‘An Examination of the Efficacy of a Technology Enhanced Learning Intervention in a First Aid Responder Course’.

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Abstract

Technology Enhanced Learning (TEL) is becoming more prevalent in education as it has evolved to enhance traditional pedagogical methods of tutoring that is face to face teaching. The utilisation of TEL on courses has been proven to enhance the learning experience for learners by increasing learner engagement and focus on courses. In this research the TEL intervention of online quizzes was introduced into a First Aid Responder course, which prior to this had relied almost exclusively on traditional well-established pedagogical methods. The aim was to provide increased positive learner motivation and engagement. Online quizzes were used as pedagogical tools to complement traditional face to face classroom instruction and ultimately improve the learner experience. This research examined the efficacy of a technology enhanced learning intervention in a first aid responder (FAR) course. A quasi experimental study was performed, with 18 learners from a 2018 cohort, as the control group and the experimental group comprised of the same 18 learners which were re-examined from a 2020 cohort. The TEL intervention of online quizzes (using Quizizz software) was applied to the 2020 group and evaluated using a mixed methods approach of both qualitative and quantitative data to ascertain the learner' experience and performance after employing the TEL intervention. The quantitative data highlighted that there was a statistical difference between the mean of the 2018 learner's scores (traditional face to face teaching) and the 2020 learners' scores that had experienced the TEL intervention of online quizzes throughout the course. A paired t-test was completed for the test scores incorporating both years (2018 and 2020) for the same cohort of learners to test the hypothesis in this research. The paired t-test demonstrated that a significant difference in the scores, $p = 0.011 < 0.05$. The null hypothesis was rejected for this paired t-test revealing that there was a statistical difference between the learner's performance scores from 2018 and 2020. Thus, the statistical evidence strongly indicates that the TEL learning method of online quizzes had a significant impact on the learners final FAR scores. To ensure balance to this research, qualitative data was also collated in the form of 6 semi-structured interviews with the learners. This qualitative data was thematically analysed to gain insight into the learners' experience of the technological intervention, to determine if the technology truly provided a positive learning experience and opportunity for the learner. The learners experience and opinion of the TEL intervention was that they found it to be extremely positive and improved their engagement with the course material, which benefited the learning experience in an innovative manner. They reported it both enhanced their learning experience and they recommended that it be retained for

future FAR courses. These findings are in line with the academic literature in this area. The online quizzes should be used going forward on future FAR courses and the findings compared.

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List of Abbreviations

BERA	British Educational Research Association
CK	Content Knowledge
CRS	Classroom Response System
DES	Department of Education and Skills
FAR	First Aid Responder
HSA	Health and Safety Authority
HEA	Higher Education Academy
ICT	Information Communication Technology
LYIT	Letterkenny Institute of Technology
NUIG	National University of Ireland Galway
OECD	Organisation for Economic Co-operation and Development
PHECC	Pre-hospital Emergency Care Council
PK	Pedagogical Knowledge
SAMR	Substitution Augmentation Modification Redefinition
TEL	Technology Enhanced Learning
TK	Technological Knowledge
TPACK	Technological Pedagogical and Content Knowledge
TPACKE	Technological Pedagogical and Content Knowledge Experience
TSPACK	Technological Space Pedagogical and Content Knowledge
VLE	Virtual Learning Environment

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Section One: Rationale and Introduction

1.1. Overview

In these ever-changing times in teaching and learning, Technology Enhanced Learning (TEL) has become more common and relevant as a means of potentially enhancing the learners learning experience. The Department of Education and Skills (DES) are promoting a much greater use of information technology in the education sector as outlined in their digital strategy for the education sector.

Until now TEL has only facilitated and progressed learning and teaching in unseen online models and has not been used on face to face FAR courses previously. TEL learning should be embraced not as another pedagogical method greatly enhancing a learners' learning experience. Traditional face to face delivery needs to be further examined as to how TEL can enhance this mode of teaching as there are potential benefits to be gained for all involved – tutor and learner alike – after embracing this process. Casanova and Moreira (2018) argue in their research that TEL should be used as a counterpart to face to face learning and teaching. Facilitation of the shift from established methods of traditional face to face learning and teaching to the use of TEL also needs to evaluated.

The primary aim of this study is to extend current research in this field by examining and evaluating how TEL can complement, strengthen and at times even replace traditional face to face delivery in a First Aid Responder (FAR) course. The researcher's aim was to discover to what degree the introduction of TEL into a FAR course affected learners' performance scores. Furthermore, to ensure a complete picture of the impact of employing a TEL intervention on traditional face to face led courses it is vital that a thorough examination be carried out to ascertain the learner's perception of their TEL learning experience.

1.2. Rationale

Traditionally, FAR courses have been taught using PowerPoint presentations, video and practical's with an assessment at the end of the course. These TEL interventions had not previously been employed on FAR courses. The researcher, an experienced tutor, anticipated

correctly, that by adding the TEL intervention - online quizzes, to a traditionally delivered course such as this FAR course, that there would be noticeable benefits for participants – thus enhancing their learning experience resulting in measurable improvements in their overall performance.

The TEL intervention also enabled the learners to partake in the course in a more interactive and engaging manner. Personally, as a tutor, continuously striving to improve established pedagogical methods and offer learners newer methods to enhance their learning was what inspired this research paper. Previous to this paper, at the end of each FAR course feedback on the course was gathered from the participants with the aim of improving future courses. This study broadened this continuous improvement approach and had the added advantage of ensuring learners had the most up-to-date and innovative method of learning FAR. It also provided the opportunity to not only employ but also validate use of a new TEL intervention and obtain detailed feedback from learners on how FAR courses could be further improved. In research conducted by Wilkinson and Barter (2016, pp.20–21) they argue that TEL can add "value to the learner experience", "a positive effect on student achievement" and "a method of engaging students in the learning process".

The use of online quizzes and classroom response systems is increasing across all levels and types of education and this paper's findings underline how important incorporating these pedagogical tools into FAR courses are so that participants can also benefit from a more modern approach to their learning experience. Cook and Babon (2017) stated in their research that online quizzes can be an effective mechanism to incentivize learners learning. In this study learners were provided with online quizzes at the end of each module which kept the participants focused and engaged with the course material from start to finish. The learners did not see the online quizzes as work, quite the opposite, they found them engaging, and an enjoyable break from the traditional pedagogical methods. These views are supported later by findings in the literature on TEL learning experience.

This study evaluated the use of online quizzes as a TEL intervention, to introduce a straightforward and entertaining intervention to complement face-to-face learning. The intervention had no obvious adverse effects for the learner as the quizzes had no weighting from a test score point of view. This ensured a more relaxed atmosphere particularly those learners new to this technology. The online quizzes were presented in a game show style

software with graphics, memes, music and leader board to ensure they were engaging for the learner to use. After searching through, and examining the available academic literature in the use of online quizzes as a TEL intervention in tutoring FAR courses, no comprehensive research into this niche area was found. This became another aim of this research - to bridge this gap literature in this sparsely researched field.

1.3. Introduction to the research design

The methodology for this study was quasi-experimental, to ascertain if Technology Enhanced Learning (TEL) enhanced the traditional face to face delivery in a First Aid Responder (FAR) course, with regards to learner's performance and perception of the learning experience. The research used learners that had completed the FAR course in 2018 and exactly the same learners again in 2020 allowing a 2-year time lapsed comparison of the learners' performance scores before (2018) and after (2020) to determine the affect if any of using TEL of online quizzes versus traditional face to face tutoring methods(Kirkwood and Price 2014; Mahon *et al.* 2018). In 2018 the learners were taught using only traditional face to face teaching and then in 2020 the same group of leaners had access to online quizzes for each module throughout the FAR course. This study was conducted with learners comprising of the staff from XXXXXX.

The study employed a mixed method approach of both qualitative data and quantitative data. The qualitative date was collated using semi-structured interviews to ascertain the learners experience and opinions of TEL through various themes. The quantitative data analysed the learner's performance scores from 2018 and 2020 by means of t-tests and Cohen's d effect size. The research proposal was submitted to the Letterkenny Institute of Technology Research Ethics Committee for approval.

1.4. Organisation of the Thesis

Section One Rationale and Introduction: outlines a comprehensive introduction to the research, rationale for this research, introduction to the research design and the thesis structure.

Section Two Literature Review and Critique: reviews and critiques the available literature surrounding technology enhanced learning (TEL). The primary focus being to evaluate the challenges, benefits and efficacy of applying a TEL intervention into a course from the learners' experience and performance. This section also investigates and critiques the concept of, TEL, classroom response systems (CRS), TEL design and theory, highlighting gaps in the literature with regard to evaluating the learners experience of using TEL on a first aid responder (FAR) course.

Section Three Implementation and Evaluation: presents the research methodology adopted in this study, a description of the research participants and site selection, the researcher's philosophy and an overview of the research techniques and procedures, inclusive of the data collection methods and analysis. The research findings are clearly outlined, with thorough analysis of the study results. The findings are also discussed with reference to related studies in this area from the academic literature. This section is then concluded with a summary of the main research findings.

Section Four Conclusion: summarizes the conclusion of the findings from this research. The limitations of the study are also outlined and recommendations for future studies in this area are presented.

Section Two: Literature Review and Critique

2.1. Introduction

This section of the research presents the literature review and critique. The approach taken for this literature review was to use a "concept matrix" modified from Webster and Watson (2002, p.5) to provide a framework to review the pertinent literature in this research area. By using this approach, the researcher can "make the transition from author- to concept-centric" as outlined by Webster and Watson (2002, p.5). In following this process specific themes began to emerge in relation to Technology Enhanced Learning (TEL). The literature review will discuss and critique the following emergent themes: what is meant by Technology Enhanced Learning, Technology Enhanced Learning Design including models and theory relating to same, Technology Enhanced Learning Evaluation including Classroom Response Systems (CRS) and the strengths and weaknesses of CRS. See Figure 2.1 for structure of the literature review.

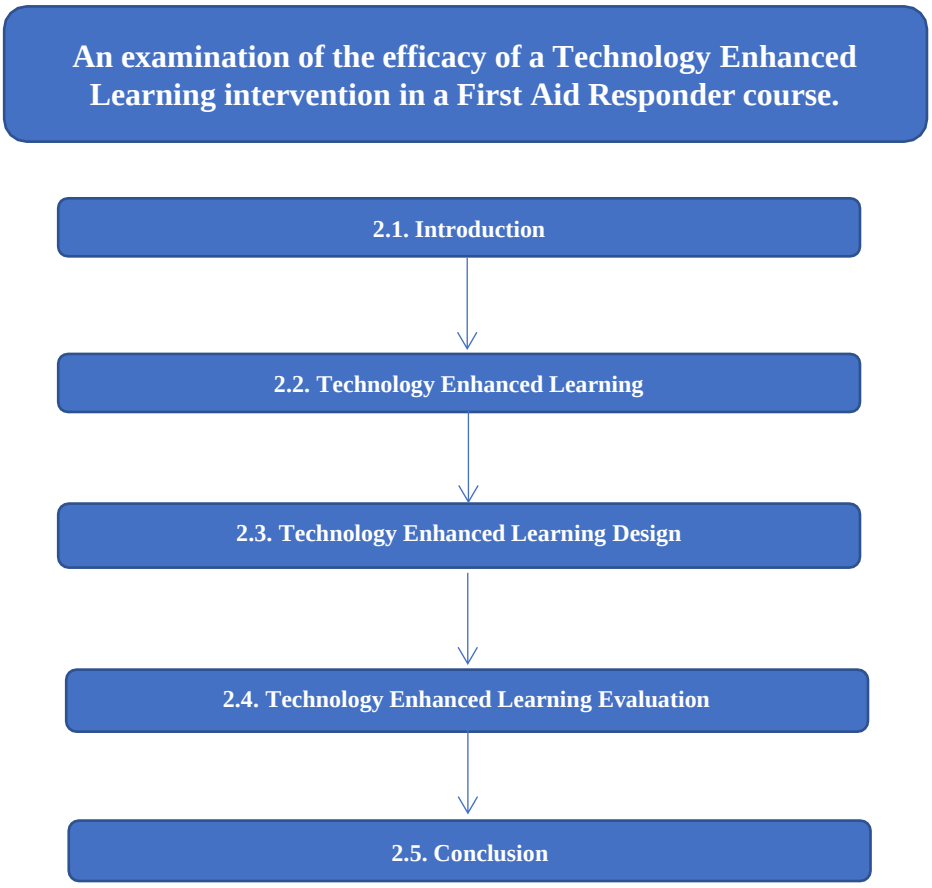

Figure 2.1. Structure of the Literature Review

2.2. Technology Enhanced Learning

Technology is omnipresent and an integral part of our daily lives. Technological devices can be found in every home and in particular learners interact more and more with technology, from an ever younger age (Avvisati and OECD 2015). There are very few tasks that do not have a digital aspect to them and teaching and learning is no exception. The use of Technology Enhanced Learning (TEL) in the education sector has been adopted at all levels, from primary level right up to higher education levels (DES 2015; Dunn and Kennedy 2019). The Higher Education Academy (HEA) (2019) describes TEL as

"a synonym for e-learning but can also be used to refer to technology enhanced classrooms and learning with technology, rather than just through technology."

(HEA 2019)

Kirkwood and Price (2014) report that they discovered through their detailed research of academic literature based on TEL, that a conclusive definition for TEL is not very forthcoming This is a view supported by more recent research conducted by Bayne (2015) and Alexander *et al.* (2019). Savage and Barnett (2017, p.9) concur on this point, that a definitive definition for TEL is lacking in the literature and they state that "there is no universally agreed-upon definition of what falls under the heading of learning technology".

However, in research conducted by Daniela *et al.* (2018, p.5) they define TEL as a "term to denote a teaching and learning process where technologies and technological solutions are used for the provision, enhancement and support of an engaging learning context". Daniela *et al.* (2018) see it as a process and supporting mechanism for engaging teaching and learning as opposed to HEA (2019) defining it as learning with technology. Cushion and Townsend (2019) describe TEL as being the interface between technology and teaching. A recent study by Alexander *et al.* (2019, p.1) defines TEL as "any system that directly supports learning and teaching" which is somewhat similar to Cushion and Townsend (2019).

According to Kirkwood and Price (2014, p.1) TEL is defined as "the application of information and communication technologies (ICT) to teaching and learning". For the purposes of this research this definition outlined by Kirkwood and Price (2014) will be used throughout the study.

However, there are dissenting voices on the application of TEL in education as outlined by Goodchild and Speed (2019). In research conducted by Goodchild and Speed (2019) they argue that there is a lack of systematic evidence to propagate the notion that TEL can enhance learning.

This is countered by the value placed on TEL by the educational sector. It is clear that TEL is an important approach to learning and teaching, as the Department of Education and Skills (DES) (2015) has clearly outlined in their current five year Digital Strategy for Schools (2015-2020) that TEL should play an integral part in learning and teaching. Learners also expect in this digital age that TEL be an integral component of the courses that they participate in as it is now a daily part of how they interact with the world (Bogusevschi *et al.* 2019).

The learning experience can potentially benefit from adapting new and innovative technology (Alexander *et al.* 2019). However, the adaption of technology to enhance a learner's experience must have sound reasoning and application. Kirkwood and Price (2014) state that by adopting TEL it provide three potential outcomes: replicates, supplements existing teaching practices or transforms teaching.

The goal for any facilitator of teaching and learning should therefore be to transform teaching practices for the learner and not just replicate current teaching practices when utilising TEL (Austen *et al.* 2016). If we only 'replicate' teaching practices, this does not add value to the students learning experience they are only receiving the same teaching practice via the medium of technology. Kirkwood and Price (2014) provide a word of warning to those adopting a TEL intervention that is not always clear to attribute causality as to what aspect provided the learning enhancement. Technology should be applied to teaching practices when it has the potential to improve the learner experience and performance and not just to have technology added for the tutors' benefit only. The leaners should be the prime beneficiary from the use of a TEL intervention. Gallagher *et al.* (2017, p.3) clearly outline in their study of TEL that "digital technologies offer great potential in terms of enhancing learning and teaching".

There are pedagogical advantages for the learners experience in adopting TEL interventions onto courses and this is supported by academic literature in this area (Zhang and Henderson

2015; Florenthal 2018). TEL interventions can provide the learner with timely formative feedback to optimise the learning experience and to highlight to the facilitator areas for focus or improvement (Nicol and Macfarlane-Dick 2006). Nicol (2007) states that TEL enables the learner to have a more flexible learning experience and to partake in learning on their own terms. TEL has the potential to transform classroom interactions for those learners that may not previously have had a voice. In line with this Mahon *et al.* (2018) posits that TEL now provides another platform or mechanism for classroom interaction between facilitator and learner.

2.3. Technology Enhanced Learning Design

Laurillard *et al.* (2018) highlight in their study that tutors should be seen as learning designers and that there should be shared experience of TEL applications in the educational sector leading to innovative TEL designers. Bogusevschi *et al.* (2019) also believe that tutors should be encouraged to design for learning when employing innovative TEL approaches to learning and teaching. To achieve this goal of innovative TEL designers we need to look at frameworks and models that can guide tutors in the learning design process (Laurillard *et al.* 2018).

According to Hilton (2016) technology should be embedded in the teaching practice or pedagogy of a lesson from the outset, technology should not be an add on or afterthought (Harris *et al.* 2009). The framework of Technological Pedagogical and Content Knowledge (TPACK) provides a solution to this requirement of embedding technology within the pedagogy of a course. This framework was proposed by Shulman (1986) and was further developed by Mishra and Koehler (2006) to TPACK. See Figure 2.2 for TPACK Framework.

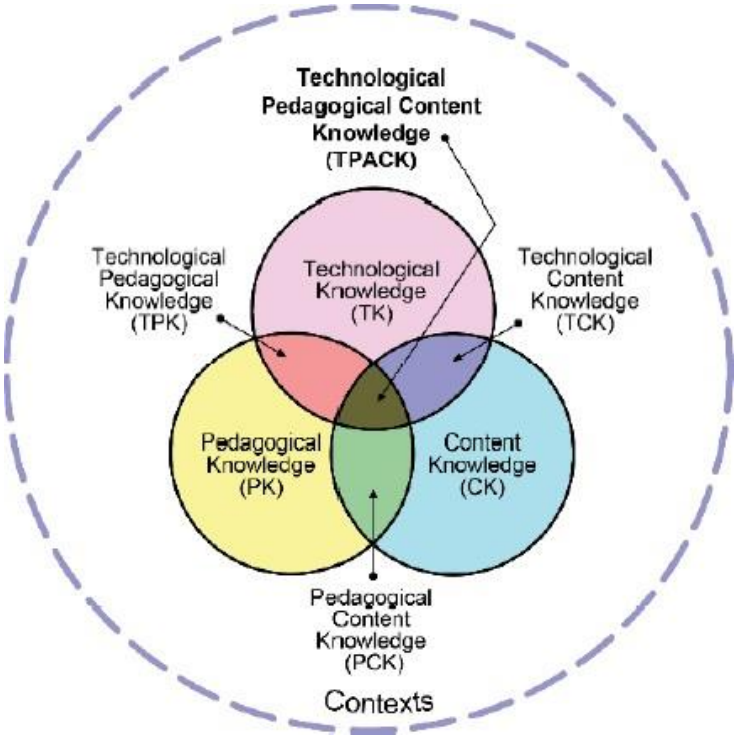

Figure 2.2. TPACK Framework

Source: (Hallissy 2017, p.20)

To ensure success when applying technological interventions onto a course, the tutor must have a combination of all three parts or knowledges as outlined in the framework. Hallissy (2017) argues that the facilitator of the learning must have knowledge of the technology they are applying Technological Knowledge (TK), know their subject area or Content Knowledge (CK) and a sound teaching practice or Pedagogical Knowledge (PK). Where these three concepts of the framework intersect the facilitator then attains what Hallissy (2017) describes as Technological Pedagogical Content Knowledge or TPACK (Hilton 2016). A weakness with the TPACK framework argued by Hilton (2016, p.72) is the "disconnect between the TPACK theory and the realities of technology integration". For example in the research on this area conducted by Hilton (2016, p.72) they state that tutors found that issues surrounding "technical difficulties" "often drew them out of TPACK and into technological knowledge (TK)". According to Hilton (2016, p.72) the TPACK framework can often be seen as a "closed space" between the tutor and the learner which is not always the case. There will be external factors such as technological support and institutional guidelines that need to be satisfied before innovative technological integration can be supported fully (Harris *et al.* 2009; Hilton 2016). In this research conducted by Hilton another potential weakness with TPACK is that is focused

on the tutor as opposed to the learner. Hilton (2016) states that it is more traditional i.e. tutor centred in its approach to the use of technological interventions.

A recent study by Adams (2019) indicates that there can be other barriers to the successful implementation of the TPACK framework such as financial constraints restricting access for tutors who are willing to embrace technological change and enhancement. Adams (2019) suggests that these can be overcome by adopting inexpensive and user-friendly technological innovations. Austen et al. (2016) state that pedagogy and learner satisfaction or experience should be the top priority when employing TEL into educational settings.

Arce-Trigatti *et al.* (2019) argue that there should be a fourth dimension to the TPACK model which is Space or the learning environment that is TSPACK. They recommend that as well as the three original components (Technology, Pedagogy and Content Knowledge) an innovative learning space should be provided to facilitate active learning for the learner. The learning environment or space should be considered as part of a revised framework.

In a study conducted by Wang (2019) the TPACK framework can be supported by learners using their mobile phones to access and facilitate learning for 'new age learners' and facilitate learning on their terms. Wang (2019) argues that this can have a positive contribution to the learners education (Arokiasamy 2017). According to Hilton (2016, p.73) the TPACK framework and the Substitution Augmentation Modification and Redefinition (SAMR) model can complement one another and "present an opportunity to plan for future technology integration that make the best use of emerging technology".

Puentedura (2013) developed the SAMR model. See Figure 2.3 (The SAMR Model enhancing technology integration). The aim of the SAMR model is to facilitate tutors to integrate technology into their teaching practices (Hamilton *et al.* 2016; Hilton 2016; Netolicka and Simonova 2017). The structure of the SAMR model has four tasks or levels: Substitution, Augmentation, Modification and Redefinition (Hilton 2016). Puentedura (2013) defines each task as follows: in substitution you obtain a "direct tool substitute" that is no "functional change" occurs. Above this in the model is Augmentation, where Puentedura (2013) describes this task as "functional improvement". The Substitution and Augmentation tasks are grouped together by Puentedura (2013) under the umbrella term of Enhancement of learning. Hilton (2016, p.69) defines enhancement "as leverage technology to replace and/or improve existing

tools in the learning task". In this model the next step is modification and Puentedura (2013) states that this is where "technology allows for significant task redesign". The final level is redefinition which according to Puentedura (2013) is where the technology facilitates the development of new tasks that could not be accomplished without technology. Both modification and redefinition are grouped together under the umbrella term 'Transformation'. According to Kirkland (2014) this 'transformation' provides a new technique for learning that could not have been conceived or even possible without this new technological intervention.

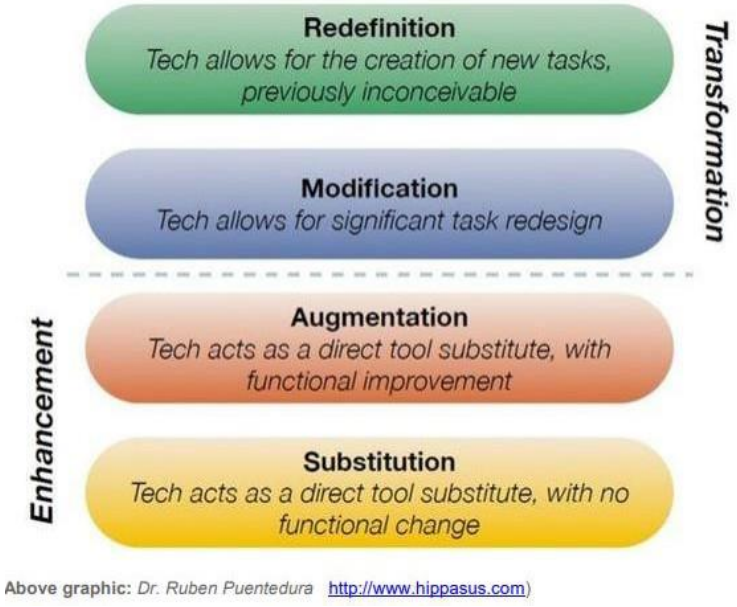

Figure 2.3. The SAMR Model enhancing technology integration

Source: (Puentedura 2013)

Hilton (2016) argues that the SAMR model is more learner centered in its approach to learning and places the learner as the primary subject which is contrast to TPACK, which focuses more on the tutor.

2.4. Technology Enhanced Learning Evaluation

Classroom Response Systems (CRS) are technologies which facilitate learners to participate in course questioning by means of portable digital device such as a mobile phone or clicker response device. Mahon *et al.* (2018) highlighted in their study that classroom questioning is advantageous for the tutor and the learner (Race 2007; Gibbs 2010; Jennings 2012). By utilising

CRS's, tutors are able to engage and connect with their learners by this additional means to further improve their learning experience (Wu *et al.* 2019).

A recent study conducted by Mahon *et al.* (2018) states that by employing CRS technology it can be beneficial to learning, and can foster psychological safety due to the alias function available to the learner to maintain their privacy should they so wish (Florenthal 2018). Mahon *et al.* (2018) also argues that it improves classroom interaction.

According to research by Lea *et al.* (2003) quizzes facilitates active learning which increases learner engagement during courses and has the knock on effect of improving the performance of learners (Dallat 2009; Ivanović *et al.* 2018). Academic literature in this area (Dallat 2009; Ivanović *et al.* 2018) states that TEL interventions such as this facilitate student centred learning (Lea *et al.* 2003). This again supports the beneficial aspects of employing CRS's. It is highlighted by Dallat (2009) that TEL can the potentially improve learner motivation (Hallissy 2017).

Academic literature lauds formative feedback as a valuable means of improving a learners performance and experience which is achieved by employing CRS, that is online quizzes in this instance (Black and Wiliam 2003; Kelly 2005; Nicol and Macfarlane-Dick 2006; Malau-Aduli *et al.* 2014; Zhang and Henderson 2015; Lull and Mathews 2016; Florenthal 2018; Mahon *et al.* 2018; Lyng and Kelleher 2019). It facilitates learners with a mechanism for assessing their own learning performance in real time as they progress through their FAR course. They do not have to wait until a course is completed and traditional performance scores in the form of summative assessment are collated by the tutor long after they have completed their learning experience. They can track and manage their learning and it provides an on the spot opportunity to focus on knowledge gaps for both the learner and tutor alike. The benefits or strengths associated with CRS have been outlined and the challenges which will now be evaluated in the following section.

Classroom Response Systems have a place in the learning experience however the researcher has to acknowledge that they do not come without their challenges when applied to a course. This section will address these challenges to provide balance to the discussion which has already highlighted their beneficial attributes.

Nicol (2007, p.53) states that “e-assessments” are limited as they facilitate the memorizing or rote learning of course material instead of activating higher order thinking in learners due to the multiple choice design of the questioning system. Damotharan *et al.* (2017) suggest that this positions CRS’s at the recall end of the Blooms taxonomy which is at the lowest end. However, Nicol (2007, p.54) is of the opinion that this limitation can be resolved by designing questions that “can be used to evaluate learning at higher cognitive levels”.

Wu *et al.* (2019) argue that connectivity for example internet availability, when using TEL could be a particular obstacle to be overcome to ensure successful implementation of TEL.

In recent research conducted by Mahon *et al.* (2018) they outlined that digital literacy of both the learner and tutor could present a challenge when employing TEL.

Constructive alignment of the CRS with the pedagogical content is an important factor when developing a TEL intervention (Lyng and Kelleher 2019; Wu *et al.* 2019). This constructive alignment ensures that the learning experience is pertinent to the course requirements and learning objectives for the learner.

A recent study by Kadry and Roufayel (2017) suggests that mobile phones could be a disruptive influence when used by learners for CRS engagement. Florenthal (2018, p.44) also concurs with this point stating that the use of mobile devices for use as response system can be a “distraction”. However, the researcher feels that this is a minor issue once learners are made aware of the confines in which mobile phones are to be used from the beginning of the course. They are a learning tool. This was made clear to all participants and did not cause any major concerns or disruptions during the piloting or testing phase of the software and actual research.

This section clearly demonstrates that challenges can arise from the use of CRS’s on courses. However, these challenges can be negated or overcome with appropriate technological knowledge (TK) being applied by the tutor and sound pedagogical planning.

2.5. Conclusion

This chapter of the research has described TEL and framed it in relation to the models of TPACK and SAMR, critiquing both models in relation to the integration of TEL interventions

into educational courses. The researcher has also clearly ascribed the definition of TEL that will be adhered to for this study which has been adapted from Kirkwood and Prices (2014, p.1) definition “the application of information and communication technologies (ICT) to teaching and learning”. The definition of TEL to be adopted is clearly outlined in this research. This is a clear recommendation made by Kirkwood and Price (2014) for any future studies of TEL such as this, that the researcher be clear as to the definition of TEL being followed. The strengths and weaknesses of Classroom Response Systems (CRS) were examined with reference to recent research and studies conducted in this area.

The next section will address the implementation and evaluation of the research. The following areas will be described and covered: research question and objectives, research, methodology, research ethics and evaluation of the data.

Section Three: Implementation and Evaluation

3.1. Introduction

This section of the research outlines the proposed methodology adopted, demonstrating the implementation and evaluation processes. The following areas with regards to the research are addressed: research question and objectives, research methodology (research philosophy and approach, research strategy and site selection), participant selection, time horizon, technique and procedure (quantitative and qualitative data collection and analysis) reliability and validity, Research ethics, evaluation (research findings and results, data analysis and conclusion) will also be addressed. All of the above are supported by appropriate academic research literature. See Figure 3.1 for structure of this implementation and evaluation section, which depicts the organisation of the following section.

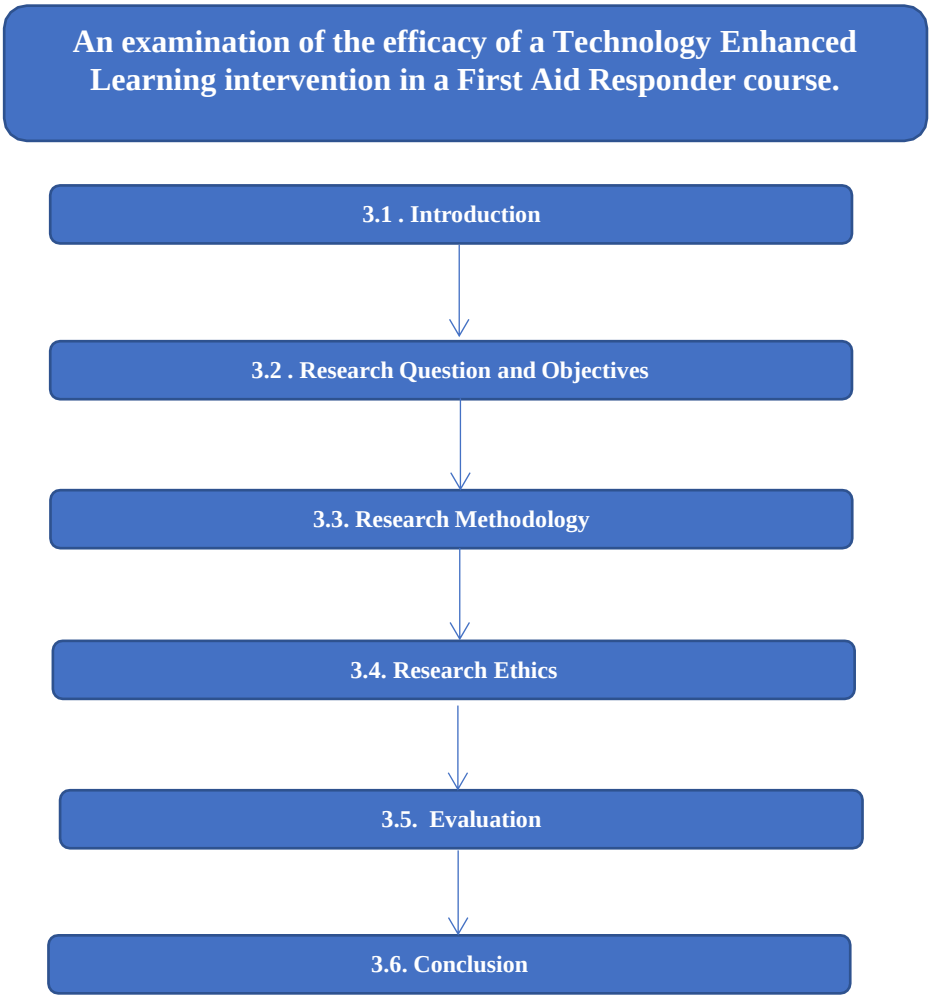

Figure 3.1. Structure of the Implementation and Evaluation

The aim of this piece of research is to answer the following research question:
'How does Technology Enhanced Learning (TEL) enhance the traditional face to face delivery in a First Aid Responder (FAR) course, with regards to learner's performance and perception of the learning experience?'

This main research question poses three further sub-research questions that were also investigated and answered through this research:

Sub-research Questions

1. Is there a difference in the learner's performance scores between traditional face to face delivery and technology enhanced delivery?
2. What were the opinions of the learners in relation to their Technology Enhanced Learning (TEL) experience?
3. How can TEL support future delivery of First Aid Responder courses?

This in turn leads to the following research objectives:
Research Objectives

1. To critically review academic literature in relation to the efficacy of Technology Enhanced Learning (TEL).
2. To evaluate the impact of TEL on learner score performance.
3. To analyse the effectiveness of TEL in enhancing the learning experience.

3.2. Research Methodology

3.2.1. Research Philosophy and Approach

The research onion presented by Thornhill *et al.* (2009) was adopted by the researcher to both position and develop the research path. See Figure 3.2 below, titled The Research Onion.

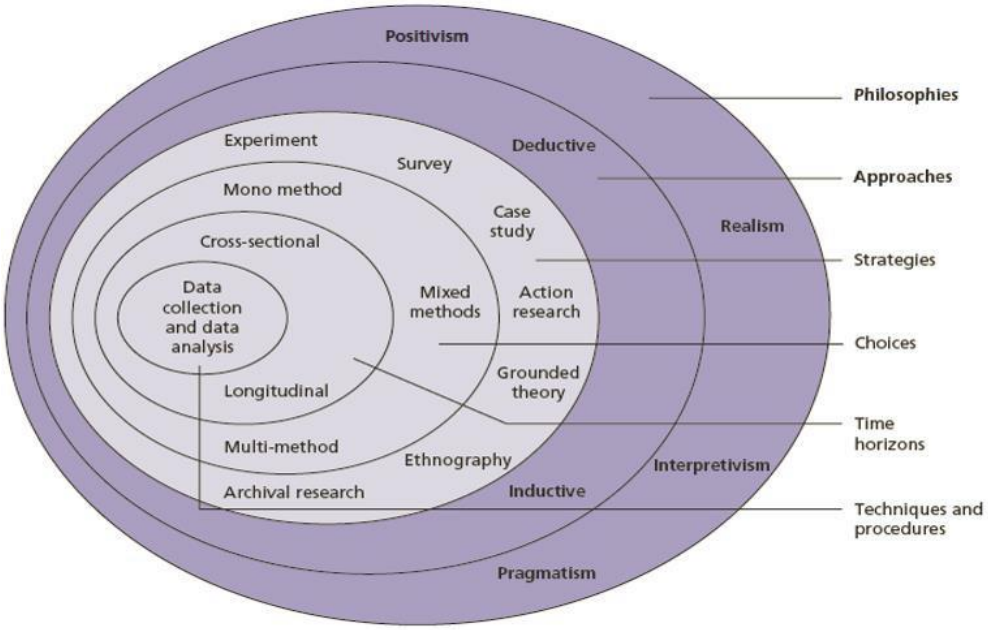

Figure 3.2. The Research Onion

Source: Thornhill et al. (2009, p.108)

The research philosophy for this study can be described as "Pragmatism" as the research question has been drawn from two opposing philosophies (Thornhill *et al.* 2009). For the quantitative part of the research question the research philosophy is "Positivism" and the qualitative part it is "Interpretivism". Thornhill *et al.* (2009, p.109) states that the pragmatic approach and adoption of "mixed methods are highly appropriate within one study". Interpretivism is also commonly referred to as "Constructivism" (Robson 2002) and the qualitative section of this mixed methods research have been adopted as this is a common approach when conducting learning and teaching research according to Maguire and Delahunt (2017). The pragmatic research philosophy followed in this research aligns the approach to a deductive approach according to Flyvbjerg (2006; Thornhill *et al.* 2009).

3.2.2. Research Strategy

Table 3.1 below provides an overview of the research alignment for the research questions, objectives and methods for this research proposal.

<table>
<tr><th colspan="4">Title: An examination of the efficacy of a Technology Enhanced Learning intervention in a First Aid Responder course.</th></tr>
<tr><th>Research Question</th><th>Research Sub-questions</th><th>Research Objectives</th><th>Methods</th></tr>
<tr><td rowspan="4">How does Technology Enhanced Learning (TEL) enhance the traditional face to face delivery in a First Aid Responder (FAR) course, with regards to learner's performance and perception of the learning experience?</td><td></td><td>To critically review academic literature in relation to the efficacy of Technology Enhanced Learning (TEL).</td><td>Literature Review using a concept matrix.</td></tr>
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<tr><td>How can TEL support future delivery of First Aid Responder courses?</td></tr>
</table>

Table 3.1. Research Alignment

3.2.3. Research Design

The researcher investigated how the TEL intervention on online quizzes (Quizizz software) adheres to the SAMR model prescribed by Puentedura (2013). The researcher populated Figure 3.3 from information gleaned from Online Tools (2019) to demonstrate how this intervention aligns with the tasks and groupings of the SAMR model. When the SAMR model is applied to this TEL intervention of online quizzes, the learners experience should be enhanced. Kadry and Roufayel (2017) are of the opinion that this will also transform the learning experiences of learners. The researcher believes that this will have a positive impact on the learner's overall performance as a result. See Figure 3.3 How online quizzes (Quizizz) fit within the SAMR Model.

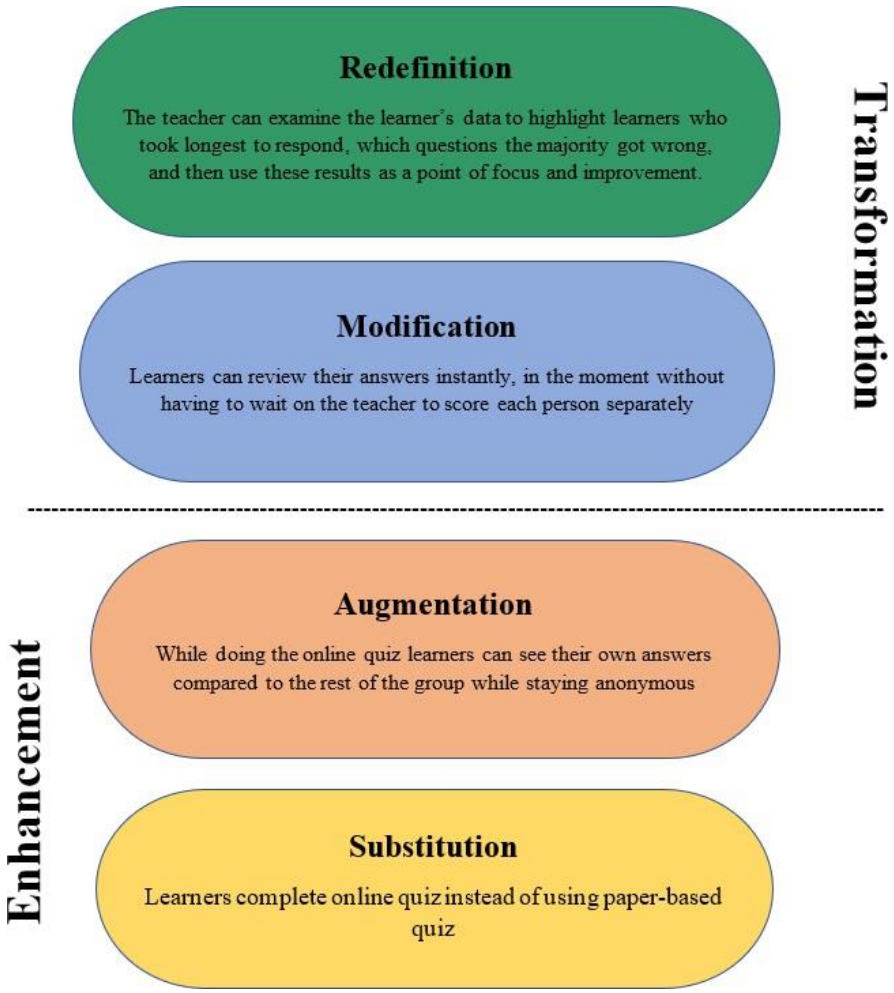

Figure 3.3. How online quizzes (Quizizz) fit within the SAMR Model

Information Source: (OnLine Tools 2019)

This research will utilise online quizzes as a Classroom Response System (CRS) facilitated by the tutor's computer and learners' mobile devices. The software that will support this technological intervention is called Quizizz. This software allows the tutor great flexibility to develop questions with images, video and audio. The software allows for easy interaction between both parties, that is the learner and the tutor. The software has an element of competition as it is hosted in the manner of game show with leader-board, memes and time limits set for each question. This offers an element of fun to the learning. This can all be controlled and prescribed by the tutor. The learner is also able to maintain privacy if they so wish by providing a team name or aliases. The software provides immediate feedback to both the learner and the tutor. This allows the tutor to focus on any areas that learners are finding problematic and may require additional attention. The software also records the data for the tutor in Excel format once the quiz is complete (Quizizz 2019). This can be emailed to learners and stored for future reference by the tutor. See Appendix E, F and G demonstrating the Quizizz software and data outputs.

3.2.4. Site Selection

XXXXXX comprises of two campuses. A campus is located in XXXXXX and the other campus is located in XXXXXX in the county of XXXXXX. The Institute has over 4000 students and 400 staff providing a variety of disciplines and studies. The Institute has four Schools – Tourism, Business, Science and Engineering facilitating a vast array of courses. This study was conducted with staff from both campuses (XXXXXX and XXXXXX), and multiple departments within each of the Schools. The intervention was completed during the FAR courses and the facilities in RM3404 – (Nursing Skills Laboratory in XXXXXX campus) and TB108 (Tourism Building in XXXXXX campus) were used. Participants were familiar with these facilities having completed studies inthese rooms for previous courses.

3.2.5. Connectivity

In rural Ireland connectivity could provide an issue in less well-connected areas. The researcher found in the scope of this study connectivity did not pose any major difficulties as both research

sites had piloted the TEL intervention prior to the study taking place without any difficulties arising. However, during the actual research process, some connectivity issues arose which will be discussed in the qualitative findings of this research.

3.2.6. Participant Profile and Selection

There were 18 staff that participated in this study. These learners had already completed traditional face to face first aid responder courses previously in 2018. The staff were a combination of administrative, technical, maintenance and academic staff giving a broad range of profiles from various functional areas and departments. As this research is cross sectional and had time constraints a population sample was selected from first aid responders' staff in XXXXXX (Thornhill *et al.* 2009). The researcher chose the participants for this study by means of non-probability sampling using purposive sampling (Thornhill *et al.* 2009). According to Thornhill *et al.* (2009, p.237) "purposive sampling" is also called "judgmental sampling" which can be best used "to answer your research question and meet your objectives". Thornhill *et al.* (2009) states that this method of sampling selection is often applied when small sample sizes such as this are utilized in research.

3.2.7. Time Horizon

The research was divided into four main sections as follows:
Section One: Rationale and Introduction
Section Two: Literature Review and Critique
Section Three: Implementation and Evaluation
Section Four: Conclusion
More than sufficient time was allocated for each section. There was an overlap of time in some of these sections for example the section two, by the very nature of this research with some sections being sequential such as the implementation and evaluation section three. See Table 3.2 displaying the timeline of the research events.

September 2019 - May 2020	Literature Review, Research Methodology.
December 2019	Research Proposal
December 2019	Ethics consent- Approval
January 2020	Information to participants & participant consent
February 2020	Utilising TEL intervention on courses & Quantitative data collection
March – April 2020	Conducting interviews Qualitative data collection
April 2020 – May 2020	Statistical analysis of data, Thematic Analysis of data, Findings, Discussions and Conclusions

Table 3.2. Research Time Horizon

3.2.8. Technique and Procedure

The design of the data gathering was sequential (Thornhill *et al.* 2009). The sequence for this data collection took place as follows, quantitative data was gathered first followed by the qualitative data. However, both types of data were prioritized with equal regard, that is the same weighting was afforded both (Creswell 2012). This was in order to answer the research question in its entirety and also the associated sub research questions. The data was collected and analysed in two distinct phases separately: learners' performance scores (quantitative) and learners experience of TEL (qualitative).

3.2.8.1. Quantitative Data Collection Method

The quantitative data for this research was collected as follows:

Eighteen participants of this particular research completed a first aid course in 2018 where traditional face to face methods were used and the learners achieved a score for their performance. The researcher had access to these records and then utilised them for the for this research with the prior consent of the participants. See Appendix A for consent form. Participants then completed the same assessments in February 2020 after employing the completed course with TEL intervention of the aforementioned online quizzes. The

quantitative data was gathered during three different First Aid Responder courses that were completed on the following dates:

- 6th of 7th of February 2020 (Number of participants = 5)
- 13th to 14th of February 2020 (Number of participants = 8)
- And 20th to 21st of February 2020 (Number of participants = 6)

These 2020 scores were then collated and each participant assigned a unique letter (A to R). Each participant was provided with this unique letter on consenting to be part of this research in order to protect their anonymity throughout the research.

3.2.8.2. Quantitative Data Analysis Technique

The quantitative data gathered for this research is classified as parametric data according to (Cohen *et al.* 2007; Thornhill *et al.* 2009; Creswell 2012). The mean scores of 2018 learners (traditional face to face teaching methods) and 2020 learners (after using TEL intervention of online quizzes) were statistically analysed using a paired t-test in Microsoft Excel to compare the scores and determine if there is any significant difference arising from these results (Thornhill *et al.* 2009).

It is important to note that the scores for 2018 and 2020 were gathered from the same cohort of learners to insure the variables in this research are related or dependent and therefore ensure the paired t-test was selected to analyse the data (Cohen *et al.* 2007). According to Cohen *et al.* (2007, pp.543–546) the paired t-test should be utilised when the same group of related participants are being "measured at two different points in time about the same variable" or "two occasions". Thornhill *et al.* (2009, p.451) recommend that paired t-test are "often used to test for changes over time" which aligns with the research being conducted for this study to analyse the changes that have taken place after a two year period after employing the TEL intervention. See Figure 3.4 outlining the chosen inferential statistics that were employed for this research.

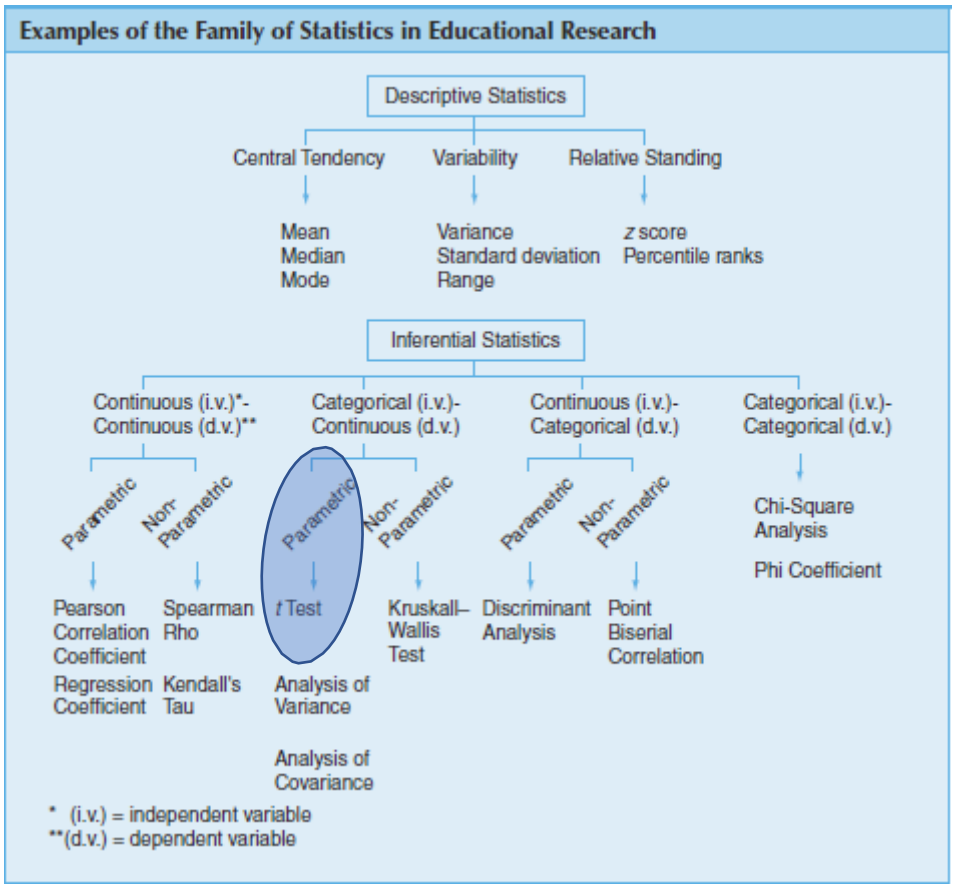

Figure 3.4. Examples of the Family of Statistics in Educational Research

Source: (Creswell 2012, p.183)

3.2.8.3. Qualitative Data Collection Method

The qualitative data was collated by interviewing six of the participants using a semi-structured interview. Each interview was given a set time limit of twenty minutes. The interviews were semi-structured interviews. Two participants were selected from each of the three courses to ensure that qualitative data was captured from each of the three First Aid Responder courses that experienced the TEL intervention. This ensured that each of the groups had input into the qualitative data gathered for this research. See Appendix B and C for copies of the participant information sheet and interview questions respectively. The amount of data collection of small samples fits with the philosophy of Interpretivism followed by the researcher according to Thornhill et al. (2009). This facilitated adequate time for the researcher to transcribe the data, to gather a manageable quantity of data and analyse same. This was decided upon as

constructivist researchers utilise interviews methods to obtain multiple viewpoints according to Robson (2002). It was important for this research to obtain the learners opinions regarding the technology enhanced learning intervention that was applied.

3.2.8.4. Qualitative Data Analysis Technique

The data was analysed using thematic analysis which is a valid approach (Braun and Clarke 2006; Bree and Gallagher 2016; Maguire and Delahunt 2017; Houghton and Houghton 2018). The data was coded using Microsoft Excel and a step by step approach of this process was adopted by the researcher to provide both transparency and validity (Bree and Gallagher 2016). According to Houghton and Houghton (2018) this step by step approach produces an audit trail to support the thematic analysis of qualitative data.

Braun and Clarke (2006) describe this process as having six phases. Phase one; familiarize yourself with your data according to Braun and Clarke (2006). This phase one was achieved by the researcher transcribing the interview data and then repeatedly reading of this data to form initial thoughts or ideas as recommended by Braun and Clarke (2006). Phase two; the thematic analysis involved generating initial codes as stated by Braun and Clarke (2006). This allowed the researcher to begin to order the interview data and prepare for phase three which was to discover emerging themes in the data (Braun and Clarke 2006; Bree and Gallagher 2016). After these phases the research progressed logically into phase four reviewing themes (Braun and Clarke 2006; Bree and Gallagher 2016) and phase five naming themes. Braun and Clarke (2006) argue that this process refines the themes. The final phase six in the process as categorized by Braun and Clarke (2006) was for the researcher to discuss and relate the themes back to the initial research question and academic literature. See Table 3.3 for Thematic Analysis Phases as presented by Braun and Clarke (2006) which helps clarify the framework adopted by the researcher in conjunction with the thematic analysis recommended by Bree and Gallagher (2016).

Each of the interviewees data was triangulated to ensure analysis was unbiased and common themes were developed from all six data sources (Bree and Gallagher 2016). As the data collection time was restricted the time horizon for this research was cross-sectional (Thornhill *et al.* 2009).

Phase Number	Phase Name	Description of Phase
1	**Familiarising yourself with your data**	Transcribing data (if necessary), reading and rereading the data, noting down initial ideas.
2	**Generating initial codes**	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3	**Searching for themes**	Collating codes into potential themes, gathering all data relevant to each potential theme.
4	**Reviewing themes**	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5	**Defining and naming themes**	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6	**Producing the report**	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Table 3.3. Thematic Analysis

Source: (Braun and Clarke 2006, p.35)

3.2.9. Reliability and Validity

A robust methodology needs to be both valid and reliable to give the research credence and weight. Ensuring validity and reliability forms the basis of all reputable and worthwhile research.

3.2.9.1. Validity

Cohen *et al.* (2007) states that when you use a multi-methods approach or mixed methods to research, you can utilise triangulation of the data gathered. According to Cohen *et al.* (Creswell 2012) from a reliability and validity point of view this triangulation is "powerful way of demonstrating validity". In order to remove any additional potential bias or issues surrounding

validity this research was based on research previously conducted in this area. For example; the interview questions developed for this study were adapted from questions obtained in the following academic literature and research into Technology Enhanced Learning (Kirkwood and Price 2014; Malau-Aduli *et al.* 2014; Fonseca *et al.* 2015; Mahon *et al.* 2018).

A pilot study was conducted with a number of first aid responders following ethical approval to test the online quizzes for usage and experience. The interview questions were also piloted to ensure that they are understood by the interviewees and they are also valid and reliable (Cohen *et al.* 2007). On completion of the interviews, the transcripts were collated, and the interviews were provided to the interviewees to ensure accuracy, which was maintained throughout the data collection process.

3.2.9.2. Reducing Bias

In order to minimise and reduce the bias effect, the data collected in this research was gathered in a both professional and scholarly manner (Creswell 2012). According to Cohen *et al.* (2007) to reduce bias there should be no power imbalance between the interviewer and the interviewee. This is the basis of this research. No power imbalance was possible as this research was completed with XXXXXX staff and non-students. The author also conducted qualitative semi-structured interviews for a previous master's research study and has employed the aforementioned learning from this process. To ensure that the scoring of learner's tests was unbiased by the researcher as examiner the PHECC approved examination A was used for all participants which has an examiner scoring and answer matrix (PHECC 2020).

3.2.10. Research Ethics

The following ethical issues were addressed by the researcher in this study: ethical approval from LYIT, consent, age, vulnerable adults, copyright and anonymity.

Ethical approval was sought by the researcher from the Letterkenny Institute of Technology Research Ethics Committee before any intervention or data collection took place. This research has adhered to all the requirements outlined by the Letterkenny Institute of Technology Research Ethics process.

The research was completed with adult learners for the sole reason of negate the effects of conducting research with learners under the age of eighteen. This removed the ethical requirement to have to obtain the consent of minors to participate in this study. The intervention was not completed with any vulnerable adults either.

Informed consent was obtained from all learners participating in this research and records of same are retained by the researcher (Cohen *et al.* 2007).

Lin (2007) states that the privacy of the learner and copyright issues are important ethical points to be addressed when utilizing instructional technology. The Technology Enhanced Learning software that was used by the researcher does not have any copyright issue as it is open to use. The quizzes were developed solely by the researcher for this study again negating any issues with copyright.

The privacy of all participants taking part in this study was adhered to throughout the research. Participants were instructed that they could use pseudo names when taking part in the online elements of research which provided them with anonymity throughout this research process. The data collected for each participant was also anonymized to afford protection to each participants privacy (Creswell 2012). In addition to this data was stored in password protected files and then stored on a secure server (Bree 2016). This ensures the participants confidentiality and privacy throughout the study for any data relating to them. This password was only available to the researcher and his supervisor as required.

3.3. Evaluation

This part of the research evaluates the data that has been gathered to address the research questions and sub-research questions posed by this study and to meet the research objectives as outlined. See Table 3.4 below highlighting the research objectives. The mixed methods approach adopted by the researcher provides a broader understanding of the study area by using these two differing approaches (Almalki 2016; Mekki *et al.* 2018). This enabled the researcher to determine not only if the TEL had an effect on learners score performances but to also obtain

their opinion on the TEL intervention to ascertain if they found it of value to their learning experience.

<table>
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<tr><td>(B.) What were the opinions of the learners in relation to their Technology Enhanced Learning (TEL) experience?</td><td rowspan="2">To analyse the effectiveness of TEL in enhancing the learning experience.</td><td rowspan="2">Qualitative Data Collection Semi-structured interviews</td></tr>
<tr><td>(C.) How can TEL support future delivery of First Aid Responder courses?</td></tr>
</table>

Table 3.4. Research Objectives

The data was gathered sequentially. Firstly, quantitative instance and then qualitative. In order to maintain this logical flow for the reader the data is presented and discussed in the same manner addressing each of the research sub-questions outlined in Table 3.4 above. The data was analysed in two distinct phases: learners' performance scores (quantitative) and learners experience of TEL (qualitative).

However, the data was not analysed alone, it was also cross-referenced where applicable, to ensure a thorough analysis of the data. The research findings outlined below highlight themes discussed in the aforementioned literature review. Subsequent to these findings, the results will be presented and discussed, outlining the main findings that emerged and their ensuing results.

3.3.1. Research Findings & Results

The aim of this research was to examine the efficacy of a TEL intervention in a First Aid Responder course. To achieve this aim, the statistical approach that was employed was paired t-tests to test the hypothesis in the research. In conjunction with this, semi-structured interviews were conducted to disseminate information on the learner's experience of the TEL intervention. This provided the researcher with data to address the research question and sub-research questions related to this research.

The quantitative data highlighted that there was a statistical difference between the mean of the 2018 learners scores (traditional face to face teaching) and the 2020 learners scores that had experienced the TEL intervention of online quizzes throughout the course. A paired t-test was completed for the test scores incorporating both years (2018 and 2020) for the same cohort of learners to test the hypothesis in this research. The null hypothesis was rejected for this paired t-test revealing that there was a statistical difference between the learner's performance scores from 2018 and 2020. This statistical finding reveals to the researcher that the use of the TEL intervention has had a significant effect on the learners scores for 2020**.**

In addition the Cohen's d test was conducted to ascertain the association of the effect size (Daniel 2017; Bakker *et al.* 2019). Bakker et al. (2019, p.2) state that the effect size "provides an assessment of the strength of findings that tests of statistical significance alone do not provide". It was found after completing the Cohen's d test that there was a medium to large effect size. According to Daniel (2017) when you have a large effect size it should be visible when you examine the raw data. The Cohen's d effect size was closer to the large effect size and so the effect size is visible in this study raw data. In research conducted by Cook *et al.* (2018) they state that the effect size can be a powerful tool to determine the applied importance of research findings.

The qualitative data was gathered to ascertain the learners experience of using the TEL interventions of online quizzes. The qualitative data supported the findings from the quantitative aspect of the study and provided greater detail that otherwise would not have been possible to obtain purely from the quantitative data. In summary, the learner's feedback on their experience was extremely positive and all participants highly recommended its use for future FAR courses. The learners felt it complemented and benefited their learning experience of the FAR course and would welcome its greater use FAR courses going forward. This concurs with findings in comparable research in this area completed by Mahon *et al.* (2018) and Alexander *et al.* (2019).

The qualitative data was consolidated and coded using a process developed by Bree and Gallagher (2016). Figure 3.5 depicts how the interview data for this research was analysed and coded using thematic analysis.

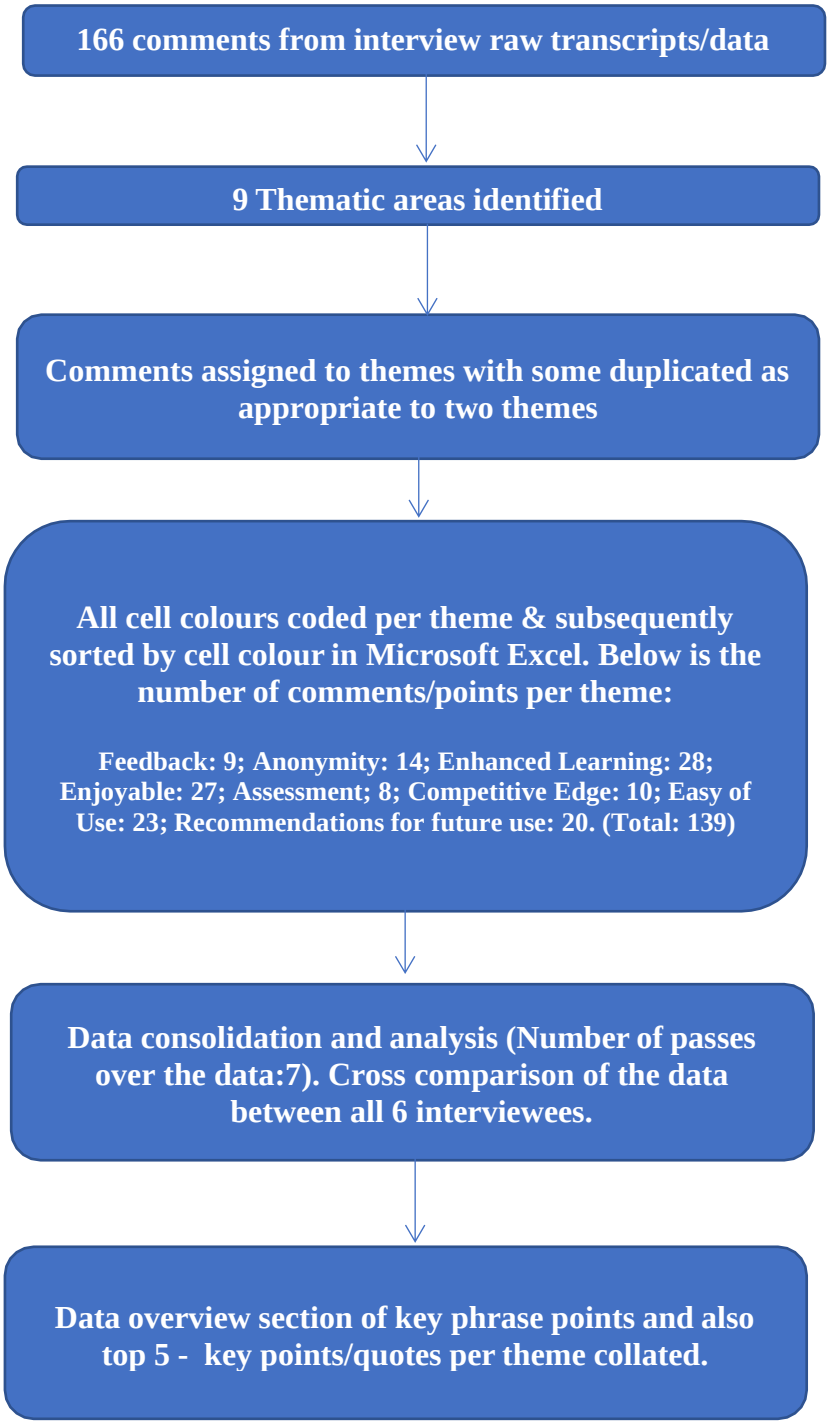

Figure 3.5. Schematic overview of the data consolidation process

Source: Adapted from Bree and Gallagher (2016)

Research Question and Objectives

3.3.2. Data Analysis

This section of the research outlines the results pertaining to each of the three sub-research questions. The findings for each sub-research question are discussed and analysed relating it back to relevant academic studies and literature in similar areas.

3.3.2.1. Sub-Research Question (A.)

(A.) Is there a difference in the learner's performance scores between traditional face to face delivery and technology enhanced delivery?

Results and Findings

The data relating to the learners from 2018 was collated along with the data for the same learners from the three First Aid Responder Courses completed on the following dates:

- 13th to 14th of February
- 20th to 21st of February
- 27th to 28th of February

The 2018 FAR course was completed using traditional pedagogical approach. The 2020 FAR courses had the TEL intervention of six online quizzes introduced into the FAR course. These quizzes were completed for six of the modules of the course. The online quizzes were conducted on the learner's own mobile phones by linking into the dedicated online quizzes that were created by the researcher for this study. Here is a list of the online quizzes that were developed and utilised in this study:

- FAR Module 1 – Patient Assessment
- FAR Module 2 – Incident Procedure
- FAR Module 3 – Cardiac First Response
- FAR Module 4 – Common Medical Emergencies
- FAR Module 5 – Injury Management and Shock
- FAR Module 6 – Care for an Unconscious Patient

These online quizzes took the form of multiple-choice questions which had time sensitive deadline of 30 seconds in which the learner could answer each question. This time element provided the participants with an extra element of competition and challenge against not just other participants but also against the clock too. The average number of questions per quiz was 6 questions with the largest quiz consisting of 10 questions and the smallest containing 4 questions. All of the questions related to the module the learners were taking at that particular part of the First Aid Responder course.

The mean scores for 2018 and 2020 were analysed using a paired t-test utilising the Excel software tool data analysis function. This was to ascertain if the means of the final scores of the 2018 learner scores and 2020 learner scores presented a significant difference. The researcher chose the paired t-test as the two sets of learners were the same participants for both years 2018 and 2020 and therefore they were dependent variables. The sample size for both sets of learners was the same n = 18.

Hypotheses:

H1$_0$. There was no significant difference in the scores between the 2018 learners (control group) and the 2020 learners (experimental group) in the FAR course: $\mu_0 = \mu_a$

H1$_a$. There was a significant difference in the scores between the 2018 learners (control group) and the 2020 learners (experimental group) in the FAR course: $\mu_0 \neq \mu_a$

The paired t-test see Table 3.5 Comparison of the 2018 and 2020 FAR Learner Scores, demonstrates that a significant difference in the scores, $p = 0.011 < 0.05$. This shows that the 0.05 level of significance the Null Hypothesis **H1$_0$** can be rejected. This indicates that a change has taken place and the TEL intervention introduced onto the 2020 course had an effect on the scores achieved by the learners. This is a significant finding and similar to findings as outlined by Alexander *et al.* (2019) and Delaram *et al.* (2017) in their research into comparable areas.

t-Test: Paired Two Sample for Means		
	FAR Scores 2020	***FAR Scores 2018***
Mean	18.94444444	17.72222222
Variance	1.937908497	2.918300654
Observations	18	18
Pearson Correlation	0.314689611	
Hypothesized Mean Difference	0	
Df	17	
t Stat	2.829114888	
P(T<=t) one-tail	0.005786652	
t Critical one-tail	1.739606726	
P(T<=t) two-tail	0.011573303	
t Critical two-tail	2.109815578	
Decision	**Reject Null Hypothesis**	

Table 3.5. Comparison of the 2018 and 2020 FAR Learner Scores

The researcher then conducted a Cohens d which provided a d = 0.788 which demonstrates a medium to large effect size of 0.8 which indicates to there is a strong association with the TEL intervention and the learners scores in the FAR course. See Table 3.6 for Cohen's d Effect Size calculation and results.

Cohen's *d* test: Effect Size			
	n	**Mean**	**Standard Dev.**
2018 Scores	18	17.72222222	1.708303443
2020 Scores	18	18.94444444	1.392087819
Mean Difference		1.222222222	
Pooled SD		1.550195631	
Cohen's *d*		0.788430955	
Small		0.2	
Medium		0.5	
Large		0.8	

Table 3.6. Cohen's d Effect Size

Thus, the statistical evidence indicates that the TEL learning method of online quizzes has had a significant impact on the learners final FAR scores. According to research by Kibble (2011) learners achieve higher on their summative assessments after completing quizzes such as these (Bouwmeester *et al.* 2013). This is also the case in this study and is confirmed by quantitative data. This is an extremely positive finding as the learners also had positive feedback while using the online quizzes during the course. This leads into the findings and results in the remaining sub-research questions B and C. The learners experience of using the TEL online quizzes will be addressed in the coming sections for each sub-research question.

3.3.2.2. Sub-Research Question (B.)

(B.) What were the opinions of the learners in relation to their Technology Enhanced Learning (TEL) experience?

Results and Findings

Learners TEL Experience

The participants that were interviewed were learners (B), (D), (E), (G), (O), and (R). These participants were interviewed to gather qualitative data on the learner's experience of TEL. The aim of this was to meet one of the research objectives and answer two of the research questions as outlined. A number of themes emerged having used thematic analysis and numerous passes over the data to sort and colour code based on the emergent themes. See Appendix I for colour code thematic analysis with main comments or quotes. Overall the feedback from all of participants interviewed was extremely positive, they found the online quizzes, enjoyable, easy to use, it enhanced their learning experience and that they would highly recommend their future use. This finding is supported by comparable studies in this area conducted recently by Shinde (2019) as she has also found a positive experience for learners engaging with TEL. This section will examine the learners experience and the next section will address the learner's recommendations for future use.

Easy to Use

All six of the learners (B), (D), (E), (G), (O), and (R) interviewed found the online quizzes "*very easy to use; nice interface; pretty cool actually; handy to log into, very easy to navigate; Instruction was good;* and *user friendly".* Ease of use for a the learner and the

tutor is an important attribute when introducing TEL onto a course which is confirmed by research in this area (Fonseca *et al.* 2015; Gallagher *et al.* 2016; Mahon *et al.* 2018; Shinde 2019). Learner (G) stated that *"you were looking forward to them"* which leads onto the next emerging theme enjoyable.

Enjoyable

This was a common theme that kept re-emerging throughout the interviews. Learners identified strongly with how enjoyable their TEL learning experience was *"grabs your attention; very engaging to look at, well displayed, enjoyable;* and *there was fun aspect to it"*. Learner (O) experienced the following *"you were learning at the same time, without realising"* and *"I think if you are enjoying something you do learn".* As a tutor this an ultimate goal for any learner to be enjoying the learning experience that they are learning without even realising. Learner enjoyment is also a factor outlined by other studies such as (Gallagher *et al.* 2016; Mahon *et al.* 2018). Alexander *et al.* (2019, p.10) also found in their research that learners "reported enjoying quizzes the most, and these were the most accessed resources". Learner (G) reported that *"it was kind of like playing a computer game"* again this is supported by findings on the benefits of game based learning experience to make it an enjoyable experience for learners (Boada *et al.* 2015; Ivanović *et al.* 2018; Aparicio *et al.* 2019). Schiefelbein *et al.* (2019) research argues that game based learning can support long term learner knowledge retention.

Enhanced Learning Experience

Kirkwood and Price (2014) highlighted in their research that determining if learning is enhanced when using TEL can sometimes be difficult to ascertain. However, in this research there was strong correlation and feedback from all leaners that they felt that it enhanced their learning experience. Learner (E) clearly states this, when she says it "*enhanced my learning".* A similar finding to Aksoy *et al.* (2019) on their research into this area, as the use of TEL can enhance the learning process (Angus and Watson 2009; Chan *et al.* 2015; Gallagher *et al.* 2016; Jaeger and Adair 2017). This view was also supported by the other participants that were interviewed as they outlined, for example Learner (O) *"by keeping you intrigued and you want to know more"*. This is also evident and supported by the learners' test scores and the preceding quantitative data gathered that the leaners learning test scores were enhanced.

Active learning was outlined by Learner (D) as a means to enhancing her learning experience *"It was active learning; it's not just passive learning, using the phone it's putting into action*

what you are learning"(Cook and Babon 2017; Wu *et al.* 2019). There is research completed on this area that has examined the effect of active learning and its potential benefits for learners in improving their learning experience (Lea *et al.* 2003; Dallat 2009; Fisher et al. 2016; Cheng *et al.* 2017; Ivanović *et al.* 2018; Wu *et al.* 2019). This supports the findings outlined by the learners during the interview process.

Anonymity

Learners were given the choice of remaining anonymous by using pseudonyms while using the online quizzes should they so wish. None of the participants choose to do this. The role of anonymity was not a major concern to any of the learners as they felt (D), (O) and (R) *"relaxed and comfortable"* in their course groups as they all knew each other as work colleagues and also the group sizes were small (5,6 and 8 learners per course group). However, all participants said that they would have preferred to use the anonymous function if they did not know the group or the group size was larger due to (R) and (G) *"if you got a few wrong you might be embarrassed"* due to the fact that the scores were on big screen displayed as a *"leader board".* A recent study conducted by Mahon *et al.* (2018) highlights that use of pseudonyms can foster psychological safety to the learner to maintain their privacy and can also benefit their learning (Florenthal 2018).

Competition

The leader board was also as a positive motivator on the learners as the majority of the learners reflected that it brought out their competitive edge. Learner (O) commented *"You were being competitive. You were trying to beat everyone. You put a lot into it. You give a 100%. It wasn't as if you were giving it 5% it will be fine. You had to give it a 100% to get through".* Where learner (G) remarked *"I enjoyed the competitive part of where I was trying to beat participant (E), she was winning all of them and I just wanted to win one of them".* While competition amongst learners can be beneficial for learning according to de Sousa (2018) competition needs to be carefully managed by tutors to ensure it does not become a negative experience for some overly competitive or students not used to losing. If this issue did arise the online quizzes could be easily adapted by placing learners into teams to avoid this individual pressure. Competition has learning benefits as outlined by research conducted by Theodoropoulos et al. (2017) where they state it has the potential to increase learning motivation. In research conducted by Chen (2019) peer competition was proven to outperform learning capacity of these groups compared with learners that had no competition element to their learning.

Digital Literacy

In recent research conducted by Mahon *et al.* (2018) they outlined that digital literacy of both the learner and tutor could present a challenge when employing TEL. The researcher overcame this by simply trialling the online quiz software with different cohorts of learners to become familiar with the software as a tutor. This also allowed the researcher to ascertain the learner's reaction to engaging with the software and highlight any potential stumbling blocks for the learner. The researcher determined that once learners were given clear step by step instructions and guidance on how to use and access the software, they were all able to participate and utilise the Classroom Response System (CRS) software. The researcher also found that learners were working on their own mobile phones to connect with the CRS software and so this familiarity of their own device provided a positive platform for the learner's engagement (Mahon *et al.* 2018). Some learners that would not have engaged with this type of technology previously for example Learner (E) stated *"I wouldn't be someone who would be that way inclined so I was surprised that I did like them. I am more a paper and pen sort of person rather than technology"*. This participant only got a smartphone this year and ended topping the leader board on most occasions in her course group. In developing this learners digital literacy it also provided an opportunity to improve her learning experience too as they gain new skills and enhance their confidence in using TEL (Gallagher *et al.* 2016).

Feedback

The theme of feedback was a common theme that was emphasised by the leaners interviewed. The learners had a positive appreciation for receiving (R) *"instant feedback, if you were wrong you got to see you were wrong right away"*(Carless and Boud 2018) and Learner (B) found that *"when you're in the classroom environment, you have to do it there and then – it's more likely to give a true reflection of how well you've learned the stuff"*(Lyng and Kelleher 2019). However, learner (R) who is from an academic background felt that while the "*instant feedback*" is beneficial they reported that they still feel that feedback of a more personal nature is required to explain to learners where they went wrong Learner (R) *"If I do an in-class test with them and they get stuff wrong, I sit down with them when I get the results and we go through where they went wrong, what's wrong. So you know, maybe the quiz, not so much feedback"*. Feedback should be timely and the online quizzes do facilitate immediate feedback for learners as outlined by Malau-Aduli *et al.* (2014, p.517) in their research found "for feedback to be effective, it must be timely" (Carless and Boud 2018). However, as indicated

by learner (R) the feedback was not 'personalised' in the classroom response system (Nicol 2007; Fisher et al. 2016; Carless and Boud 2018).

Another interesting finding highlighted by Learner (B) *"it allowed each person in the group to answer questions individually, rather than just asking a question of somebody – you know throwing the answer back to you".* This meant that you had full learner engagement and all learners had the chance to participate on the course. This concurs with research conducted by Hoekstra (2015) as they state that classroom response systems facilitate a platform for promoting learner engagement and participation which benefits the learners learning experience (Subhash and Cudney 2018).

3.3.2.3. Sub-Research Question (C.)

(C.) How can TEL support future delivery of First Aid Responder courses?

Results and Findings

Assessment

Learners responded positively to the formative assessment format of online quizzes. They felt it helped to prepare them for final course exam and gave them confidence for it too. Learner (E) stated *"you had the quiz at the end of that module that you were doing"* and *"it was still fresh in your head and it was a great way of testing you and it kept it fresh then when we actually went to do the written test.* Learner (D) *"It was nice having the quiz at the end. It kind of made you focus the mind as opposed to doing the exam at the very end. You were being continuously assessed".* Learner (E) *"it gives you more confidence for doing"* the end course exam. These findings are in line with the results of similar research conducted by Mahon *et al.* (2018) as they state that classroom response systems such as these online quizzes can empower learners with self-confidence. In a study conducted by Lyng and Kelleher (2019) they also found that by doing formative assessments such as this, it prepared learners for summative assessments at the end of courses. It was interesting to note that all learners indicated that they did not want all online assessments in future courses as it allowed them to reflect on their answers before submitting their assessments. They still wanted to retain the written exam at

the end of the course for example learner (D) stated *"I think there is a need for both. I wouldn't throw out the paper-based totally."*

Recommendation for Future Use

All six interviewees highly recommended retaining online quizzes such as these for future use. Learner (E) *"Yes absolutely, I would be happy to use it again definitely I found it good and it should be use by other lecturers".* Learner (B) "*yes definitely, they were very relevant to what we were learning and it enhanced the day and made it more interesting, kept you engaged",* learner (D) *"without a doubt definitely",* learner (G) *"yes I think they should be a part of it",* learner (O) and (R) *"yes I found them beneficial".* This positive feedback from learners on the use of TEL is in alignment with other research findings in this area (Malau-Aduli *et al.* 2014; Fonseca *et al.* 2015; Gallagher, Short, Brereton, Cranny, Maguire, *et al.* 2017; Lyng and Kelleher 2019).

As the online quizzes were timed one participant Learner (E) recommended "*You may want to take account of that* (slow it down) *for the more mature participant. For the first one for people who have never done it before you might want to give it more time and then speed it up then".* This participant did not experience any difficulty herself as it was noted during the course she actually topped the leader board on the majority of occasions in her group however this is a valid recommendation and one that could be easily adopted for future use. It would assist learners by doing a warm up online quiz to familiarize them with the technology and ensure all participants were comfortable and aware of expectations surrounding them.

3.4. Conclusion

To apply any technology onto a course it must be initiated by the tutor or facilitator and the new technological intervention integrated into the pedagogy of a course. However, it is important that the learner feed into TPACK framework by providing feedback on the intervention. The learner should be consulted on their learning Experience (E) of the technological intervention to determine if the technology truly provides a positive learning experience and opportunity for the learner. The framework could then be referred to as TPACKE to include the learners experience to ensure the learner has a voice in the integration or embedding of beneficial technology interventions onto their courses. See figure 3.6. This

concurs with research conducted by Dennerlein *et al.* (2020) where they state that any TEL innovations should be co-designed with all the parties involved including the leaners (Robinson 2017). It is therefore paramount that the learners experience (E) be acknowledged and captured in TPACKE.

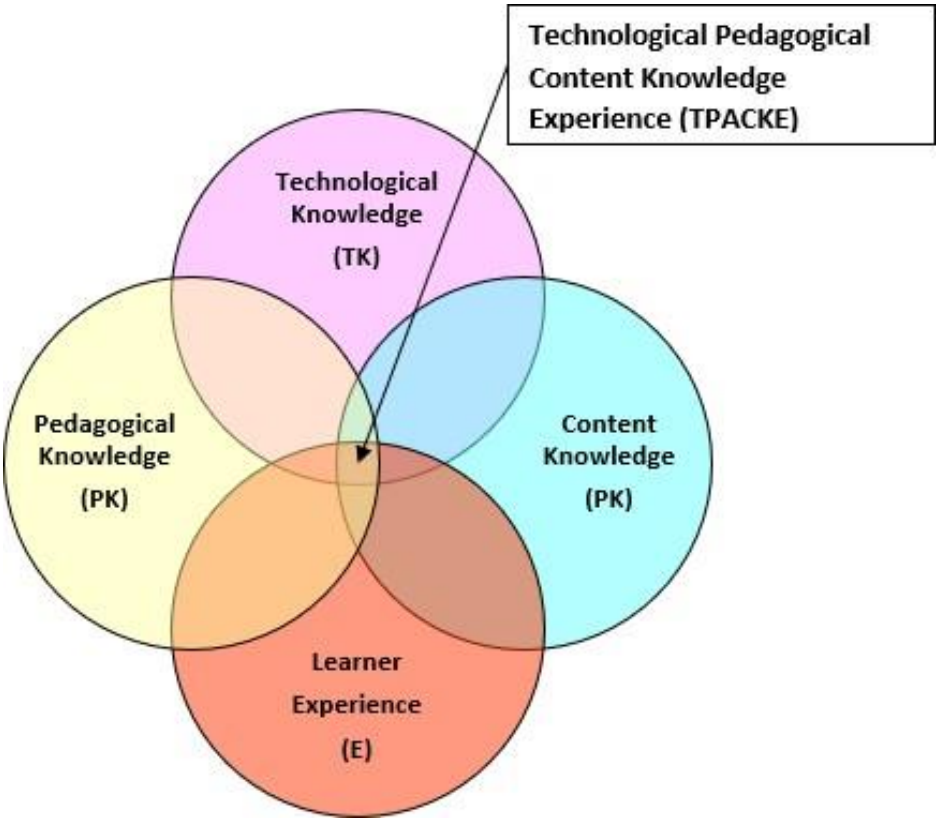

Figure 3.6. Modified TPACKE Framework

In comparison the researcher is of the opinion that this is a strength of the SAMR model as the learners' experience and performance are of paramount importance when applying any TEL intervention. Overall the learners evaluated their TEL learning experience as a positive one. They found the technology engaging, user friendly and fun to use (Gallagher, Short, Brereton, Cranny, Maguire, *et al.* 2017; Alexander *et al.* 2019). Learners also reported that it assisted in their learning for the final course assessment as it kept them focused and engaged throughout the course knowing that they had online quizzes at the end of each module (Hoekstra 2015; Lyng and Kelleher 2019). Learners recommended that the online quizzes be retained for future use in first aid courses such as this. Learner (O) requesting more of them in future First Aid Responder courses *"There wasn't enough of them* (online quizzes) *...a few more*".

Section Four: Conclusion

4.1. Conclusion

In this research an examination of the efficacy of a Technology Enhanced Learning intervention in a First Aid Responder course was conducted. The main research question was to ascertain does Technology Enhanced Learning (TEL) enhance the traditional face to face delivery in a First Aid Responder (FAR) course, with regards to learner's performance and determine the perception of their learning experience.

This research conclusively demonstrated that there is a statistical difference in the mean of the test scores for this group of learners. There was a significant measurable difference in the scores between the 2018 learners (control group) and the 2020 learners (experimental group) in the FAR course. The paired t-test see Table 3.5 Comparison of the 2018 and 2020 FAR Learner Scores, demonstrates that a significant difference in the scores, $p = 0.011 < 0.05$. This shows that the 0.05 level of significance the Null Hypothesis H10 can be rejected. This indicates that a decisive change has taken place and the TEL intervention introduced onto the 2020 course had a positive effect on the scores achieved by the learners. This is a significant finding and reinforced by similar findings outlined by Alexander et al. (2019) and Delaram et al. (2017) in their research into comparable areas. This answers the first half of the research question with regards to leaners' performance and it clearly demonstrates and proves that TEL greatly enhances the traditional face to face delivery method and can be added to FAR courses to good effect.

The next phase of the research examined the learner's perception of their learning experience. Overall the experience of learners was that they found it to be positive, engaging ,even entertaining diversion, which nonetheless benefited the learning experience in an innovative manner (Malau-Aduli *et al.* 2014; Fonseca *et al.* 2015; Gallagher, Short, Brereton, Cranny and Maguire 2017; Lyng and Kelleher 2019). They found it both enhanced their learning experience and they recommended that it be retained for future FAR courses. However, it should be noted that they did not recommend a switch to total online quizzes as a means of assessment. Learners wanted to preserve the traditional written assessment as part of the course. They felt that the online quizzes enhanced their learning experience and prepared them for their final FAR course written assessment.

This research effectively demonstrated that the use of TEL intervention of online quizzes can be successfully employed to complement and supplement traditional face to face teaching methods which can enhance the learners' performance and their perception of their learning experience in a more beneficial manner than learners taught solely in traditional face to face methods of this FAR course. This research also examined some of the challenges associated with CRS's, outlined in the literature review and closed many gaps in the academic literature relating to TEL as a means of improving traditional face to face teaching.

4.2. Research Limitations

The primary research limitation associate with this study is the small group size. This was a small-scale study and the researcher found that this was a limiting factor in this research., however this is acceptable according to research conducted by Thornhill et al. (2009). This would be a recommendation for future studies in this area to extend the group sizes that experience the TEL intervention.

In addition to this the use of staff or mature learners may have led to a biased group due to purposive sampling. The researcher also acknowledges that the FAR course is of short duration with small group sizes and additional studies in this area would benefit from comparing a greater number of FAR participants.

Regarding the online quizzes, learners may have benefited from the quizzes receiving a minor score that could have counted towards the final course test scores. This would have incentivized learners to engage further with the online quizzes by giving them slightly more weight. Conversely, it could then be argued that due to exam pressure, this may then affect the enjoyment and learning experience negatively. Careful consideration and testing would have to be considered before employing this measure of awarding marks to online quizzes.

The timescale was another limiting factor which could be examined and expanded upon for future research into this area by providing the researcher with a greater duration to extend this research as this study was conducted as part of an ongoing taught master's program.

4.3.Suggestions for Further Research

Based on recommendations of the learner's online quizzes such as this will be utilised on all future First Aid Responder courses. A suggestion for future research would be for the tutor to facilitate learners to develop their own online quiz. The idea would be for each learner to be given a module and after learning has taken place they would be asked to develop a quiz for their peers based on that module content. The tutor would then facilitate this transition onto online format using the Quizizz software for the learner to then host a quiz for their peers. The learners would then be interviewed and test scores collated from their summative assessment to ascertain the learning experience of this approach to peer learning and use of TEL intervention (Lull and Mathews 2016).

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Appendices

Appendix A: Participant Consent Form

Privacy Statement: The only persons who will have access to the data is the researcher and their supervisor. The researcher will treat all information and personal data that you provide as strictly confidential and hold it securely. Full details of the LYIT's data protection policy as well as information regarding your rights as a data subject are available on our Policies and Publications page or on request by emailing dpo@lyit.ie.
Title of Project: An examination of the efficacy of a Technology Enhanced Learning intervention in a First Aid Responder course.
Name of Chief Investigator: Laurence Dempsey

I,_____agree to take part in the above study and consent to my data being used for the purpose of this research study as outlined in the information sheet.

- I confirm that I have been given and have read and understood the information sheet for the above study and have asked and received answers to any questions raised.
- I understand that I will participate in a 20-minute interview which will be audio recorded.
- I understand that the researcher will use my score results obtained in 2018 and 2020 as research data that will be analysed for the purpose of this study.
- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without my rights being affected in any way.
- I understand that the researchers will hold all information and data collected securely and in confidence and that all efforts will be made to ensure that I cannot be identified as a participant in the study (except as might be required by law) and I give permission for the researchers to hold relevant personal data on me.
- If I withdraw from the study, there will be no negative consequences
- I am aware that should I at any time I feel uncomfortable with being recorded, I can request that the recording equipment be turned off.
- I am aware that I am permitted to view all research and transcripts that have taken place. concerning my involvement. I can request a copy of the report from the researcher.
- All information will be confidential and used only for the purposes of the research study.
- I understand that ID codes will be used to protect my anonymity and confidentiality and names of people and places will be changed.
- I agree that quotations may be used for the research.

I agree to take part in the above study and consent to my data being used for the purpose of this research study as outlined in the information sheet.

Signature of participant:_____**Date:** _____

Investigator's signature:_____**Date:** _____

Appendix B: Participant Information Sheet

Title of Study: An examination of the efficacy of a Technology Enhanced Learning intervention in a First Aid Responder course.
Name of Principal Researcher: Laurence Dempsey.
You are being invited to participate in a research study. Thank you for taking time to read this.
What is the purpose of this study?
As part of the requirements for a Master of Arts in Learning and Teaching that I am pursuing in Letterkenny Institute of Technology, I wish to carry out a study. The study is concerned with examining the effectiveness of adopting a Technology Enhanced Learning (TEL) intervention in a First Aid Responder (FAR) course. I want to examine the effectiveness of this intervention by comparing your previous theory results when you were taught using traditional teaching methods only with your results after completing a TEL learning approach.
Are you 18 years of age?
If you are not over 18 years of age then your data will not be considered for this study. You still have access to all the available resources that are part of this intervention. You do not have to continue with this consent form. Thank you for your time.
Description of study procedure:
This intervention aims to provide learners with additional learning support in the FAR course, by allowing them to access online quizzes on their mobile devices throughout the course. If you agree to be in this study then you will be asked to do the following things:

- Complete the enclosed consent form.
- Allow the researcher to have access to your 2018 and 2020 theory course scores.
- Allow the researcher to interview you about your experience of this Technology Enhanced Learning approach.

Why have you been chosen?
You have been chosen because this study is focusing on the First Aid Responder course and you are due to complete a refresher of this course.
Are there any benefits in participating in this study?
You have access to the resources in this intervention regardless if you do or do not take part in the study. However, in order to establish whether this intervention is effective and can be used for future learners and adopted in similar FAR courses, data is required.

Are there any risks or discomforts in being involved in this study?
As part of this study you will be asked to allow the researcher to use the results you obtained in 2018 and 2020 theory assessments as research data that will be analysed. There are no reasonable expected risks involved in this study.

What happens if you refuse to participate?
Your participation in this study is entirely voluntary. If you decide not to take part in this study your rights will not be affected in any way. If you decide to take part you may still withdraw at any time throughout the study and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will also not affect your rights in any way.

Will your participation in this study be kept confidential?
Yes, this study will be anonymous. Your identity throughout the study will remain confidential. You will be identified by a study number, e.g. A1 ensuring that your name will

not be published or disclosed to anyone.

What will happen to the information which you give?
The data recorded for this study will be kept strictly confidential for the duration of the study. All research data will be kept in a secure location for a further 5 years and then destroyed.

Privacy Statement
The only persons who will have access to the data is the researcher and their supervisor. The researcher will treat all information and personal data that you provide as strictly confidential and hold it securely. Full details of the LYIT's data protection policy as well as information regarding your rights as a data subject are available on our Policies and Publications page or on request by emailing dpo@lyit.ie.

What will happen to the results?
The results from the study will be presented in the thesis. They will be seen by my supervisor, a second marker and an external examiner. The thesis may possibly be read by other people with an interest in this field. Results of the study will be made available to the participant.

Will I be paid for participating in this study?
No.
Has this study been reviewed by an Ethics committee?
The Research Ethics committee at Letterkenny Institute of Technology have reviewed this study.

Who can I contact if I have any questions or concerns about this study?
You have the right to ask any questions you may have about this research study and have your questions answered by me at any time before, during or after the research. If you would like any further information about the study, at any time please contact me: Laurence Dempsey at XXXXXX or by telephone at XXXXXX.

If you agree to take part in the study, please sign the consent form attached.

Appendix C: Interview Questions

PARTICIPANT INTERVIEW FORM

Title of Study: An examination of the efficacy of a Technology Enhanced Learning intervention in a First Aid Responder course.

Name of Principal Investigator: Laurence Dempsey.

The interview questions for this research were developed and adapted from questions obtained in the following academic literature and research into Technology Enhanced Learning (Kirkwood and Price 2014; Malau-Aduli *et al.* 2014; Fonseca *et al.* 2015; Mahon *et al.* 2018)

The aim of this interview process is to gather data on the learners' experience of TEL to answer the following research sub-questions:

- What were the opinions of the learners in relation to their Technology Enhanced Learning (TEL) experience?
- How can TEL support future delivery of First Aid Responder (FAR) courses?

The **10 interview questions** are divided into two sections. Section one of the interview is to garner the learners' experience of Technology Enhanced Learning. Section two to determine the support for future delivery of TEL on FAR courses i.e. recommendations.

Section 1 - Learners TEL Experience

1. Did you find the online quizzes easy to use? Please explain why?
2. In your opinion, did the use of these online quizzes enhance your learning experience of first aid?
3. Do you think the online quizzes were enjoyable? If so why?
4. What were the advantages for you of using online quizzes?
5. What were the disadvantages for you of using online quizzes?
6. Did you find it easier to participate in the course using a question system such as this? Why or Why not?
7. Did you like the anonymity of the question response system? If so why was that?

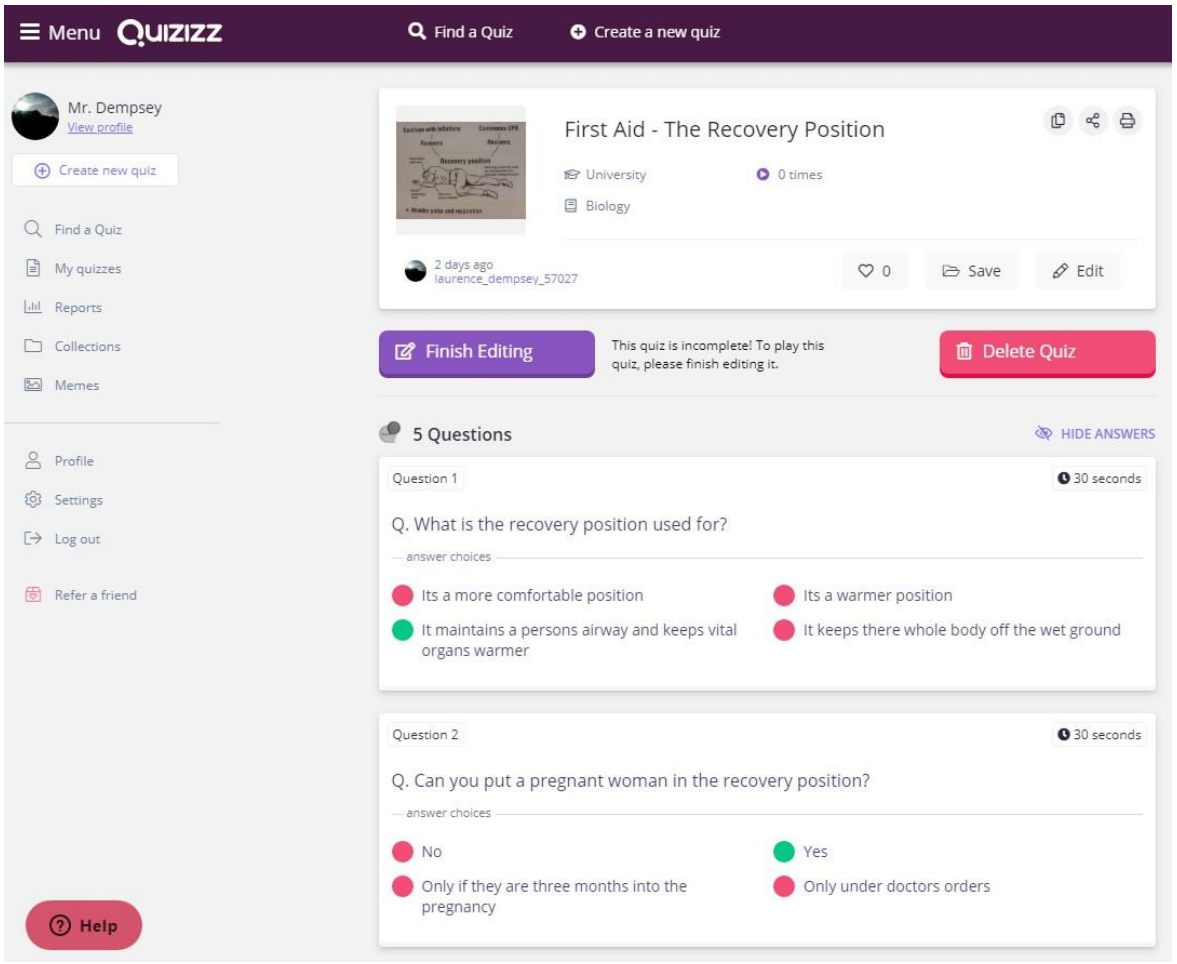
Section 2 - Recommendations

8. Would you like to see online quizzes on your mobile devices replace more traditional paper-based assessments?
9. Do you think these online quizzes should be part of future First Aid Responder courses?
10. Is there any other information you would like to add to this interview on your TEL experience?

Appendix D: Gantt Chart Timescale for Research

Tasks	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
• Lit. Review and Critique • Implementation - Research Methodology . *Deadline:* Ethics approval application submitted (25-11-19)									
• Pilot Data collection with participants • Complete Lit. Review . Arrange FAR courses and Interview schedule									
• Complete Info. and Consent process • Data collection – complete FAR courses using TEL intervention and performance scores . Conduct 6 interviews									
• Evaluation - of research findings • Data analysis . Develop discussion and synthesise with literature									
• Finalise conclusion, introduction, recommendations and abstract. • Revise and proof all sections. • *Deadline:* Final Draft to supervisor (29-5-20)									
• Final revision and proof all sections and any supervisor recommendations . *Deadline:* final submission of dissertation by end of June with supervisor approval (20-6-20)									
. *Deadline:* Final deadline not until July 30th giving month to extend timeline for any of the above tasks should an overrun occur giving this research i.e. a buffer.									

Appendix E: Example of Quizizz Screenshot



Appendix F: Quizizz Example of Feedback

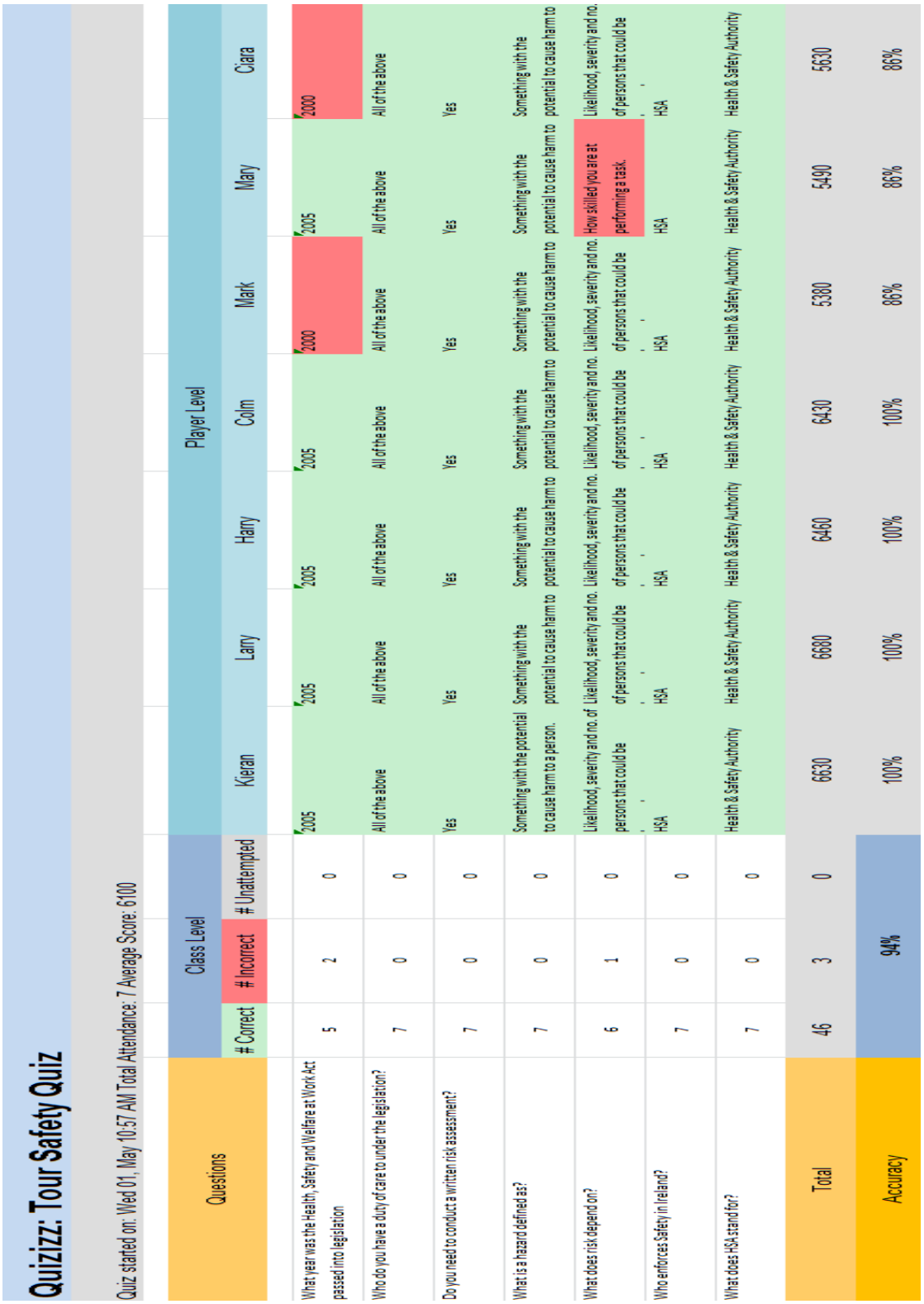
Quizizz: Tour Safety Quiz

Quiz started on: Wed 01, May 10:57 AM Total Attendance: 7 Average Score: 6100

Players	Score	Accuracy	Started At	Info
Kieran	6630	100%	Wed 01, May 11:41 AM	IP Address: 111.111.111 Mobile Safari on iPhone
Larry	6680	100%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Chrome Mobile on Generic Smartphone
Harry	6460	100%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Chrome Mobile on Generic Smartphone
Colm	6430	100%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Chrome Mobile on Generic Smartphone
Mark	5380	86%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Firefox on Other
Mary	5490	86%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Samsung Internet on Samsung $2
Ciara	5630	86%	Wed 01, May 11:41 AM	IP Address: 111.111.111.111 Chrome Mobile on Generic Smartphone

Privacy Note: All participants names and IP addresses are fictitious and displayed for example purposes only.

Appendix G: Quizizz Example of Feedback



Quizizz: Tour Safety Quiz

Quiz started on: Wed 01, May 10:57 AM Total Attendance: 7 Average Score: 6100

Questions	Class Level			Player Level							
	# Correct	# Incorrect	# Unattempted	Kieran	Larry	Harry	Colm	Mark	Mary	Ciara	
What year was the Health, Safety and Welfare at Work Act passed into legislation	5	2	0	2005	2005	2005	2005	2000	2005	2000	
Who do you have a duty of care to under the legislation?	7	0	0	All of the above	All of the above	All of the above	All of the above	All of the above	All of the above	All of the above	
Do you need to conduct a written risk assessment?	7	0	0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
What is a hazard defined as?	7	0	0	Something with the potential to cause harm to a person.	Something with the potential to cause harm to	Something with the potential to cause harm to	Something with the potential to cause harm to	Something with the potential to cause harm to	Something with the potential to cause harm to	Something with the potential to cause harm to	
What does risk depend on?	6	1	0	Likelihood, severity and no. of persons that could be	Likelihood, severity and no. of persons that could be	Likelihood, severity and no. of persons that could be	Likelihood, severity and no. of persons that could be	Likelihood, severity and no. of persons that could be	How skilled you are at performing a task.	Likelihood, severity and no. of persons that could be	
Who enforces Safety in Ireland?	7	0	0	HSA	HSA	HSA	HSA	HSA	HSA	HSA	
What does HSA stand for?	7	0	0	Health & Safety Authority	Health & Safety Authority	Health & Safety Authority	Health & Safety Authority	Health & Safety Authority	Health & Safety Authority	Health & Safety Authority	
Total	46	3	0	6630	6680	6460	6430	5380	5490	5630	
Accuracy	94%			100%	100%	100%	100%	86%	86%	86%	

Privacy Note: All participants names are fictitious and displayed for example purposes only.

Appendix H: Paired T-Tests & Cohen's d test

t-Test: Paired Two Sample for Means		
	FAR Scores 2020	***FAR Scores 2018***
Mean	18.94444444	17.72222222
Variance	1.937908497	2.918300654
Observations	18	18
Pearson Correlation	0.314689611	
Hypothesized Mean Difference	0	
Df	17	
t Stat	2.829114888	
P(T<=t) one-tail	0.005786652	
t Critical one-tail	1.739606726	
P(T<=t) two-tail	0.011573303	
t Critical two-tail	2.109815578	
Decision	**Reject Null Hypothesis**	

Comparison of the 2018 and 2020 FAR Learner Scores

Cohen's *d* test: Effect Size			
	n	**Mean**	**Standard Dev.**
2018 Scores	18	17.72222222	1.708303443
2020 Scores	18	18.94444444	1.392087819
Mean Difference		1.222222222	
Pooled SD		1.550195631	
Cohen's *d*		0.788430955	
Small		0.2	
Medium		0.5	
Large		0.8	

Cohen's d Effect Size

Appendix I: Interview Colour Coded Thematic Analysis

	Data overview and Key Points
Theme	**Future Use**
Data overview/ quotes	very relevant to what we were learning; enhanced the day; made it more interesting; kept you engaged; kept you focused; provided variation in the day; I think you should keep them; it definitely enhances the course; bit of fun as well; its reinforcing what you are learning; refreshing and it definitely helps and gives you more confidence for doing the exam at the end, helps you remember your stuff; It's a great initiative and definitely would recommend there use in future courses; I found them beneficial; I think they're a great idea; it should be use by other lecturers; I think there is a need for both. I wouldn't throw out the paper-based totally.
1	All participants highly recommended keeping the online quizzes for future courses (definitely, great initiative/idea, beneficial,)
2	Relevant and reinforces what we were learning, kept them engaged and focused
3	Enhanced the course for them
4	Gave participants more confidence for doing exam at end of course (helps you remember your stuff)
5	Caution that still need written exam at the end i.e. need for both;

	Data overview and Key Points
Theme	**Feedback**
Data overview/ quotes	an advantage you could go back to a question at the end and redo. If you were wrong you got to see you were wrong right away, or what was the right answer; the instant feedback; it was interactive – it allowed each person in the group to answer questions individually, rather than just asking a question of somebody; good thing was they were done straight away after you did every subject, it was still fresh in your head; when you're in the classroom environment, you have to do it there and then – it's more likely to give a true reflection of how well you've learned the stuff;
1	Instant feedback, participants could see straight away if they were right or wrong and redo incorrect questions at end (advantage)
2	Allowed each person to answer questions individually not just one person answering in the class
3	In the classroom environment, you to do it there and then it's more likely to give a true reflection of how well you have learnt the material
4	good thing was they were done straight away after you did every subject, it was still fresh in your head

	Data overview and Key Points
Theme	**Anonymity**
Data overview/ quotes	atmosphere was relaxed, the participants knew each other which was great. If we didn't know each other it might have been a bit more awkward/that could be a disadvantage yes that's good that it can be anonymised; group size - small group anonymity not needed but if bigger group yes it would avoid embarrassment, GDPR; if somebody is constantly getting it wrong or came last maybe they'd feel embarrassed/others might be laughing at you because of the leader board; allowed each person to answer questions individually, rather than just asking a question of somebody; good thing about it was it was private, like apart from the score at the end, nobody knew how many you got wrong; Overall it didn't bother the participants (not an issue)
1	Overall anonymity not an issue for participants as they all knew each other/ relaxed atmosphere - would have
2	Group size important if small group anonymity not required however in big group would be desirable
3	Embarrassment at getting wrong/coming last due to leader board on big screen
4	Leader board only displayed scores so not clear to group how many you got wrong
5	GDPR was raised as an issue by one participant

	Data overview and Key Points
Theme	**Enhanced Learning Experience**
Data overview/ quotes	it definitely did yes help learning first aid, because I got a few of them wrong, you learn from your mistakes; I think it definitely enhances the course; made it more interesting, kept you engaged; enhanced my learning; it would make you want to learn more, it's a novel/innovative teaching method and should be used in a more widespread basis in education; it helped back up the learning; great complementary type of teaching method; great for reinforcing the learning, it wasn't just the videos, you knew that the quiz was coming so you made that extra effort; refreshing and it definitely helps you remember your stuff; kept you alert that you knew you were going to be tested; it got your mind wakened up again, reenergised; for revision purposes it got you thinking; another method of learning, it was active learning; it's not just passive learning, using the phone it's putting into action what you are learning. I think if you are enjoying something you learn; You brought the fun element into it and you were learning at the same time, without realising you were learning; it introduced some variation to the way the material was delivered, it was interactive; it allowed each person in the group to answer questions individually, rather than just asking a question of one person responding; You give a 100%. It wasn't as if you were giving it 5% it will be fine. You had to give it a 100% to get through; by keeping you intrigued and you want to know more
1	You learn from your mistakes
2	enhanced my learning; it would make you want to learn more, kept you engaged; enhanced my learning
3	it's a novel/innovative teaching method and should be used in a more widespread basis in education;
4	It was active learning; it's not just passive learning, using the phone it's putting into action what you are learning, it was interactive
5	another method of learning; great for reinforcing the learning
6	kept you alert that you knew you were going to be tested; it got your mind wakened up again, reenergised
7	you were learning at the same time, without realising
8	Kept you intrigued and you want to know more, I think if you are enjoying something you learn, brought the fun element into it and you were learning at the same time

	Data overview and Key Points
Theme	**Enjoyable**
Data overview/ quotes	bright, grabs your attention that is what I like about it; It wasn't like those surveys you take at the end of using a service it was good, there was fun aspect/element to it; very well done, nice, colourful, very engaging to look at; you were learning at the same time, without realising; attractive; you wanted to use them and they complemented very nicely the teaching materials on the course; They just made it more enjoyable; I like that kind of puzzle aspect to it; kept it interesting; relaxed; They were really well displayed; The visuals were great; you were looking forward to the next one and I thought it was a good idea, it worked well; It was like a quiz; you didn't know what you were going to be asked, it reminded be a bit of that show, Who wants to be a millionaire, you know the way you had four choices, and if you got it right I think it lit up in green and if you got it wrong it lit up in red; they were catchy, the memes after each question they were good, they made it fun; didn't feel like hard work, I was surprised that I did like them. everyone enjoyed it, different, We are all kids deepen down; It was kind of like playing a computer game really it was like the Nintendo Wii with the music, Tetris kind of vibe to it, an element of those computer-based games because it does keep it interesting; I am the type of person, my attention span it only goes for so long. It holds your focus by keeping you intrigued and you want to know more
1	Grabs your attention, it wasn't like those surveys you take at the end of using a service; very engaging to look at, well displayed, enjoyable
2	you were learning at the same time, without realising
3	didn't feel like hard work
4	All participants responded extremely positively to their experience of using online quizzes - everyone enjoyed it
5	We are all kids deepen down; It was kind of like playing a computer game/quiz show, I like that kind of puzzle aspect to it

	Data overview and Key Points
Theme	**Assessment**
Data overview/ quotes	nice having the quiz at the end of that module, made you focus the mind as opposed to doing the exam at the very end. You were being continuously being assessed; The good thing about it was they were done straight away it was still fresh in your head and it was a great way of testing you and it kept it fresh then when we actually went to do the written test; they were always at the back of your head when you were learning so it kept you alert that you knew you were you were going to be tested you know in the next few minutes; I am kind of a detailed kind of a guy, I like specific questions, and it comes from having worked in analytical science; advantage of the paper one at the end is that once you've gone through it - it's easier to flick back through your answers on paper one before you hand them up and see did I fill in the answers the way I wanted to fill them in; I think not totally replaced, I think with the pen and paper exams too you are taking more time and you're probably thinking about the answers more whereas when you are
1	Having quizzes at the end of each module helped participants to focus their mind as opposed to doing the exam at the very end.
2	You were being continuously being assessed
3	They were always at the back of your head when you were learning so it kept you alert that you knew you were you were going to be tested
4	Participants still welcomed having the traditional assessment at the end as it allowed them to reflect and review their answers before submitting
5	They were done straight away it was still fresh in your head and it was a great way of testing you and it kept it fresh then when we actually went to do the written test

	Data overview and Key Points
Theme	**Competitive Edge**
Data overview/ quotes	competition in the group; if you did it in a quicker time you got extra points; it took out my competitive edge; you tried to beat everybody else. You put a lot into it. It wasn't as if you were giving it 5% it will be fine. You had to give it a 100%; you can see their scores moving up and down and your place moving up and down it does it can put you under pressure; everybody's doing it so why not try to do as well as you could; I enjoyed the competitive part of where I was trying to beat participant E, she was winning all of them and I just wanted to win one of them!; I think it timed down; I suppose if you missed one, you lost your train of thought at all it could put you on the back foot because they were time pressured;
1	Competition within the group; You had to give it a 100%; you can see their scores moving up and down and your place moving up and down
2	It took out my competitive edge; you tried to beat everybody else
3	If you missed one, you lost your train of thought at all it could put you on the back foot because they were time pressured
4	I enjoyed the competitive part of where I was trying to beat participant E, she was winning all of them and I just wanted to win one of them

	Data overview and Key Points
Theme	**Digital Literacy**
Data overview/ quotes	I've got two hi-tech kids who teach me everything; especially with the new generation coming up, they are more computer literate; people may not have a phone to put the app onto; I only got my first smartphone this time last year, I was using a nokia, using the phone I've used 'Slido' before you know for online contributions. I had a bit of experience of using the phone; I was surprised that I did like them. I am more a paper and pen sort of person rather than technology; You can't go all online; breaks up the monotony of the pen and paper
1	new generation coming up, they are more computer literate
2	I only got my first smartphone this time last year, I was surprised that I did like them. I am more a paper and pen sort of person rather than technology;
3	You can't go all online;

	Data overview and Key Points
Theme	**Easy to Use**
Data overview/ quotes	It was a nice interface; very easy to use, easy instructions; pretty cool actually; handy to log into, very easy to navigate; Instruction was good; just a case of logging into the app, putting in the code and then everyone was ready it was straight forward; user friendly; quick and easy; well laid out. They prompted you and you knew when the next question was coming up. I think it timed down, you knew what was coming, You were looking forward for to them coming up; were very attractive, you kind of wanted to use them, nice graphics and complemented nicely the material on the course from each of the topics; good idea, worked well; when you did a few of them you got the hang of it; slow down the speed between questions, may want to take account of that for the more mature participant. For the first one for people who have never done it before you might want to give it more time and then speed it up; maybe for people that weren't used to the phone quizzes maybe a little practice one before they started the course. So that people know what to expect.
1	nice interface; very easy to use, easy instructions; pretty cool actually; handy to log into, very easy to navigate; Instruction was good; user friendly; quick and easy; well laid out
2	You were looking forward for to them coming up; were very attractive, you kind of wanted to use them, nice graphics and complemented nicely the material on the course
3	Improvement to give more time for more mature or inexperienced participants - maybe a practice run
4	good idea, worked well; when you did a few of them you got the hang of it