network is not a simple task or a decision following an

impulse to do so, but a mind-set and a way of life. It is a conscious choice of continuous learning, a dedication to search, collect and curate interesting information, and a passion to create, distribute, share and collaborate with other like-minded people while employing the Internet as a communication medium. Typically a minimal set of tools and activities required for a personal learning network require one or more social networking accounts to link up and communicate with other social networkers who have similar interests and needs; follow, contribute and distribute content discovered or generated over a blog, a wiki or any other social bookmarking online tool; join and participate in discussion groups, fora and other social gatherings to acquire new information while at the same time sharing personal knowledge with others. Much of these online tools have been made available and are possible through the advent of Web 2.0 technologies (O'Reilly, 2005; Sclater, 2008) that characteristically present dynamic rather than static websites displaying user-generated content.

The personal learning network element is put into practice through the use of crowdsourcing and the generic use of Web 2.0 technologies. To crowdsource is a technique employed to bring together the skills, know-how, expertise and content provided by numerous online users who are willing and eager to share, contribute and collaborate with others they do not know and share only a network and a goal to achieve or even accomplish a mission. Commercially this technique is already widely employed especially in the software area as Cox (2011) reports. Perhaps the most notorious testimony is the Open-Source Initiative (OSI) that promotes the sharing of software that online developers are more than happy to contribute to the success of the final deliverable. Wikipedia, an open encyclopaedia, is a platform for any online user to contribute a piece of knowledge by authoring, editing and appending new information. Another example is Linux, an operating system, that was developed by hundreds of software developers who collectively created a system that challenged the conventional operating systems as it was as effective and even more efficient. Worth mentioning also the Mechanical Turk that Ramakrishnan & Halevy (2011) developed and deployed online as a way for online businesses to advertise jobs that needed to be done and which numerous online users choose to work together to get the job done.

The idea of bringing together the expertise, knowledge and goodwill of online users, domain experts and knowledge providers has also been witnessed in a plethora of other

areas like word-processing systems (Bernstein, et al., 2010) like Soylent[1], user interfacing (Bernstein, Brandt, Miller, & Karger, 2011), astronomy research (Christian, et al., 2012), news applications (Fitt, 2011), culture (Casal, 2011), politics (Bommert, 2010), commerce (Belleamme, Lambert, & Schwienbacher, 2010), and employment like SuggestBot (Cosley, Frankowski, Terveen, & Riedl, 2007) . What all these areas have in common is the scenario where typically a complex task is submitted to potential contributors, partners and associates who independently from each other reply back with their version of a solution to different parts of the task. Within this same scenario users, unknown to each other, are indirectly in *communication* to *collaborate* on a task that *connects* them together and which indirectly helps them to *learn collectively* from each other. These four terms in italic are precisely the four foundation keystones upon which crowdsourcing is based (Literat, 2012), and upon which the use of such a technique is justified within this work. The use of crowdsourcing in tertiary education is at the centre of this research as it taps into the freely available academic content found online together with additional resources that domain experts, academics and other knowledge providers are happy to share and contribute. My interpretation of crowdsourcing in this respect is simply the application and practical use of data provided over social networks to add value to e-learning by enhancing its effectiveness.

This thesis applies the same concepts of crowdsourcing to e-learning within the higher education domain as recent research has already been investigating such possibilities. In one project (Costa, Silva, Antunes, & Ribeiro, 2011) investigated how active learning benefitted from the outcome of a crowdsourced knowledge-base. They reported a rise in the learners' performance especially when compared against standard and established academic techniques except in the cases where detailed and focussed areas were taken into consideration. This seems to indicate that unless human intervention or some kind of content tailoring is not performed the crowdsourced information is too generic and lacks the focus learners require. On the other hand if the targeted academic topic is already focussed beforehand then the crowdsourcing process tends to be more accurate and effective. Research reported by Weld, et al., (2012) is perhaps the most recent work that associated crowdsourcing with higher education as they argued that such a combination could potentially assist e-learning to achieve it true potential. They also employ social media and Web 2.0 concepts as they employ crowdsourcing to exploit

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[1] http://projects.csail.mit.edu/soylent/

such media and the availability of free online resources and expertise. Cox (2011), on a similar note, points out the beneficial cheaper costs and ease of scalability when it comes to tap and parse the massive amount of heterogeneous online knowledge sources. It would cost far more to employ a group of trained and knowledgeable professional domain experts than it would to employ a crowdsourcing exercise.

Bonabeau (2009) comments on a different aspect of crowdsourcing benefits as unbiased educational content and decisions are reduced due to the diverse contributions emanating from different societal sources. However such a diversity and lack of structure within the online sources and social media employed creates logistical and conceptual concerns in order to control, manage and extract beneficial resources suitable for educational purposes. A number of such resources, like the Open Educational Resources[2] (OER) and Merlot[3], provide structured multimedia academic resources that are indexed and meta-tagged and thereby easily and precisely retrieved to be fruitfully employed. Additionally there exist freely available online tools, like ConsiderIt[4] that aggregates web resources and assists in resolving the hard task crowdsourcing applications encounter.

This thesis aims to investigate the theoretical and practical educational connotations with regard to methodology, pedagogy and effectiveness, rather than the commercialisation aspects and/or business plan of adopting such a study. Additionally the extent of how much student engage in e-learning is an issue to keep in mind as the use of social media in conjunction with education could potentially alleviate this issue. Such an argument is sustained by a number of studies and inevitably the connectivism learning theory, which is discussed later on in the chapter, is often attributed to justify such a phenomenon. A research study (Junco, Heiberger, & Loken, 2010) investigated the use of tweets[5] within a classroom setting and concluded that both learner and educator showed increased signs of engagement during teaching that surmounted what happens within a classical face-to-face situation. Their report delivered "*experimental evidence that Twitter can be used as an educational tool to help engage students and to mobilise faculty into a more active and participatory role*" (p.1). In another study (Rutherford, 2010) a positive correlation was shown to exist between the adoption of

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[2] https://www.oercommons.org/
[3] https://www.merlot.org/merlot/index.htm
[4] http://consider.it/
[5] https://twitter.com

social networks and the positive attributes of the learning process experienced. Rutherford provided insightful and optimistic inferences on the pre-service engagement of learners through Web 2.0 applications and social networking. Several other researchers (Junco, 2011; McLeod-Grant and Bellows, 2012; Churcher, Downs, & Tewksbury, 2014) followed suit and drew similar conclusions as to the positive effects social media have during the educational process which not only engages learners further but enables communication channels whereby students are able to collaborate and collectively learn. These conclusions justify the adoption of social networks within the context of crowdsourcing as part of the personal learning network component. The blending of the two research areas of higher education and crowdsourcing is being argued to be a natural blend that potentially offers fruitful outcomes. In a simple comparison to a teacher within a schoolroom with students it is straightforward to assume that a willing teacher would employ and do the utmost to facilitate the learning process through the most appropriate and effective media and channels. Even though this seems an ideal scenario, in the unlikely event that it is not so, the noble intentions of the teacher and the willingness of students to learn might still be interrupted by communicative issues. An optimal setting does not guarantee no communicative barriers. Similarly, crowdsourcing requires an optimal setting together with online support functionality to attract the correct crowd and aggregate the required resources to provide the expected output. Eventually those who consume could potentially provide recursively within a continuous and collaborative cycle that generates and yields valid academic content. This research project similarly assumes an ideal situation where academics, and knowledge providers wilfully and enthusiastically inject the much needed content to feed the crowdsourcing mechanism. This includes, apart from the intentional academic resources portals highlighted earlier, web users who author, comment, discuss, tweet, post, and contribute in any other way over social media, blogs, wikis, and any other Web 2.0 enabled applications. The challenging issue tackled by this research study is to attempt to take advantage and reap valid material from the freely available online knowledge-bases populated by web users and social media, which is otherwise humanly laborious to do and gainfully employ. The outcome eventually is a freely available academic resource that provides content as part of the learner's personal learning network.

b) *Personal Learning Portfolio and Learner Profiling*

The Personal Learning Portfolio (PLP) is the second component within the personal learning environment that constitutes the second approach adopted during this research. Gooren-Sieber & Henrich, (2012) talk about a collection of a student's work that characterises her/his academic record. The authors argue that such portfolios have evolved over the years from traditional physical learning portfolios to the e-learning domain in order to personalise learning. Lorenzo & Ittelson (2005) describe such portfolios as valuable learning tools that go beyond the simplicity of an electronic collection of student artefacts. The authors identify six categories of personal learning portfolios amongst which is a learner profiling functionality that employs the portfolio to plan educational content in line with the unique characteristics of the student. To this extent Daunert & Price (2014) suggest that, based on latest research, personal learning portfolios are "practical tools for supporting self-directed and reflective learning" (p.231). In the next section this second technique is coupled with the self-determination learning theory in an effort to address the motivation issues learners reported in respect to e-learning systems. This is confirmed by other studies (Attwell, 2007b; D'Alessandro, 2011; Gooren-Sieber & Henrich, 2012) that highlight the escalation of student enthusiasm to further participate and take initiative in their learning process. In this respect Yongqiang & Jinwu (2011) attribute cognitive improvement, a rise in individualised learning, and overall improvement in the e-learning medium. Furthermore, Daunert & Price (2014) state that portfolios also support collaborative learning whereby learners share their work and resources for educational purposes. This is perfectly inline with the personal learning network concept discussed at the beginning of this section. D'Alessandro (2011) also highlights this coupling as he concludes that through the use of personal learning portfolios within a PLE it is possible to capture and manage the students' knowledge status. Furthermore, the author remarks that the educational process can improve if the same learners socially engage and strike connections within their peer community to discuss, contribute and share content. The close correlation between learner profiling and personal learning portfolio is also acknowledged in the research reported by Guo & Greer (2006) who confirm that personal learning portfolios are ideal sources of information to initialise learner models that are eventually employed to create adaptive educational material. They highlight the benefits of learner profiling and how such an approach is strategic to reflective and

personalised learning. A learner profile contains specific and essential information related to the academic persona of a unique student. Such profiles represent a direct mapping to the distinctive characteristics of individual students as they differ in their academic background, interests, preferences, and learning goals. The student could be initially asked to explicitly declare the specific qualities, descriptions or characteristics that can be employed to develop the profile. On the other hand, numerous simple learner profile generators automatically develop the required profile that can be used to personalise the service being rendered (Schiaffino & Amandi, 2009). A well-known and basic issue with automatic profile generators is the inability to produce a profile at the very beginning of the process when no previous information about the learner is available. This problem commonly referred to as the 'cold start' effect (Bobadilla, 2012) can be easily and quickly addressed by adopting the explicit collection of learner interests and needs at the beginning of the process, and eventually employ automatic profile generation from then onwards. The initial explicit method generates enough information and momentum for the automatic method to seamlessly take over the process and effectively generates a learner profile that can be productively used to personalise the content. The content that is presented is highly dependable on the application area under consideration together with the reasons for doing so. In the case of online information systems like newspapers the generated profiles would characteristically contain the reading habits and patterns together with topical items the readers are interested in, while ensuring not to include others that they dislike. Another domain dependent example is a personal scheduling system where the profile generated ensures to take into account not just the date, time, venue and participants, but also personal priority issues together with re/scheduling habits and patterns. Within the academic domain the profile generated encapsulates as much as possible the comprehensive learner characteristics that deal with knowledge, interests, and educational needs. In this respect a learner profile is considered a collection of inferences about information concerning a student that one is not able to observe (Zukerman & Albrecht, 2001). The main use of the learner profile is to adapt and personalise the learning process as well as the content and the delivery of the educational material. An automated learner profile can be generated using Computer Science techniques that go beyond the scope of this thesis but for completeness sake the most commonly employed profiling techniques are highlighted shortly. Important to point out that a basic learner profile generator is employed and described in some detail

later on in Chapter 4. Adding value to services and personalising the content delivered to a consumer has been widely investigated as part of the ICT research arena (Brusilovsky, Stock, & Strapparava, 2000). Numerous methods have been developed and can be adopted to create the unique profile of a person that in return are conveniently used to tailor the information intended for consumption (Degemmis, Lops, Semeraro, & Abbattista, 2003). Contextually the profile generated for a specific learner can be productively applied to filter and assemble adequate and tailored learning material for the consumption of the same learner. These techniques have been well researched and documented, as they have been efficaciously used to create effective personal profiling descriptions that are crucial in the customisation of services rendered. In one research project (Gauch, Speretta, Chandramouli, & Micarelli, 2007) the authors manage to alleviate the issue of information overload experienced online as personal profiles were used to customise the browsing content. Other similar studies were reported in other domains like health (Cawsey, Grasso, and Paris, 2007), electronic-commerce (Goy, Andrissono, and Petrone, 2007), and tourism (Krüger, et al., 2007).

Closer to home there have also been studies into the application of personal profiles within an academic setting, like the one by Brusilovsky and Millán (2007) who investigated the effects of customising teaching materials to their individual learners. Similarly, in another study (Vargas-Vera & Lytras, 2008) the e-learning application itself kept track of the individual learners and customised online content and services thereby adding value to what was presented to the same learners. This aspect of user profiling fits perfectly with the PLP component within this research project as every single learner has the prospect of a personal and unique student profile generated. This had already been documented in a research study (Dagger, Wade, & Conlan, 2003) that reported how online education evolved towards the customisation of devices, interfaces, and communications to the specific requirements of every learner depending on their unique learning patterns, portfolios and requirements. As a consequence numerous education researchers focussed on the development of appropriate techniques in an effort to increase e-learning effectiveness as Manouselis and Sampson (2002) report. Unfortunately such research primarily focussed on the e-learning system itself as a software application disconnected from the complex realities of learning online. Van Harmelen (2006) in fact reports on how such research resulted in integrating the e-learning environment as part of the individual personal networks or PLN. Still one can

appreciate that such research aimed at converging towards an ideal learning environment which they attempted to simulate and recreate. On paper an exemplary scenario would be a one to one learner – educator situation where the educator is fully aware of the academic needs and knowledge interests of the student and can skilfully adapt and personalise the content, resources, medium and delivery exactly in synch with the student. This work aspires to such ends with much larger student numbers and assisted with numerous and effective online tools.

Three of the most widely employed artificial intelligent techniques to generate a user profile are briefly presented and brought into context. These are:

- Association rules that were initially introduced by Agrawal, et al., (1993) identify relations between sets of articles with a particular area by matching patterns within the data. The rules parse through a collection of a learner's academic history together with a respective record of interests and subjects and generate associations amongst them in a way that similar associations can be pointed out from new or unparsed items. This implies that if such artificially intelligent techniques were to be applied then some prior information about the learner's academic patterns and interests is necessary to generate the essential association rules. Such rules have been employed in a variety of areas ranging from electronic commerce to weather forecasting.

- Case-Based reasoning is another artificial intelligent technique employed to generate a user profile that was conceptually inspired by Robert Shank (1982). The reasoning behind it is to compare prior similar cases to the problem at hand and applies the solution. In the eventuality of a learner who requires instruction about a specific topic, a case-based reasoner would refer to previous matching cases and through adaptation and assimilation applies a similar solution or teaching strategy. In an unlikely even that the reasoned needs to identify a target class for a case that has no classification, then a solution to this dilemma is simply fitting the class that is most similar. This technique has been applied to a variety of areas from information filtering to clustering of similar documents.

- Bayesian networks are based on the concept of a network of points, which could potentially be topical documents, interconnected to each other with links or lines. The concepts underlying this third technique were formalised by Pearl (1985) who maped numerous related topics using links similar to a network and worked on the notion that if two topics were not linked then they had no relation whatsoever. This also meant that if a learner's interest or a document about this interest was linked to another document which in turn was linked to a third, then the third document or interest could be recommended to the learner. Such networks have been successfully employed (García, Amandia, Schiaffinoa, & Campoa, 2007) to identify specific learner behaviour patterns during e-learning sessions and capture the specific learning behaviour. Other areas where Bayesian networks were employed include web browsing patterns, expert and assistive systems, and intelligent tutoring systems.

This study is not about which user profiling technique to employ or about the efficiency of any particular technique as it is not within the scope of this project. Every one of the above described user profiling techniques can be fruitfully used to create and assemble a functional personal profile for individual learners that eventually is employed to customise and tailor the academic content presented within the proposed environment. Important to point out that the three user profiling techniques do not necessarily operate the same, but simply that they function in different ways. The ultimate goal, as far as this thesis is concerned, is that an artificial intelligent piece of software is applied as part of the personal learning portfolio component, which together with the personal learning network make up the e-learning personal learning environment under investigation. Whereas the functionality of the personal learning network component is achieved through the use of crowdsourced social networks, the personal learning portfolio component is implemented through a simple process of user profile generation that is sourced through the combination of explicit interest declaration and the eventual interactions with the environment. The learners' feedback is used to refine the generated profile to better personalise the educational content that follows.

c) *Personal Learning Environment and Personalisation*

The combination of a personal learning network (PLN) and a portfolio (PLP) help in establishing an environment that is not only personal, but even more effective due to its customised and tailored content that fits even closer to the user's needs and interests. Siemens (2012) explored aspects of personalised learning with a focus on how to connect all the information provided online in a way which makes sense in context; using networks to help amalgamate all the information acquired in a meaningful way. The integration of available web techniques and other online collaborative technologies like crowdsourcing and user profiling are being investigated in this thesis to answer the research question set. Gurzick & White (2013) report how these technologies connect knowledge workers to their online personal networks for information exchange, informal learning, and social support, thereby supporting the notion of a personal learning network that has value-added advantages due to the use of social media. The personal learning environment brings together the two components (PLN and PLP) in a conceptual way within an integrated e-learning user interface whereby the issue of impersonality identified earlier is predominantly being addressed. As highlighted earlier the challenge to overcome the impersonal factor within educational settings has featured within all the latest Horizon reports (Johnson, et al., 2014; 2015; 2016). Personalising learning is referred to consistently within these reports as a wide range of educational activities like academic programmes and support strategies, instructional approaches and learning experiences. The particularity about them is that they are intended to address and focus specifically on the distinctive "*learning needs, interests, aspirations, or cultural backgrounds of individual students*" (NMC Horizon Report: 2016, p.28). These reports are highly conducive in identifying factors and potential approaches to overcome this 'difficult' personalisation 'challenge' as they highlight similar challenges to be matters that they "*understand but for which solutions are elusive*". The use of data mining and learning analytics were some of the initial approaches identified whereby additional educational-related information is extracted from existent data and results concerning the unique student. Computer Science techniques are used as tools to identify specific patterns and trends that shed light and expound further decisive information about the student and the learning preferences. Pearson and Knewton (Knewton, 2016) have teamed up in an attempt to integrate personalisation in the online courses they offer. This partnership that started in 2013 has launched a full scale

initiative earlier this year by offering four hundred thousand first year university students the possibility to make use of personalised educational services. Tailored feedback and customised academic advice was delivered based on information that was extracted from the same students' success and failure patterns while going through the educational material. Another interesting partnership was struck between University of Edinburgh and CogBooks who developed an online tool that personalises the students' graphic user interface as they progress through the different course activities (CogBooks, 2015). The academics in return have used this same information to fine-tune their material and teaching in general. Two other similar partnership between CogBooks and Arizona State University and University of Colorado Boulder have also been using personalisation techniques to provide formative feedback to individual students based on analysis of learner-generated data (Lawlor, 2015). CogBooks are encouraged by the result obtained and claim that they are successfully achieving their goal of 'educating everyone uniquely' (CogBooks, 2016). Similar results were reported by the University of Wisconsin-Milwaukee (Reddy, 2014) who developed a self-paced programme called U-Pace that incorporates personalised feedback, individualised progress reports, and motivational notifications to make students aware of their strengths and weaknesses. The outcome showed that students performed sixteen percent higher on assessments over those who did not follow the U-Pace programme. This trend is also evidenced in courses being offered by MITx (MIT, 2016), the MIT wing that gives away free online courses, with the premise that specific students, as a result of their declared needs and interests, might be presented with variations in the academic content presentation. Two other related initiatives worth mentioning are those established by the Bill & Melinda Gates Foundation[6], and the IMS Global Learning Consortium[7]. The Gates foundation set up a grant program called ALMAP (Adaptive Learning Market Acceleration Program) that promoted personalised learning research, while setting up also a ground-breaking learning program called Enlearn[8] whose purpose was to assist and encourage the development of adaptive learning material that can enable a more personalised teaching and learning experience thereby transforming the entire classroom ecosystem into an adaptive environment suitable to the learning needs of each student. On the other hand the IMS initiative brought together a

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[6] http://www.gatesfoundation.org/
[7] https://www.imsglobal.org/
[8] http://www.enlearn.org/

consortium of over three hundred universities, higher-education institutions and vendors in an effort to standardise and establish a shared vocabulary for recording students' academic data. The protocol of metrics, called Caliper (IMS, 2013), was intended to make it easier to describe a learner's profile across institutions and learning environments.

It is obvious and natural that a human educator is much more effective when a personalised methodology is employed. Within an e-learning environment such recognition is also being confirmed as institutions across the world agree that a single invariable and inflexible style, method or approach is not possible for all learners (Educause, 2016). Lonn et al., (2015) define personalised learning in a way that higher education institutions can take technological advantage through "*the measurement, collection, analysis and report of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs*" (p. 4). The on-going research in this area is on the rise as access to data tools and techniques are easier to use and highly accessible together with the availability of large sets of data that assists in the customisation of the learning process and the handling the issue, stated at the beginning of this section, of static impersonality. This third e-learning concern is directly associated with the use of intelligent computer science techniques described earlier as part of the personal learning environment. The intelligent part of this proposed personal learning environment offers a customised delivery based on the previous two sections and grounded within the adaptive learning theory. This theory together with the other two established theories, Connectivism associated with the PLN solution to isolation, and Self-determination associated with the PLP solution to lack of motivation, is discussed in further detail in the next section.

2.2   *Learning Theories*

Learning theories are at the backbone of every educational-based designed research study as the investigator adopts an epistemological stance upon which assumptions, decisions and inferences are drawn. Different perspectives based on the different learning factors upon which every learning theory is based on are critical by the way one regards knowledge itself, but also by the educational process, and the actual act of

learning. In this respect a learning theory forms part of the pedagogical model adopted together with the educational material employed, the methodology engaged, sequence, medium through which it is presented and finally a review of what has been learnt. Tomei (2010) defines pedagogy "*as the art and science of teaching children*" (p. 1), and describes how the evolution of learning theories has transformed the pedagogical model from a state of submissive or receptive child and teacher knows-it-all, to a learner-centred and academic facilitator. Pedagogy must not be an ad hoc concept that is left to chance or not given enough thought and planning, but requires sound theoretical foundations especially within the area of technology-enhanced education. McKenzie (2003) points out that it is because of a pedagogical model was not followed that numerous academic institutions had a low return on their technological investments. McKenzie was reacting to a statement by the US secretary of education, Dr Roderick Paige, who side-lined the importance of pedagogy and imposed changes that were not grounded in any learning theories.

Based on these factors, the study, the research questions, and the methodologies adopted are structured around the predominant learning theories that characterise and represent the researcher's theoretical beliefs and positioning. The approach adopted should be based according to Alexander & Boud (2001) on five elements upon which a learning theory is grounded on, namely, the learning experience itself, the active way learners construct such experiences, the holistic process that is inductive to learning, the social and cultural influences within the learning process, and the contextual influences in which it occurs. Even though a combination of approaches have been identified and expanded in the previous section, the prevailing concept that is being investigated is related to e-learning and the use of learning networks to assist the educational process. Connectivism (Siemens, 2004) is considered by numerous researchers (Downes, 2008; Kop & Hill, 2008; Duke, Harper, & Johnston, 2013) as the leading learning theory in the digital age as social networks and learners' online presence is considered influential on their academic work and personal lives (Ureña & Valenzuela-González, 2011). The authors argue that according to George Siemens' theory "online social network contacts represent a potential and valuable source of information" (p.142). This source of information is not enough and definitely does not constitute a complete learning environment. In this respect Ng (2015), amongst others (Hung, 2014; Duke, Harper, & Johnston, 2013), asserts that learning theories that support online learning like

connectivism need also take into consideration those teaching contexts that are not in real time (asynchronous) as these situations have a major impact on the learning outcome. In this respect Mayes & De Freitas (2013) actually argue against the adoption or need of new learning theories to accommodate the digital age and assert that all that is required for effective learning is the knowledge of how the underlying processes and theoretical constructs enable learning, be it face-to-face or over e-learning. The point being made here is that a learning theory adequate for learning within the digital area and applied to this e-learning research is not enough or complete in isolation. This is especially true when a combination of methodologies is being proposed to enhance the effectiveness of e-learning. Ng (2015) subscribes to this same notion when he states that "*It is inevitable that the blending of more than one learning theory in the design of a sequence of pedagogically sound learning activities would be required*" (p.93). To such ends this thesis proposes two additional learning theories, self-determination and adaptive, in combination with the connectivism learning theory as they subscribe to the proposed underlying methodologies. As mentioned earlier the three methodologies, crowdsourcing, learner profiling and personalisation, were proposed and employed to address the three e-learning concerns identified, namely, isolation, motivation and impersonality respectively. These three methodologies coupled with the three e-learning concerns have been implemented within the three structural e-learning components, personal learning network, portfolio and environment grounded upon the three stated learning theories, connectivism, self-determination, and adaptive learning theory respectively. The figure below depicts the combination of techniques, e-learning concerns, conceptual e-learning components, and respective learning theories as envisaged within this proposed research study. As pointed out earlier, the connectivism learning theory is the predominant established theory in this project as it has been associated with the use of social media in education, and coined as a "*learning theory for the digital age*" (Siemens, 2004). This theory puts into context the online reality of learners making use of social networks as it "*dismisses the three dominant learning theories, behaviourism, cognitivism, and constructivism*", according to Wheeler (2012). The educational process is envisaged external to the learner within a personal network of technologies, communities and social media.
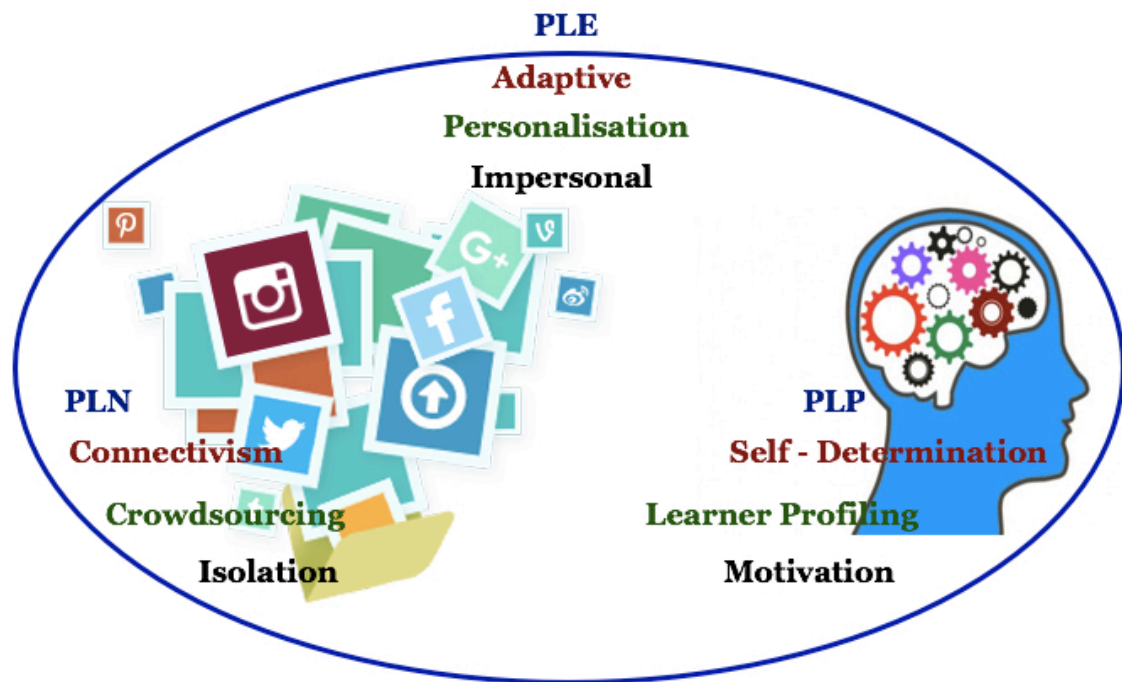
Figure 2.2 – Combination of techniques, learning theories, concepts and concerns

Closely related to this definition also lies the social-constructivism theory that according to Vygotsky (1978) learning occurs as a result of interactions between individuals influenced by the cultural and societal environment. Whereas this learning theory takes into consideration the role of others within the learning process as mediators to acquire novel information and knowledge, connectivism takes it a step further and highlights the importance of the networked information whereby the learner and the mediators contribute and receive in a mutual beneficial learning community. I particularly argue that the connectivism learning theory significantly contributes to this research project as it highlights the importance of learners identifying the source and the content itself of what interests them and what they need to learn. This places the responsibility directly on the learner who is required to bring together a cohesive set of personal learning tools within an environment that is socially networked and academically healthy within which learners can store their knowledge. Such a theory supports my own post-positivistic epistemological point of view whereby the contextual reality of an online experience determines and distinguishes our overall interaction and the amount and quality of what we intellectually extract. The medium employed is clearly an imperative factor in the facilitation of the learning process. The extent and capacity of the medium's influence is also dependent on the student at the receiving end of this

interaction. A number of educational studies have been reported that directly refer to the learning theory of connectivism. Loureiro and Bettencourt (2010) investigated how to enhance the educational process by focussing on optimising such process within higher education by integrating Web 2.0 tools and subscribing to connectivism. Robson (2013) took a step further to investigate the next generation of online courses by scrutinising the content and processes of initial generations of e-learning courses. He draws the conclusion that "*e-learning content is experiencing a shift in underlying pedagogical theories from cognitive, instructivist, and behaviourist to social, constructivist and connectivist*" (p.177). Even Duke, Harper, & Johnston, (2013) argue that connectivism's diversity through different networks is ideal to assist learners in the new generation to learn. They encourage educators to continually evaluate how connectivism in conjunction with other learning theories can be used in the online learning process. Furthermore, Hung (2014), makes extensive use of ideas from this same learning theory to design new models in an effort to optimise the movement of connected knowledge, expanding learning spaces and structures, and employing open technology to connect people.

The second learning theory to be adopted by this research is the self-determination learning theory, and is associated with the e-learning motivational issue identified earlier. This theory relies entirely on supporting learners' fundamental tendency to conduct themselves in an optimal way in order to maximise the benefits they can extract. As highlighted in Chapter 1 Deci & Ryan (1991) identify a variety of motivational types as they justify a learner's action within their self-determination theory. It was also argued that e-learning effectiveness is very much dependent upon the motivational levels of students whether it is basic matter that is enjoyable to do, or a much more considerable piece of work that leads to a distinct fulfilment. One way to extract information regarding what exactly motivates a person is to identify and point out patterns and characteristics within the profile of the same learner. Similarly Chue (2015) reports that a learner's personality traits are directly related to her/his academic performance, and which in turn is accumulated and represented within the same learner's personal learning portfolio. Such a learning portfolio is representative of the learner's academic profile that potentially acts as a catalyst to enhance motivation. This direct relationship between motivation and self-determination (Deci, Vallerand, Pelletier, & Ryan, 1991) conveniently fits in with the learner's characteristic learning

profile represented within a portfolio and which can be used to customise the learning material and process. The learner profile is required to be dynamic in order to accommodate the shifting interests of the learner reflected within the portfolio and to maintain the motivation levels at their highest. Other self-determination learning theorists like Linnenbrink & Pintrich (2002) focussed specifically on social cognitive models of motivation that apart from restating the dynamic nature of motivation, highlight the fact that a learner's current interests, situation and context play an important role in the levels of motivation and eventual academic achievement. To this extent and in an effort to boost learners' motivation during e-learning the individual learner profile is generated from the accumulated personal learning portfolio as subscribed by the self-determination learning theory. In line with this theory is also the association that Wheeler (2012) asserts between PLEs with self-regulated learning, mentioned earlier. Additionally the author believes that such personal technologies do encourage learners to be self-determined in their learning approach. Such a view is corroborated by others (Hase & Kenyon, 2007) who conceptualise self-determined learning, referred to as Heutagogy, to contextual formal and informal learning whereby they accentuate self-directed and non-linear learning. Wheeler (2012) further argues, in line with this self-determination learning theory and other digital age theories, that the impetus lies on the 'learning to learn' which eventually brings in the issue of learner motivation and knowledge sharing.

Finally, the theory of adaptive learning closes the trio of established theories as a critical theory to address concerns about the e-learning medium being an impersonal one. This theory subscribes to the notion of personalisation and the value-adding process of tailoring information and content to the needs and interests of the learner. Oxman and Wong (2014) state that the escalation of adaptive learning will lead to pervasiveness throughout all levels of education. In their recent study they conclude that higher education institutions have not only proved the concept, but also the effectiveness of adaptive learning systems. They identify three distinct components to adaptive learning, namely, a model of the content structure, which they refer to as the content model; a learner model, which refers to the means of understanding student abilities; and finally the instructional model, which binds the previous two models to deliver a tailored and dynamic material. These different models have been conceptualised as part of the proposed e-learning environment and are expanded further in the next chapter that deals

with methodology. Adaptivity within e-learning environments is not a new concept as numerous researchers (Soonthornphisaj, et. al., 2006; Drachsler, et. al., 2008; Kay, 2008; Tan, et. al., 2008; Bian & Xie, 2009; Bobadilla, et. al., 2009) have in the last decade investigated and reported the benefits and potential of personalised and adaptive learning systems. Bian & Xie (2010) argue in terms of a complete learning support system that should be individualised to provide "*user personalization features to adapt to the user view which including not only learning resources but also individualized learning process and strategies*" (p. 203). The authors highlight the issue that learning needs to be adapted to the individual characteristics that are obviously directly dependent on the uniqueness of a person but also on the context and time. In another recent study (Salehi, Kamalabadi, & Ghaznavi Ghoushchi, 2014) the dual factors of a learner's unique needs, interests and characteristics together with the dynamicity of these same variables as they go through a healthy transformation process of refinement over time. The authors conclude that personalised e-learning and proper tailored recommendations of learning material is possible through the integration of three main factors, namely, taking into account the dynamic interests of learners, assuming that learners have a combination of preferences, and that the educational material itself is multi-facetted and multi-dimensional. If the e-learning system takes into consideration these issues then it can truly deliver personalised and contextual learning material and recommendations. The personal interests that the learners identify as representative of themselves brings into context the rise of self-representation through social media. Much of the literature is related to self-representation through narration (Eakin, 2008; Poletti & Rak, 2014), digital games (Kimppa & Muukkonen, 2007; French, 2010) or other media like photographs (Davies, 2007) that contribute to the online persona or identity. A learner could easily represent her/himself using a real name or a pseudonym to remain anonymous while making good use of an e-learning platform keeping in mind that the projected character or persona is what is being personalised. Similar to the user's control over her/his online self-representation, the learner can explicitly control the learning environment through choice of interests and online behaviour that potentially could be far from reality. This also holds to students in a class while interacting face-to-face with an educator as they portray a self that can be far from their real character. Eakin (2015) argues in similar way when talking about self-representation online and off, namely that "identity work proves to be not much

different online than off because cultural imperatives for identity coherence operate equally in both environments" (p. 11).

The three learning theories introduced and discussed above characterise the educational aspects of this research study as they come together towards one goal. They are somewhat related to each other as the focus is taken off the educator and predominantly focuses on engaging learners and their peers. The theories are specifically intended to address the three e-learning concerns through the integration of three techniques in a single e-learning platform. It has been shown in the literature that as mass education accentuates these e-learning issues, the need to address and offer a functional and effective solution is expected. The proposed e-learning environment, while referring again to Figure 2.2, is intended to address the following three matters:

- To keep the learner motivated as much as possible throughout the learning process by ensuring that the specific learning process is captured in some way that represents patterns in the needs, interests and enthralments of the same learner. The self-determination learning theory addresses these concerns and the personal learning portfolio component encapsulates this effort.

- To integrate the learner within a comprehensive learning society whose members are sources of information as much as they are recipients. The connectivism learning theory focuses on a digital society where every learner is not isolated but forms part of a healthy network of academic nodes. The personal learning network that each learner possesses embodies this effort and forms part of the proposed environment.

- To personalise the learning process through the tailoring of the academic content while ensuring that the tailored medium optimises the delivery of this academic content. The adaptive learning theory specifically addresses this issue by ensuring that the learning process is not impersonal or detached from the learner. The personal learning environment, that incorporates the previous two components, PLN and PLP, epitomises the overall effort and contribution of this research study and thesis.

2.3 *E-learning Effectiveness*

The research question revolves around the issue of e-learning effectiveness and therefore the need to clarify the concept of effectiveness is critical. The best place to start this process is precisely with the 2-Sigma problem that Bloom (1984) refers to when he claims that individual human tutoring increased the effectiveness of learning by two standard deviations. Other research work (Halawia, McCarthy, & Piresc, 2009; Vidakovic, Bevis, & Alexander, 2003; Kartha, 2006; Skylar, Higgins, Boone, & Jones, 2005; Suanpang & Petocz, 2006) employed a plethora of methods to evaluate e-learning effectiveness and the results overall were not conclusive or consistent across the studies. In a similar research performed on the effectiveness of a VLE, Piccoli, Ahmad, & Ives (2001) arrived at the same conclusions when they attempted to assess a Web-based VLE's effectiveness in relation to basic ICT skills training.

What would be useful and practical later on in this research work is to identify what characteristics better depict e-learning effectiveness. This would assist the collection of the necessary data and eventually reassure the validation, reliability and interpretation of the results. A number of studies have investigated the effectiveness of e-learning, and these assist in identifying measured characteristics that were shared. The majority of these studies predominantly investigated and compared e-learning in relation to face-to-face instruction giving a mixture of outcomes. In a 2011 white paper, Academic Partnerships (AP, 2011) identified four types of research trends that investigate the effectiveness of online learning. The research being proposed here is somewhat related to the first and fourth categories, namely learning outcomes and impact on instructional design and delivery, but not to the other two categorises that focus on the growth of online learning and its cost as a direct impact of its effectiveness. Chan, Chow, & Jia, (2003) proposed a study to assess e-learning effectiveness grounded on four underlying components (Figure 2.3). The authors argue that a variety of matters are required to be considered to successfully assess the effective outcome of an e-learning course including methods used for evaluation, results obtained, and the course itself. According to the authors the proposed framework can be easily adapted to assess and evaluate the effectiveness of online teaching as well.
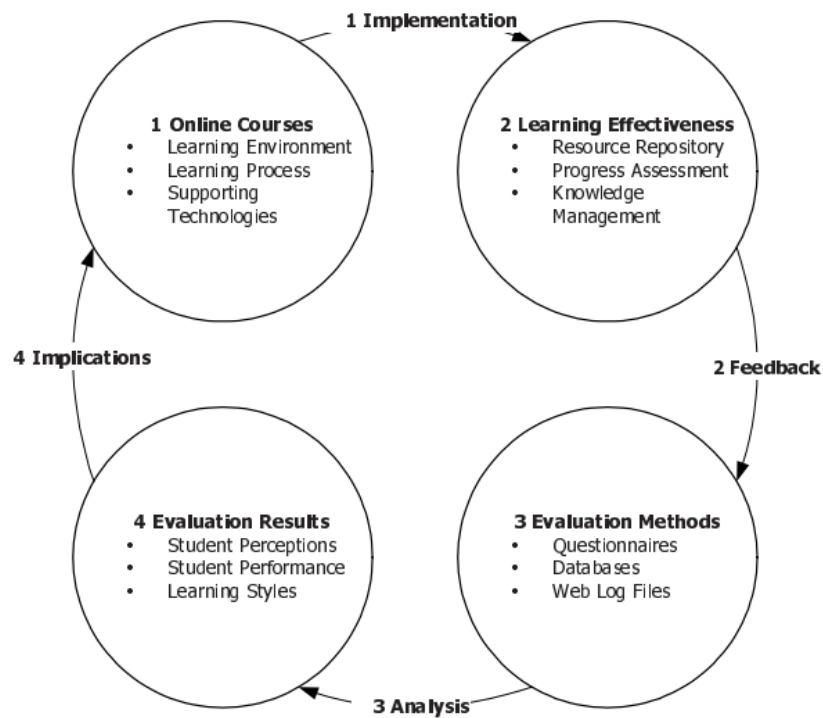
Figure 2.3 – Framework for evaluation of learning effectiveness in online courses (Chan, Chow, & Jia, 2003)

Other studies (Bernard, et al. 2004; Means, et al., 2009; Xu & Smith Jaggars, 2011; Johnson & Cuellar Mejia, 2014) have been reported over the years where a series of mixed results simply show that online learning can potentially increase the completion rate at higher education. It also goes out to show that further research and investigation is required to assess the way e-learning courses are assessed to be effective or not. The conflicting findings from these studies also raise the question of which factors from e-learning need to be taken into consideration and measured in some way.

Neuhauser (2002) performed a study that characteristically included a number of best practices that were employed at the time and have also been employed since then. The methodology employed by Neuhauser is adopted in this research work and is fully described in the next chapter. The study took two (2) sections from the course that was delivered in both modalities and compared them together. Learning preferences together with gender, age, preferences, and style were compared to extract the overall effectiveness of the final outcome. It is worth highlighting the fact once more that this study by Neuhauser, like all others documented here, reported the effectiveness of e-

learning in comparison to the standard face-to-face instruction. On the contrary, the research study being performed and reported in this dissertation is different and quite unique in its nature. The effectiveness of e-learning within a personalised environment is being investigated in contrast to both face-to-face instruction, and to static e-learning delivery. In this case the participants are asked to give feedback on three modes provided employing similar tools and techniques that have been repeatedly employed and tested by similar studies.

2.4 *Case Studies*

The use of personal learning environments as e-learning platforms are further investigated in this section before closing the literature review chapter and moving on to the methodology in the next chapter. Attwell (2007a) is reported in formally conceptualising a personal learning environment as a personal assembly of a learner to assist the learning process. It is for this reason that the self-determination learning theory, described in the previous section, becomes relevant as the learner decides and controls which applications, resources and services are relevant and most conducive to knowledge acquisition. The same author also points out that such an environment supports novel learning modalities that have become possible due to the pervasiveness of technology and social media. This fact brings in the second learning theory described earlier, connectivism, that highlights the networking part of the personal learning environment. In another study (Charlier, Henri, Peraya, & Gillet, 2010) a distinctive classification is given to differentiate a personal learning environment from a standard virtual learning environment (VLE). The authors clearly identify the learner from the teacher as sole users of the two different environments, PLE and VLE respectively. This dimension that differentiates the two environments is further substantiated by the availability of resources and accessibility. In contrast to a VLE, a personal learning environment is openly available to other educational bodies and resources emanating from alternate sources. Conversely a PLE is conveniently flexible and not bound with any institutional policies or restrictions.

A number of PLE models have emerged over the years together with their respective theoretical setup. Al-Zoube (2009) identified three categories of PLEs that clearly

distinguish one model from another. The architectural setup is a distinguishing factor that a particular PLE has over another. Whether the learning environment is based on a client / server architecture or whether it is web-based is an important distinction. Peter, Leroy & Leprêtre (2010) clearly stipulated that *"PLEs are an ad hoc, opportunistic aggregation of Web 2.0 services built to support a specific learning goal"* (p. 1). Some examples of such PLEs that fall under this category can be found in PLEX (Beauvoir, 2005) and ELGG[9]. The architecture behind PLEX, a personal learning environment launched by the Centre for Educational Technology, Interoperability and Standards, is based on a plugin concept that makes it very easy to integrate especially for developers who make use of software packages to write programs. On the other hand ELGG is an open source social networking engine that enables learners to generate applications that are made up of individualised components. These so called 'socially-aware' software programs can easily form part of a personal learning environment depending on the requirements and requests that the same learner specifies. The end product is a personalised network of coordinated fully featured social media resources and Web 2.0 applications.

A second method to categorise PLEs is by specifying the underlying platform that facilitates and supports functionality and multiple capabilities. Established higher educational institutions tend to make use of their current learning platform to accommodate or 'piggyback' additional tools and applications to implement a personal learning environment. White & Davis (2011) report about a study that the University of Southampton has performed in an effort to replace parts of its current infrastructural platform to support the learners' own chosen environments. The university believes that the learning process can be enhanced and consolidated if the learners are allowed to operate within a composite environment set on the university's own platform. Such a platform could easily be an existent virtual learning environment like Blackboard[10] or Moodle[11] that support several ancillary components and that are extendable to incorporate social networks. Social networks make it even easier for their services to be included onto existent platforms by providing an easy medium, called an Application Program Interface (API), for developers to integrate complete components that provide additional functionality and services.

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[9] www.elgg.org
[10] www.blackboard.com
[11] www.moodle.org

A final distinctive factor that separates one PLE from another is differentiating according to the pedagogical approach adopted. The most liberal approach towards a PLE is the one where the learner has full control of what, how and when to learn anything at all. This self regulated approach basically represents available independent services or information sources that can be bundled up together into an evolvable compound. The learner is in full control and requires good academic skills as much as self control together with confidence in oneself in order to ensure and maintain the correct educational track. Attributes mentioned earlier of an open architectural setup at the foundation of the personal learning environment apply here as well as the learner is able to choose, pick and incorporate tools that perform what is required and fit in with the rest together with the learner's way of learning. Conde, Garcia-Penalvo & Alier (2011) abide by this methodology and clearly state that an effective PLE is one where it is possible for students to choose the tools they would like to use within a personal space. Similarly, Ebner & Taraghi (2010) report on what the Technical University in Graz employ as their PLE pedagogy whereby students are at liberty to adjust the portal according to their tastes and needs by inserting and adjusting available components in the form of web widgets. Some examples of these web-based components that can be aggregated onto a student's personal learning environment include Google Apps[12], YouTube[13] media, Twitter[14] feeds and posts from Instagram[15], Pinterest[16] and Facebook[17]. Available environments for students to practice self-directed pedagogy include Edmodo[18], myYahoo[19] and iGoogle[20].

A second pedagogical approach is one that allows the involvement of the educator in the setting up, content and overall administration of the personal learning environment. To this extent a number of researchers refer to this approach as an institutionalised personal learning environment (Garcia-Penalvo, et. al., 2011; Millard, et. al., 2011; White & Davis, 2011; Moccozet, et. al., 2012) as the emphasis is on both the learners and the academics to customise and tailor the existent system in a semi-structured way

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[12] https://apps.google.com
[13] www.yahoo.com
[14] www.twitter.com
[15] www.instagram.com
[16] www.pinterest.com
[17] www.facebook.com
[18] www.edmodo.com
[19] www. my.yahoo.com
[20] http://www.igoogleportal.com

according to the declared academic needs. Casquero et. al., (2010) also envisaged such a pedagogical approach as an amalgamation of freely available tools, services, data and information with the platform provided by the higher education institution. An effort to encourage learners to make use of such environments should be the priority of the educational institution. Dabbagh & Kitsantas (2012) propose a framework based on this particular category whereby the goal is to encourage academics and empower students within a "*transformative cycle of creating PLEs that support self-regulated learning*" (p. 6). It is worth pointing out that current institutional virtual learning environments or learning management systems (LMS) that are predominantly proprietary do not easily allow the integration of externally developed components and require some amount of tweaking and technical expertise. Fiedler & Väljataga (2013) recommend that future institutional platforms need to be highly inclusive to ensure that students can easily and productively extend their functionality and range of services.

The final pedagogical approach that distinguishes a personal learning environment from others specified above is a category that adds the element of personalisation to the previous category, namely a personal learning environment that incorporates management from both the learner and academic, but includes additional customisation features. The word customisation itself has been used and abused over and over when used in relation to personal learning environments. Fiedler & Väljataga (2013) have reported, after analysing the work of numerous PLE researchers, that "*a rather careless and uncritical use of the term*" (p. 6) has resulted in uncertainty amongst the researchers themselves. Amongst others White & Davis, (2011) consider personalisation of the personal learning environment from an aesthetic point of view focussing on how a particular learner can adjust the layout, background and themes. On the other hand Ebner & Taraghi, (2010) fall amongst those researchers who extend the significance of personalisation to the choice of services, applications, choice of widgets, and sources of information. Valtonen et. al., (2012) are less artificial in their approach and attribute personalised learning within a PLE setting to what learners contribute to the situation through their academic decisions and the unique course directions adopted "*about their learning in a self-managed way*" (p. 733).

All three interpretations seem to create an illusion of choice and not really what the term personalisation from an educational point of view is being referred to. Earlier in Section 2.1 the way in which this research refers to and makes use of the term personalisation

was specified and clarified to ensure that the personalisation being referred to in this thesis has to do with the customisation of the educational content. The tailored content accommodates the learner's interests while at the same time befits an evolving learner profile. A smart or intelligent personal learning environment, as the one being proposed, takes personalisation to a conceptual level whereby it *"provides personalized pedagogical assistant to the learner such as recommendation of material, common interest learners, and adaptive path personal learning"* (Al-Zoube, 2009, p. 60). The author infers that intelligent PLEs enhance *"the quality of the instruction while reducing the demands of an instructional designer"* (p. 60).

A number of available systems are based on this last category and which in one way or another attempt to deliver on the concept of a PLE that truly impersonates a one-to-one educational process between a learner and an educator. Pearson, Gkatzidou, & Green (2009) propose an adaptable PLE which is tailored to the specific requirements, interests and needs of students. The flexible model they present is student-centred that attempts to involve multiple players apart from the students and tutors including designers, content experts and developers.

In another initiative an integrated e-learning system was presented and documented (Casquero, Portillo, Ovelar, Benito, & Romo, 2010) to demonstrate how a learner can assume complete command of the learning process. Similar to the last PLE category presented above this conceptual framework is administered by the higher education institution while integrating social network tools, services, as well as content. The authors conclude that by merging the institution's online learning environment together with the learners' personal social networks it would be possible to create an educational environment that can realistically support life-long learning.

Cui & Zhang (2011) endeavoured to personalise e-learning through an intelligent PLE that was based on portal technology. By portal technology they mean a one-stop-shop for a learner to login and access all the required information, services and tools, which is basically similar to an institution's VLE or learning management system. The prototyped system made use of intelligent systems to provide the necessary personalisation through customised content material. The portal used explicit information provided by the learner to categorise the learner with similar others and provide meaningful information that should match their interests and needs.

Adding the concepts of planning and execution to the institution's LMS platform was what Morales, Garrido & Serina (2011) proposed in an effort to personalise the e-learning medium and enhance the experience. The term planning refers to the process of customising activities and tasks to the unique needs of a student or a group of students thereby creating an academic route. The authors focus on how such routes can be properly set from a planning point of view while at the same time keeping track and assess the performance of each route. In the case where a route is not performing as expected or a discrepancy is reported, then instead of regenerating a new route, the plan is adjusted and tweaked accordingly. Morales, Garrido & Serina conclude that their "*approach is very valuable to maximise the stability of the learning process, and also for the performance and quality of the learning routes*" (p. 241).

In a recent empirical investigation Xu, Huang, Wang & Heales (2014) employed a personalised VLE, supported by intelligent software, to enhance the overall outcome while employing an e-learning system. An empirical field experiment was held to test the embellished VLE and the results "*suggested that personalized e-learning facilities enhance online learning effectiveness in terms of examination, satisfaction, and self-efficacy criteria*" (p. 430). The authors conclude that e-learning effectiveness improves as a result of automatic and intelligent content management, instantaneous customised feedback and self-evaluation management. The inferences drawn from their work also state that tailored tasks and adapted learning methods extend the learners' capabilities academically, enhance their thinking processes and amplify the educational experience.

Aeiad & Meziane (2015) present their work about an e-learning platform that makes use of free online resources to customise and tailor the experience. The system that was developed and tested retrieved information and content from online websites and free content providers while it presented the learner with purposely planned and designed content that takes into consideration their background and requirements. The authors claim that their "approach, functionality and architecture are improvements on existing e-learning systems" (p. 298). They also propose to include and take into consideration the learners' characteristics together with their academic outcome in the next generation of the same system.

Finally, a Malaysian-based iClass learning management system (Ined, 2016) closes this overview of case studies. This LMS resulted from a project that aimed in establishing a

personalised framework that could adapt to the different needs of the learners. The collaborative nature of this web-based system allows the adaptation of content and graphical interface to ensure the learner takes advantage of the academic environment. Similar to other LMSs iClass has the flexibility of allowing additional plugins developed and made available by third-party services that further reinforce the personalisation element. The system has been adopted and applied also to secondary schools by Oxford University (OUP, 2016) as it provides students with an enhanced learning experience in class. The University of Hong Kong are very proud of their next generation e-learning system as "its instant performance analysis help teachers understand students' learning progress, which greatly enhance effectiveness in teaching and learning" (p. 3).

The case studies reviewed above that fall within the same category as that being proposed still differ in their methodological approach as well as in the functionality they offer. It is mportant to point out that even though they are grounded within the virtual learning system of their educational institution, none of them evolved and/or adapted what is being presented to the learner while the PLE is being employed. The closest that one case study (Aeiad & Meziane, 2015) comes to the iPLE is in its future work as the authors plan to create a feedback cycle into their next prototype to ensure that the personalisation is dynamic and fits better the learner's profile. The learner profiling methodologies currently in use can be replaced as more effective components can easily plug in to efficiently generate a better profile. The way these are employed and the information they process all depends on the theoretical stance adopted together with the philosophical perspective based on the respective learning theories.

2.5   *Chapter Closure*

The three themes that have been presented in this chapter (Figure 2.2) ensure that the reader is in the ideal position to understand better the research study documented. The themes have four recurring threads that specifically represent e-learning issues (Isolation / Motivation / Impersonalisation), techniques borrowed from the computing domain (Crowdsourcing / Learner Profiling / Personalisation), education learning theories (Connectivism / Self-Determination / Adaptive), and the respective e-learning

component (PLN / PLP / PLE). They all form part of the rationale underlying the research question set in Chapter 1 whereby it has been justified how all four threads link together and complement each other. These are put in practice with a methodology that is expanded in the next chapter, and implemented within the proposed intelligent personal learning environment, iPLE, in Chapter 4. Finally, this chapter closes with an overview about e-learning effectiveness and a visit to a number of case studies. The attributes that characterise e-learning effectiveness need to be measured later on in the empirical exercise, and the results evaluated in Chapter 5 are required to ensure that they are based on sound and valid education principles. On the other hand the different case studies have given evidence of a growing research area where IT and education are merging to contribute to future e-learning platforms and environments.

The next chapter delves into the methodological details of the research study. The particulars about the empirical study are described in some detail to ensure a reliable and complete theoretical setup that encompasses the research objectives. Issues about data collection, ethics, validation and reliability are also covered in the next chapter.

Chapter 3

Methodology

This chapter covers all the methods that are employed during the research study. Every step involved, from developing the intelligent personal learning environment to the different data collection methods and the interpretation of the results, are dealt with and expanded. The hypothesis stated in Chapter 1 was followed by a full literature review of the different issues, techniques, learning theories and e-learning attributes that play an important role in this empirical study. The methodology adopted brings together best practices from a number of similar studies and collects the required data to perform the necessary analysis of the set objectives. The first two sections narrate the processes involved in personalisation and generation of a learner profile without going into much technical detail. The section that follows describes the finer details of the empirical study including logistical and technical details, while the rest of the other sections supplement further information about the empirical study. The participants employed to test and generate data play an important role in the overall evaluation of the hypothesis and are the subject of the following subsections. The chapter proceeds by elaborating

further on the relevant theoretical underpinning of the study that is grounded on sound learning theories. Next the data collection methods employed and the eventual analysis of such data that follows are discussed in detail, together with the validation and reliability of the data collected. The chapter comes to a close by highlighting the ethical issues involved and ways that the designed methodology is meant to overcome them.

3.1 *Personalisation Process*

The process of personalisation has been applied in a number of e-learning environments as mentioned earlier in Section 2.4 but further investigation is needed to understand the different flavours of personalisation. Before going into the different interpretive levels of personalisation as witnessed in numerous attempts of e-learning environments, it is worth noting that the adaptive learning theory was discussed and justified in Chapter 2 for making use of this concept. Adaptation can exhibit itself at different levels and varying intensity within the learner surroundings and physical or visual environment, in the educational processes and academic tasks performed, as well as within the teaching process and pedagogical process employed. The main reason for employing personalisation at some level and subscribe to the adaptive learning theory is to counteract and address the issue of e-learning being impersonal. Other issues, how they have been addressed and the corresponding learning theories have been addressed in Chapter 2 and are discussed further on in the thesis.

The first interpretation that loosely claims to perform personalisation is the customisation of the physical environment itself and the cosmetic look and feel. The visual personalisation of the learner interface may seem superficial but it does impinge on the overall human-computer interaction (HCI) element that numerous researchers focus on. At the next level of personalisation is the selection and inclusion of specific services, apps and/or widgets within the learning environment. Such plugins add functionality and enhance the overall academic competence that is made available to all those learners who opt to include and incorporate as part of their personal learning environment. This degree of personalisation can be employed in isolation but can also be coupled with the personalisation of the learning interface. Positioning and adapting the different plugins according to one's tastes and preferences further supports the learner in owning the learning environment while at the same time enhancing the

effectiveness of the e-learning experience. The third level of personalisation is an enhancement on the previous two as the customisation factor is incremented through the modification of the educational content itself. Apart from the visual and graphic appearance of the personal learning environment, and apart from the different functionality that can be incorporated at will, the academic content itself and the educational resources employed can further add to the personalisation level as it is tweaked and modelled to fit the specific learner. The learner related data can be directly gathered by asking the same learner a series of questions to source and build a knowledge base. This knowledge base encapsulates academic knowledge that represents as close as possible all that needs to be known about the learner. The information about the learner could also be accumulated indirectly or implicitly by keeping track of the learner's actions and academic record. Once this information is available it can be used, as explained in the next section, to generate a learner profile that are employed to personalise the learning environment. The methodology employed in this project subscribes to the third level of personalisation whereby the information about the learner is collected using a mixture of the explicit and implicit methods described above. Learners are initially asked to specify their interests by choosing from a set of generic interests. This learner information is employed immediately right from the very beginning to personalise the interface, the services and the academic content. From then onwards all the actions and feedback accumulated from the individual learner are stored and used as implicit information to refine and further fine-tune the personalisation provided. As the student/PLE exchanges increase the personalisation process further adjusts to fit even closer to the unique preferences and interests of the specific learner. Clustering techniques are also employed to propose and recommend academic content that other learners with similar interests and preferences have given positive feedback about. A learner can be associated with more than one cluster that individually represent different aspects of the learner's distinct interests. Details of how and where the learner's information is saved during and after the use of the personal learning environment are described in some detail in Chapter 4. On the other hand the exact methodologies of how the collected and accumulated learner information is used to generate the learner profile are expanded further in the next section.

3.2 *Creating Learner Profiles*

Similar to the personalisation process discussed in the previous section but to a lesser extent, the use of learner profiles has been employed in some e-learning studies (Mencar, Castiello, & Fanelli, 2008a; Ferreira-Satler et. al., 2012; Chughtai, Selamat, & Ghani, 2014). This area of the research is particularly delicate and precarious because there is a fine line between what can be considered educational studies and what can be argued to be computer science. The theoretical reasoning behind the fruitful use and dynamic employment of learner representation to assist and enhance the learning process is part and parcel of the methods investigated in educational research. On the other hand the technical and procedural details of how to generate and employ this learner representation or profile falls under the remit of information technology and more specific within the area of computer science and artificial intelligence. As clarified earlier in Chapter 1 this research focuses on the educational aspect and does not go into the technical details as they go beyond the intended scope. The concept of personal learning portfolios from the education research domain have already been associated with learner profiles in Section 2.1b) together with another e-learning concern in an attempt to address motivation or the lack of it. It has been argued that what motivates a student includes the enthusiasm and the participative feeling within the learning process itself. In Section 2.2 the self-determination learning theory was also associated with motivation and the use of profiles as learners feel participative in the formation of their portfolio and eventually of its effect on the adaptive e-learning environment. The information collected and the eventual knowledge accumulated about the learner from the previously explained personalisation process is processed and saved by the underlying platform to assist in the customisation process. Learner profiling is the process that purposely developed software performs after extracting significant features from information provided about a learner, associated interests, feedback given, and academic outcomes achieved. This generated profile is considered as an information capsule about the learner and is used to transform the next interaction with the learner. The personalised learning environment is influenced and adapted according to the learner profile that has been created through the information initially provided by the learner and later on by the information extracted during every session. Learner interests are number coded and are automatically associated with individual learners. Other information related to progress, paths followed, likes/dislikes, feedback given,

assessment outcomes, subject preferences, and other essential data is also coded up and saved in association with each individual learner. This constitutes the necessary portfolio information to keep a dynamic record of the learner profile. The three parts of the learner profile, namely the user interface preferences, academic services adopted, and academic content are automatically updated and continuously refined every time the learner logs in and interacts with the environment. The feature extraction process is part of the learner profile generation and is responsible of identifying significant attributes in the content to characterise the learner's preferences and unique properties. One final issue worth mentioning, before switching to the empirical study itself, is the fact that all the software components are simple implementations of established and freely-available computer science methods including feature extraction, pattern matching and user profiling. These components are self-contained computer programs that can be replaced or upgraded by other components that provide similar functionality. Details of how the algorithms were implemented in the different methods go beyond the scope of this thesis but have been purposely designed and developed specifically for this empirical study. The technical details are presented and briefly explained in Appendix Q.

3.3   *Empirical Study*

The entire research project pivots upon the data collected, analysed and interpreted. This data are extracted from the empirical study that are described in detail in this section. A number of studies (Bernard, Abrami, Lou, Borokhovski, Wade, & Wozney, 2004; Means, Toyama, Murphy, Bakia, & Jones, 2009; Xu & Smith Jaggars, 2011; Johnson & Cuellar Mejia, 2014) have over the years employed similar empirical studies to collect data and infer conclusions from its interpretation. In an effort to ensure the validity and reliability of the empirical study, best practices from the different studies were adopted as proposed by Neuhauser (2002). In her study to investigate whether online education is more effective than F2F instruction, two sections from the same course were delivered to the same group of participants to draw conclusions from the relevant data collected. In this case the comparison was done between three different kinds of delivery, namely, Face-to-Face (F2F), a static online learning mode similar to a Virtual Learning Environment (VLE), and finally via a dynamic personal learning environment which are referred to as the Intelligent Personal Learning Environment (iPLE). Similar

to the Neuhauser study, the data collected to test the effectiveness of the latter mode of delivery, consisted of a mixed method approach. Qualitative data was collected by means of questionnaires, semi-structured interviews, and focus groups; as well as quantitative data collection by means of electronic user surveys and evaluation forms. These were submitted pre- and post-testing considering they are accredited as the most commonly used instruments to measure e-learning effectiveness (Noesgaard & Ørngreen, 2015). Further details about the data collection methods employed are expanded in Section 3.6 together with the analysis that it are subjected to in the section following that.

The platforms employed to deliver the two e-learning modes, VLE and iPLE, were fundamentally similar to each other with the only difference that the dynamic personal learning environment had additional dynamic components that the traditional static online course does not usually have. The F2F component was delivered to all the participants by the same instructor using traditional presentation media together with verbal explanations. While the VLE and the F2F required no initial input from the participants, the third mode, the iPLE, expected minimal input to start off the personalisation process. Input from the participants was required as an initial trigger for the personal learning environment to customise and tailor the environment according to the unique combination of the participant's interests. Further details related to the platform developed specifically for this empirical study are given in Chapter 4 while snippets of the face-to-face and static online course are displayed in Appendix A and B respectively.

3.4   *The Participants*

The participants that participated in the empirical study to collect the necessary data have been enrolled from the higher education sector. In particular the entire corpus of ICT and Computer Science teachers within the secondary schools in Malta were asked to participate in the study as part of their annual in-service training at the end of the scholastic year. An informant sheet, shown in Appendix C, was distributed to all the potential participants to ensure enrolment was performed in full knowledge of what the study entails. This included also what is expected from them, risks and benefits,

confidentiality assurance, how to withdraw and how much time it will entail. A respective informant consent form, shown in Appendix D, was presented to the participants to sign and confirm their voluntary participation. Amongst other issues the participants sign off within the consent form reaffirms the possibility of withdrawing at any time and a reassurance of confidentiality. The initial data regarding the participants' basic information was collected through an initial survey, but full details about this data and other collected data are expanded in Section 3.6. The group of enrolled participants was divided into three subgroups in alphabetic order. The reason for this subdivision is to concurrently expose each subgroup to the three modes of delivery as explained in the previous section. The exact logistics of this setup was setup as shown in the table below.

Table 3.1 - Logistics of empirical study

Week 1	First Period	Second	Third Period
Group A	F2F	VLE	iPLE
Group B	iPLE	F2F	VLE
Group C	VLE	iPLE	F2F
Week 2			
Group A	VLE	iPLE	F2F
Group B	F2F	VLE	iPLE
Group C	iPLE	F2F	VLE
Week 3			
Group A	iPLE	F2F	VLE
Group B	VLE	iPLE	F2F
Group C	F2F	VLE	iPLE

The particular setup that equally exposes each group to the three modalities was done for two reasons. The first reason was specifically for functional reasons so that all the participants could contribute to the evaluation of the proposed system when comparing it to the other two modes. The second reason was purely due to ethical issues that are discussed further in Section 3.8. Note that each group was able to commence a fresh week of tuition with a different modality to ensure that no group was disadvantaged in any way.

3.5   *Theoretical Framework*

The educational connotations that were discussed in Section 2.2 attributed three specific learning theories to the combination of approaches adopted in this research study. The associated learning theories that were reviewed are connectivism, self-determination, and adaptive learning. The way that each of these learning theories form part of my underlying epistemological reasoning are highlighted and reflected within a theoretical framework that influences and determines the design and implementation of the empirical study and the research study in general.

The use of social media were evidenced within the dynamic material presented within the proposed personal learning environment. This material was closely related to the individual participant's interests, and as Siemens (2004) argues it makes use of networked technologies, shifting and distributing the learning outside the learner. Additional related links and potential of further relevant material reaffirms this theory's main tenet on the importance of rather than learners internalising knowledge, they know how to identify the required knowledge themselves. Such an theory subscribes to the notion that it is the learner's responsibility to address and support the specific and personal learning needs. It was also argued earlier that the post-positivistic theoretical stance adopted in this study was pragmatically mapped within the empirical study. The proposed online experience was meant to determine and distinguish the generic interactive events together with the frequency and property of what the participants extracted within the real context.

The interaction intended by the connectivism learning theory is further reinforced by another learning theory, introduced earlier in Section 2.2, whereby the motivation of the learner is pivotal to the learning process independently of the medium. The self-determination learning theory is critical in the success of the proposed mode of delivery because it is being assumed that the participants are doing their utmost to extract maximum benefits from the resources provided based on their personal interests. The sequential delivery presented by a typical learning management system assumes the student goes through the incremental material covering the required content in order to master some topic. In this case if the learner's motivation does not lead to the multi-directional content provided then the concept behind the connected information will lose its purpose. This does not mean that as a consequence the learner will drift away from the main focus, but simply that this additional information can potentially complement the central educational focus by aligning the learner's interest with the

topic being taught. The personal learning environment was designed in such a way as to maintain the learner's focus on the topic central to the online course, but at the same time allowed marginal related material that not only maintains interest but also enhances the learning process.

Such an adaptation subscribes closely to the third established theory about adaptive learning. As argued earlier in Section 3.1 personalisation adds value to the learning process as the content is moulded to the individual requirements and interest of the student. The proposed system tailors and attempts to customise the entire e-learning process as close as possible to the specific student profile. In line with the three components to adaptive learning highlighted by Oxman and Wong (2014), the proposed personal learning environment encapsulated all the three models. The content model was represented through the pre-set structure of the material being taught, and which was employed in its unaltered state during the static online course. The learner model was based on two factors, the specific characteristics of the participants specified in the previous section, and the explicit specification of the same participants. Finally, the instructional model was represented within the dynamic learning environment itself as the content model was modified and tweaked to accommodate the dynamic learner model.

The three established theories that were expanded in detail in Section 2.2 were embodied within the theoretical framework of this research as they provide a combination of diverse contextual lenses through which it was possible and feasible to realistically propose and design this research and its corresponding empirical study in a way to facilitate the collection of the right data. This data collected was employed to evaluate the effectiveness of the dynamic personal learning environment in comparison to both the face-to-face mode of delivery and the dynamic online course. The different data collection methods together with a data collection plan are now presented in light of this theoretical framework. Apart from the ethical considerations, the data analysis that follows, as well as the validity and reliability of the collected data, complements the theoretical framework and brings to completion the methodology of this research study.

3.6   *Data Collection Methods*

A mixed set of data collection methods has been accurately and meticulously planned and developed to ensure to collect the required data to ultimately get to what needs to be measured and known. This naturally led to how to extract such information, the methods, and what needs to be done with it, the analysis. Over and above this, the validity and reliability of the entire process needed to be sound. A mixture of quantitative and qualitative instruments were employed depending on the medium and nature of what data was being collected. The proposed methods for this empirical research study were the following five data collection (***DC***) instruments:

***DC₁** – Pre-test using a survey tool for data collection*;

This quantitative instrument was designed to extract information about the participants prior to their exposure to the proposed system. The survey tool itself was adopted and adapted from the validated Technology Acceptance Model (TAM) instrument (Davis, 1993) whereby the attitudes and level of technology acceptance by the participants were captured. The reason this model was chosen is due to its popularity and the frequency of its use in such situations (Ma & Liu, 2004; Kim & Chang, 2007; Yarbrough & Smith, 2007). The technology acceptance model is intention-based and developed specifically for justifying user acceptance of computer technology. Masrom (2007) makes extensive use of the TAM within an e-learning environment to investigate the effects of user acceptance and attitudes on the use of e-learning within an application.

The pre-test survey employed, shown in Appendix E, contained twenty-four (24) items which are subdivided into eight (8) sections. Apart from the basic personal information, qualifications and work related details, the sections included personal use of technology, and the participants' views about e-learning courses, e-learning design and online assessment. The data collected in this pre-test were employed as a baseline to create a realistic contrast with the post-test together with additional data that was collected.

DC$_2$ – Intermediate participant opinion using dichotomous questions;

Quick participant opinion were recorded at different intervals during the progress of the delivery mode under investigation. Simple questions, similar to the ones shown in Appendix G, were purposely designed to minimise the interruption of the flow of instruction while gathering minute yet frequent input from the participant. Such a methodology is similar to the momentary time sampling methodology (Meany-Daboul, Roscoe, Bourret, & Ahearn, 2007) from which it was adapted. The data collected was meant to record the participants' evolving sentiments and opinions that could not be captured with the other data collection methods adopted.

DC$_3$ – Intermediate assessment using a questionnaire as an evaluation tool;

A series of assessments following the completion of each part of the course are employed to collect participants' scores on their understanding of the presented content. This is in no way meant to measure the ability or the academic achievement of the participants, but merely to complement and support the results from the other methods employed. Similar studies (Neuhauser, 2010; Joy & Garcia, 2000; Domenic, 2010) have employed this instrument to assist them in measuring learning effectiveness. In this study the participants' scores resulting from the various assessments were used to shed additional light on the hypothesis stated in Chapter 1. The questionnaire, shown in Appendix H, were entirely based on the content and was distributed in a printed format in the case of the face-to-face mode of delivery, while in the other two modalities it was made available as a soft copy at the end of the static and dynamic sessions.

DC$_4$ – Final experience evaluation using a number of focus group sessions;

The final data collection method employed was at the very end of the empirical study with the help of focus group sessions. The reason behind these focus group sessions was to understand further the participants' perceptions and attitudes towards the proposed dynamic learning environment. A semi-structured focus group tool (Appendix I) was used with randomly selected participants in three (3) groups of between 8 to 10

participants. The structure and content of these sessions have been adopted and adapted from Wilkinson (2012) and were meant to mainly discuss the following questions:

- ➢ Q1: Which modality was most effective and functional?

- ➢ Q2: Were the personal interests effective and add value to the experience?

- ➢ Q3: Which mode or combination of modes would you prefer/recommend?

DC_5 – Post-test using a survey tool for data collection;

This final quantitative instrument was designed in tandem with the *DC_1* pre-test survey to extract information from the participants prior to their experience and exposure to the intelligent personal learning environment. The TAM model, introduced earlier, was also adapted and employed as an instrument to design and develop this data collection survey tool. The post-test survey, as seen in Appendix F, contains thirty (30) items concentrated within five (5) sections. The first section covered the basic participant information, while the other sections tackled the main issues under investigation, namely, effectiveness of the proposed medium in comparison to the other two modes, any changes related to e-learning, its design and online assessment.

Table 3.2 - Data collection legend & summary

Data Collection Method	What is being measured
DC_1 – Pre-test survey	Technology use, e-learning familiarity
DC_2 – Intermediate opinion	Transitional participant attitudes
DC_3 – Intermediate questionnaire	Assessment of content acquisition
DC_4 – Final focus groups	Overall attitudes of experience
DC_5 – Post-test survey	Effectiveness of different modalities

The data collection methods have been tabulated in Table 3.2 above together with a short summary of each to serve as a legend. The same DC methods can be seen within the overall data collection plan in Figure 3.1 below. This helps to visualise the administration of the different methods during the empirical study in chronological order.
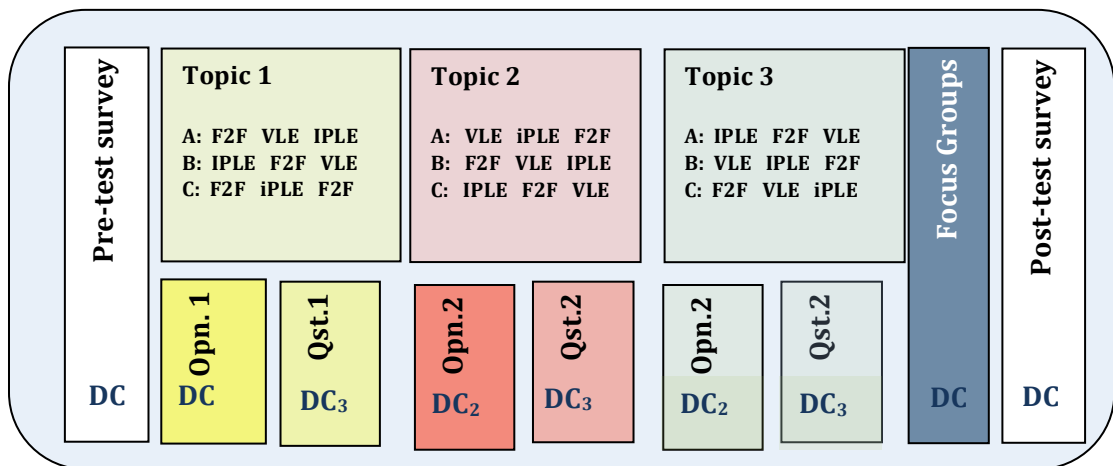

Figure 3.1 - Data Collection Plan

3.7   *Data Analysis*

All the data collected during the empirical study, with the instruments employed as described in the previous section, were fruitfully processed and analysed to enable an informed interpretation and presentation of the results. The limited data that was collected is not meant to generalise or extrapolate the findings, not because it is insufficient, but simply because it was designed to reliably address the specific personalisation issue. The data analysis, documented in Chapter 6, is meant to inform, illuminate and provide a basis for further investigation. Overlap between the reasons for collecting the planned data is also intentional, not only to ensure that the research question is amply covered, but also to reconfirm the drawn interpretations from the different instruments employed.

A number of statistical tests were employed to analyse the data. The study followed best practices to ensure the fitting analysis for the purpose of this research is performed (Cohen, Manion, & Morrison, 2007). Similar studies in the effectiveness of e-learning (Chan, Chow, & Jia, 2003; Neuhauser, 2010; Domenic, 2010; Al-Adwan, Al-Adwan, & Smedley, 2013) have also made use of a mixture of data analysis instruments that have been widely employed in different areas of education research (AP, 2011; Baxter & Jack, 2008; Bernard, Abrami, Lou, Borokhovski, Wade, & Wozney, 2004; Joy & Garcia, 2000). The analysis of the available quantitative data was kept as simple as possible, while statistical tools and graphical representations facilitated the presentation of the results as well as the interpretation of the analysis. The qualitative data resulting from some of the data collection instruments used, such as the focus groups and participants' comments, were thematically analysed in a systematic way to ensure that the same conclusions were drawn should the empirical study was to be repeated and the data collected recreated. Thematic content analysis is a widely employed and accepted tool to analyse qualitative data (Burnard, et al., 2008). Such an instrument is ideal in the absence of numerical or quantitative data as the processing of textual data collected can be analysed and investigated to identify and report any patterns which are referred to as themes. According to Braun & Clarke (2006) a "*theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set*" (p. 82). Additionally, Thomas & Harden (2007) conclude that, in an effort to understand how to optimally take advantage of qualitative research in order to inform policy and practice, thematic analysis takes advantage of years of methodological qualitative research development.

Details on validity and reliability are discussed in Section 3.9.

The data analysis instruments that were employed in this thesis are the following:

- Standard descriptive statistics including percentages, mean and standard deviations about the data collected from the pre-test and post-test (DC_1 and DC_5) to highlight any significant and relevant findings. These instruments were also employed to underline and report any notable differences between the mode of delivery under investigation and the other two modes. The data from DC_4 and DC_5 were both employed to shed light on this aspect of the research.

- Pearson Chi-Squared tests and Friedman tests to assess the validity of the null hypothesis and the fitting between the two variables, namely 'personalisation' and 'interests', as observed and as expected theoretically. Data from DC_2 & DC_3 were employed to extract such results in preparation for critical evaluation and discussion;

- Thematic Content Analysis using data collected from DC_4 was performed to further draw additional results to supplement the previous ones. Full transcripts from the focus groups were done and employed within a purposely designed qualitative data analysis tool.

3.8   *Ethical Considerations*

All ethical considerations have been well thought out on the outset of this research. Prior to the drafting of the proposal for this research study a comprehensive ethics training course was completed in May 2014 at the School of Education at the University of Sheffield. The Research Ethics and Integrity course (FCS6100) ensured that any ethical issue related to the proposed research would need to be identified and documented within the ethics clearance request that the same university places as a requirement before commencing the research study itself. In October 2014 a completed ethics application form (Appendix J) was submitted to the university's ethics board, which approved the project on the 16th December 2014, as shown in Appendix K.

The main concern with having a control group during the empirical study, as declared in Section A5ii. of the Ethics form, was surpassed by subjecting all the participants that were divided into three groups to all modalities of instruction employed during the study. In this way none of the participants were held at a disadvantage compared to any other participant. Another ethical issue that was resolved during the data collection stage was whether the participants were anonymous or not. The participants were informed about the study through an information sheet (Appendix C) which was distributed prior to the commencement of the study. They were also asked to sign a consent form (Appendix D) to allow the use of the data collected throughout the study.

At no point during the study were the participants asked to identify themselves or submit personal information. The online system maintained a live session every time the participants accessed the online environments from their personal laptops and made use of the proposed learning environment. No logging-in requirements were imposed and all that the system registered were the interests of the individual learners and their responses to the other data collection instruments associated with those interests.

3.9 *Validity and Reliability of Data Collected*

The aim of this section is to ensure and document the efforts done to maintain high values of validity and reliability during the data collection and analysis stages. It is only possible to reduce as much as possible a threat or a breach to either one or both. Cohen, Manion, & Morrison, (2007) as well as Kleven (2007) identify four types of validity related to data collection in educational research. These are construct validity, statistical, internal and external validity, and need not all apply to this research. Construct validity, which refers to and ensures the validity of inferences that are made from the indicators to constructs, is relevant in this case. The construct that constitutes the participants' judgment of the effectiveness of the proposed medium was captured directly in the post-study survey, DC_2, rather than being inferred. Additionally, other indicators that have been designed in relation to this same construct have been designed within the instrument that collects the intermediate participant opinion, DC_3. This is intended to measure also the evolving opinion of participants and thereby ensure the validity of such a construct. From a statistical validity point of view, the different modalities employed during the empirical study served as variables, and thereby the validity of inferences about co-variation between these variables was ensured. The use of participants' interests as part of the personalisation process within the dynamic learning environment was intended to be critical in inducing the effectiveness of this medium amongst the participants. It is for this reason and to ensure internal validity that the participants' opinion about the use of their interests was captured. Internal validity specifically ensures that any interpretation with respect to the effectiveness of the dynamic medium is influenced by the use of personalisation techniques through the use of interests. Such a validity reassurance is decisive within this research. This was extended to a wider context and to other personalisation techniques rendering external

validity relevant as well. The integrity of external validity is secured in this case due to the fact that the empirical study is a proof of concept involving personalisation of education material. Additionally the group of participants was representative of learners with varying ages, gender, and interests but with approximately the same level of education.

The consistency and stability of the results extracted from the data collection instruments described ensures the reliability of this study. The empirical study can potentially be administered with a different group of participants over different periods of time. Reducing the number of variables that are not relevant to the study and which are not being captured ensures that the reliability of the data collection instruments are able to capture the required data to draw the same conclusions.

3.10 *Chapter Closure*

The methodology that characterises the empirical study of this research study has been described in detail, including details about the participants, the collected data, and ethical issues. Apart from the details related to the empirical study itself, the personalisation process and the learner profile generation components were also tackled to shed light on their theoretical contribution rather than their technical inner workings. This chapter made extensive use of the literature review covered in the previous chapter and has now laid the foundations for the actual implementation of the proposed personal learning environment that are the main focus of the next chapter.

Chapter 4

iPLE

This chapter covers all the details about the actual tool employed during the empirical study, called the intelligent Personal Learning Environment or iPLE. Following the detailed discussion of the strategies employed in the previous chapter together with the educational theories and the data collection methods employed, the rationale behind this tool are explained in the first subsection. This is followed by a technical description of what the requirements of the proposed tool were. These specifications are formally designed in the next section before the actual development process is briefly described to give an overview of the interface and the testing performed before the system was deployed during the empirical test. The chapter comes to a close with a complete review of the environment usability to ensure that the iPLE embodies the theoretical reasoning mentioned in Chapter 2 together with the methodologies highlighted in Chapter 3. This facilitated the collection of the required data.

4.1 *Rationale*

The iPLE is grounded on the main hypothesis of this work, namely, that personalisation and the learner's interest adds effectiveness to the learning process. The iPLE is only one of the three modalities that was employed during the empirical study, but it is the one that required most development. The other two modalities that are expanded in some detail in Section 4.5, the Face-to-Face (F2F) and the traditional e-learning platform or Virtual Learning Environment (VLE), required equal attention and just as much preparation as the iPLE. The education content for all three modalities was separately and distinctly prepared to reflect the specific medium. All participants had the opportunity to commence a new topic with each of the three modalities to ensure there was no bias in the exposure of participants to the different modalities. The specific requirements of the iPLE are now listed to ensure that the design and the development reflect the above rationale.

4.2 *Specification & Design*

The proposed environment is required to accommodate the underlying methodologies proposed in Chapter 2 while ensuring to incorporate data collection tools required to test the objectives set in the introduction. The iPLE was one of three modalities employed during the empirical study, but embodies the hypothesis upon which this thesis is founded. This means that the practices of personalisation, crowdsourcing and learning portfolios were integrated within the design and development as they subscribe to my own ontological and epistemological positions of socio-constructivism and connectivism. Specific technologies introduced earlier like Web 2.0 and information portals served as content providers to the domains of interest identified by the participants. In this respect nine areas of interest were employed based on a collation of categories from the Open Directory Project (ODP, 2013), OpenCyc platform (OCP, 2015), and Wikipedia category hierarchies (Wikipedia, 2015). These nine categories formed part of the interface that are described in the next section, and are Sports, Games, Cooking, Art, Movies, Outdoors, Reading, Gardening, and Music. Similar attempts to explicitly employ categories of interests, like Google Personal (Google, 2011), and Liu, Yu, & Meng, (2002), have been found to reduce the initial concern known as the cold start effect (Bobadilla, 2012),

whereby information provision services fail to target specific content due to lack of initial knowledge directly related to the learners' interests.

The three most popular social networks were employed to aggregate content related to the nine different interests categories. Sareah (2015), eBiz (2015), and Milanovic (2015), unanimously agree that Facebook[21], Twitter[22] and LinkedIn[23] are the three most popular and important social media sites that enjoy global acceptance and worldwide recognition as social and content media providers. These three sources also formed part of the proposed iPLE as content related to the learners' interests was presented in some form peripheral to the main educational content being transmitted. One other requirement was to anonymise the entire session while at the same time maintain the same learner's profile seamlessly between the sessions. This detail formed an integral part of the system to ensure that the information about the learner's interests was maintained, together with any information gathered during the sessions, while at the same time not requiring any user identification data. This goes in line with the ethical considerations mentioned earlier in Section 3.8, but at the same time was crucial for the empirical study to ensure that all the collected data through a specific user session originated from the same learner, irrespective of the exact user identity. This was achieved through the use of personal laptops that the participants were asked to bring along every day. The different data collection instruments that have been proposed in Section 3.6 all formed part of the iPLE in one way or another. Some of the methods involved explicit feedback from the user, while others collected data implicitly as the learner made use of the different parts of the iPLE as a modality.

All the specifications mentioned above acted as requirements to the system that was developed. The design upon which the implementation was based is shown in Figure 4.1 while the activity flow during a typical session is captured in Figure 4.2. The top-level design diagram depicts a number of sub-systems that together make up the final iPLE. The learner interacts with the system through an embellished user interface that was specially designed to optimise the learner's interaction throughout the session. A modern look-and-feel was planned for the initial screens, but use of design templates, known as Cascading Style-Sheets (or CSS) were employed throughout the rest of the course

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[21] www.facebook.com
[22] www.twitter.com
[23] www.linkedin.com

content. CSS ensures that all course interfaces are consistent while at the same time makes it easier for future designers to change the designs of the entire course by simply changing or editing a single design template.
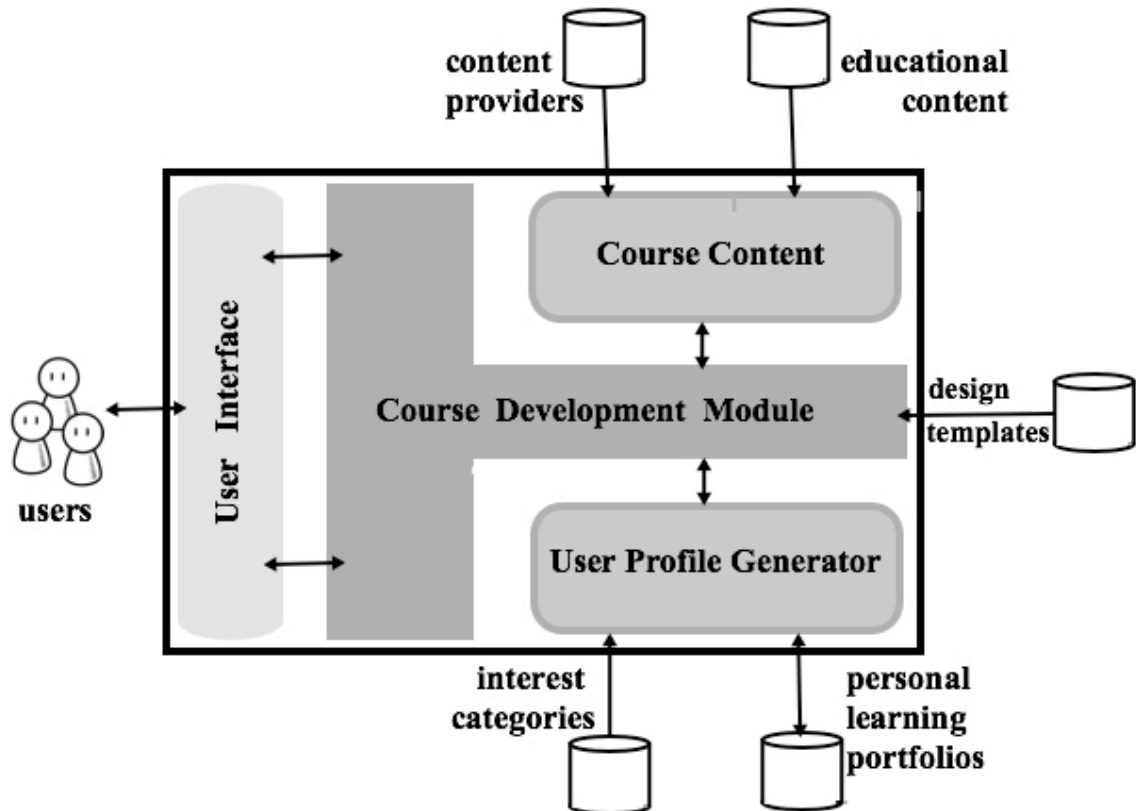

Figure 4.1 – iPLE top-level design

At the heart of the design is the course development module. The purpose of this first component is to customise the course content to fit the profile of the learner who made use of this modality. A second component is the course content module with the task to compile the actual contents from the externally supplied educational content in combination with content provided from the crowd via the three most popular social media. It is important to point out that the social media employed can be externally edited and controlled through an admin interface. Similar to other programmed components these modules are easily replaceable and upgradable with other components that provide similar functionality. The user profile generation component merges the specific user personal learning portfolio with the specific interests categories that have been explicitly selected by the same learner. It is worth highlighting the fact that during the initial interactions default content related to the learner's interest was presented until further interaction assisted in refining the personal learning portfolio. The details related to the

functionality provided by the profile generator were expanded in Section 3.2 and highlighted the fact that its functionality become much more effective once the learner makes use of the iPLE and provides further input to generate and further refine the profile encapsulated within the personal learning portfolio. It is worth expanding further about the three components that make up the unique learner profile and which together contribute to the uniqueness of a particular learner. Each of the three components identified in Section 3.2, namely, the user interface preferences, academic services adopted, and academic content are important to contribute to the different aspects of the personalisation process that other similar systems seem to focus solely on either one of them. It is also important that these components are maintained up-to-date and as dynamic as possible in order to evolve and truly represent, as close as possible, the learner. The user interface preferences are the simplest of all three as a number of design templates make it possible to switch from one interface to another seamlessly without affecting the content or the functionality. New and different design templates can be included and made available through the admin interface while ensuring that each design complies with the basic interface design. The learner preference for a specific design was easily stored locally on the participants laptops and could be changed at any point during any of the learner's interaction with the iPLE. The academic services adopted or the available widgets that can be included within the iPLE are also editable by the administrator who can provide new functional components that need to comply with the iPLE design requirements. These widgets include sources of social media related to the learner's interests as well as sources of freely-available online information. Finally, the academic content was tweaked and adapted, together with all the other information provided within the iPLE, to fit the specific learner profile reflecting interests, preferences, feedback and progress. Another functionality within the user profile generator is the clustering component that took into consideration other learners with similar or closely related profiles. This application simply checks other stored anonymous profiles whether they match at least any two out of the three components that make up the learner profile. If a match is found the iPLE simply brings up sample widgets and information sources that could interest the particular learner to adopt or ignore completely.

The third and last component that provides input to the course development module is the externally supplied design template. This template can be easily edited by an educational
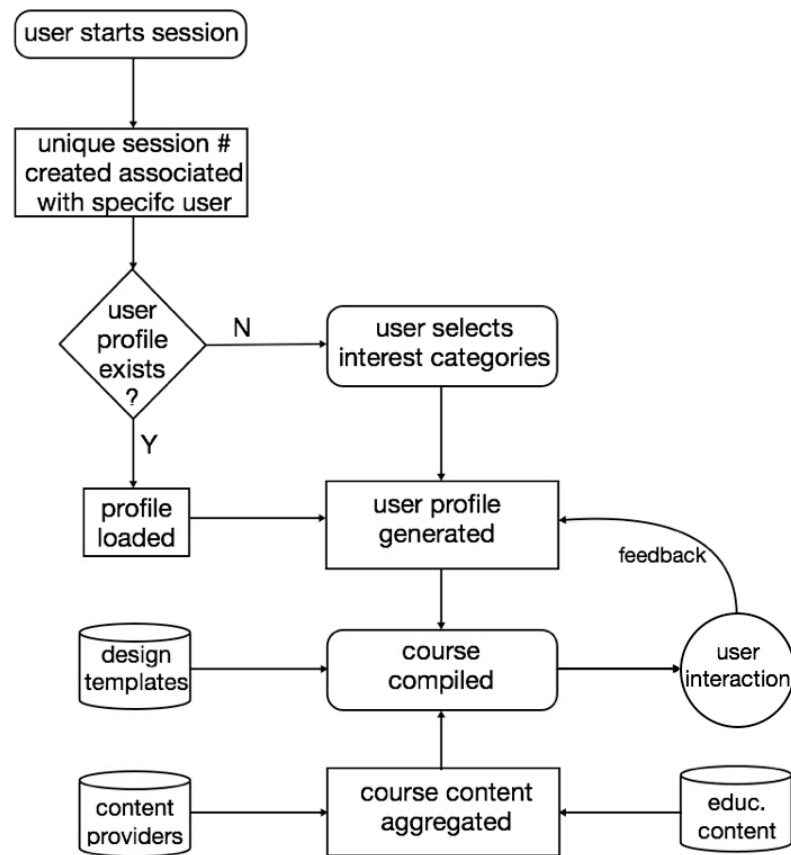
Figure 4.2 – iPLE flowchart

usability expert and ensures that all the course material presentation is consistent. Finally the user interface was simply a standard web browser. This ensures that the iPLE can work across any platform, whether the user uses a Windows based computer or an Apple iOS computer.

Figure 4.2 complements the iPLE design and depicts a typical run through a user interaction with the system. The crux of this flowchart is the cyclic activity that the learner drives when interacting with the system. This feedback further feeds into the user profile refinement and eventually to a better-tailored course compilation. The content providers and educational content are displayed as external data storages providing input to the course content being aggregated. Similarly, the design templates are shown as an external data storage applied to the content when the course is being compiled before presenting it back to the learner. Similar profiles, based on similar learners' interests, are employed to target content for other learners, while session details and characteristics are locally saved as part of the user's browser data called cookies. Further technical details and detailed specifications regarding the iPLE implementation are covered in the following section.

Having gone through the main specification and design details of the iPLE, the major highlights of the development process follow. The reason for these details is simply to ensure that the educational connotations and theoretical underpinnings, discussed earlier in the methodology chapter materialised within the final prototype employed for data collection.

4.3   *Development & Testing*

The implementation of the iPLE platform follows directly the specification designed in the previous section based on the theoretical principles that underline this research project. The modality under investigation makes use of three practices in a measured attempt to increase the effectiveness of e-learning. Personalisation is introduced through the explicit user selection of personal interests, crowdsourcing is merged within the environment through the employment of social media related to the same interests, and finally learning portfolios assist in refining the personalisation process.

Figure 4.3 – Interest Selection screen

The platform used an Internet browser as a user interface, and so all the development is Web 2.0 related. The underlying technology employed was PHP (PHP, 2015) together

with the traditional HyperText Markup Language (W3C, 2015). At the back-end of the iPLE is a MySQL database (Bulger, Greenspan, & Wall, 2003) to store all the learner profiles, educational content, interest lists, design templates, and information from content providers. All the data collected during the empirical study was also stored in the back-end database, while specific learner data was stored on the hosts' own computers as part of browser-based cookies, as mentioned earlier. Appendix M shows the front interface of the iPLE modality that was employed during the empirical study. The initial welcome screen consists of a simple floating banner, which reveals the portal to the three sections of the educational material. Figure 4.3 is a screenshot whereby the learner was required to make a maximum of three interest choices that formed the basis of the crowdsourced content presented to the same learner. Intermediate user opinions, as part of the data collection plan, namely $DC_{3,}$, were gathered through simple pop-ups as shown in Figure 4.4 (see all the pop-ups in Appendix G), while intermediate assessments, DC_4, were collected at the end of each week (Appendix H).

Figure 4.4 – Pop-up collecting intermediate user feedback (DC$_3$)

A typical course page is shown in Figure 4.5, depicting the educational content at the central part of the browser. On the periphery of the learner's focus were numerous contributions from crowdsourcing social media providers providing content that were both related to the educational material, as well as to the learner's interests, or both at the same time. Any of the provided links opened a new tab when clicked rather than loading onto the same browser tab. This ensured that the user was at liberty to browse off to check out the related content and could easily return at any point to the iPLE by switching back to the original tab. Additionally, a number of icons were omni-present, namely, the user interests icons at the top left of the interface reflecting the learner's choices; the switch interests icon, , at the top right, enabling the learner to switch to other interests at any time; as well as, the back, forward and main menu icons at the bottom of each page.

Figure 4.5 – Typical iPLE course page

4.4 *Environment Usability*

Usability of the intelligent personal learning environment features high because special attention to detail and ease-of-use were considered priorities. The empirical study focuses on the educational connotations of the proposed setup and thereby usability issues were required not to be an issue but actually assist even more the learner while experiencing the iPLE. The entire iPLE environment was designed and developed with a learner-centric methodology to ensure the usability aspect is optimised thereby ensuring that the learner experience is not lacking or of hindrance to the empirical study. The use of pop-ups was employed to relay minor messages to the learner while interacting with the
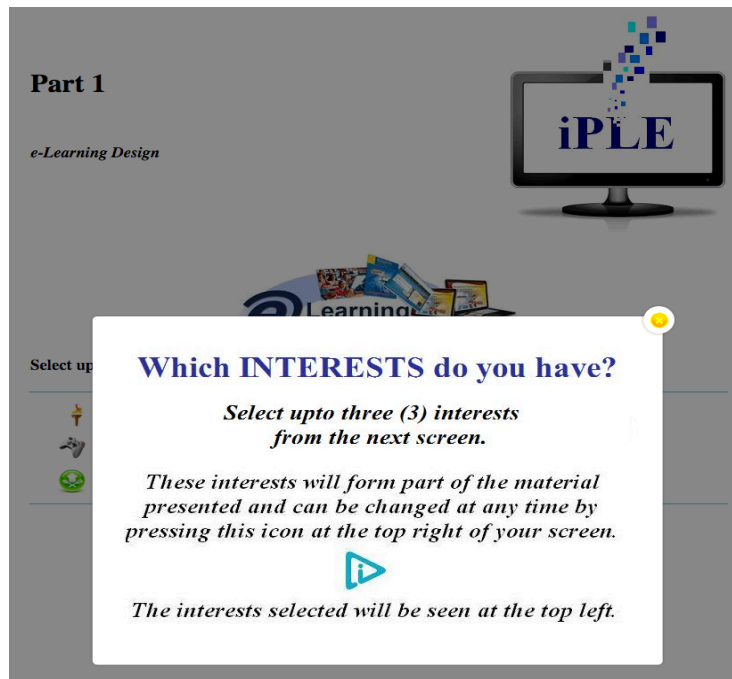

Figure 4.6 – Information pop-ups to enhance environment usability

platform. In one scenario for example, just before the learner was asked to explicitly select a maximum of three interests, a pop-up window informed the learners what needed to be done once the pop-up was cleared. The information, shown in Figure 4.6, included the meaning of the interests icon, as well as, information about the possibility of switching interests half way through the course without losing the location or the sequence of the course being followed. Another environment usability concept to assist the users was the consistency of the interfaces with the help of design templates. These design templates, totally designed in CSS3 (W3C, 2015), can easily be externally edited to ensure a global adaptation of the educational and information content.

Other iPLE features that raise the usability factor can be seen in the intuitive way intermediate learner feedback was collected while using the environment. As shown in Appendix G the use of a simple intuitive interface was employed to capture at a click of a mouse the learners' opinions and attitudes regarding the overall effectiveness as well as the specific assessment regarding other micro features present within the iPLE.

4.5   *The Other Two Modalities*

Two other modalities formed part of the empirical study as planned in Section 3.3 in an effort to set up the best testing environment for the iPLE at the centre of this research study. Transitioning between the different modalities was planned to be seamless as far as the educational content was concerned with an outline of the chosen topical areas that ran through the three different modalities in a way to ensure that the only variable was the modality itself.

The first of the other two modalities was the static e-learning environment that is referred to as the VLE. The design principles that went into developing this control environment were similar to those employed in the iPLE described earlier. The rationale behind this design decision was to ensure that no additional environment variables impinge or effect the results of the empirical study. The static online course material presented within the VLE (Appendix B) was typical of static e-learning courses whereby the learner is expected to navigate through the material sequentially with multiple hyperlinks to the main menu, to previous or following course sections, as well as an indication of current location. The major decisions that went into the design of the iPLE were mainly planned for the VLE with a foresight to include additional functionality and content place holders. The look and feel of the templates developed were purposely standardised for easier maintenance and faster modular integration of additional components, while the basic colour schemes and user interface configuration were all neutrally set in the same way.

The second of the other modalities, apart from the iPLE, was the classical face-to-face modality that was completely independent from the other modalities as far as design and delivery was concerned. A tutor specialised in technology-enhanced education from the faculty of education at the University of Malta delivered the three-part syllabus after personally planning and preparing all the required lecturing material and resources. No

connection whatsoever was established with the other modalities and neither of the VLE or iPLE environments were shared with the F2F tutor. Three topical areas subdivided into three equal portions were authored using a presentation software with the assumption that the learners are covering one section out of three every day while the rest of the material to be covered by the two other modalities. All that was revealed were logistical details that included the schedule of classes and groups, shown in Table 3.1, that were to be delivered over the 3 weeks. The detailed syllabus included diagrams that were used in the preparation of the VLE and iPLE, as well as, specific information related to the three topics covered over the three weeks, namely:

i. Instructional Design
ii. Online Assessment
iii. Technology Tools

4.6 *Chapter Closure*

The first prototype of the intelligent personal learning environment, iPLE, was the main focus of this chapter. The empirical study was positioned entirely around the functionality presented within this proposed environment and thereby every aspect of the iPLE has been clearly explained in detail and justified. The iPLE brings together all the methodologies, learning theories, and academic concepts that have been introduced earlier and positioned together into a single functional and rational concept. While introducing the details of the iPLE a balance had to be struck to ensure that all the individual components were thoroughly covered while at the same time safeguard the reader by not overcasting the education rationale with too much technical detail. The different components within the iPLE were justified by theoretical and epistemological reasons backed with design choices and decisions. This platform was only one of three modalities used during the empirical study but the only one that was put to test. To this extent it was made possible to collect the required data that are presented and analysed in the next chapter.

Chapter 5

Results

This chapter brings together all the research done in preparation for this thesis, the planning and implementation of the empirical study to test the hypothesis, and all the hard work involved in synchronising it all. The empirical study described in the previous chapter was purposely designed to collect data in order to evaluate the effectiveness of personalising e-learning. The previous two chapters highlighted the basis of the design methodology and presented the theoretical foundations of the proposed work together with my personal epistemological positioning. The results presented in this chapter were collected during a three-week period at the University of Malta in July 2015, using a number of data collection instruments that were listed in Section 3.6. A number of data analysis methods and presentation modalities are presented and justified, after that the standard participants' demographic data is graphically represented in the next section. The chapter draws to a close with a thematic content analysis of the focus groups transcripts in preparation for a full discussion of all the results in the next chapter in an effort to shed light on the outcome of the study.

5.1 *Participants' Demographics*

The planning for the empirical study started eighteen months prior to its actual occurrence in July 2015 as the research proposal took shape together with research question and hypothesis. Ethical clearance, shown in Appendix K, was granted on the 18th December 2014, following the completed submission of the Ethics Form (Appendix J) at the beginning of October 2014. By the end of 2014 further logistics related to venue, scheduling and potential participants were finalised in agreement with the Maltese National Education division who held yearly in-service training for all their educators from the public and private educational institutions. It was agreed that the upcoming in-service training related to ICT was to be held during July 2015 under my direct control as the principle investigator. In April 2015 an email was sent out to all attendees to pronounce the possibility of their participation in an educational study as part of their upcoming in-service training. The recruitment took place during the first week of July 2015, and the actual in-service training and introduction to the empirical study started on the 6th July 2015 for the following three weeks. A total of 120 attendees agreed to participate in the study to form a convenient sample of a possible target audience of higher education candidates. The participants were given a collective introductory meeting to earmark them about the necessary information regarding the study, the venue, the study they are participating in, and the academic programme itself for the next three weeks. The welcome flyer, shown in Appendix L, included information about a number of things related to the empirical study, namely:

- Training programme – The programme as detailed in Section 3.4 was specifically designed to eliminate any ethical issues, as well as, reduce any potential advantages/disadvantages for any of the groups. This was achieved by dividing the participants into three groups and the programme into three sections delivered via three modalities over three weeks. The learners in any particular group had a specific programme of study to follow over the three weeks. They were given details about the group they formed part of, the programme of study sequence, and the details of the modality and venue for each part of the course. All the participants attended the same section of the course at the same time delivered in three different modalities at three different locations. They seamlessly switched from one venue to another according to their time-table to complete the entire programme by the end of each day;

- A full explanation of the three different modalities was delivered concurrently to the three different groups covering the same academic content. The modalities were clearly labelled and iconised to ensure the participants recognised one modality from another. The venues were communicated to the participants beforehand and were clearly labelled and marked;

- Participants' distribution in groups that was randomly done according to the surnames' alphabetic order, and colour coded to ensure the groups had no particular ordering or ranking, namely:

  o Mint Group   -   Surnames A – C
  o Peach Group   -   Surnames D – M
  o Turquoise Group   -   Surnames N – Z

- Venue information was given in form of a map showing all the rooms where the different modalities were being delivered, together with details about coffee break areas, bathrooms, and emergency exits. Clearly marked labelling and directions were placed at the venues to ensure the participants had no difficulty finding the particular location as specified on their time-tables;

- Information about the iPLE was given separately from the details given in the Informant Sheet (Appendix C). This included the use of the 'interest' icon which featured throughout the iPLE interface. Other information included navigation guidelines, featured items, interest-related material, and feeds from social networks;

The presentation of results starts with the initial pre-study survey, referred to as the data collection method DC_1. This instrument yielded a number of results about the participants' demographics that shed insights on the other results collected from the other planned methods. The first interesting result (**R_1**) originating from DC_1 involved the participants' gender as the convenient sample of secondary school teachers was randomly asked to form part of the study. The gender of the participants as collected in the survey is slightly biased with a percentage of 60% women and 40% men. The pie chart shown in Figure 5.1 clearly depicts the close gender distribution that is indicative of a fair participation of both sexes.
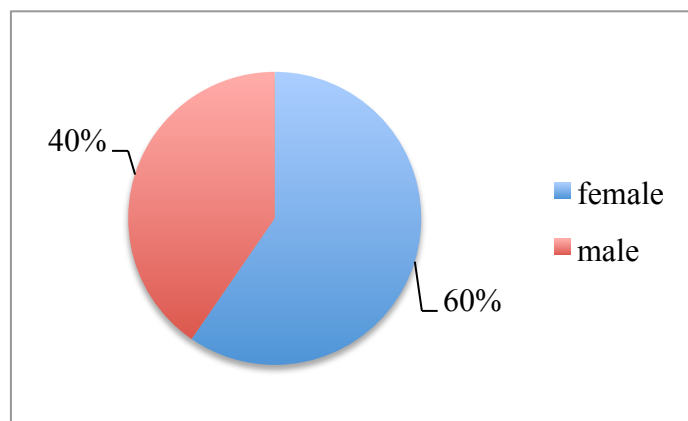

Figure 5.1 – Participants' Gender Distribution

This resulting gender balance is very much in line and fits in with the national picture of the teachers' gender distribution in Malta (NSO, 2014). 33% of the entire secondary school teacher population in Malta are male, compared with the 40% recorded during this study for ICT teachers. Similarly, 67% of the Maltese secondary school teachers are female, comparable to the 60% females within the participating ICT that was documented above. This means that the sample population of ICT teachers that participated in the empirical study is representative, giving additional value to the ensuing discussions and eventual conclusions. This also holds true in terms of the participants' ages as the next result, extracted from the DC_1, instrument is presented and discussed next.

A second resulting outcome (**R₂**) from the pre-study survey instrument (DC₁) involves the participants' age groups. It resulted that the age groups are distributed unevenly with a majority of 75% in the age group 25 to 36 years old. The other age groups, as shown in the bar chart in Figure 5.2, are relatively low, with 5% in the group of 18 to 24 years old, 18% in the 37 to 48 age group, and finally 2% in the 49 to 64 age group. The age groups were adopted from the Standard Survey Classification (PGA, 2014) that are commonly used in market research and other classification surveys, as well as units of analysis. When comparing these results to the entire secondary schools teacher population provided by the Maltese National Education Division[24] the sample population does not vary by a considerable difference and fits nicely within the national pattern. The fact that both age distributions are highly similar augurs very well for the empirical study and strengthens the confidence in the data collected, the results obtained, and the conclusions drawn.
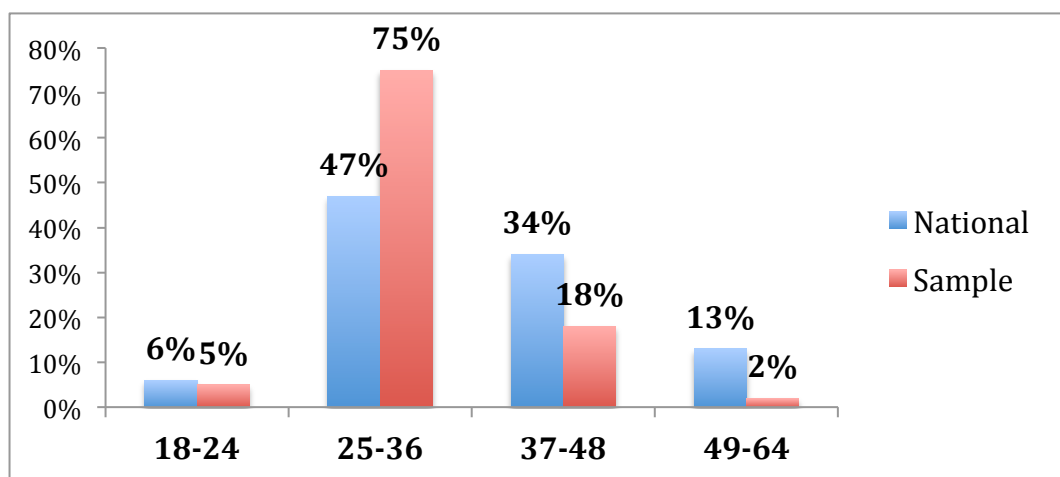

Figure 5.2 – Participants' Age Groups

When investigating the participants' highest qualifications the pre-survey result (**R₃**) gave an interesting outcome considering the participants are secondary school teachers of Information Technology (IT) and Computer Science (CS). Teaching such subjects compared to other classical established subjects like English, Maths and Maltese is different due to the low percentage of students who opt to learn IT and Computing. The prospects of a B.Ed. graduate in IT/CS compared to a PGCE candidate are very low and this justifies the greater number of the latter, as shown in Figure 5.3 overleaf. A small

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[24] http://researchanddevelopment.gov.mt

percentage of the participants (14%) took the next step in their career and pursued a Masters in an effort either to proceed to a Ph.D. or simply to enhance their knowledge and education.
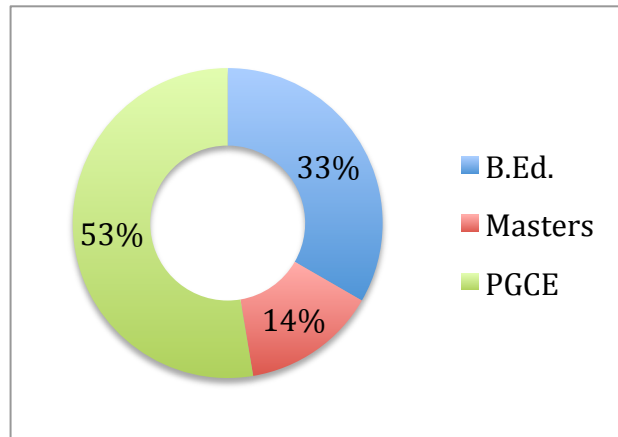

Figure 5.3 – Highest Participants' Qualification

The pre-survey data collected delved further into the use of computers and Internet service amongst the participants. Result **R₄** shows that the usage is very high amongst the participants as clearly depicted in Figure 5.4. This could have an impact on the other results of this study as the participants are highly fluent with the technology and are in an advantageous position to be able to offer an educated opinion about the different modalities and the effectiveness of the iPLE.

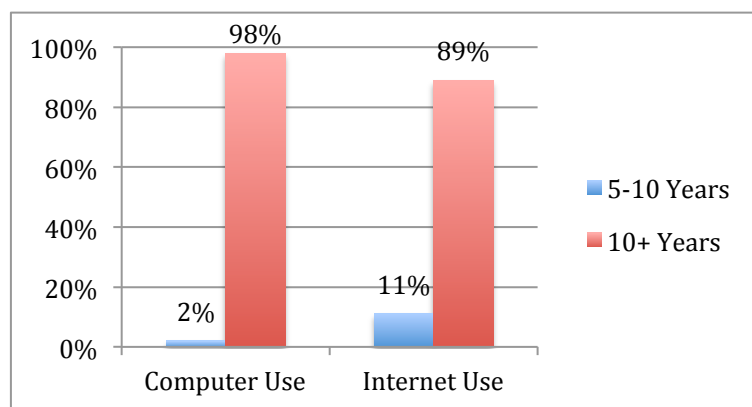
Figure 5.4 – Participants' Use of Computers & Internet service over the years

This result also augured well as the participants had no difficulty acclimatising to the VLE and iPLE due to their high frequency in technology use over the years.

The previous result also holds and can be extended to the recorded use of technology on a daily basis. The result (**R₅**) substantiates the previous results as clearly shown in Figure 5.5 whereby the participants had the option to choose one statement out of five possible answers that describes their daily use of a computer or tablet, as well as the use of the
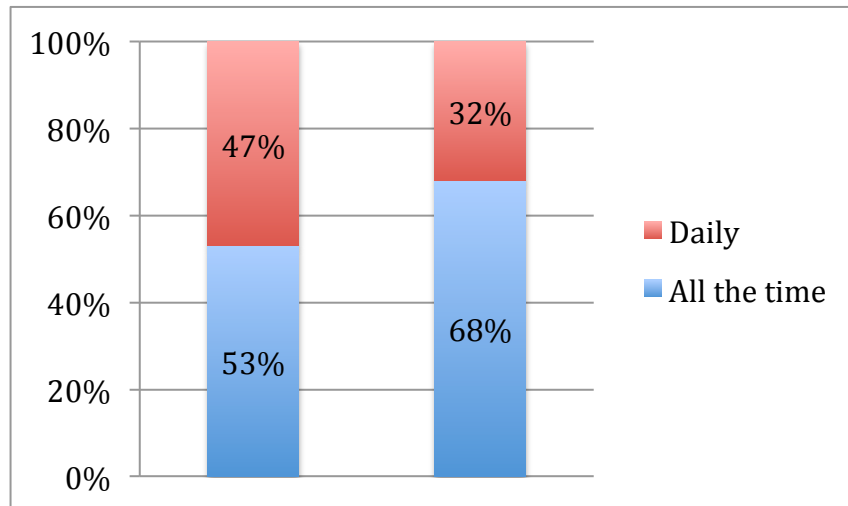

Figure 5.5 – Participants' Current use of Computer/Tablet & Internet Service

Internet service. The top two categories in either case were selected reflecting a heavy and fluent use that apart from reconfirming their expert use of the technology, the result re-validates the confidence of the analysis outcome and the empirical study conclusions. This comes as no surprise as the empirical study participants live the technology on a daily basis as they prepare classes, research their topics, and develop class lesson plans. Apart from their obvious interest in the technology, their expertise in the subject, and their affinity to information technology, these secondary school teachers in Malta are given resources in the form of online access, software and hardware (laptops) to complement their commitment.

Over and above both previous results the pre-survey instrument delved further into the participants' use of social networks, adaptable sites, and dynamic websites to investigate the participants' confidence when using Internet-based technologies. The usage statistics shown in Figure 5.6 indicate that the majority of the participants are not only avid social network users but also comfortable enough to experiment and venture into the use of new technologies. The results (**R₆**) show that close to half the respondents positively confirmed they have made use of adaptable sites and are familiar with adaptable websites confirming their experience and suitability to evaluate the iPLE.
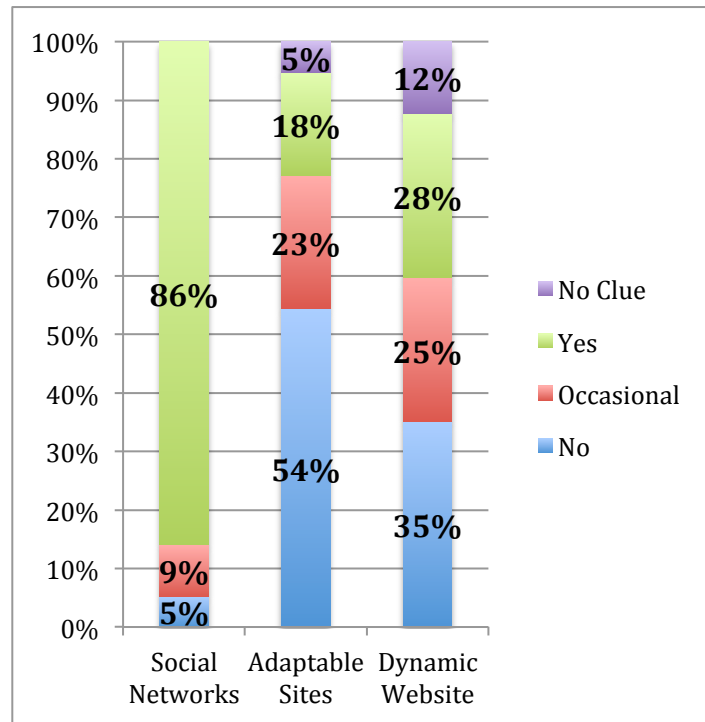
Figure 5.6 - Use of Social Networks, Adaptable Sites & Dynamic Websites

Finally, a result (**R₇**) that corroborates the previous results, as in that it verifies the participants' confidence with the use of technology in the amount of customisation they perform on the settings of their computer/tablet and the interface of social networks they use. The high percentages depicted in Figure 5.7 substantiate the fact that the participants believe that the environment should be tailored to their personal needs.

Figure 5.7 – Customisation of Computer/Tablet settings & Social Networks Interface

5.2   *iPLE effectiveness*

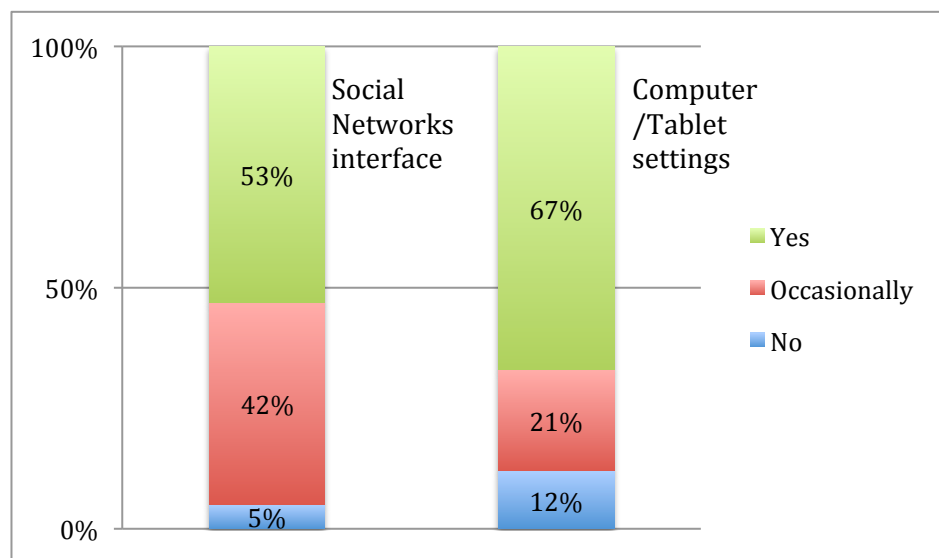The research question posed at the very start of this thesis in Section 1.3 specifically queries the effectiveness of a novel modality different from the static e-learning environment. For this reason the empirical study, the first of its kind, was designed, developed, and tested to compare the proposed iPLE to a static e-learning environment as well as to a classical face-to-face. To these ends different data collection methods were used, but before starting to report the different results related to the effectiveness of the iPLE, it useful to revisit the main hypothesis in order to form the null hypothesis, H_0, and the alternative hypothesis, H_1.

> H_0 : The combination of personalisation and users' interests have no effect whatsoever on the learning process within an e-learning environment;

> H_1 : The combination of personalisation and users' interests render e-learning more effective;

The next step in the process to determine whether to reject H_0 or not is to present additional results together with statistical analysis to support the rejection or otherwise.

The data collected during the pre-test survey, DC_1, specifically Question 18 (see Appendix E), produced a histogram as shown in Figure 5.8 indicating a normal distribution of the participants' opinion whether e-learning is as effective as face-to-face.
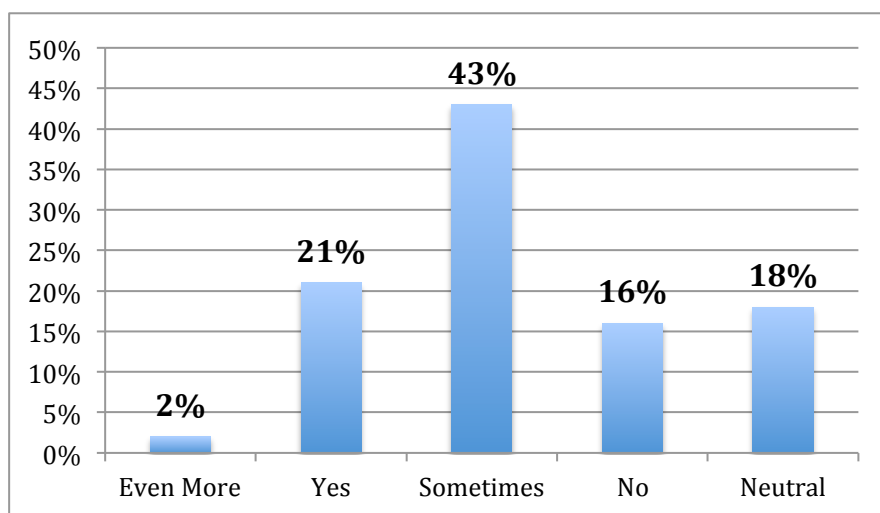

Figure 5.8 – Participants' pre-study opinion on whether e-learning is as effective as

This result (R_8) is very much in line with numerous conclusions drawn in similar studies (Domenic, 2010; Jones, Morales, & Knezek, 2005; Neuhauser, 2002) whereby e-learning effectiveness is directly compared to the face-to-face modality. This contrasts with what is being compared in this study as the hypothesis actually refers to a comparison between standard e-learning and the proposed iPLE, rather than a comparison between the iPLE and face-to-face. In accordance with this the participants showed a preference to face-to-face delivery over both modalities, as evidenced in the results (R_9) that emerged from the data collection instrument DC_2. The intermediate opinions, as described in Section 3.6, employed simple single-click pop-up dialogue boxes for the participants to express a quick opinion in a very efficient way. The results produced are depicted in the pie chart below (Figure 5.9) which clearly shows that F2F is the preferred modality, with iPLE closely tailing behind it.
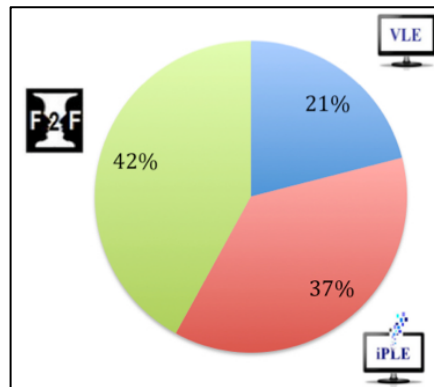
Figure 5.9 – Participants' opinion on most effective modality

Additionally a number of results related to the specific comparison between the VLE and iPLE were also collected as part of the post-study survey, DC_5. A combination of three instances are presented here and help shed light on the acceptance or rejection of the null hypothesis.

The first of these results (R_{10}) emerged from three specific instances within the post-study survey (Appendix F, Qsts. 4, 6, and 7) whereby the participants were asked to compare the VLE and iPLE modalities. The results shown in Figure 5.10 clearly indicate a positive reaction to the iPLE with interesting variations between the three questions. The participants examine the iPLE from different perspectives through these three questions as their professional opinion might vary from their personal use of the environment, and again in contrast with whether they would recommend it to their students. This subjectivity also emerged when the focus groups data was analysed and

remarked on in the next section. A high percentage, more than three-quarters, of the participants considered the iPLE to be more effective than the VLE, which slightly dropped to 65% when they had to consider whether they had to make good use of it or not. The percentage further dropped, but still more than half the participants, when it came down whether to recommend its use to their students or not.
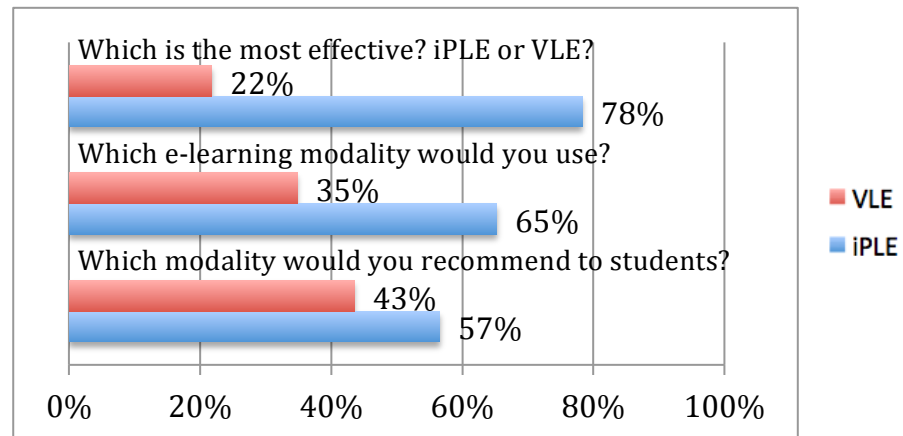
Figure 5.10 – Comparison between VLE & iPLE

The use of interests within the iPLE is highly significant and considered a main contributor to the functionality of this modality. A combination of results from DC_2 and DC_5 are also presented here to further contribute to the statistical analysis. In an effort to measure the use of learner interests and how significant and characteristic these are of the iPLE, the participants were asked to give feedback during the first and last week of the empirical study. As part of the intermediate data collected from the DC_3 instrument (Appendix G) the iPLE users were asked to compare and rate the use of interests within the iPLE content. The results (R_{11}) shown in Figure 5.11 reveal a staggering shift between the beginning and the end of the study. Initially nearly half the participants were indifferent or neutral to the idea of using personal interests, with a major percentage that

Figure 5.11 – Rate the use of Interests within the iPLE content

were in favour than against. Towards the end of the empirical study a total of 71% of the participants were happy and/or very happy about this particular feature while only 3% were not happy at al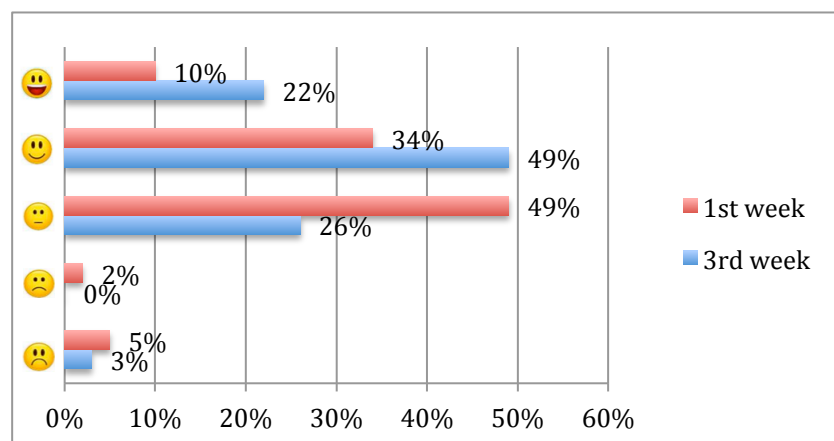l. It is very interesting to note the shift in opinion over the period that the study was being held. The most significant swing can be noticed from the neutral rating to the positive or top rating over the same period with a consistent minor percentage against the use of such a feature. This particular issue is also tackled in the following paragraphs but covered in detail within the focus groups analysis in the following section.

Participants were also asked to vote and give an opinion on whether interests are being helpful or not during the first and third week of the empirical study. The results shown in Figure 5.12 reconfirm the previous outcome where an initial positive result got stronger after two weeks of exposure to the iPLE. An outstanding majority embraced the use of personal interests towards the end of the study and consider such a feature or attribute to be helpful and beneficial.
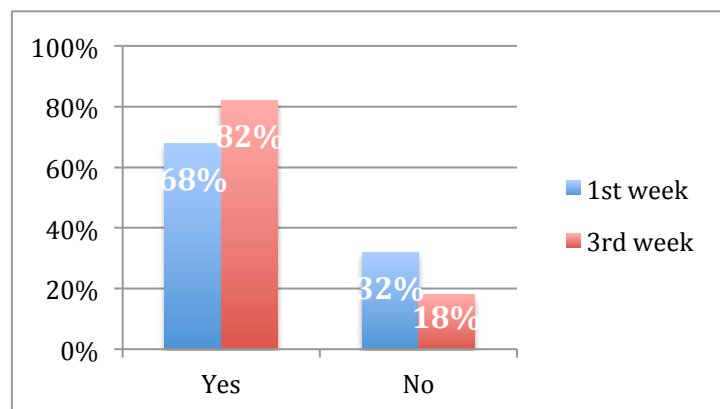
Figure 5.12 – Are the Interests being helpful?

Finally the participants were asked whether the use of personal interests is effective within an e-learning course or not. A total of 82% agreed in one way or another that interests are effective and did not mind having them featured. The results shown in Figure 5.13 also show that apart from a very small percentage that are indifferent, a minority of 18% do not think that this is a good idea or that it has a positive effect on the e-learning medium. These percentages are very close to and in agreement with the previous results that collectively show that the participants feel very confident and in favour of making use of personal interests. Their opinion strengthened over time as the interaction with the iPLE increased.
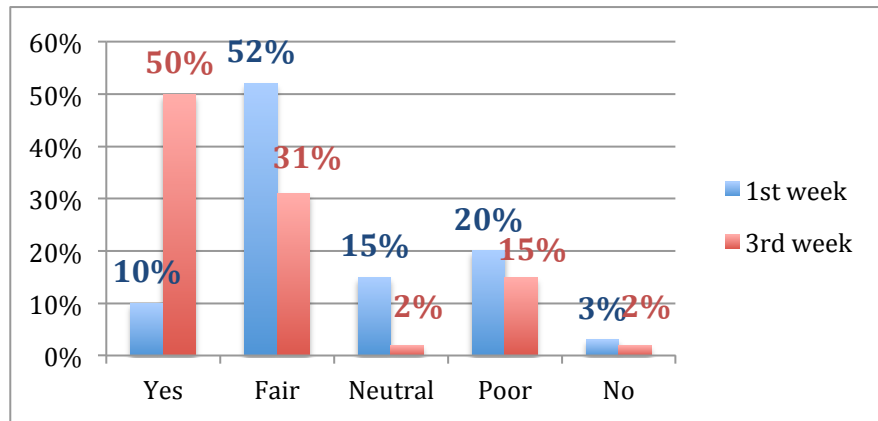
Figure 5.13 – Effectiveness of Personal Interests

Personalisation is another contributor to the iPLE functionality. A mixture of results related to the use of personal learning portfolios are presented here after being collected through the pre-study survey, DC_1, the intermediate questionnaires, DC_3, and the post-study survey, DC_5. The participants had already shown their confidence to personalise their environment as reported earlier in part of the result R_7, but furthermore they were specifically asked within the post-study survey whether personalisation is an important factor in the success of e-learning. The resultant outcome (R_{12}) is shown in Figure 5.14 where an overwhelming majority reconfirm their allure towards personalisation.
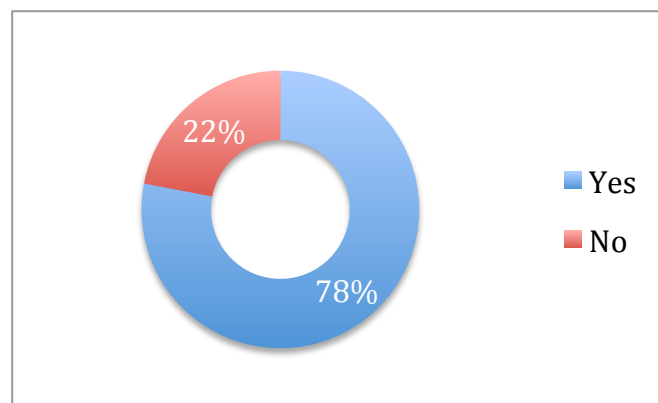
Figure 5.14 – Importance of Personalisation in the success of e-learning

To further analyse the iPLE effectiveness especially in relation to the variables 'personalisation' and 'interests', a statistical analysis software package was used. IBM SPSS Statistics[25], Version 22, is an extensively employed predictive analytics software that is widely accepted within the educational research community. It is particularly useful to predict with confidence and statistically analyse resulting data collected from an

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[25] http://www-01.ibm.com/software/analytics/spss/

empirical study similar to the one executed during this thesis. Due to the categorical nature of the data collected in the post-study survey, the Pearson Chi-Squared test has been employed to shed light on the correlation between the iPLE under investigation and the two distinguishing features, personalisation and interests. Additionally, since the data is nominal, in contrast to ordinal, Friedman tests were done. This non-parametric alternative to the one-way ANOVA with repeated measures is typically employed to test for differences between groups of data as collected in the following three variables from DC_4.

The three sets of data collected are sourced from these three questions:

- Is the iPLE more effective than the VLE?
- Is Personalisation an important factor in the success of e-learning?
- Is the use of personal Interests effective within an e-learning course?

In the first of these statistical analysis a series of cross-tab tests involving Chi-Squared and Friedman tests between the above three sets are presented below.

Table 5.1 shows the cross-tab result between the iPLE and Personalisation variables giving a Chi-Squared test result of 39.441 with a degree of freedom of 1 and a p-value of less than 0.01 (Asymptotic Significance). The significance level of 0.05 is standard.

Table 5.1 – iPLE * Personalisation – $X^2(1) = 39.441$, p < 0.01

			Personalisation		Total
			0	1	Total
iPLE	0	% within iPLE	38.5%	61.5%	100.0%
	1	% within iPLE	0.0%	100.0%	100.0%
Total		% within iPLE	8.3%	91.7%	100.0%

The results reflect the positive inclination that was already reported in the previous result. Statistically the relationship between personalisation and the use of the iPLE is shown to be 39.441 which is far greater than the critical chi-square statistical value (maximum

value with p < 0.01 and degree of freedom of 1 is 10.83). The consequence of these results and their contribution towards the rejection of the null hypothesis are expanded later on in Section 6.2 where a full discussion of the research questions are performed. Similarly, Table 5.2 shows the cross-tab result between the iPLE and learner Interests variables giving a Chi-Squared test result of 38.463 with a degree of freedom of 1 and a p-value of less than 0.01.

Table 5.2 – iPLE * Interests – $X^2(1) = 38.463$, p < 0.01

| | | | Interests | | Total |
			0	1	
iPLE	0	% within iPLE	61.5%	38.5%	100.0%
	1	% within iPLE	7.4%	92.6%	100.0%
Total		% within iPLE	19.2%	80.8%	100.0%

The chi-square value in this case is also above the maximum allowed value with the resultant p-value and degree of freedom. This result confirms the previous results and is also discussed and analysed further in Chapter 6.

Applying non-parametric tests to all the three variables provides additional descriptive statistics as shown in Table 5.3 below.

Table 5.3 – Descriptive Statistics

	Mean (0 – 1)	Std. Deviation
Personalisation	0.92	0.278
Interests	0.81	0.395
iPLE	0.78	0.414

Additionally the Friedman's test, explained earlier, gives a Chi-Square value of 13.0 with a degree of freedom of 1 and a p-value of less that 0.01, which stated formally is:

$$X^2(1) = 13.0, \ p < 0.01$$

Finally, a pairwise comparison between the three variables was done to test the null hypothesis and measure how much the distributions of the different pairs are close to

each other. To do so a non-parametric statistical analysis was done on K-related samples. The output is shown in both tabular form (Table 5.4) and graphical (Figure 5.15).

Table 5.4 – Pairwise Comparisons

	Test Statistic	Std.Test Stat.	Std. Error
iPLE – Interests	0.025	0.766	0.033
iPLE – Personalisation	0.133	4.086	0.033
Interests – Personalisation	0.108	3.320	0.033
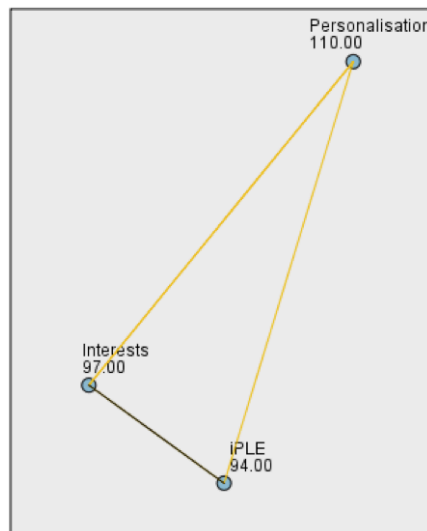
Figure 5.15 – Pairwise comparison between variables

What emerges from this pairwise comparison is that the mean iPLE score and the Interest score are significantly different from the mean Personalisation score. This result is significant as the p-values are less than the 0.05 level of significance, however, the mean iPLE score is comparable to the Interest score as the p-value exceeds the 0.05 criterion.

All the statistical analysis results where possible through the extensive use of the SPSS tool but the inferences drawn and the conclusions driven can only be done through an in-depth discussion. Before proceeding to the full analyses of these results in Chapter 6, in

light of the research questions set in Chapter 1 and the hypothesis declared earlier in this chapter, another set of results from a different tool, focus groups, are presented.

5.3 *Focus Groups*

The data collected through the method DC_4 are employed to supplement the results presented in the previous section. Three focus groups were held with subsets from the three participant groups at the end of the three weeks. The entire sessions were recorded and full transcripts are available in Appendix P. The focus groups were guided and led by the lead researcher according to the Focus Group Tool (Appendix I).

The focus group participants were subdivided into three sub-groups (Mint, Turquoise and Peach) after that forty-two (42) volunteers (approximately a third of the original sample) agreed to participate. Three groups of fourteen persons each were randomly distributed in one of the sub-groups according to the alphabetical order of their family names. The demographics of the focus groups participant have been tabulated below (Table 5.5) and it can be seen that they approximately match with the empirical study sample population demographics presented earlier in Section 5.1 with a 60% female and 40% male participation.

Table 5.5 – Focus Groups Participants' Demographics

	Male	Female	Total
Group 1	4	10	14
Group 2	4	10	14
Group 3	5	9	14
Total	13	29	42
Percentage	31%	69%	100%

The participants were briefed as individual groups and each session took approximately an hour whereby a brief introduction was requested from each participant to ensure that everyone was at ease. The introductory part of the session was purposely set to be generic

to capture initial thoughts but also to help all the participants to settle down, focus, and converge onto the real issues that needed to be discussed and analysed. Transcripts of the recorded sessions were performed by the principal investigator (PI) and double-checked for correctness by the same academic who delivered the face-to-face sessions during the empirical study. Participants in each group were anonymously tagged by a code representing the initial of their colour group (M:Mint, T:Tourquoise, P:Peach) and a digit (1 to 14) that marks their clockwise position around the table from the principal investigator. The transcripts were subsequently employed and processed using the software package NVivo[26] to analyse the content and perform a thematic content analysis. NVivo is a dedicated software application, made available by the University of Sheffield, which performs qualitative data analysis, especially for unstructured and non-numeric data like text from the focus group transcripts. Thematic analysis traditionally involves six sequential and incremental steps (Braun & Clarke, 2006), starting with a familiarisation to the collected data itself and generating initial codes. This is followed by a search for different themes, evaluating the identified matters, outlining each theme with a unique name, and lastly reporting on the findings. After that the transcripts were entered into NVivo, five thematic containers called 'nodes' were created to be able to cluster the text within the different nodes. These nodes were identified as a natural consequence of how the focus group tool was developed (see Appendix I) and thereby the discussions and comments accumulated around the themes that were posed by the focus group leader and around which the participants were urged to reflect and remark.

The five nodes were:

- N_1:   Opinion about iPLE;
- N_2:   Comparison between iPLE and VLE;
- N_3:   The iPLE experience;
- N_4:   Effectiveness of Personal Interests;
- N_5:   Preference between modalities – VLE / F2F / iPLE.

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[26] http://www.qsrinternational.com/product

The next step in the process to qualitatively analyse the transcripts was to annotate, or 'code' as it is referred to in NVivo, the different parts of the text to the corresponding nodes identified above. Coding was performed manually by parsing each sentence within the transcript and deriving a link between the data and one of the nodes. Even though the five specified nodes above have been accentuated due to their direct reference by the principal investigator during the focus groups, additional sub-topics emerged that were still closely related to one of the five nodes. It is worth adding a final node to collate those additional themes that do not fit exactly within one of the five specified nodes.

- N_6:   Other   – Comparisons to traditional teaching;
            – Conservative comments;
            – Associations with leisure activities;

Following the arduous task of combing through the text line-by-line coding the different parts of the text to the corresponding node, the process of qualitative analysis could begin. The participants within the focus group dedicated different times to the different issues discussed, and these are reflected in the percentages of the annotated text. This also gives a clear indication of how the thematic analysis can evolve by focussing further on those issues or terms that are topical and of apparent importance. The pie chart shown in Figure 5.16 explicitly points out the bias of the participants towards the nodes N_1, N_2 and N_5 that together dominate over 80% of the conversations. What is even more interesting is the fact that these nodes are closely related to each other as they tackle the effectiveness of one modality over another.
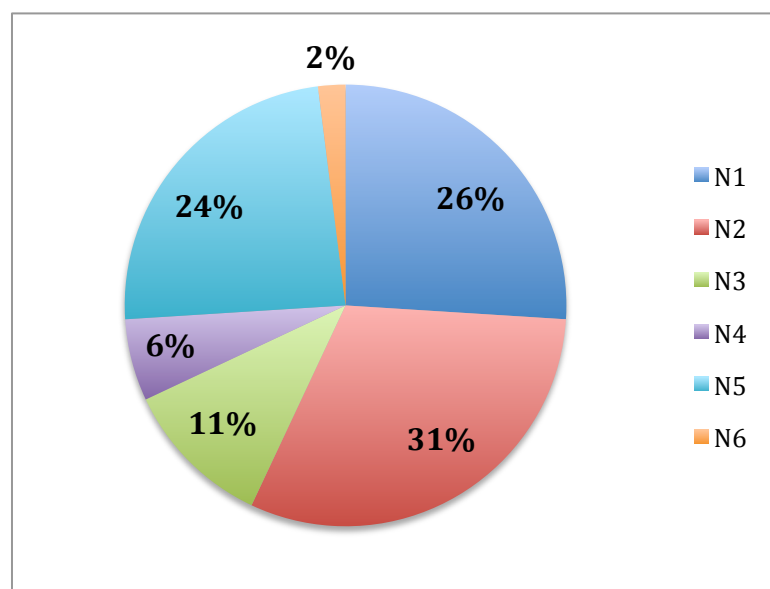

Figure 5.16 – Participants' focus during DC$_4$

Nodes N_3, N_4 and N_6 that together account for less than 20% of the conversations are analysed in some detail further on as they might reveal interesting issues that specific participants might have picked up and that might shed light on important and crucial matters. The initial interventions that were completely unrelated to the overall topical areas of the focus groups, like thoughts about e-learning in general, were not considered as important but simply instigated by the principal investigator to allow the participants to orientate themselves, relax and feel safe to contribute to the proper planned discussion.

The three prevalent nodes were further analysed to extract the word frequencies, and the results obtained can be seen in the word cloud produced by the same NVivo software in Figure 5.17. It clearly highlights three words, namely 'iple', 'students', and 'interests', that cover close to ten percent (9.52%) of the entire corpus.

Figure 5.17 – Word cloud for most referred to terms during the Focus Groups

To further analyse these three most popular terms it would help to investigate further how the participants verbally expressed themselves in relation to these codes. The iPLE was obviously at the centre of the conversations as it challenged the traditional meaning of e-learning. Some of the participants were pleasantly surprised, few examples follow:

> *"I like the complementary information and it amazes me how the logic behind it automatically collected the links of interest."* (M2)

… and appreciated the benefits that the new modality brought about …

"Through iPLE the links might show me things that I hadn't even known that exists." (M5)

While others were not so happy about the iPLE, as in …

"During my experience I felt that the links distracted me and I lost focus 100% on where I was supposed to be focusing." (M2)

and …

"I found them too distracting and was being drawn to the links." (P14)

What is interesting is the fact that some participants compared and related the iPLE environment to other environment or features they are familiar or accustomed to. One participant stated:

"I was thinking they looked like advertising." (P13)

… while another participant actually assimilated it to a popular software application which features similar functionality.

"It felt like Gmail with additional stuff on the side that I tend to ignore completely." (M5)

The 'interests' term featured prominently as some participants found the suggested interests links helpful while others considered them irrelevant.

"I chose my interests, and enjoyed it." (T8)

> *"I found them focused on my interest and I liked that"* (P11)

and …

> *"If you have interests on the topics, but you see more information, that might interest you and broaden your horizon on that particular subject."* (T10)

The third most popular term within the nodes was the term 'students' as participants instinctively analysed and commented about the iPLE as if it was developed for their students. As the leading investigator conducting the focus groups I tried to drive their thoughts away from their students and focus on their personal use of the modality, yet their comments reveal an interesting fact:

> *"For students recommendation to use iPLE, focused students iPLE, unfocused class VLE, although I have good students, I would go for iPLE, and we still need to supervise them. To leave students alone on VLE the focused students will get lost like the weaker ones, good students to iPLE and the unfocused to VLE, if I don't have to follow a syllabus then I would go for iPLE."* (T13)

> *"Students and teachers I would recommend VLE and general public I would recommend iPLE."* (P6)

… and

> *"I doubt this system works at school, the students would get lost clicking the links, for 16+ students it would be more adequate."* (P3)

What comes out from this is the realisation that a modality like the iPLE is much more adequate to students who are either mature and disciplined enough not to roam away, or students who are not bound by some subject syllabus or topic assessment. This is also in line with the previous results R_{11} from the previous section whereby the participants responded very positively to the iPLE being more effective than the VLE but hesitated

and dropped their preference when it came to recommend the use of the iPLE to their students but still quite high at 57%. Such a result would have not emerged if the participants were not teachers with professional and personal insights.

Some other interesting concepts to report even though they fall within the smaller node N_6 are noteworthy as they were neither considered or mentioned by the principal investigator and nor did they feature in the word cloud as most frequent terms used. Very few participants within every focus group at some point referred back to the traditional teaching scenario and the safety of such a setting. This could be directly linked to the fact that all the participants are secondary school teachers and their main point of reference, as well as what they are most used to, is the traditional classroom and the importance to cover the specified subject syllabi. Some evidence of this can be found in the following quotes:

> *"Honestly I preferred face-to-face I understood what was expected of me, I get put off by too much digital content and diagrams"* (P12)

and …

> *"I missed the guidance of the "teacher" since all the way to university study we always had a guidance."* (P13)

This could also be evidenced by some conservative comments that particular participants expressed showing signs of apprehension if they do not conform with the norm and with what education should be like.

> *"If there are topics I don't know, if the lecturer gave me reading material I would read them ..."* (M13)

> *"I rather use points from the book, when using a PC, I get distracted to go online and see news and other things and get distracted, I doubt this system works at school, the students would get lost clicking the links ..."* (P3)

and …

>*"I don't really feel like I'm studying on a PC, I get distracted,*
>
>*I rather use a book, I rather have something in my hand ..."*   (P2)

Some participants considered the experience as too liberal to be considered educational as in a classroom, and associated the activities with a mode of leisure.

>*"I might use it as a break"*   (P7)

>*"I think it's best used instead of a game or not to waste time."*   (M4)

While others reverted back to their 'teacher' role and proposed that time restrictions are always required to reach specific educational goals.

>*"If I had an exam tomorrow, I would tell myself to look at the*
>
>*link provided another day and focus on the job at hand."*   (T2)

>*"I feel that if I was given a topic, or time to end the course I*
>
>*would feel less distracted"*   (M4)

>*"I might use the links later, but you need to be disciplined and*
>
>*not waste time"*   (P12)

>*"A course without a deadline, I would feel distracted and time*
>
>*based I would be more disciplined, based on school children it*
>
>*would certainly throw discipline out of the window."*   (M6)

Further insights into the outcome of the qualitative analysis performed on the focus groups are presented in Chapter 6.

The output from the thematic content analysis performed by NVivo also allows the visualisation of the word tree in relation to the neighbouring text to better understand the context of its use. Figure 5.18 shows the word tree for the most occurring term, iPLE, as it was discussed during the focus groups.
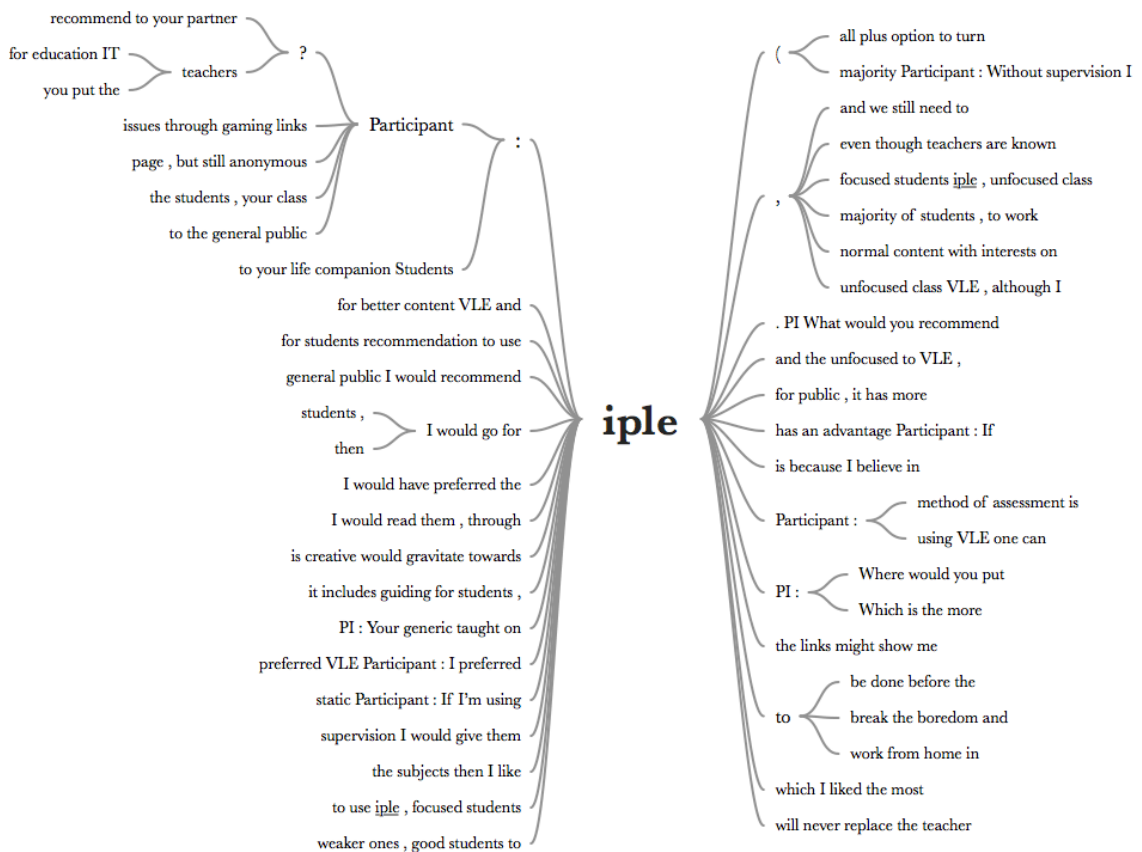

Figure 5.18 – Word tree for the term 'iPLE'

From this visualised word tree it can be noticed that apart from the interventions made by the principal investigator, the interventions made by the participants reflect mixed feelings as well as potential and room for improvement. In an attempt to justify the functionality of the iPLE some participants proposed to have it available on request.

> *"I would even add the possibility of switching between iPLE and VLE"* (T10)

and …

> *"The advantage of switching it on and off is a benefit"*   (M5)

In another instance some participants declared that they would adopt and put their trust in a similar platform as it matches their style or because they believe in the concept especially because of the fact that it is not what normally one expects from an e-learning environment.

> *"iPLE which I liked the most based on my way of working"* (M6)

> *"Most students would opt for VLE, however someone who is creative would gravitate towards iPLE to break the boredom and keep engaged."*   (T11)

> *"If I'm using iPLE is because I believe in it and it helps me"*   (M11)

One final observation that comes out from the word tree (at the bottom right of the visualisation in Figure 5.18) is the tautology that no teaching aid would ever replace a human teacher, and yet a participant insisted to put it on record.

> *"iPLE will never replace the teacher"*   (T4)

This might seem to be a simple comment but additional comments regarding the participants' choice of medium uncover a trend or a concern towards e-learning.

> *"I noticed that the content was same in all modules but the face-to-face was given more explanation since the points weren't read but more information was given"*   (P2)

> *"With a F2F you can get more information and understanding"* (T7)

> *"The majority would prefer the F2F"*   (M11)

Reference to a preference to the traditional classroom was discussed earlier and attributed to the fact that the participants are educators by profession, yet hidden

concerns potentially lie below the surface. These comments that practically emerged from all the three focus groups could be attributed to another notorious e-learning issue that has not been tackled in this study, namely, adaptability struggle. This concern is not within the scope of this thesis yet its importance is duly noted and discussed further in Chapter 7.

5.4   *Chapter Closure*

This chapter reported on all the results obtained from the different data collection instruments employed. The focus was on the effectiveness of the iPLE in comparison with the static e-learning environment and the standard face-to-face teaching. The results from the empirical study involved the extensive use by 120 participants of the iPLE in comparison with the VLE and F2F, followed by a series of focus groups with 42 participants. The data collected was presented here using three types of software, namely basic statistical visualisation software, Microsoft Excel, together with advanced statistical software, SPSS and thematic analysis software, NVivo. These results are analysed further and critically employed to provide useful insights on the hypothesis of this thesis, as well as, the educational connotations of this study to the higher education research community in general.

Chapter 6

Discussion

This phase of the research process comes to a closure as a full evaluation of the empirical study results is performed in this chapter to discuss and critically assess the ultimate outcome. The results reported in the previous chapter assist in shedding light on the hypothesis and eventually the research question set in Chapter 1. To better understand the full effect and impact of the results evaluation the chapter proceeds with a restatement of the main aim of this thesis setting the scene for a comprehensive discussion. The main research question was split into three sub-questions that are revisited in the next three subsections to offer a more focussed and in-depth interpretation of the results. The chapter closes with an overall assessment of the entire results set drawing generic deductions and meaningful educational inferences related to the future of e-learning and personalised instruction.

6.1 *From Research Question to Empirical Results*

The sequence of events that led to the specification, design, and implementation of the empirical study were triggered with the research question statement in Chapter 1. The whole research proposed in this thesis revolved around the concept of personalising e-learning. In Chapter 2 the full philosophical reasoning underlying this thesis was presented together with my personal epistemological stance about the subject matter. The three main pillars upon which the entire research study is grounded are similarly layered with four interlinked concepts that have been duly presented and justified. Three e-learning concerns lie at the basis of this philosophy with an effort to address them and contain them, namely, isolation, lack of motivation, and impersonal environment. The techniques and methods used to address these e-learning concerns feature on the next level each coupled with a fitting theoretical learning theory. Crowdsourcing through social networks was proposed and used as the technique to address the isolation issue accompanied by the connectivism learning theory. Learner profiles generated by students themselves were planned and implemented to motivate learners to improve their academic portfolio as upheld by the self-determination learning theory. And finally personalisation techniques that customise the environment, services and content were adopted to tackle the impersonal e-learning environment driven by the adaptive learning theory. The prototype intelligent personal learning environment, iPLE, was designed and documented in Chapter 3. Full details of how the personal learning network (PLN) representing the first pillar, the personal learning portfolio (PLP) for the second pillar and the iPLE for the third pillar were given and justified in Chapter 4. These were fully developed based on the set specifications and with the precise intent to collect data, presented in Chapter 5, that is used to shed light on the research question that was fragmented into three sub-questions with the intention to analyse at a finer level the main themes of this research work. Each of the research sub-questions are discussed in detail and critically evaluated based on all the data collected, the presented results, together with the details of the statistical and thematic analysis presented earlier. For convenience sake, the sub-question were:

  i.   Does personalisation render the learning process more effective?
 ii.   How effective is the use of personal interests within an e-learning environment?
iii.   Is an adaptive dynamic learning environment beneficial to e-learning?

6.2   *Research Question 1*

The first of these sub-questions delves into the effect of personalisation in the learning process and whether it renders such a practice even more effective. A number of studies support this notion through different approaches while academically based on a variety of learning theories. Xu, Huang, Wang, & Heales, (2014) strongly claim to enhance e-learning effectiveness through the use of personalisation techniques to cater for the individual needs of different learners. They make use of virtual learning environments in combination with intelligent software agents based on the constructivist learning theory. This study was somewhat limited as it based its findings on the academic achievements of a group of undergraduates who were offered monetary compensation for their participation in a weeklong field study. In an earlier study Domenic (2010) evaluated the effectiveness of online learning in contrast to the classical classroom delivered instruction. In this classical comparison research study between e-learning and face-to-face media a fully-fledged empirical study was setup with a sample of army students where half of them attended traditional classes and the other half covered the same material online. At the end of the study the academic achievement of all the graduate students was assessed and used to conclude that there was no significant and academically relevant differences. The indications given in this case were that equivalent academic tasks could be as effective as any other irrespective of the medium employed whether it is online or face-to-face. Other studies (Neuhauser, 2002; Chan, Chow, & Jia, 2003), cited earlier, also reached similar conclusions whereby e-learning had no significant advantageous edge over the effectiveness of face-to-face.

The question of how to measure academic effectiveness is crucial in this case and as just shown in previous projects different researchers employ different methodologies to reach their conclusions. In a recent study Noesgaard & Ørngreen (2015) attempted to define and measure the effectiveness of e-learning while trying to identify those factors that make an e-learning solution effective. A thorough literature review about e-learning effectiveness revealed nineteen different measuring methodologies with the most common mode of measurement being quantitative through pre and post assessments. The authors propose an e-learning effectiveness categorisation model based on three factors, namely, context, the e-learning system itself, and the learners. They state that "*support and resources, the individuals' motivation and prior experience and interaction between*

the artefact and the individuals that use it, all influence effectiveness" (p. 278). This brings into perspective the complexity of measuring e-learning effectiveness and that no single way is documented across the different studies.

Noesgaard & Ørngreen (2015) conclude that the use of quantitative methods are not enough and comprehensive, but insist on the inclusion of open-ended qualitative methods to improve the validity of the e-learning effectiveness. Additionally they specify that the best way to investigate what makes an e-learning system most effective is through the identification of individual factors and/or features, which can then be studied and scrutinised in isolation.

This first research sub-question has more granularity than the generic e-learning effectiveness studies discussed earlier. The focus is on the personalisation element and whether this particular factor has any effect on the electronic educational process. The results that emerged from this empirical study, particularly R_{12}, presented sets of data directly related to personalisation, and the statistical analysis shown in Table 5.1 summarises the significance of these results. A Chi-square value of 39.441 and a degree of freedom (df) of 1, gives a p-value of less than 0.01. The interpretation of this is that the likelihood that the null hypothesis is correct is less than 1%. To put this into perspective, the null hypothesis for this sub-question rejects the influence of personalisation within a learning process, but the p-value being so low rejects this null hypothesis. This does not mean that one can determine the extent by which personalisation renders the learning process more effective, but one can safely say that personalisation and the learning process are definitely dependent on one another.

This makes perfect sense when considering the fact that personalising a service or a product to the precise specifications of the consumer or of who are making use of it, adds value and renders that service or product superior to a standard off-the-shelf, one-size-fits-all equivalent. It also ties with the philosophical association of this particular feature, personalisation, with the adaptive learning theory. In Section 2.2 it was argued that the personalisation of environment, services and content subscribes to the work of numerous adaptive learning theorists and researchers (Soonthornphisaj, et. al., 2006; Drachsler, et. al., 2008; Kay, 2008; Tan, et. al., 2008; Bian & Xie, 2009; Bobadilla, et. al., 2009; Bian & Xie, 2010; Salehi, Kamalabadi, & Ghaznavi Ghoushchi, 2014).   Outcomes from these research projects have revealed that personalisation, even though variably engaged and at

diverse intensities, enhanced in one way or another the effectiveness of the e-learning process.

Morales, Garrido, & Serina, (2011) conclude in a similar project that personalisation of e-learning routes is imperative to support productive lifelong education. They propose the authoring of tailored learning paths to fit individual students using a planning and execution perspective. Similarly, other researchers have acknowledged the validity of personalising e-learning by employing different computer science techniques like Neural Networks (Idris, Yusof, & Saad, 2009), Just-in-time adaptivity (Ullrich, Lu, & Melis, 2009), and Execution model and authoring middleware (Perez-Rodriquez, Rodriguez, Anido-Rifon, & Llamas-Nistal, 2010).

6.3   Research Question 2

The second research sub-question tackles the effect of employing the use of personal interests in combination with Web 2.0 techniques. These techniques include the integration of social networks and content aggregated from online sources related to the participants' interests. In a study (Steen, 2008) to investigate how to design successful and effective e-learning, a complex and fluid process that brings together a number of variables is highlighted. The author points out that the designer, apart from the arduous job of juggling learning theories, academic content, resources, and graphical interface, additional considerations need to be kept in mind. Amongst them lies the principle that an effective medium is unique for each learner and needs to be personalised through the use and incorporation of personal interests. Additionally, Clark & Mayer (2011) list the use of personal interests within the design of an e-learning environment as one of eight primary multimedia instructional principles. Bates (2011) takes it a step further and argues that e-learning is more effective if customised and personalised with the help of Web 2.0 tools. The author points out that these tools offer dynamic design models in real time that accommodate the individual preferences of each learner. He argues that "*courses can be structured around individual students' interests, allowing them to seek appropriate content and resources to support the development of negotiated competencies or learning outcomes*" (p. 28). This subscribes with the associated learning theory of connectivism (Siemens, 2004) whereby, as already argued in Section 2.2, it

promotes the use of social networks and Web 2.0 technologies, and above all maintains that "*learning is centered around the interests of the learner*" (Downes, 2008). Several sets of results have been collected during the empirical study in relation to this sub-question, and the task here is to make sense out of these results and attempt to reach an all-encompassing analysis and conclusion. Results R_6 and R_7 collected from the pre-test survey, DC_1, give a good indication of the initial participants' state of mind. Considering that the empirical study participants are ICT teachers, their propensity and compatibility towards the use of technology and its application in education could be somewhat expected. However, additional results collected from the post-test survey, DC_5, and documented in R_{11} show a repeated positive outlook on the use of personal interests. Additionally, the analytical analysis presented in Table 5.2 presents a Chi-Square test between the iPLE and interests giving a result of 38.463 with a degree of freedom of 1 and a p-value of less than 0.01. As stated earlier a cut-off standard significance level for the p-value is 0.05 and anything below this 5% threshold is statistically considered a very low probability. This means that the null hypothesis for this sub-question is rejected, and that there is a reasonable probability that the use of learners' interests and e-learning effectiveness are dependent on one another. This outcome is also reflected in the focus group results and the thematic analysis outcome presented in Section 5.3 where the term 'interests' featured as the second most frequently referred to word following the term 'iPLE'. As mentioned earlier, this confirms the strong integration and overlap between the qualitative and quantitative data analysis. Additionally a number of similar research studies have previously highlighted the personalisation factor within their e-learning success. Dabbagh & Kitsantas (2011) propose a pedagogical framework that makes use of social networks to offer personalised learning environments that support student self-regulated learning. Furthermore, Vargas-Vera & Lytras (2008) take advantage of the semantic web and Web 2.0 to propose a framework of a high-performance e-learning system by making use of user profiles and identities. Other studies (Attwell, 2007a; Chatti, et. al., 2010; Pearson, et. al., 2009; Schaffert & Hilzensauer, 2008; Wilson, et. al., 2006) have employed personalisation to enhance learning environments and challenge the static e-learning systems. Finally, research related to user profiling (Gauch, et. al., 2007; Pivec & Baumann, 2004; Vargas-Vera & Lytras, 2008) investigate the profiling of individual learners through their interests and needs in an effort to personalise the e-learning process.

6.4   *Research Question 3*

The last of the sub-questions that collectively add up to the main research question enquires into the beneficial effects of adaptive dynamic learning environments to e-learning. Aeiad and Meziane (2015) state that through a process of adaptation they are able to transform a standard academic programme that some learner have difficulty following into an all-inclusive educational environment. Similarly, numerous studies (Dagger, Wade, & Conlan, 2003; Pivec & Baumann, 2004; Brusilovsky & Millán, 2007; Canales, Peña, Peredo, Sossa, & Gutiérrez, 2007; Ullrich, Lu, & Melis, 2009; Pearson, Gkatzidou, & Green, 2009; Oxman & Wong, 2014) have highlighted a variety of beneficial effects that a dynamic e-learning environment can potentially be achieved. Particularly Pearson, Gkatzidou, & Green, (2009) report that the learners that experienced the adaptable PLE they proposed, supporting learners' needs and preferences, gave the students a sense of pride, autonomy, achievement, and an overwhelming determination to do more. This subscibes exactly with the associated self-determination learning theory (Deci, Vallerand, Pelletier, & Ryan, 1991) that focusses on motivational processes learners experience when making use of e-learning environments where behavioural performance can potential make or break the overall success (Deci & Ryan, 2002). In relation to these factors and to address specifically this research sub-question different kinds of data was collected during the empirical study to shed light and allow insights through the analysis of the results. The statistical analysis shown in Table 5.4 and depicted in Figure 5.15 show the relationship between the different factors embedded within the iPLE to represent an adaptive dynamic learning environment whereby the participants expressed their views during the data collection sessions. Apart from the focus groups outcome (Section 5.3) that also shows a strong participants' bias towards the iPLE, the Chi-Squared value of 13.1 given by the Friedman's test in Section 5.2 has a p-value of less than 0.01 which also rejects the null hypothesis for this sub-question. It is important to note that even in this case one cannot declare the extent of dependency between the adaptive dynamic learning environment and the e-learning process but if the distribution of this data was due entirely to chance, then there is less than 1% chance of seeing this exact distribution again. It is also worth pointing out, and this also features in the concluding chapter, that a number of participants during the focus groups reported

'distractions' and 'advert-like' situations when experiencing the iPLE (Figure 5.17). This overlap between the qualitative and quantitative is significant and gives greater confidence to the outcome achieved. The integration of both types of data is strongly evidenced in answering this third research sub-question, while a slight detachment where the differently collected data diverged can be noticed in the previous research sub-questions. What the participants record in the pre- and post-survey about the importance of personalisation in the learning process is not explicitly stated or perceived as essential when participating in the focus groups. This drift between results interpretation from qualitative and quantitative data collected can also be attributed to the fact that the iPLE was employed for a relatively short time which limited the participants' exposure to the benefits of content adaptation and supplementary tailored information that improves and scales up over time and over multiple interactions.

The outcome from discussing the three sub-questions leads to a realisation that the proposed iPLE model reflects a paradigm shift not just from the static e-learning platforms but also from the numerous research prototypes that attempt to push and enhance e-learning towards a cutting-edge technology. This proposed iPLE as witnessed through the above discussion and conceptually depicted in Figure 2.2 takes the PLE research to the next level as it addresses previous e-learning concerns through the application of a combination of techniques. The difference from what the existent research projects offer is the amalgamation of three distinct areas that happen to be research domains in their own right. The educational aspect lies within the proposed e-learning environment itself (PLE) and is the most prominent and intense due to the focus and emphasis of this thesis. The social aspect emerges from the adoption of a personal network (PLN) through the use of social networks and the potential of crowdsourcing. Finally the technological aspect evidences itself through learning portfolios (PLP) as learner profiling techniques are borrowed from the computer science research domain. Bringing all three areas harmoniously together, justified with their corresponding strengths and contributions, and supported by respective learning theories, generates a robust and reliable endeavour. It builds on previous research studies (Chan, Chow, & Jia, 2003; Mencar, Castiello, & Fanelli, 2008b; Domenic M, 2010) and attempts to lay the foundation for future structured undertakings whereby e-learning environments are systematically and meticulously investigated through the different factors that contribute to their success and effectiveness.

6.5   *Chapter Closure*

This chapter has critically evaluated the results obtained during the data collection phase of the empirical study. Three sub-questions listed in Chapter 1 have been analysed in detail as they collectively constitute the main research question or hypothesis that earlier in Section 5.2 brought about the statements of the null hypothesis, H_0, and the alternative hypothesis, H_1. Each of the sub-questions discussed in the previous three sections have each tackled one of the three components stated in the main hypothesis, and each one of them rejected the null hypothesis to an extent that the alternative hypothesis is accepted.

In the first instance it was shown that the process of measuring e-learning effectiveness is a complex one that ideally employs the integration of quantitative and qualitative research methods to collect and analyse data. This study used a mixed method approach in line with this understanding through pre and post surveys, intermediate questionnaires, and focus groups. The results presented and the evaluation of these outcomes have shown that in line with similar studies the personalisation element plays a crucial role in the effectiveness of the learning environment. The conclusions drawn from the first research question do not quantify the extent of this rendered effectiveness, but gives significant indications to support such a hypothesis. It has been argued that through the application of the adaptive learning theory through the personalisation process does address impersonal issues and enhances e-learning effectiveness.

The second sub-question brought out the arguments in favour of employing learners' personal interests in combination with Web 2.0 technologies in an effort to render it more effective. The numerous results extracted from the heterogeneous data collection methods employed have been shown to support this hypothesis, and that they are in line with outcomes from similar research studies referenced. The conclusions drawn from the second research question confirm the effectiveness of personal interests especially within a personal network that is crowdsourced around these interests as endorsed by the connectivism learning theory. Additionally it was also shown that the use of social networks have assisted online learners to self-regulate the education process while reducing issues of isolation.

Finally, the third sub-question brings into perspective the benefits of incorporating a customised e-learning environment that dynamically accommodates the specific profile of a unique learner. The results collected and the statistical analysis performed has shown a strong correlation between the effects of learner profiling through user actions/feedback and elements of self-determination to improve such a profile. Conclusions extracted from this research question include an overwhelming bias towards the use of the iPLE especially as the learners' motivation increased over the period of the empirical study.

This means that the combination of personalisation and learners' interests significantly render e-learning more effective. The extent of this effectiveness is not within the scope of this research as the learners' feedback has clearly shown that there exist a number of issues and constraints that need attention and further investigation. A number of reported studies and research projects have been referenced to show the alignment of this work with the literature in the field. It is important to mention that the iPLE empirical study has added a new dimension to the field where a three-way comparison between a virtual learning environment, face-to-face and an intelligent learning system has been performed and documented. The methodologies employed and the instruments employed are very similar to these studies, but with a difference of comparing three modalities while proposing a pedagogical shift towards merging of technologies, that gave rise to this discussion. The outcomes from this discussion are not intended to simplify or curtail the complexities that this research has delved into. They have barely scratched the surface of an intricate and multifaceted concept that at face value helps and assists in the learning process rather than hindering or has no effect whatsoever.

Chapter 7

Conclusions & Future Directions

Within the course of this thesis I have proposed to add value to the static e-learning systems by personalising the content being presented. The personalisation process was brought together through the amalgamation of crowd sources together with learners' interests as they relate to the specific learners. A prototype was developed and tested within an empirical study where participants experienced and compared the proposed environment with a static e-learning environment and a standard face-to-face delivery. A number of data collection instruments have been integrated within the empirical study to accumulate participants' feedback. The results were fully documented and analysed using a combination of quantitative and qualitative data analysis tools that generated essential assessment information. A discussion to critically evaluate these results followed whereby the null hypothesis was rejected, while supporting the alternate hypothesis and providing a positive reply to the main research question. The thesis now draws to a close as the final conclusions and future work are presented and recommended.

7.1 *Revisiting the Research Question*

The thesis is organised around a principal research question and an associated main central hypothesis upon which the empirical study was grounded. The research question probed into the possibility of combining the use of personal learning portfolios and Web 2.0 technologies to render e-learning more effective. Following a thorough literature review and an intense analysis of the problem at hand, a multifaceted solution was proposed that incorporated a multi-layered architecture. Three aspects of the same study were attributed to this research work following a detailed discussion in the previous chapter. Every aspect was incorporated with a working prototype of the iPLE, tested, test data collected and presented, and a full critical analysis of the results was performed. The full details of each aspect can be summarised in the table below whereby the different iPLE layered facets listed in the first column manifest themselves respectively within the different iPLE aspect, namely, Educational, Social and Technological.

Table 7.1 – iPLE aspects & paradigms

iPLE aspect	**Educational**	**Social**	**Technological**
E-learning concern	Impersonal	Isolation	Motivation
Methodology/technique used	Personalisation	Crowdsourcing	Learner Profiling
Learning theory	Adaptive	Connectivism	Self-determination
Conceptual implementation	PLE	PLN	PLP

The PLE, that traditionally incorporates the PLN and PLP, is characterised by the educational aspect and justifies the main focus of this research study and thesis as it brings together the social and technological aspects. It is important to highlight the fact that two other aspects characterised by crowdsourcing research and learner profiling techniques do not fall within the scope of this research and thereby no technical detail of how they were developed is given but only of how they were implemented and employed. Use of personal interests were used to trigger off the learners' portfolios, and eventually this same portfolio evolved as learners proceeded through the educational material presented. Web 2.0 technologies were also employed in the form of content provided from social networks related to the same users' interests.

The proposed intelligent personal learning environment is a research prototype at this stage that attempts to encapsulate these different components in an effort to investigate the pedagogical effect of an elevated e-learning platform. The prototype was extensively

employed during the empirical study and miscellaneous data collection instruments ensured to collect a set of quantitative and qualitative data. Analysis of this data using statistical and thematic content assisted the critical analysis of the iPLE, but more importantly supported the main hypothesis and provided feedback to the central research question.

7.2 Limitations and Recommendations

The outcome supported by the different analytic tools that was discussed in the previous chapter is not deterministic in any way but indicative. Even though the feedback from the empirical study indicated a positive outcome, a number of limitations and issues have been duly recorded and are worth mentioning as they can potentially shed light on future directions. Perhaps the most significant limitations were highlighted during the focus groups as participants commented on the iPLE when comparing it to the VLE. In fact a number of issues emerged during the thematic analysis of the focus groups data in Section 5.3 amongst which was the issue of switching between the modalities. What was clear and as expected was the obvious preference towards the F2F modality above either of the other two learning modalities. It would be unrealistic and over ambitious attempting to propose or aspire towards an e-learning platform that replaces, or even more, surpass the F2F delivery medium. Previous studies (Chan, Chow, & Jia, 2003; Domenic, 2010; Neuhauser, 2002; Xu, Huang, Wang, & Heales, 2014; Khan, 2016) consistently compared their proposed e-learning system to the traditional face-to-face, but this study involved a three-way comparison with a specific focus on whether it improved effectiveness from a standard e-learning environment rather than from the F2F modality. The participants made it clear that traditional face-to-face teaching is a superior medium, not because of the fact they are educators themselves, but simply because they could easily relate to the educator, effortlessly assimilate their needs to the content, and impulsively react to the learning process. This gives a good indication of what the iPLE should be aiming at in an effort to reduce the cognitive gap between the human and technological educators. Having said this one must not take traditional face-to-face teaching for granted because if an educator attempts to deliver a F2F session unprepared or inadequately, an e-learning session would be much more effective especially if it had been purposely designed, planned and pedagogically sound.

Another limitation that was duly pointed out by the participants was about the look and feel of how the content from the social networks looks like within the iPLE. The very fact that some participants thought that this content seemed like adverts and instinctively assumed that such content was to be ignored says a lot. In our daily browsing patterns combing through emails and social network sites we get familiar and immune to adverts and impulsively blank them out and ignore them completely. Some participants did point out that some of this content was very interesting, directly related to the actual educational content, and that they bookmarked them to go back to them eventually. A related limitation that was observed was about this content being a distraction to the learning process. Some educators were clearly looking at this experience at a personal level and extracted more benefit from the exercise, but others kept referring back to how the iPLE would function and perform in their classroom with their own students. When questioned about which modality would they recommend for three different and distinct groups of people, they agreed that the iPLE would sport well with their colleagues and with the general public who are disciplined enough not to roam away from the actual e-learning course at hand. On the other hand, students in a classroom who are following a particular academic syllabus would not benefit from the iPLE due to their ease of distraction, lack of experience, and need to be monitored.

The connotations of these limitations give rise to recommendations that might assist future versions of the iPLE to achieve better results and overcome such limitations. The fact that this research is set within the higher education arena limits the shortcomings pointed out if the iPLE was to be employed in a primary or secondary school classroom. However the message is clear, and attention needs to be given to address the fact that even adults could easily get distracted, or are not disciplined enough to roam off out of interest of a specific topic, and return to the original sequence of the e-learning course they were originally following. The iPLE environment needs to be appealing enough to lure the learner back even after roaming off to satisfy a curiosity or to complement the content being presented. The environment is required to cultivate an interest that highly appeals to the learner who nurtures even more a need to learn, as professed by the connectivism learning theory, by taking full advantage of the multitude of resources being presented. The learner is required to take control and show academic maturity, as the self-determination learning theory asserts, to optimise the use of the learning medium. This same medium, in turn, and compatible with the adaptive learning theory, needs to be

tailored and customised to capture the learner's interest and further impart personal benefits. An effective e-learning platform incorporates the three aspects proposed earlier within an intelligent personal learning environment that brings together a healthy knowledge eco-system networked around the learner, and customisation functionalities that the same learner drives and determines.

To complete this section about limitations it is worth delving into those specific limitations related to the research process itself that might have had an implicit effect on the final outcome. The research documented in this thesis is mainly focussed around the empirical study that was purposely designed, executed and completed in July 2015. A number of issues and limitations related to the empirical instrument emerged during the study itself as a number of participants, even though briefed on the first day during the orientation session, had difficulty coming to terms that the iPLE actually allowed them to roam away and browse items of interest which were being proposed. As stated earlier, some found it distracting while others found it interesting, but some others ignored them completely as they would do when browsing the web themselves. This is mainly due to the concept of people setting objectives when browsing online. If someone's intention is to achieve a specific objective, like booking a flight, purchasing a book, checking email or completing an online course, they know exactly what they need to do and how to go about it, thereby ignoring any peripheral distractions. On the other hand someone who is simply browsing for the sake of leisurely surfing through a social network or through the hits returned from a search engine, then such a person is more open and susceptible to follow suggestions and recommendations that have been strategically placed on the web interface. The implications to the e-learning environment come back to the reflections made related to the focus groups results. A number of the participants, especially due to their profession, commented that one has to distinguish between study and browsing. The concept of having a blend of interests within the learning process, and/or having unofficial knowledge sources as part of the academic content is still irregular and untraditional. Kress & Pachler (2007) did point this out when they attempted to justify the reason behind learners personalising their learning environment to fit their needs due to their different interests. The authors state that *"what we have here is a transition from a stable, settled world of knowledge produced by authority / authors, to a world of instability, flux, of knowledge produced by the individual in her or his life-world, out of resources available to her or him, and in relation to both needs and interests that come*

from the reader's life-world" (p.25). This is directly in line with the connectivism learning theory whose social constructivism roots highlight the fact that knowledge is constructed by the individual persons, generated at a social level, and held within the context that is has been produced and employed. This impinges on the pedagogical aspect in a way that teaching becomes indirect whereby the learner drives the educational process within a supportive environment and learns through experience. Siemens (2004) points out that the "*pipe is more important than the content within the pipe*", demoting the importance of academic knowledge per se. He describes this model of learning whereby "*learning is no longer an internal, individualistic activity*" and that this can alter when new innovative tools are employed. Haythornthwaite (2002) also refers to new tools and media as they add innovative and interesting opportunities for potential connections and relationships as well as endorsing hidden links. And it is this constellation of knowledge connections that the learner, facilitated by the efficacy of the technology, is able to make sense and find a way through the social and technological network to achieve the required educational goals.

Additional similar empirical results and case studies are required to convince academic institutions and e-learning portals to adopt new and effective methodologies. Above all the learner is central to the success of any e-learning platform, and a familiarity with the interface as well as an experienced awareness of the benefits and capabilities will affect the academic success of the student together with the overall effective outcome of the e-learning environment itself. The implication of this is that, in retrospect, if the study was to be repeated, the participants would be asked to experience or view a session of how the iPLE works during their orientation. In this case the orientation would be devised to be over the span of a day rather than an hour presentation during which additional information would be given to the participants. A longer orientation would have helped the participants warm up to the iPLE and to a different way of experiencing an innovative e-learning environment. This would have captured participants' reactions and feedback right from the start rather than having a good portion of the results collected during the 'cold start' that might have skewed the overall outcome. Additionally, the participants could have been given some literature through printed leaflets, video testimonials or email info-letters before the actual exercise initialised especially if this information was combined with a dummy display online environment for the participants to have a look at, experience, and get used to.

The research process could also be improved if the empirical study targets a specific e-learning design issue and developed to collect granular data and draw finer design conclusions. Noesgaard & Ørngreen, (2015) provide insights on the design of effective e-learning systems while at the same time appeal to scholars and design engineer "*to target their measurement efforts to counting what counts for them and their stakeholders*" (p. 278). Similarly, in a very recent study Khan (2016) reports that special focus was placed on the curriculum design to ensure to develop and deploy the most effective online system to teach English. The implications of this are that the research study and the empirical study can be specifically designed to focus and highlight particular academic issues rather than others.

Another matter that could have had an impact on the qualitative data collected is the additional use of the interview instrument. Interviews were not designed as part of the data collection plan as the considerable number of participants and the limited time available to perform the interviews would have reduced the time the participants had in contact with the iPLE. Alternatively only the use of focus groups was planned and executed as this instrument, to the contrary to interviews, can address issues and feedback from a bigger number of participants in a relatively same time period. Without interviews specific information might have been missed and justified participants' reactions and recommendations would have further enriched the data analysis and eventual discussion. In retrospect the interview instrument would at least be attempted by asking for volunteers from the participants who are willing to contribute further through a personal interview face-to-face or even over video conferencing. Interviews have the advantage of producing finer, specific and relevant information and thereby data related to particular iPLE features could have been gathered and analysed. Similarly specific questions about the personal interest of individual participants would have potentially identified subtle technicalities that did not emerge in the focus groups. On the other hand focus groups allow the elaboration of ideas and thereby it was possible to capture qualitative data related to how the modalities differ from each other and how they could be employed with different kind of learners. Such debates between the participants would not have been possible through interviews only. In an ideal situation both instruments are employed to maximise collection of data and reduce the possibility of missing any details or issues. Having said this if a choice had to be done due to time limitations then a post-study survey could potentially capture much of what an interview would, while a focus

group cannot be easily replaced. Therefore the use of focus group rather than a personal interview is somewhat justified.

A final limitation with the empirical instrument that would potentially impact the final outcome of this research is the choice of participants and of subject domain. The participants that formed part of the convenient sample were all from the ICT education domain who obviously had previous knowledge and an affinity with the technology and e-learning. This was an advantage in its own right as the empirical study was intended to go beyond the technology and the use of a browser, but specifically to focus on the pedagogical effectiveness of the proposed medium. Still it would be interesting and would add to the discussion if other participants from diverse backgrounds contributed to the data collected following an intense experience with the iPLE. In retrospect the outcome from the empirical study could have potentially been different and compelling if it was free from a bias that the domain chosen could impinge. To do so the participants would have to be enrolled from the community of teachers or from tertiary students across different domains. This would involve additional resources, different instruments and a complete change in the way the entire study would have been carried out. So in this case the limitation is more of an opportunity to perform the same study with a different objective and with different goals completely different from the current ones. If this were the case the methodology would have to be redesigned to accommodate additional requirements that have previously been assumed and addressed accordingly. The pre-study survey would also have to be adapted to enquire further in the participants' IT competency level together with a pre-knowledge of their interests and domain of expertise. The iPLE itself would have been geared with different topics or a neutral generic topic considering heterogeneous participants. The implication would have been that the conclusions drawn would be much more generic, domain independent and academically robust. The intermediate assessments and post-study survey would again focus on specific and finer details to capture additional data that would identify any changes in the participants' skills and knowledge level. This additional information would have been focussed much more on the assessment outcomes, similar to other numerous studies, rather than the subtle differences between the iPLE and a standard e-learning environment.

7.3   *Future Directions*

The research presented a possible way forward for future e-learning environments in an effort to optimise their effectiveness while addressing a number of issues online learners encounter. The three pillar concept introduced in Chapter 2 (Figure 2.2) and further expanded and reinforced at the beginning of the chapter (Figure 7.1) has shown that tackling individual aspects systematically can lead to a better understanding of the inner dynamics of a complex issue like e-learning. Such graphical representation can help visualise the problem at hand and lead to other research questions and potential solutions. One possibility could be the identification of an additional e-learning concern and work up through the layers of the pillar model addressing the methodology to counteract the issue, the philosophy behind such a solution through the learning theory it is grounded on, and eventually the manifestation of the solution within the e-learning environment. As a case in point an issue that surfaced during the focus groups thematic analysis was the adaptability struggle. What emerged from the participants' comments was a preconceived notion that the face-to-face modality is more effective due to their academic experience and their daily professional practice that they are used to. Apart from a potential aversion to technology, that cannot be ignored, learners, and not necessarily educators, consider the traditional classroom to be a familiar environment that they fully understand, relate to, and that comes most natural to them especially because of the passive role adopted during F2F. Future research should focus in how e-learning turns the tables on the learners in relation to participation, behaviour and required effort. What methodology should be adopted to effectively introduce the learners to the e-learning platform? Which learning theory subscribes to such a philosophical undertaking? How can resistance to change be controlled and actually reverse the learners' mind-set? How will this be implemented and eventually performed in reality?

Other future research directions that emerged include the customisability and control of the environment by the learner, especially in the tertiary level. Participants pointed out that they would have recommended the iPLE to their peers if they could switch it on and off at their will. This interesting concept emulates the behaviour of online learners who are very focused when they have a specific objective to reach, but willing and open to related suggestions and recommendations when they are following a course, like a MOOC, out of interest and without any assessment repercussions or time restrictions.

Another research direction can potentially be within the crowdsourcing domain where additional sources could be automatically included and harvested to add richer and diverse content to the knowledge base of the iPLE. The current version collates information from pre-stated sources on specific interest areas. An extensible and fully automated system would be able to enhance the repertoire, or even better, refine the interests categories thereby optimising further more the personalisation process of the e-learning environment.

These future research directions give rise to potential projects or research ventures as spinoffs from this thesis. The first project I would like to take forward as a direct result of this work is about the concept of customised online textbooks. Miller & Ranum (2014) worked on a project called Runestone that was meant to develop and deploy educational resources and tools for learners to interact with and use within an open source environment. This budding platform provides an arena for educators to generate tailored educational material that can be used with their students or employed as additional teaching material to traditional courses. Runestone is able to host custom versions of textbooks, currently servicing five thousand students a day, and is being employed in over a hundred institutions around the world. The project being proposed would integrate with Runestone by embracing the already existent growing base of educators making use of Runestone while exploiting the data being generated which is currently above the thirty million mark (Miller & Ranum, 2014). The proposed project could potentially prod further by employing this corpus of user data to identify different learner profiles that the next iPLE generation can take advantage of, giving new meaning to e-learning. Can the next generation electronic e-learning systems come in the form of e-books based on intelligent personal learning environments? What control would the learner have on the intelligent environment? Will artificial intelligence take over the e-learning field with the focused development of customised electronic textbooks that bring together multimedia, crowdsourcing and personal portfolios? The main role within this scenario is still educational with additional lateral aspects, like social and technological that are required to supplement and refine the overall e-learning experience to converge towards a unique e-learning experience befitting a unique learner.

7.4   *Final Thoughts*

This thesis has been a tiny step in the right direction. A miniscule positive response to the research question that proposed a way into how to optimise the e-learning platform through a blend of methods grounded on a combination of learning theories in an effort to address a number of e-learning concerns. The research that was pursued following the research question statement characterised the design, methodologies adopted and the actual development of the prototype platform called iPLE.   At the centre of this research journey lies the empirical study that was meticulously and methodically designed to reflect the research decisions taken and the pedagogical enhancements proposed. The empirical study served also as an excellent channel to collect the necessary data to critically evaluate what was being proposed through a number of quantitative and qualitative data collection instruments. The results that the hundred and twenty participants generated over a period of three weeks while experiencing an equal exposure to a standard e-learning platform, traditional face-to-face, and the proposed iPLE were duly analysed. Standard and complex statistical analysis together with thematic content analysis was performed using Excel, SPSS and NVivo respectively to extract meaningful information that shed light on the outcome of the empirical study and the entire research project. The discussion that pursued indicated a number of positive outcomes while it also revealed a few interesting limitations which led to potential alternate outcomes and recommended countermeasures to enhance the prototype and improve the empirical study in general. The evaluation concluded that the goals and objectives of the research have been successfully met or exceeded.

The research study reported in this thesis has shown the necessity of personalising the e-learning services that are currently available, and achieving this through the underlying methodologies employed in collaboration with the learner. It has been shown that by combining three techniques, crowdsourcing, learner profiling and personalisation, into a functional system it is possible to enhance effectiveness (Montebello, 2014a) by delivering a tailored environment that adapts to the learner. It has also been shown that it is possible to make use of social networks to crowdsource additional information to supplement the academic content (Montebello, 2014b). Finally, the intelligent personal learning environment, iPLE, has been developed and implemented to incorporate these

capabilities (Montebello, 2016), and characterise the underlying philosophy of this research by demonstrating the hypothesis, since the iPLE:

  i.   Makes use of social networks as additional sources of information;
  ii. Allows learners to select areas of interests according to their preferences;
  iii. Employs artificial intelligent techniques to generate a specific learner profile;
  iv. Uses the generated learner profile to target other similar information;
  v.   Clusters similar learners to propose and suggest additional relevant information;
  vi. Refines the learner profile through a feedback cycle process;

This research study and this thesis do not only recapitulate all the hard work performed over the last four years, and nor do they characterise the end of an exhilarating journey, but merely demarcate the beginning of a promising way forward as new research avenues have been uncovered which potentially could characterise the future of online education and intelligent e-learning platforms. This is all very promising and encouraging because the work presented helps to improve and enhance people's interaction and attitude towards e-learning and online education in general.

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Appendices

Appendix A

Face-to-Face Course (F2F)

Appendix B

Static Online Course (VLE)

Part 1   ... 2/12

e Learning
DESIGN

The Learning Triangle

This course introduces instructional design principles and relates the principles to the development of online courses. It includes many Web resources, is interactive, and encourages much discussion among participants of concepts, ideas and strategies for effective online teaching. Topics covered are the following:

Objectives
Descriptions of what students should be able to do at the end of the course

Assessments
Tasks that provide feedback on students' knowledge and skills

Instructional Activities
Contexts and activities that foster students' active engagement in learning
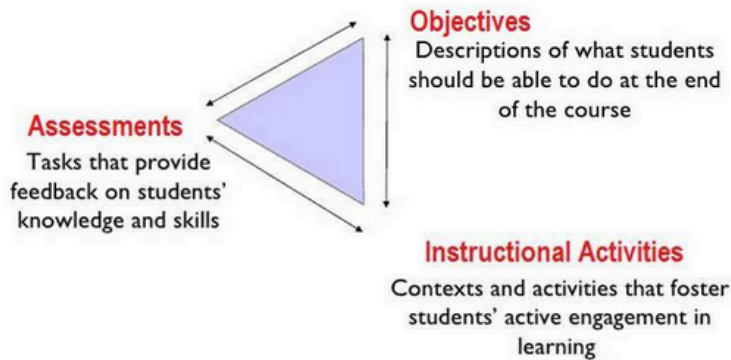
(Source: Eberly Center for Teaching Excellence, Carnegie Mellon)

Is this course for you?

- Starting to design an e-Learning class?
- Trying to make your material more effective for an online course?
- You would like to clarify issues like:
    - Course design is too often overlooked by course developers;
    - Or otherwise misunderstood;
    - If it "looks good" the visuals are sufficient;

PREV   MAIN MENU   NEXT

Appendix C

Informant Information Sheet

Information Sheet

Please read this information sheet carefully before you decide to participate in the study.

Project Title: How can the combination of personal learning portfolios and social networks render e-learning more effective?

Purpose of the research study: The purpose of this research study is to investigate the pedagogical effect of the use of personalised learning portfolios (PLP) in combination with social networks to personalise the learning experience.

The lead researcher: Matthew Montebello is a postgraduate researcher within the Higher Education stream at the School of Education at University of Sheffield collecting data as part of his doctoral thesis.

What you will do in the study: You will be asked to access educational material related to your area, namely, ICT. This will form part of a complete course of study associated with online education. You will be asked to participate in a number of assessed exercises and will also require your feedback to review other participants work. Your actions when accessing the educational material will be logged anonymously and no reference to your name will be done. There will be no photographs, audio tapes or video tapes of your participation. At the end of the exercise you will be asked to complete a questionnaire and to participate in a focus group and short interview to give feedback. You will be free to skip any question/s that make you feel uncomfortable and stop the interview/survey/focus group at any time.

Time required: The study will be held during the period of your in-service (INSET) training that is annually held by the Education division.

Risks and Benefits: There are no anticipated physical, psychological, professional or personal risks and/or hazards while participating in this study but should you feel that you are being subjected to any risk you can stop participating at any point during the study. There are educational benefits to you for participating in this research study that will expose you to new and novel online education techniques and methodologies. The study will help clarify and shed light on how such practices enhance the learning process and you will have contributed to such ends.

Confidentiality and Participation: The information that you give in the study will be handled confidentially. Your data will be anonymous which means that your name will not be collected or linked to the data. It will be impossible to deduce your identity even if someone attempts to do so. Your data, feedback, responses and participation will be reported in a way that will not identify you in any way. Your participation in the study is completely voluntary and you have the right to withdraw from the study at any time without any prejudice or any kind of penalty.

How to withdraw from the study: Any participant can withdraw by logging out of the portal and still take advantage of the educational material as part of your in-service training by using the 'guest' account which is fully anonymous and captures no data. Your participation in surveys, interviews and focus groups is totally voluntary.

Appreciation: There will be no payment given for participating in the study, but your contribution to this research is highly appreciated and of great value to the success and completion of the entire research study. Thank You.

If you have questions about the study, contact …

Either / Or	Matthew Montebello	Dr Tim Herrick
Office	Room 1A05, ICT building, University of Malta. Msida.	Room 3.09, 388 Glossop Road
Phone	(+356) 79820528 or 23402132.	(+44) (0)114 222 8109
Email	matthew.montebello@um.edu.mt	t.herrick@sheffield.ac.uk

You will receive a copy of this form for your records.

Appendix D

Informant Consent Form

Participant Consent Form

Title of Research Project: How can the combination of personal learning portfolios and social networks render e-learning more effective?
Name of Researcher: Matthew Montebello

Participant Identification Number for this project:
Please initial box

1. I confirm that I have read and understand the information sheet dated _____ explaining the above research project and I have had the opportunity to ask questions about the project.
2. I understand that my participation is voluntary and that I am free to withdraw it any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. Contact numbers of lead researchers are +35679820528 or +441142228109.
3. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.
4. I agree for the data collected from me to be used in future research
5. I agree to take part in the above research project.

_____   _____   _____
Name of Participant   Date   Signature

_____   _____   _____
 Lead Researcher   Date   Signature

To be signed and dated in presence of the participant

You will receive a copy of this form for your records.

Appendix E

Pre-Test Survey

Initial Survey

Let us get to know you ... (2 pages only)

Basic Information

1. Gender: ○ male ○ female

2. Age Group: [please choose ⇕]

Qualifications

3. What is your *highest qualification*?

   ○ PGCE
   ○ B.Ed.
   ○ Masters
   ○ Doctorate   Other: [_____]

Work Related

4. Gender of your students: [please choose ⇕]

5. Age Group of your students: [please choose ⇕]

6. Subjects you teach: [please choose ⇕]

Personal Use of Technology

7. For how many years have you *used a computer*? [- Please select - ⇕]

8. For how many years have you *used the Internet*? [- Please select - ⇕]

9. How often do you *currently use the compute/tablet*? [- Please select - ⇕]

10. How often do you *currently use the Internet*? [- Please select - ⇕]

[Proceed to Page 2/2]

More on the use of technology

11. Do you **customise the settings** on your computer/tablet?
(E.g. Background colour, icons size, font size on screen)
- Please select -

12. Do you make **use of Social Networks**?
(E.g. Facebook, Twitter, Flickr, Blogger)
- Please select -

13. Do you customise the interface of Social Networks you use?
(E.g. Profile picture, Interests, About info., Status)
- Please select -

14. Do you make **use of Adaptable sites**?
(E.g. myYahoo, NetVibes, GoogleCards)
- Please select -

15. Would you make use of **Dynamic Website Customisation that Adapts to the User Preferences?**
- Please select -

E-learning Courses

16. How do you **feel about online courses**?
- Please select -

17. Have you ever **followed a course online**?
○ Yes ○ No

18. Do you think that **e-learning is as effective as face-to-face**?
- Please select -

19. Have you ever **employed e-learning in your teaching**?
○ Yes ○ No

20. How much do you use the provided **Learning Management System**?
- Please select -

E-learning Design

21. Would you like to **design e-learning courses**?
○ Yes ○ No

22. Regarding abilities to **design e-learning courses ...**
- Please select -

Online Assessment

23. Do you agree with **performing Online Assessment**?
○ Yes ○ No

24. Regarding **abilities to set Online Assessment ...**
- Please select -

Submit my feedback

Appendix F

Post-Test Survey

E-learning Design

13. Is there a need of *special abilities to design* an Online Course? ⚪ Yes ⚪ No

14. Would you consider *Designing an Online Course* yourself? ⚪ Yes ⚪ No

15. Which *modality* was *most effective* during the *Instructional Design course*? (list in order of most effective) [- Please select - ⬍]

Online Assessment

16. Is there a need of *special abilities to set* Online assessment? ⚪ Yes ⚪ No

17. Would you consider performing *Student Assessment Online?* ⚪ Yes ⚪ No

18. Which *modality* was *most effective* during the *Online Assessment course*? (list in order of most effective) [- Please select - ⬍]

Any Other Comments ...

Any feedback is anonymous and welcome.

[Submit my feedback]

Appendix G

Intermediate User Opinions.

Appendix H

Intermediate Tasks

e **Learning** DESIGN

Activity (5/5)

The activity has 5 sections (First section was done in Part 1, second and third sections in Part 2, the fourth and this last one in this Part 3).

Keep in mind:

- This is not an assessed activity but intended for you to gain experience;
- It is purposely meant to be adapted to Online Education;
- It is also intended to be a high-level activity as a proof-of-concept;
- Activity is incremental and ongoing over the 3 parts of the topic;
- Feel free to
  - Discuss with other participants
  - Exchange notes
  - Use notebook provided

- **Sample *model answers* are available [here] (new tab will open).**

In this fifth and last section you are required to:

1. Identify a topical area of your choice
2. Draft an Instructional Analysis chart
3. Identify the media and resources to be employed
4. Specify tools to develop your instruments

5. Develop sample assessment for your topic
   - What assessment instrument would you use?
   - List at least 3 activities you would plan;
   - No need to cover all the sub-goals.

Some examples include:

- Survey, poll, questionnaire;
- Rubric, multiple-choice, descriptive;
- Video, group-work, communication.

blogging
Debating
Opinion
Recommending
Validating
Reporting
Online
Itemizing
Quizzing
Peer Editing
Judging
Rubrics
Collaborative
Wikis
E-portfolios
Activities
Poll

Appendix I

Focus Group Tool

- *Welcome*: Introduce yourself and highlight the topic of this session;
- *Aim*: To analyse in some detail the iPLE modality;
- *Guidelines*: No wrong/right answers. Use of first names. Colleagues;
- *Questions*:

a.	Kick-off with a short description about any experience you have had with e-learning in general.
b.	What are your generic thoughts about the iPLE environment?
c.	Putting the F2F modality apart, how would you compare the iPLE to the VLE?
d.	Which is the most function of both? In which ways?
e.	In what way, if any, did the iPLE experience affect you positively or you have any reservations?
f.	Did the use of personal interests effective? And did they ADD any value? How?
g.	If you had to recommend a preferred modality (VLE or iPLE), which one would you go for? - For the general public; - For your class; - For your peers – ICT educators.
h.	What are your final thoughts/judgements on the iPLE platform as an e-learning modality?

Appendix J

Ethics Application Form

University Research Ethics Application Form for Staff and PGRs

The University Of Sheffield.

This form has been approved by the University Research Ethics Committee (UREC)

Date:	1st October 2014
Name of applicant:	Matthew Montebello
Research project title:	How can the combination of personal learning portfolios and social networks render e-learning more effective?

Complete this form if you are a **member of staff or a postgraduate research student** who plans to undertake a research project which requires ethics approval via the University Ethics Review Procedure. [X]

or

Complete this form if you plan to submit a **'generic' research ethics application (i.e. an application** that will cover several sufficiently similar research projects). Information on the 'generic' route is at: www.sheffield.ac.uk/ris/other/gov-ethics/ethicspolicy/approval-procedure/review-procedure/generic-research-projects [ ]

PLEASE NOTE THAT YOUR DEPARTMENT MAY USE A VARIATION OF THIS FORM:
PLEASE CHECK WITH THE ETHICS ADMINISTRATOR IN YOUR DEPARTMENT

> **This form should be accompanied, where appropriate, by all Information Sheets/Covering Letters/Written Scripts which you propose to use to inform the prospective participants about the proposed research, and/or by a Consent Form where you need to use one.**

Further guidance on how to apply is at: www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy/approval-procedure/review-procedure

Guidance on the possible routes for obtaining ethics approval (i.e. on the University Ethics Review Procedure, the NHS procedure and the Social Care Research Ethics Committee, and the Alternative procedure) is at: www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy/approval-procedure/ethics-approval

Once you have completed this research ethics application form in full, and other documents where appropriate, check that your name, the title of your research project and the date is contained in the footer of each page and email it to the Ethics Administrator of your academic department. Please note that the original signed and dated version of 'Part B' of the application form should also be provided to the Ethics Administrator in hard copy. Ethics Administrators are listed at:

www.shef.ac.uk/polopoly_fs/1.99105!/file/Ethics-Administrators.pdf

I confirm that I have read the current version of the University of Sheffield 'Ethics Policy Governing Research Involving Human Participants, Personal Data and Human Tissue', as shown on the University's research ethics website at: www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy | X |

Part A

A1. **Title of Research Project**: How can the combination of personal learning portfolios and social networks render e-learning more effective?

A2. **Contact person** (normally the Principal Investigator, in the case of staff-led research projects, or the student in the case of supervised-postgraduate researcher projects):

Title: Mr

Name: Matthew Montebello

Post: Post graduate research student

Department: School of Education

Email: edp12mm@sheffield.ac.uk

Telephone:(+356)79820528

A2.1.   Is this a postgraduate researcher project? If yes, please provide the Supervisor's contact details:

Title: Dr

Name: Tim Herrick

Post: Senior University Teacher

Department: School of Education

Email: t.herrick@sheffield.ac.uk

Telephone: (+44) (0)114 222 8109

A2.2.   Other key investigators/co-applicants (within/outside University), where applicable. Please list all (add more if necessary):

Title:

Name:

Post:

Department:

Email:

Telephone:

A3.   Proposed Project Duration:

Start date: 1st October 2014

End date: 30th September 2016

A4.   Mark 'X' in one or more of the following boxes if your research:

	involves adults with mental incapacity or mental illness
	involves prisoners or others in custodial care (e.g. young offenders)
	involves children or young people aged under 18 years

<table>
<tr><td>☐</td><td>involves using samples of human biological material collected before for another purpose</td></tr>
<tr><td>☐</td><td>involves taking new samples of human biological material (e.g. blood, tissue) *</td></tr>
<tr><td>☐</td><td>involves testing a medicinal product *</td></tr>
<tr><td>☐</td><td>involves taking new samples of human biological material (e.g. blood, tissue) *</td></tr>
<tr><td>☐</td><td>involves additional radiation above that required for clinical care *</td></tr>
<tr><td>☐</td><td>involves investigating a medical device *</td></tr>
<tr><td>☐</td><td>is social care research</td></tr>
<tr><td>☐</td><td>is ESRC funded</td></tr>
</table>

* If you have marked boxes marked * then you also need to obtain confirmation that appropriate University insurance is in place. The procedure for doing so is entirely by email. Please send an email addressed to insurance@shef.ac.uk and request a copy of the 'Clinical Trial Insurance Application Form'.

It is recommended that you familiarise yourself with the University's Ethics Policy Governing Research Involving Human Participants, Personal Data and Human Tissue before completing the following questions. Please note that if you provide sufficient information about the research (what you intend to do, how it will be carried out and how you intend to minimise any risks), this will help the ethics reviewers to make an informed judgement quickly without having to ask for further details.

A5. **Briefly summarise:**

   i. **The project's aims and objectives:**
       (this must be in language comprehensible to a lay person)

The purpose of this research proposal is to investigate the pedagogical effect of the use of personalised learning portfolios (PLP) in combination with social networks to personalise the learning experience.

ii. The project's methodology:
(this must be in language comprehensible to a lay person)

A mixed method approach will be adopted and applied to the sample population and control group alike. The research approaches include use of qualitative data collection by means of questionnaires, semi-structured interviews, and focus groups; as well as quantitative data collection by means of electronic user surveys and evaluation forms submitted pre- and post-testing.

A6. What is the potential for physical and/or psychological harm/distress to participants?

Participants will be secondary school teachers attending their annual in-service training during their working hours. The informants will volunteer to participate and will be informed of the study being undertaken.

A7. Does your research raise any issues of personal safety for you or other researchers involved in the project? (especially if taking place outside working hours or off University premises)

None

If yes, explain how these issues will be managed.

A8. How will the potential participants in the project be:

i. Identified?

All the ICT teachers in secondary schools in Malta.

ii. Approached?

> Through the national ICT education officer.

iii. Recruited?

> An information pack will be forwarded via their education officer and asked to volunteer.

A9. **Will informed consent be obtained from the participants?**

Yes [X] No [ ]

> **If informed consent or consent is <u>NOT</u> to be obtained please explain why.** Further guidance is at: www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy/policy-notes/consent

A9.1. This question is only applicable if you are planning to obtain informed consent:

How do you plan to obtain informed consent? (i.e. the proposed process?):

> Participant who have been approached and accepted to be recruited will be asked to sign a consent form with the possibility of opting out of the study at any point. An information sheet will be handed out to the participants before the start of the study. The information contained within this sheet will include but not be limited to:
>
> - Description and purpose of the study;
> - Protection of confidentiality;
> - What is involved as a participant;
> - Voluntary participation;
> - Risks and discomforts;
> - Dissemination of info. collected and results;
> - Potential benefits;
> - Principal investigator contact information.

Remember to attach your consent form and information sheet (where appropriate)

A10. **What measures will be put in place to ensure confidentiality of personal data, where appropriate?**

> All data collection will be performed online through a purposely developed portal. Login details will contain no names or identification details but unique alphanumeric credential will simply be

randomly assigned to participants who will use them to gain access and use the portal.

Questionnaires, interviews and focus group require no identification details.

A11. **Will financial/in kind payments (other than reasonable expenses and compensation for time) be offered to participants?** (Indicate how much and on what basis this has been decided)

No none as this will form part of their annual in-service training on related ICT topics.

A12. **Will the research involve the production of recorded media such as audio and/or video recordings?**

YES ☐ NO ☒

A12.1. This question is only applicable if you are planning to produce recorded media:

How will you ensure that there is a clear agreement with participants as to how these recorded media may be stored, used and (if appropriate) destroyed?

Not applicable

Guidance on a range of ethical issues, including safety and well-being, consent and anonymity, confidentiality and data protection are available at: www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy/policy-notes

University Research Ethics Application Form - Part B - The Signed Declaration

Title of Research Project:

How can the combination of personal learning portfolios and social networks render e-learning more effective?

I confirm my responsibility to deliver the research project in accordance with the University of Sheffield's policies and procedures, which include the University's *'Financial Regulations'*, *'Good Research Practice Standards'* and the *'Ethics Policy Governing Research Involving Human Participants, Personal Data and Human Tissue'* (Ethics Policy) and, where externally funded, with the terms and conditions of the research funder.

In signing this research ethics application form I am also confirming that:

- The form is accurate to the best of my knowledge and belief.
- The project will abide by the University's Ethics Policy.
- There is no potential material interest that may, or may appear to, impair the independence and objectivity of researchers conducting this project.
- Subject to the research being approved, I undertake to adhere to the project protocol without unagreed deviation and to comply with any conditions set out in the letter from the University ethics reviewers notifying me of this.
- I undertake to inform the ethics reviewers of significant changes to the protocol (by contacting my academic department's Ethics Administrator in the first instance).
- I am aware of my responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data, including the need to register when necessary with the appropriate Data Protection Officer (within the University the Data Protection Officer is based in CiCS).
- I understand that the project, including research records and data, may be subject to inspection for audit purposes, if required in future.
- I understand that personal data about me as a researcher in this form will be held by those involved in the ethics review procedure (e.g. the Ethics Administrator and/or ethics reviewers) and that this will be managed according to Data Protection Act principles.
- If this is an application for a 'generic' project, all the individual projects that fit under the generic project are compatible with this application.

- **I understand that this project cannot be submitted for ethics approval in more than one department, and that if I wish to appeal against the decision made, this must be done through the original department.**

Name of the Principal Investigator (or the name of the Supervisor if this is a postgraduate researcher project):

Dr Tim Herrick

If this is a postgraduate researcher project, insert the student's name here:

Matthew Montebello

Signature of Principal Investigator (or the Supervisor):

	Date:

Email the completed application form and provide a signed, hard copy of 'Part B' to the Ethics Administrator (also enclose, if relevant, other documents).

Appendix K

Ethics Clearance

The University Of Sheffield.

16/12/2014

Matthew Montebello
School of Education

Dear Matthew

PROJECT TITLE: How can the combination of personal learning portfolios and social networks render e-learning more effective?
APPLICATION: Reference Number 002038

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 08/12/2014 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 002038 (dated 08/11/2014).
- Participant information sheet 003104 (20/10/2014)
- Participant consent form 003398 (08/11/2014)

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Professor Daniel Goodley
Ethics Administrator
School of Education

Appendix L

Participants' Welcome Flyer

Dear Participant,

Welcome to the 2015 Inset training held at the faculty of ICT in collaboration with the Education Division.

- ✓ The 3-week programme is made up of three separate topics delivered in three different modalities.
- ✓ The schedule will be setup as follows:

> Week 1 – Topic 1 – Instructional Design – 3 Parts
> Week 2 – Topic 2 – Online Assessment – 3 Parts
> Week 3 – Topic 3 – Technology Tools – 3 Parts

- ✓ Each topic will be presented in three (3) different modalities to expose all ICT educators to a variety of modalities in a way that they can assess and distinguish between them.
- ✓ The three modalities are:
  - o Face-to-Face (F2F) – Traditional lecture setting
  - o Virtual Learning Environment (VLE) – Standard e-learning course
  - o Intelligent Personal Learning Environment (iPLE) – Modality under investigation
- ✓ Due to the 3 modalities being employed the participants have been divided into three groups, namely:
  - o Mint Group   Surnames A - C
  - o Orange Group   Surnames D - M
  - o Turquoise Group   Surnames N - Z
- ✓ The schedule for these 3 weeks is as follows:

Week 1 – Instructional Design

|	8.30 – 9.30	10.00 – 11.00	11.30 – 12.30
Mint	F2F (Auditorium)	VLE (Room 6)	iPLE (Room 7)
Orange	iPLE (Room 7)	F2F (Auditorium)	VLE (Room 6)
Turquoise	VLE (Room 6)	iPLE (Room 7)	F2F (Auditorium)

- ✓ **Week 2 – Online Assessment**

	8.30 – 9.30	10.00 – 11.00	11.30 – 12.30
Mint	VLE (Room 6)	iPLE (Room 7)	F2F (Auditorium)
Orange	F2F (Auditorium)	VLE (Room 6)	iPLE (Room 7)
Turquoise	iPLE (Room 7)	F2F (Auditorium)	VLE (Room 6)

- ✓ **Week 3 – Technology Tools**

	8.30 – 9.30	10.00 – 11.00	11.30 – 12.30
Mint	iPLE (Room 7)	F2F (Auditorium)	VLE (Room 6)
Orange	VLE (Room 6)	iPLE (Room 7)	F2F (Auditorium)
Turquoise	F2F (Auditorium)	VLE (Room 6)	iPLE (Room 7)

✓ The rooms for the different modalities are shown here:
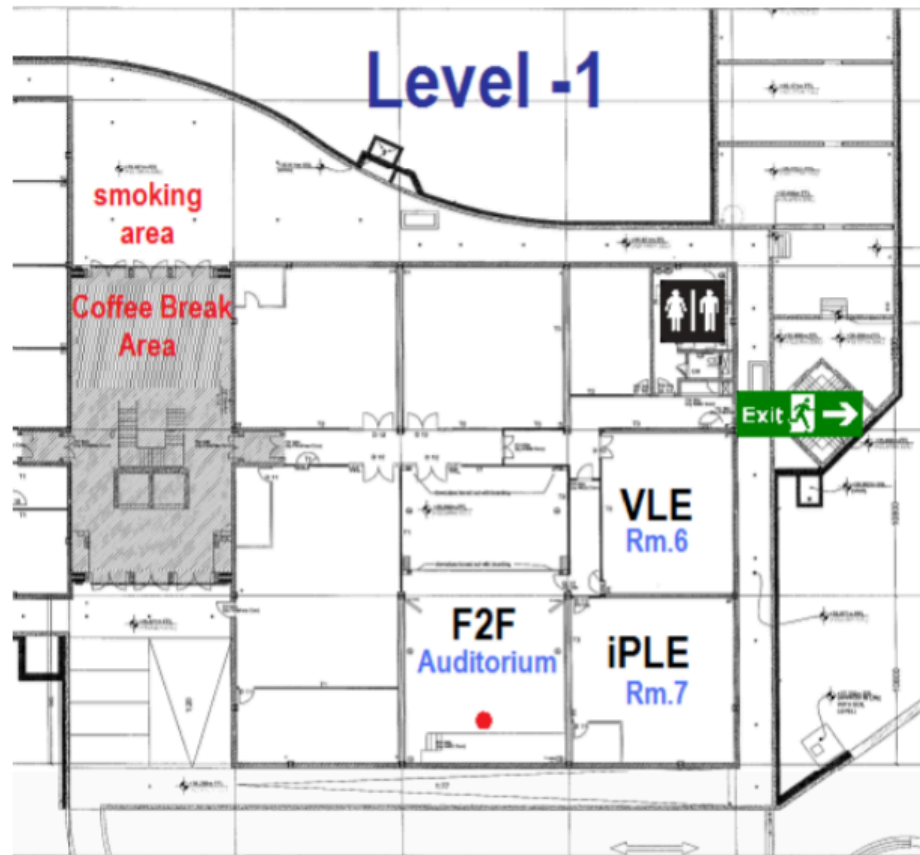
✓ Other information worth pointing out:
  o WIFI access sheet is included in your pack;

  o This symbol is used during one of the modalities to represent your interests;

  o Feel free to follow the provided links associated with your interests but ensure to return back to the material being presented to complete that part of course within the allocated hour;

  o Kindly complete the short surveys during the course and at the end of each part you are following;

✓ There will be coffee breaks within the designated area in between the sessions.

Thanks

Matthew Montebello

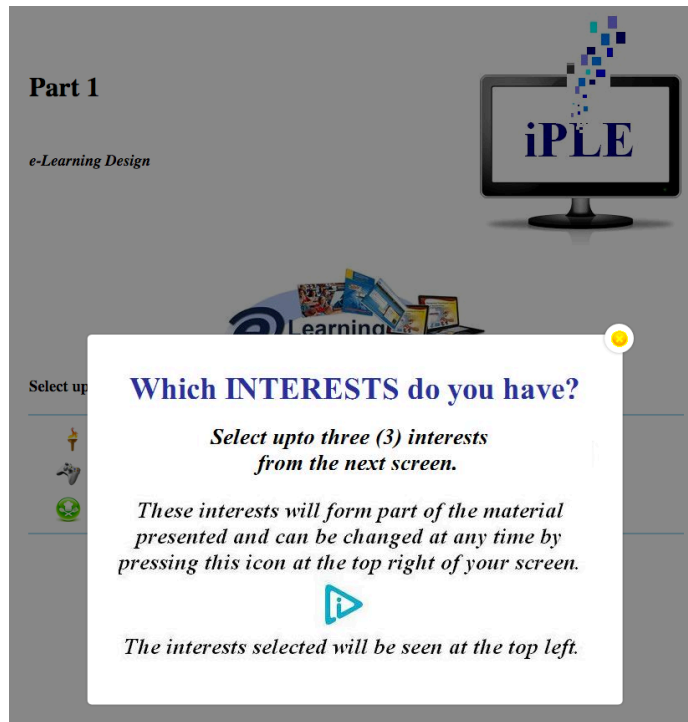# Appendix M

iPLE Front Interface
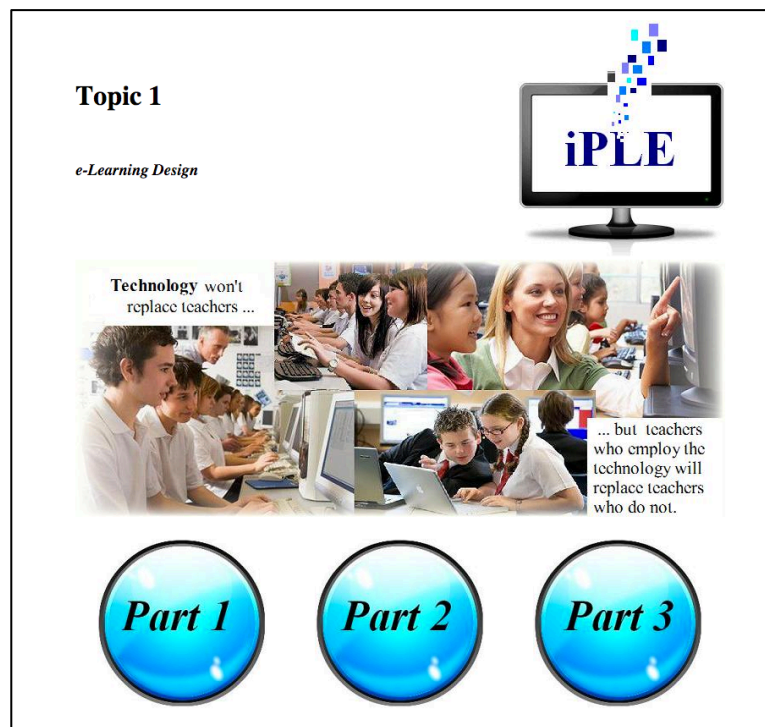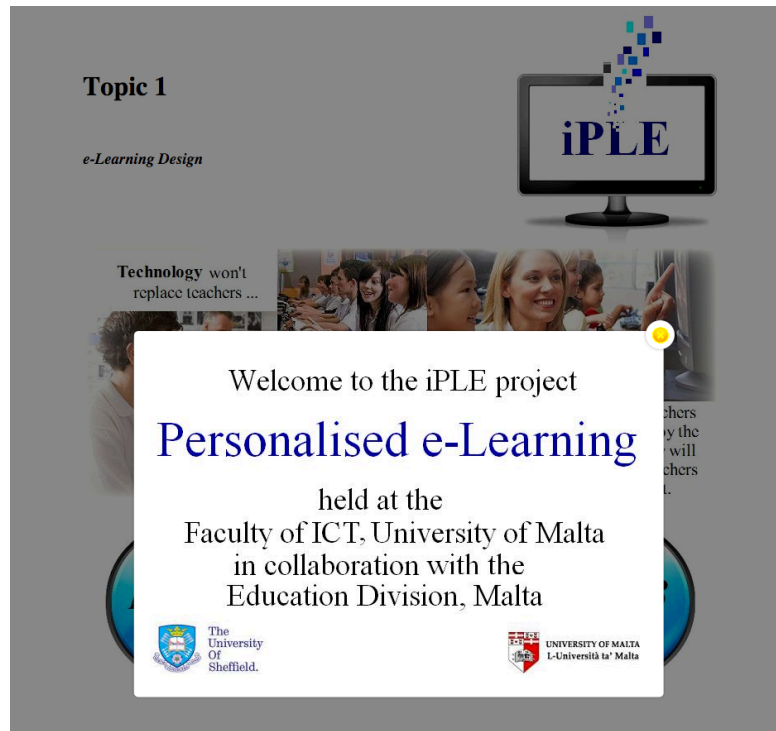
Appendix N

Select Interests

Appendix O

Sample Informant Completed

Consent Form (Total 120)

Participant Consent Form

Title of Research Project: How can the combination of personal learning portfolios and social networks render e-learning more effective?

Name of Researcher: Matthew Montebello

Participant Identification Number for this project:

Please initial box

1. I confirm that I have read and understand the information sheet dated 7/7/15 explaining the above research project and I have had the opportunity to ask questions about the project.

2. I understand that my participation is voluntary and that I am free to withdraw it any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. Contact numbers of lead researchers are +35679820528 or +441142228109.

3. I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.

4. I agree for the data collected from me to be used in future research.

5. I allow photos that I appear in to be used for documentation only.

6. I agree to take part in the above research project.

Robert Spiteri	7/7/15	*(signature)*
Name of Participant	Date	Signature

Matthew Montebello	7/7/15	*(signature)*
Lead Researcher	Date	Signature

To be signed and dated in presence of the participant

You will receive a copy of this form for your records.

Appendix P

Focus Groups Transcripts

Mint Transcript

PI: The idea of the focus group is to analyse in further detail the modality that was under investigation, the iPLE, from Room 7, we are looking for feedback to understand who are the best participants for this platform, other than your day to day activities in your day job, please forget the classroom, we understand that some of you felt frustrated since they wouldn't be using such a platform in the classroom. This exercise is for research purposes, therefore your feedback is highly valued for this e-learning platform.

Such an e-learning platform might be developed and used in 30 years' time, using artificial intelligence personalised to the needs of students.

PI: What was your experience in e-learning so far?

Participant M1: No I have never done an e-learning course

PI: Some of you might have done a MOOC course such Coursera or Masters, some of you are doing Masters, is there anyone who would be interested in taking up an e-learning course that is certificate based? So none of you have any experience in e-learning courses here, this is important for our research since you won't be comparing the VLE and iPLE to any e-learning modules, we are not mentioning face-to-face here, for me face-to-face is the ultimate learning experience, I am a teacher like yourselves, the difference between me and an Engineering professor who cannot teach is that I did the BED like you before that and students grasp that.

PI: Your generic taught on iPLE, normal content with interests on the right with links of Twitter and Facebook, and one of the interests and content interests.

Participant M2: During the F2F we discussed that the links could distract the students from the content, during my experience I felt that the links distracted me and I lost focus 100% on where I was supposed to be focusing.

Participant M3: I agree with my colleague, I lost time on the important thing and ended up looking at links.

PI: Imagine you're home in the comfort of your sofa, how would you react, I would still feel distracted in the links and music that the site was suggesting, we did not have a target, or time based so we lost time.

Participant M4: I feel that if I was given a topic, or time to end the course I would feel less distracted

Participant M6: A course without a deadline, I would feel distracted and time based I would be more disciplined, based on school children it would certainly throw discipline out of the window.

Participant M7: At home one would have even more distractions with social media and messenger apps.

PI: Putting the F2F modality apart

PI: Let's focus on iPLE and VLE, how do you compare them, think about it

PI: The reason is that focus groups are restricted to 7 so that you all feel comfortable

PI: Give me your feedback as a software developer, as the man behind the development of the platform

Participant M8: The difference I saw is that one product offers links the other doesn't, ultimately the time you spent as a developer is not worth is, and if I had to look for an interest I could just do a google search.

Participant M6: For the links not to distract me I ended up ignoring them

Participant M9: I agree

Participant M8: Me too

Participant M10: I would have preferred the iPLE to be done before the VLE, since there was some continuous process.

Participant M11: The majority would prefer the F2F

Participant M12: They have the advantage for better content VLE and iPLE has an advantage

Participant M5: If there are topics I don't know, if the lecturer gave me reading material I would read them, through iPLE the links might show me things that I hadn't even known that exists.

Participant M2: You might find things about yourself you didn't know at all.

Participant M13: You can also ignore topics that you know or are familiar with.

Participant M14: If you had to switch interests on and off, does that help, can you compare

Participant M7: You need self-control

Participant M8: I preferred VLE

Participant M1: I preferred iPLE

PI: Which is the more functional of the two?

Participant M2: I like the complementary information and it amazes me how the logic behind it automatically collected the links of interest

Participant M4: I think it's best used instead of a game or not to waste time.

Participant M5: It felt like gmail with additional stuff on the side that I tend to ignore completely

Participant M6: iPLE which I liked the most based on my way of working

PI: Imagine having a platform if it were a personal teacher

Participant M7: VLE is statistic

Participant M11: If I'm using iPLE is because I believe in it and it helps me

Participant M5: The advantage of switching it on and off is a benefit

PI: In what way did the iPLE experience effect you positively or not, or you have reservations

Participant M13: I don't want to be negative there were things which I liked, I don't want to strike everything out,

PI: The system is simulating a teacher a person

PI: The links provided where relevant to your interests?

Participant M12: what I said earlier, you can discover new content from this

Participant M3: I agree, for me however I would rather have it in a specific placed rather than all over the place

PI: during the activity there are no links

PI: Where the links effected, did they add any value?

Participant M9: depending on the content of the site, the links provided me with more information

Participant M10: Obviously, the links help you with your interests

PI: what would you add as an interest

Participant M14: more depth, such as sciences, music was generic, there wasn't much on voice

Participant M3: Certain sub topics, I don't know if its possible to do them, certain topics are very wide

PI: if you had to recommend one of the modalities, excl the F2F, would you recommend it to your life companion. Students: iPLE (all) – plus option to turn it off

Participant M4 VLE (1)

PI: recommendation to the general public

Participant M10: iPLE (all) – plus option to turn it off

Participant M14: an easily distracted (not computer literate) student I would recommend VLE

PI: recommendation to the students, your class

Participant M1: iPLE (majority)

Participant M10: Without supervision I would give them iPLE

PI: Where would you put the teachers?

Participant M9: iPLE, even though teachers are known to be very distracted

PI: what are your final thoughts / judgements on the iPLE platform as an e-learning modality?

Participant M14: Flexible, focused, distracting, dynamic, personalised, vast.

--- End of Transcript ---

Turquoise Transcript

PI: did you ever experience e-learning courses

Participant T1: the "EUN" courses

Participant T2: I also did an EUN course and e-Twinning and master class seminar in Gozo and another course in Latvia on internet teaching tools

PI: you went home after the first day and your relatives asked for feedback, what will you say about iPLE?

Participant T3: when I thought about it, we saw different systems that complement each other, but in different styles.

Participant T4: I agree as well

Participant T5: the visual items we saw where different from what we are used to

Participant T6: the Mint group we had F2F on the first day, the second day was different, all items where linked, I still kept track of what was going on

Participant T7: with a F2F you can get more information and understanding

PI: forget face-to-face for now, how does the VLE and iPLE compare

Participant T5: less distraction would be appreciated, we lost track when we went into facebook, when you think of your students in secondary school, students must be motivated and interested in going on researching the subject

PI: forget about the students

Participant T8: I chose my interests, and enjoyed it

PI: did you notice missing interests?

Participant T9: you don't have time to think about other interests

Participant T10: if you have interests on the topics, but you see more information, that might interest you and broaden your horizon on that particular subject.

PI: what did you find most function? VLE or iPLE?

Participant T11: most students would opt for VLE, however someone who is creative would gravitate towards iPLE to break the boredom and keep engaged.

PI: in what way did the iPLE affect you positively?

Participant t12: flexibility, freedom, dynamitic, creative, system can help you investigate and discover new things, doing something out of interest.

PI: which module would you recommend to your partner?

Participant T8: iPLE, majority of students, to work during summer months, VLE

PI: which module would you recommend to the general public, students or educators?

Participant T13: for students recommendation to use iPLE, focused students iPLE, unfocused class VLE, although I have good students, I would go for iPLE, and we still need to supervise them. To leave students alone on VLE the focused students will get lost like the weaker ones,

good students to iPLE and the unfocused to VLE, if I don't have to follow a syllabus then I would go for iPLE.

PI: What would you recommend to the education officer for education IT teachers?

Participant T14: iPLE to work from home in my own time, what you get isn't restricted, you are broadening your horizon on whatever interest you have.

Participant T2: If I had an exam tomorrow, I would tell myself to look at the link provided another day and focus on the job at hand.

Participant T1: does the administrator have access to track what the student is doing

PI: yes, we can even see where the mouse travelled on the page, but still anonymous

Participant T4: iPLE will never replace the teacher

PI: e-learning courses are on the rise, their standard and content is the same for everyone no PIer who and how many times you take it.

PI: what are your final thoughts on the platform of iPLE

Participant T2: positive, good and it works, must be integrated slowly, I think its good for the googling environment, effective, motivation is required, you have to have an interest in it, dynamic, has its limitation, the individual can control and customise the system, interesting.

Participant T3: I liked it a lot and think it has potential but needs further work

Participant T6: I agree

Participant T14: agree too but would add more control

Participant T7: More social media and interests

Participant T13: True, that would be great

Participant T9: I agree

Participant T11: Me too

Participant T10: I would even add the possibility of switching between iPLE and VLE

Participant T12: I'd rather it was controlled

Participant T5: I really enjoyed the iPLE and found it interesting and different

Participant T7: Yes it's not the usual e-learning

Participant T9: Yes true

Participant T3: Will it be publicly available?

PI: still at research and prototype stage

Participant T3: interesting

PI: thank you

-- End of Transcript --

Peach Transcript

PI: Your experience in ELearning- ever used, first time, experience?

Participant P1: I have done courses, taken not given, I enjoyed it, because I was doing it in my own time, but it meant more hard work, more work than if it where given by lectures, the advantage was that I learned in my own time, one of the assignment was written other was recording, and small quizzes within the course, the temptation to press next and skip sections is there, then you get to the quiz part and you're stuck, the progress being done is also checked in real time by the teacher/supervisor/co-ordinator. I enjoyed it and we were thinking about running a course ourselves, however we are aware that there is a lot more work for the administrator of the course.

Participant P2: I haven't done anything in e-learning, I don't really feel like I'm studying on a PC, I get distracted, I rather use a book, I rather have something in my hand, when I attempted something I never finished it.

PI: you get different methods of e-learning

Participant P3: I rather use points from the book, when using a PC, I get distracted to go online and see news and other things and get distracted, I doubt this system works at school, the students would get lost clicking the links, for 16+ students it would be more adequate.

PI: online learning is usually aimed at mature students, however younger students are introduced to see the capacity of online students, our culture is not used to choosing what they want to learn or do.

Participant P4: never did full e-learning module, at university we did some modules, we felt like they were a bit of waste of time. I am thinking of doing my masters online but you need to be committed, and not get distracted. The advantage in price and flexibility.

Participant P5: I did my master's degree in e-learning, and the experience was very positive. We had a moderate, and the flexibility was key, as I used to work at night, communication online used to be difficult, and the Maltese students we used to meet together and call each other. They used to send us the notes and we used to print them the quantities used to be so much too hard to follow on a monitor, we used to have three days seminar and thesis with viva, I have no regrets and I would recommend it to others, it was much cheaper as well. It was very intensive, discussion, forums and one assignment a week done as a group.

For the local students it was very easier, the foreigners lived very far away, the locals chose to meet up more frequently.

Participant P6: never had an experience of e-learning, for a mature student I think its very good, as for my students it would be very limiting, if you leave younger students alone, they will get to distracted, some cannot read, others might not have a computer at home.

Participant P7: never did a course, followed relatives doing them, I understand the structure, you can learn more online with sharing information from other students, repeat online lectures and read books online from anywhere. Especially for part time study. You need to be focused and responsible in what you're doing and use limits and planning. In secondary students it would have a number of disadvantages.

Participant P8: never did an e-learning course, I think using this type of learning for my students both the low and high achievers would be difficult, since in my opinion, they still need the teachers guidance, the low achievers have difficulty who cannot read, the foreigners cannot read English. For adults I think it would have a lot of advantages, as the others mentioned earlier.

Participant P9: never had such an experience but I would surely considerate it should the I come across the right course, I underestimated the type of learning, I found it more demanding. It is more flexible but I realised how much work you need to put in it.

Participant P10: what I did with my students was using videos using a similar system followed by a test.

PI: what are your thoughts of iPLE?

Participant P4: I didn't find them necessary,

Participant P11: I found them focused on my interest and I liked that

Participant P6: I got distracted, I marked a few to favourites to see later

Participant P7: I don't need to add content but reduce it, I might use it as a break

Participant P12: I might use the links later, but you need to be disciplined and not waste time

Participant P13: I was thinking they looked like advertising, might have made more sense if they linked to the type of course you're doing rather than your interests, you're broadening your horizon on that particular subject

Participant P14: I found them too distracting and was being drawn to the links, the ended up looking at certain things in the sites, that where related to the topic of design such as white space font etc

PI: between iPLE and VLE, how do they compare?

Participant P2: not much of a difference – more interaction with links in one but no difference (majority)

PI: the function between the two modules, what do you think about that how did it effect you?

Participant P8: the function got me interested into taking an online course, however as a secondary school teacher, with increased internet usage, infrastructure, and more freedom in using the equipment I would be inclined to use such a system with my student. Examinations would be geared towards what the students are learning.

Participant P11: how to set objectives was done well and explained and it is understood by me as a student

Participant P12: honestly I preferred face-to-face I understood what was expected of me, I get put off by too much digital content and diagrams.

Participant P14: if there was a short quiz to see if you're understanding half way through it would have helped me understand what I'm understanding

Participant P13: I missed the guidance of the "teacher" since all the way to university study we always had a guidance.

Participant P3: it was close to a course I did in the past, that included on a lot of text and included diagrams I preferred working alone without having to interact with others

Participant P2: I noticed that the content was same in all modules but the face-to-face was given more explanation since the points weren't read but more information was given

PI: did the content come across

Participant P1: I was tempted to skip and go to next when something didn't catch my interest, then I had to go back to it when I reached the activity in the end

Participant P5: the student would feel the same since we are teaching in the same method of guiding and hand-holding

PI: if you had to recommend VLE or iPLE to the general public, to a class you're giving, to other educators, what would you recommend?

Participant P9: VLE because it includes guiding for students, iPLE for public, it has more interesting items, as an educator, I would recommend VLE

Participant P10: use the Internet on your own rather than have something prompted to you

My recommendation of VLE would be aimed at everyone, the proper way to study is with the book and notes.

Participant P14: if the interests would agree with the subjects then I like iPLE

Participant P4: using VLE one can go and search online on the related topic. I would rather have related links to the topic I'm studying rather than an interest.

Participant P5: accessibility is very important, students with a disability, are more inclined to using the online systems, for hearing impaired, different languages, etc.

Participant P6: Students and teachers I would recommend VLE and general public I would recommend iPLE

Participant P7: method of assessment is also important, test, multiple choice etc. it would appeal more towards a certain type of student.

PI: any final thoughts you have of the experience

Participant P1: we have experienced and reactions on the past, teachers find Frontal tool difficult to use

Participant P2: teachers don't need certain distractions

Participant P3: Still I think its quite positive and interesting the way it works

Participant P8: yes true I agree

Participant P9: I agree, I really enjoyed it eventually

Participant P12: Wouldn't disagree but still I would want to have control as a teacher

Participant P13: Control? Why should you control students who want to learn?

PI: Let's focus on the iPLE please

Participant P11: I would recommend it and would like to see more personalisation

Participant P10: that would be great

Participant P8: I agree, well done.

-- End of Transcript --

Appendix Q

Learner Profiling Techniques

Learner interest filtering using Term frequency:

Weight of the interest term in a document: $W_i = F_i / N_w$ where

- the term i is the learner's interest term;
- F_i represents the number of occurrences;
- N_w is the total number of words.

And Inverse Document frequency:

$$W_i = F_i * ln (D_T / D_i)   \text{where}$$

- D_T represents the total number of documents;
- D_i is the number of documents containing the interest i.

Learner profile update (Buckley, Salton, & Allan, 1994):

$$p\text{-}new_k = (\alpha \quad p\text{-}old_k) + (\beta/r \sum_{i=1}^{r} dw_{ik}) - (\gamma/s \sum_{i=1}^{s} dw_{ik})$$

where:

- r is the number of relevant documents;
- dw_{ik} is the weight of term k in the document i;
- s is the number of non-relevant documents;
- $\alpha, \beta,$ and γ are tuning parameters.

New profile generated using cosine similarity metric:

$$c_{ij} = \sum(dw_{ik} * qw_{jk}) / \sqrt{[\sum dw_{ik}^2 * \sum qw_{jk}^2]}$$

Clustering algorithm for an initial set of k-means $m_1^{(1)}, \ldots, m_k^{(1)}$

i. Assignment step:
   Sum of squares $S_i^{(t)} = \{x_p : || x_p - m_i^{(t)} ||^2 \leq || x_p - m_j^{(t)} ||^2 \; \forall j, \; 1 \leq j \leq k\}$
   Where each x_p is assigned to exactly one $S^{(t)}$

ii. Update step:
   New means to the centroid of the cluster $= m_i^{(t+1)} = \sum_{x_j \in S_i^{(t)}} x_j \; / \; |S_i^{(t)}|$