The School of Flames.

Knowledge Retention Models for Recruit Firefighters.

Barbara Cahill, BSc., MSc.

PhD

Dublin City University

Supervisors: Professor Charlotte Holland, Professor Caroline McMullan

School of STEM Education, Innovation and Global Studies

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of PhD is entirely my own work, and that I have exercised reasonable care to ensure that the work is original and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: 

Candidate ID number: 16213339

Date: 27/11/2023

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For Mum.

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Abbreviations

AfL	Assessment for Learning
AoL	Assessment of Learning
CBL	Case-Based Learning
CEU	Continuing Education Units
CFBT	Compartment Fire Behaviour Training
CFO	Chief Fire Officer
CLR	Comprehensive Literature Review
CLT	Cognitive Load Theory
CPD	Continual Professional Development
CPG	Clinical Practical Guidelines
DBR	Design-Based Research
DCU	Dublin City University
DFB	Dublin Fire Brigade
ECT	European Credit Transfer
EFR	Emergency First Responder
EMS	Emergency Medical Service
EQF	European Qualifications Framework
EQF	European Qualifications Framework
ERCC	Eastern Regional Control Centre
ERCC	East Regional Communications Centre
FEMA	Federal Emergency Management Agency
FESTI	Fire and Emergency Services Training Institute
FSC	Fire Service College
IC	Incident Commander
ICS	Incident Command System
ICS	Incident Command System
ICT	Information and Communication Technology
IFSAC	International Fire Service Accreditation Congress
JPR	Job Performance Requirements
K12	K12 Primary education starting in kindergarten to secondary education - grade 12 in the USA
LFB	London Fire Brigade
LMS	Learning Management System
NDFEM	National Directorate for Fire and Emergency Management
NFA	National Fire Academy
NFPA	National Fire Protection Association
NFQ	National Framework of Qualifications
NFQA	National Framework Qualifications Authority
NIFV	the Institute for Safety - Netherlands
NOS	National Occupational Standards
NZFS	New Zealand Fire Service

OBI	O'Brien Institute – Dublin Fire Brigade Training Centre
PBL	Problem-Based Learning
PHECC	Pre-Hospital Emergency Care Council
PPE	Personal Protective Equipment
QF	Qualified Firefighter
QQI	Quality and Qualifications Ireland
RCSI	Royal College of Surgeons
REC	Research Ethics Committee
RTC	Road Traffic Collision
SA	Sentiment Analysis
SCORM	Sharable Content Object Reference Model
SFJ	Skills for Justice
TRI 2.0	Technology Readiness Index 2.0
UK	United Kingdom
USA	United States of America
VR	Virtual Reality
XVR	eXtreme Virtual Reality

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The School of Flames. Knowledge Retention Models for Recruit Firefighters.

Barbara Cahill

Abstract

This research set out to explore pedagogical models that could be used within Dublin Fire Brigade training settings to enhance the quality of teaching and learning for new recruits, with a focus on examining learning interactions/ engagement, learning experiences, and learning outcomes vis-à-vis knowledge-building and skills-retention for heuristic decision-making in the context of critical incidents. The research took inspiration from the Design-Based Research approach to investigate the traditional pedagogical model used within recruit training and to design and trial two adapted pedagogical models, each incorporating a fully immersed online module at the outset and instructor-led demonstrations and assessment. The first of the adapted models, the Blended model, included online modules that recruits completed before the traditional training by instructors was implemented. The second model, Tine, a station rotation model, offered opportunities for recruits to engage in the online modules, followed by staged engagement of recruits in instructor-led learning, peer learning, problem-based learning, and assessment of learning by instructors. The Tine model surpassed both the Traditional and Blended models in terms of knowledge retention by recruits. Recommendations from this study include exploration of the integration of the Tine model in other subjects within the recruit curriculum, such as Breathing Apparatus or Pump Operations, researching new technologies to assist the Tine model in future iterations and conducting a review of current Road Traffic Collision training materials.

Chapter 1: Introduction

1.1 Introduction

Throughout history humans have been developing ways to control fire, however uncontrolled fire-related events remain a reality. From the Great Fire of Rome (64 AD) to the Great Fire of London (1666) and even the tragic Stardust fire (Dublin 1981) it is evident that the scale and severity of fire events can differ with the potential to cause considerable loss of life and extensive property damage. The training provided to firefighters to address such diverse incidents is critical to effectively resolving future emergencies. In Ireland, firefighter training is provided at local and national levels via fire service centres around the country and is underpinned by the Fire Services Act 1981 and 2003. Nationally the most significant fire service training providers align with the urban areas of high density, namely, Dublin, Cork, Limerick, and Galway. All these brigades have a full-time fire brigade supported by a cadre of dedicated retained firefighters. This research examined the training model used within Dublin Fire Brigade (DFB) training settings and explored alternative pedagogical models that could enhance the quality of teaching and learning for firefighters in the context of critical incidents.

1.2 Irish Fire Service Overview

According to the Department of Housing, Local Government and Heritage (2023) there are two hundred and eighteen fire stations in the Republic of Ireland as of 2023. These fire stations are staffed by over three thousand firefighters under the governance of thirty local fire authorities. The Department of Housing, Local Government and Heritage plays an advisory, legislative and policy-making role in the daily operations of all nationwide Brigades. The NDFEM is responsible for national standards, and the essential statutory requirements are framed by the Fire Services Act (1981; 2003). The fire service responds to fires, road traffic collisions and other emergencies, including chemical, biological, radiological or nuclear incidents, search and rescue incidents, severe flooding and transport incidents.

Dublin Fire Brigade

Dublin Fire Brigade is an integrated fire, rescue and emergency ambulance service that operates in the Dublin City and County area, home to over 1.35 million people and covers

an area of 921.7 km^2. In 2021, DFB was responsible for handling over 203,000 emergency 999/112 calls, 38,713 fire and rescue mobilisations, and 164,781 emergency medical service mobilisations across the four local authorities (DFB Annual Report, 2021, p.8). The organisation operates twelve full-time and two retained fire stations, a nationally and internationally accredited Training Centre, and the East Regional Communications Centre (ERCC). With twenty-one frontline fire appliances and fourteen ambulances, up to one hundred and twenty paramedics are available daily to provide support to those in need. It's worth noting that all full-time firefighters, approximately one thousand, are trained to a paramedic standard. Additionally, the Brigade has eighty-one advanced paramedics trained to deliver lifesaving treatment to the citizens of Dublin in an out-of-hospital medical emergency.

Dublin Fire Brigade Training Centre

Dublin Fire Brigade Training Centre, the O'Brien Institute (OBI), is located in the leafy suburbs of Marino, Dublin. The OBI is a building complex built in 1883 as an orphan home and school; the purchase of the land and building costs were financed by a trust founded by the will of Bridget O'Brien in 1876. Ms O'Brien had stipulated in her will that this building would always be used as a place of learning. Dublin Corporation (now known as Dublin City Council) purchased this site in 1981 to provide Dublin Fire Brigade with a dedicated training centre, continuing the site's long history of learning. The first recruits began training in July 1985. The training courses provided to staff and other fire services include firefighter recruit training, paramedic training (in partnership with the Royal College of Surgeons of Ireland), swift water rescue training, high-line rescue training, compartment firefighting training, and emergency driving training. Through its external training division, DFB delivers fire, medical and safety training to local authority staff, other fire services, companies and individuals at the training centre or off-site as required. The instructors who deliver both internal and external training are seconded from their day-to-day operational duties, they are considered to be subject matter experts in their respective fields due to their extensive operational and lived experience, such as Breathing Apparatus, Hazardous Material or Road Traffic Collision training.

Researchers Background

I have been employed by Dublin Fire Brigade since 1995, when I first joined as a firefighter. Over the years, I have gained a great deal of experience responding to fire and medical

emergencies while working in all the Dublin stations before having roles of management responsibility at Tara Street and North Strand Fire Stations. In 2004, I was promoted to Sub Officer and seconded to the ERCC, where I was responsible for ensuring that fire appliances were mobilised quickly and efficiently. I was later promoted to Station Officer in 2008 and was stationed in several different locations across Dublin. As a Station Officer, I became a Breathing Apparatus instructor and a Pre-Hospital Emergency Care Council (PHECC) paramedic tutor, which gave me valuable insights into course design and developing training needs analysis for the Brigade Training Officer. In 2018, I was promoted to Third Officer, where I currently have Major Emergency Management and Human Resources portfolios. In addition to my work at DFB, I have completed a BSc in Computer Applications and a MSc in Emergency Management from Dublin City University (DCU).

1.3 Research Rationale

The fire service typically has a militaristic culture embedded into its hierarchical core. Training would usually be delivered face-to-face in the format of a didactic lesson followed by a skill demonstration and or exercise. Many skills are taught using rote learning, and this would be framed by demonstration, imitation and then repetition. The initial motivation for this research was sparked while completing daily operational and functional tests in a Dublin fire station. I asked a new crew member to identify a critical safety feature on equipment they used frequently. The crew member struggled with this essential task and needed assistance completing the safety check. I asked the firefighter further questions about the same piece of equipment, and the firefighter needed help answering my queries. I was very concerned when I discovered that this firefighter had just completed recruit training and appeared unable to recall vital safety information only a few weeks after going into service. Since I had recently completed an MSc in Emergency Management, I was eager to build on my studies in the emergency service realm, and this provided the focus for an area of research. Fundamentally, this research examined pedagogical models that could support firefighters' knowledge retention. This ability to recall information during the response phase of an emergency should evoke a heuristic response that enables the firefighter to access and apply their knowledge, skills and experience when needed. This research examined current practices in terms of recruit firefighter training. Furthermore, it explored alternative models that could enhance firefighters' retention of necessary knowledge and skills when dealing with critical incidents.

1.4 Overview of Research Approach

This research set out to explore pedagogical models that could be used within Dublin Fire Brigade training settings to enhance the quality of teaching and learning for new recruits, with a focus on examining learning interactions, engagement, learning experiences, and learning outcomes, with a specific focus on knowledge retention. In the context of this research, the term pedagogy encompasses the performance of teaching and connects the self-contained act of teaching with culture, structure and mechanisms of social control (Alexander, 2008, p.3). The research took inspiration from the Design-Based Research (DBR) approach to investigate the traditional pedagogical model used within recruit training and to design and trial two adapted pedagogical models, each incorporating a fully immersed online module at the outset and instructor-led demonstrations and assessment. The first of the adapted models, the Blended model, included online modules that recruits completed before the traditional training by instructors was implemented. The second pedagogical model, Tine (Gaelic for fire), embodied a station rotation model by offering opportunities for recruits to engage in online modules, followed by staged engagement of recruits in instructor-led learning, peer learning, problem-based learning, and assessment of learning by instructors. The traditional and alternative training models were developed to explore the following research questions.

1. What are the key characteristics of, and core pedagogical processes employed within, the Traditional pedagogical model implemented within DFB training for recruit firefighters?

2. What impact does the integration of Blended and Tine pedagogical models have on learning interactions/ engagement, learning experiences, and the retention of knowledge of DFB recruit trainees?
    a) How does the integration of Blended modes of training (online/ face-to-face learning) impact learning interactions/ engagement, learning experiences and learning outcomes of DFB fire service recruit trainees?
    b) How does the Tine Model impact learning interactions/ engagement, learning experiences, and learning outcomes of DFB recruit trainees?
3. What design principles and contextual factors are pivotal to the successful implementation of Blended and Tine models?

a) What design principles are central to the effectiveness of Blended and Tine pedagogical models?
b) What is the level of readiness of the DFB recruit trainees, trainers, and officers for the integration of technology within fire service training?
c) What is the level of readiness of DFB trainers for transitions toward student-centred and problem-based learning?

This study employed a mixed-method research approach with participants, including an Emergency Medical Service (EMS) training cohort in 2019 and a firefighter recruit intake in 2020. The data collection tools used were interviews, focus groups, questionnaires, observations and a formative assessment. The data analysis relied heavily on Braun and Clarke's (2021) thematic analysis of the data sets. The qualitative data was transcribed, initial codes were identified, these codes were grouped, and the data was then interrogated using NVIVO software. The quantitative data from the questionnaires and formative assessment were separately analysed. The resulting information was used to underpin the overall data analysis and inform the findings and conclusions of this research.

1.5 Contributions of this Research

This study was initiated in response to observations of poor knowledge retention by a recently qualified firefighter while on active duty, which prompted thinking about the learning theories and pedagogical models that might better foster the retention of knowledge by fire service personnel. As outlined in the literature review chapter, there was a dearth of literature on fire service training. The likely severe impacts of inadequate preparation for firefighting and the lack of research on this provided the warrant for this study, which set out to investigate current practices in terms of existing fire service training and explore alternative models, the Blended as mentioned above and Tine models. This thesis makes the following significant contributions to knowledge and research in the field of emergency management education:

1. This study provides evidence of current DFB firefighter training practices and deficits therein that may contribute to poor knowledge retention.

2. This study provides evidence of enhanced knowledge retention using the Blended and Tine models within recruit training. Thus, it provides a warrant for DFB to move away

from the behaviourist-cognitivist approaches embodied with the Traditional model of RTC training.

3. This study articulates the principles and further provides evidence of the beneficial outcomes of fire service training in terms of enhanced student engagement and better knowledge retention, in deploying the Tine model, a learner-centred approach to fire service training that includes peer-to-peer and scenario-based learning. From the models tested, the findings point to the Tine model's potential to enhance knowledge retention and foster quality peer-to-peering learning in an active learning environment.

4. This study provides evidence to support the integration of online learning modules within recruit training at DFB, particularly in terms of the readiness of recruits for technology integration for online learning.

1.6 Reflections on the research journey

As previously mentioned, at the start of this research, I had completed undergraduate and postgraduate studies and naively thought that I was proficient in conducting research. In the first year of study, two things became evident. Firstly, I needed to deepen my knowledge of models, theories, processes and philosophical rationales underpinning different framings of education and training. Within the literature review, I examined the processes involved in the re-orientation towards student-centred tertiary education promoted through the Bologna Process (European Education Area 2023) and teaching, learning and assessment approaches used within education and training contexts. Furthermore, as each country has a different fire service training model, I reviewed other educational models and approaches and evaluated the effectiveness or otherwise of these. The latter provided further evidence of the need for this research study, as knowledge and skills retention were an issue for operational firefighters in several jurisdictions and thus had to be addressed within pre-service or in-service fire service training. Secondly, I needed to broaden my knowledge and skill set of research methods and processes. To support this, I undertook several graduate studies modules in qualitative and quantitative research across the period of study, which enhanced ongoing decision-making on framing this research study, including the research models, data collection tools and data analysis processes.

In the second year of the study, I entered the design phase. Through critical reflection on various pedagogical models and approaches within the literature, and dialogue with colleagues, I framed a new pedagogical model for implementation in firefighter training inspired by a K12 Station Rotation model (K12 education includes primary education starting in kindergarten, and secondary education ending in grade 12 in the United States). This model is now called the Tine model and has been modified from its initial blueprint into its now-tested model. Unfortunately, during my second year of studies, I became ill and had to overcome many procedures in the following years. These procedures may have prolonged my research journey but only strengthened my resolve to complete this research. The following body of work was undertaken to establish this studies data collection tools and explore the many research methodologies. I went to summer school in DCU to learn more about Design-Based Research, which inspired the framing of the research approaches to be deployed in exploring the Traditional, Blended and Tine models. I gained ethical approval from DCU's Research Ethics Committee (REC) for this study (Appendix A.1) and proceeded to structure the data collection tools for this study. The qualitative data collection tools centred on observations, semi-structured interviews and focus groups with the instructors and students. The quantitative data were collected in several ways, including a questionnaire focused on participants' demographics, attitudes and experience with technology and a standardised instrument called the Technology Readiness Index (TRI) which provided a snapshot of participant readiness for technology integration in the training context. In addition, the study utilised the Ebbinghaus Forgetting Curve (1885) to project and compare the participants' performance concerning knowledge retention across the three models implemented in this study.

One consistent obstacle that emerged during the early years of this research was getting access to recruit firefighters, which was delayed due to restrictions on recruitment of new firefighters (just two cohorts of new recruits were trained in DFB during the period of research, in 2017 and 2020) and resistance to changes to the status quo in terms of training within DFB. The latter challenge was overcome following a meeting with the Chief Fire Officer (CFO), who agreed to allow a pilot study using the Tine model for the scheduled EMS recruit class in October 2019 to ascertain its viability and effectiveness. I liaised with the EMS training staff and identified a suitable online module titled "Pentrox delivery" from the existing suite within the EMS programme that would be tested using the Tine model during this pilot study. I met with the participating students and asked their permission to

conduct this research. The EMS class all agreed to participate in the pilot. The feedback from focus groups and interviews deemed the EMS pilot a success, with students and instructors indicating a strong preference for the Tine model instead of the current traditional model in situ. The findings of the pilot were relayed to the CFO, who permitted the Tine model to be used during the next intake of firefighters during their course on Road Traffic Collisions (RTC) in 2020. It is worth noting that COVID-19 restrictions were in place during the data-collection phase of this study. This, in practice, led to an increased physical distancing between students within the traditional classroom setting and likely contributed to greater student familiarity with online technologies, such as Zoom and WhatsApp, for social interactions and communications.

In 2020, the Traditional, Blended and Tine models were tested with the new recruits during the recruitment firefighter training courses Road Traffic Collision (RTC) aspect. Before the RTC training, students completed a survey to capture demographic information, their access to and usage of different technologies and attitudes to technologies using the Technology Readiness Index (TRI 2.0). The 2020 recruit cohort was split into three sub-groups. All groups engaged in the same face-to-face in-class instruction. Set 2 and 3 had access to online RTC training material and completed the three identified RTC online modules before starting their face-to-face instruction. Set 1 and 2 completed the traditional drill yard training model for RTC. Set 3 engaged in the Tine model within the drill yard dimension of RTC training. Over forty hours of digital video footage were captured of the interactions of consenting recruits within the classroom and the drill yard lessons. Some footage consisted of the students waiting for their drills to start, and some footage was lost during a system update. However, approximately twelve hours of footage was analysed from the digital recordings for this research. In addition to this, I also observed over sixty hours of in-person engagement across a two-week timeframe by instructors and recruits across the three sub-groups via in-class sessions and skills lessons in the drill yard. All students participated in semi-structured focus groups, and the lead instructor from each set was interviewed individually. One learning point from the student and instructor interviews was that it would have been beneficial to expand on some of the focus groups questions, paying more attention to the inquiry of the students' previous interaction with blended and online learning. However, the time allocated to engage in focus groups had been carefully negotiated with DFB, and I had to work within a tight timeframe to conduct the focus groups.

When all the data was captured, the video footage from the face-to-face instruction in the classroom and the focus groups was transcribed, the initial codes and categories emerged through reading and re-reading of data sets. At this juncture, I felt like there was an insurmountable amount of data to make sense of. Personally, the data analysis phase was the most challenging part of the research journey, particularly trying to make sense of the multiple data sets collected in the context of the research questions posed. To address this issue, I used the NVIVO software to assist with analysing the different data streams. As a visual learner, NVIVO allowed me to code in colours and easily group data into categories or themes. Overall, the research journey has been a steep learning curve for me. However, the journey will have been worth it if the recommendations of this research can be implemented to support firefighters' life-long learning and, importantly, knowledge retention

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1.7 The Thesis Structure

Chapter Two presents a synopsis of the literature review, framed by the Seven-Step Model of the Comprehensive Literature Review created by Onwuegbuzie et al. (2016). The literature review examined the following areas: Learning paradigms, learning approaches, motivational factors, and domestic and international fire service training models. In this chapter, the literature on approaches to training with fire services within and beyond Ireland is critically reviewed. The aim was to critique these approaches in terms of preparing newly qualified and long-serving firefighters for the practice of firefighting.

Chapter two examines innovation and orientation in relation to education and training, and the potential implications for firefighting training. It became apparent from the start of this literature review that there is only a limited amount of literature on the theory of knowledge retention and training models within fire service training. Therefore, it was necessary to explore a wider range of topics such as learning paradigms, learning approaches, and motivational factors. This was done through evaluations of training conducted by fire services both in Ireland and overseas, as well as in other emergency management and education contexts.

Chapter Three sets out the worldview and philosophical assumptions that underpinned the research approach, adapting Saunders et al. (2016, p.124) "Research Onion" to present the

research philosophy supporting this study and to explain the assumptions underpinning decisions on the research process across six dimensions, namely, philosophy, methodology, strategies, approaches, time-horizons and data collection and analysis. This research study follows pragmatism as its research philosophy. Inductive reasoning supports the frame of analysis, as this study implements two exploratory training models rather than attempting to prove or disprove a pre-determined hypothesis. The third level of the Research Onion inspired the study's frame and boundary, which was based on the Design-Based Research model. The research was conducted using qualitative techniques and tools to gather and analyse data. However, a quantitative tool was also used to generate descriptive statistics to investigate one aspect of the study. This helped in obtaining context-based findings on the technology readiness of a broader cohort of participants. Furthermore, the Ebbinghaus Forgetting Curve was used to examine knowledge retention of recruit firefighters across the three models, Traditional, Blended and Tine. The study has been classified as having a cross-sectional time horizon and finally, the data collection tools and analysis included the thematic analysis of observations, interviews, surveys, and focus groups, as well as the generation of descriptive statistics from surveys.

Chapter Four presents an analysis of both quantitative and qualitative data collected from different levels of research. The pilot EMS study findings are discussed, followed by a rigorous examination of the data collected during the Traditional, Blended, and Tine models. The Traditional model mirrored the current training model in situ. The Blended model was the second model examined and its genesis is discussed in Chapter Four with regard to its leanings towards the flipped classroom concept, which allowed the students to access course material outside of a traditional classroom setting via online learning before or during face-to-face instruction. A fundamental principle of this research focused on the retention of knowledge and training models to support this concept, the literature was scanned for models that would allow learners to construct their learning at their own pace while accessing traditional face-to-face instruction. By relocating elements of the Road Traffic Collision course to an online modality, it was conceptualised that this would allow in-class time to be utilised for inquiry, application, and assessment. Finally, the last model examined was the Tine model, this model was created to combine the flexibility of the flipped classroom with effective pedagogical models that promote knowledge retention. At the core of its design lies the Station Rotation model, which has proven to be an effective way of personalising learning. This model involves rotating through various learning modalities, including

computer-based instruction, group projects, and individual tutoring. The Tine model further expands on this concept by introducing peer-to-peer, problem-based, and case-based learning into its structure using the constructivist station rotational approach. One of the key elements of the Tine model is the importance of not just learning information, but also putting that knowledge into practice.

Chapter Five presents a detailed summary of the study's findings, drawing overall conclusions from the data and suggesting areas for future research. As mentioned previously, this study investigated three training models applied in DFB, namely the Traditional, Blended, and Tine models. It analysed each model's effectiveness in Road Traffic Collision training, and the results informed the responses to the meta-level research questions. The Traditional model used didactic teaching and behaviourist training practices. The Blended model combined face-to-face learning with self-directed access to an online suite of RTC modules. The Tine model offered students face-to-face instruction, online training material, and cooperative problem-based and case-based learning during rotational skills lessons. The Tine model aimed to encourage a constructivist pedagogical approach, where students could build on their previous knowledge and examine real-world scenarios in structured peer-to-peer learning environments.

Chapter 2: Literature Review

2.1 Introduction

As Wentz (2014, p.2) explains, a "literature review is a synthesis of previous work in a specific area, providing a critical account of what is known, how it is known, and what is unknown". In this chapter, the literature on approaches to training with fire services within and beyond Ireland is critically reviewed. The aim is to critique these approaches in terms of preparing newly qualified and long-serving firefighters for the practice of firefighting. The chapter also explores innovation and orientations regarding education and training, and the implications for firefighting training. Saunders et al. (2007, p.57) highlight that "the literature review underpins the rationale for research, and it enables researchers to develop a good understanding and insight into relevant previous research and trends that have emerged". It was clear from the outset of this literature review that there was a modest amount of literature encompassing the theory of knowledge retention and training models within fire service training. Therefore, there was a need to explore more broadly topics such as learning paradigms, learning approaches, and motivational factors within evaluations of training conducted by fire services here in Ireland and abroad, and in other emergency management and education contexts.

2.2 Beginning the Journey

The study aimed to explore teaching and learning practices that could enhance the learning experience of new Dublin Fire Brigade recruits. The primary focus was on improving their ability to make informed decisions during critical incidents by retaining knowledge and skills. Onwuegbuzie et al. (2016, p.60) note that "research questions are formulated by identifying gaps in the existing literature". Therefore, an extensive literature review was conducted to identify evidence of effective pedagogical models for training firefighter recruits. In the context of this study, the research questions were developed by narrowing down the purpose statement, in response to the outcome from this review of the literature.

2.3 Literature Review Methodology

The framing of this literature review was inspired by the *Seven-Step Model of the Comprehensive Literature Review* (CLR) created by Onwuegbuzie et al. (2016, p.58) as outlined in Figure 2.1 below. This model consists of three distinct phases. The first phase,

called the Exploration Phase, involved exploring my own beliefs (further detailed in Chapter 4) and conducting an initial literature review on topics related to the research areas. The subsequent steps in this phase included searching and storing data, selecting or deselecting relevant information for the investigation, and expanding the search to other modes, as outlined by Onwuegbuzie et al. (2016, p.54) as "Media, Observation(s), Documents, Expert(s), Secondary (MODES) if necessary." In the second phase, the Interpretation Phase, the data was analysed, and the information was synthesized.

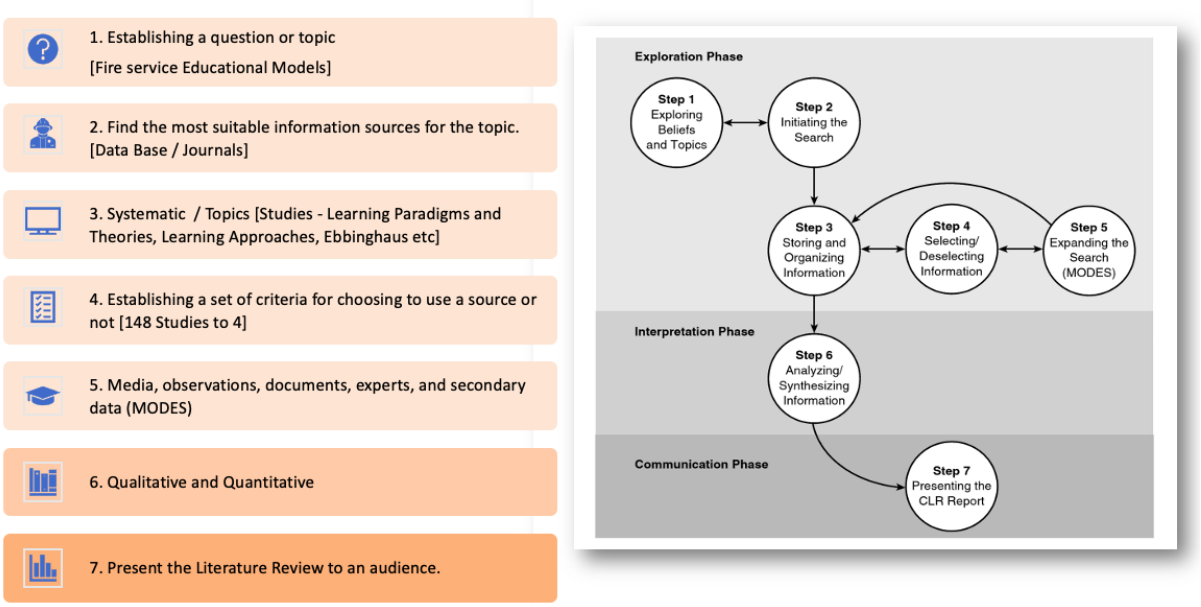


Figure 2.1 The Seven-Step Model for a Comprehensive Literature Review, Seven Steps to Comprehensive Literature Review (Onwuegbuzie et al., 2016, p. 58).

During this Interpretation phase, the data gathered from the literature were classified into themes of: Training Models, Learning Paradigms, Motivation, Learning under Stress and Learning Approaches as shown in Figure 2.4. Subsequently, the collated literature was analysed per the relevant theme and the outcomes considered in the context of the proposed research questions.

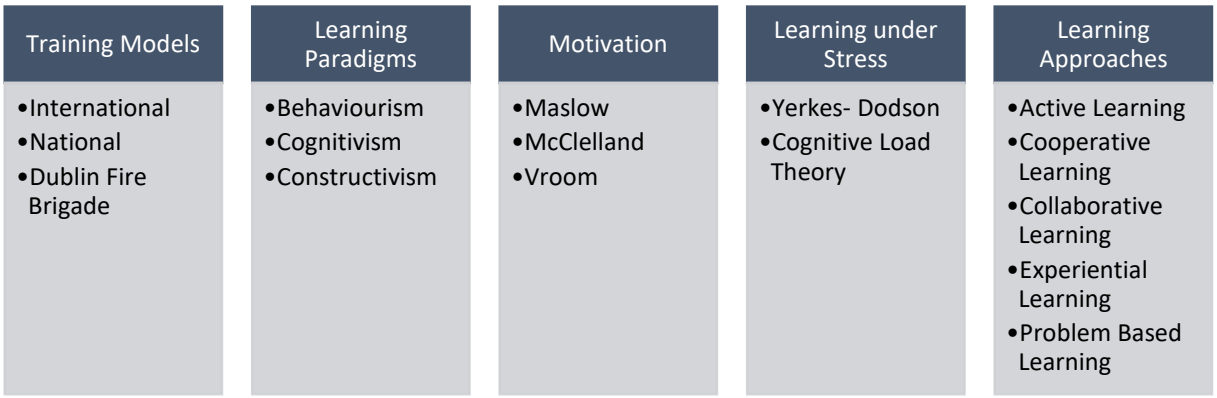


Figure 2.4 Overview Literature Research Topics

The Communication Phase was the final step in completing this literature review, which essential involved deciding "how to convey the information, analysis, and the conclusions and implications" (Onwuegbuzie and Frels, 2016, p.57). There are various ways to present the literature review using the AVOW method. AVOW stands for Acting, Visualizing, Oral, and Writing. Acting involves using poetry, music, or dance to present the literature review. Visualizing involves using paintings, drawings, or photography to present the literature review. The oral presentation involves presenting the literature review verbally. Lastly, writing involves producing a written account of the literature review. These are some effective ways to present a literature review using the AVOW method. The written medium was deemed the most suitable format for this thesis, and through the course of this chapter, the literature review is now disseminated to the 'appropriate audience' (Onwuegbuzie et al., 2016, p.58).

2.4 Exploration Phase

To conduct research into the realm of fire service education and training, a roadmap must be signposted, and the areas of concentrated focus delineated. The areas of focus were initially developed from a primary literature search, Figure 2.2 depicts an overview of the literature research topics which emerged from the primary literature review. The initial review was also used as an opportunity to address my knowledge gaps in the context of learning theories, theorists, and educational models. After I had formed a foundation in pedagogical theory and practices, it was necessary to interrogate the literature to narrow the scope in terms of fire service training models.

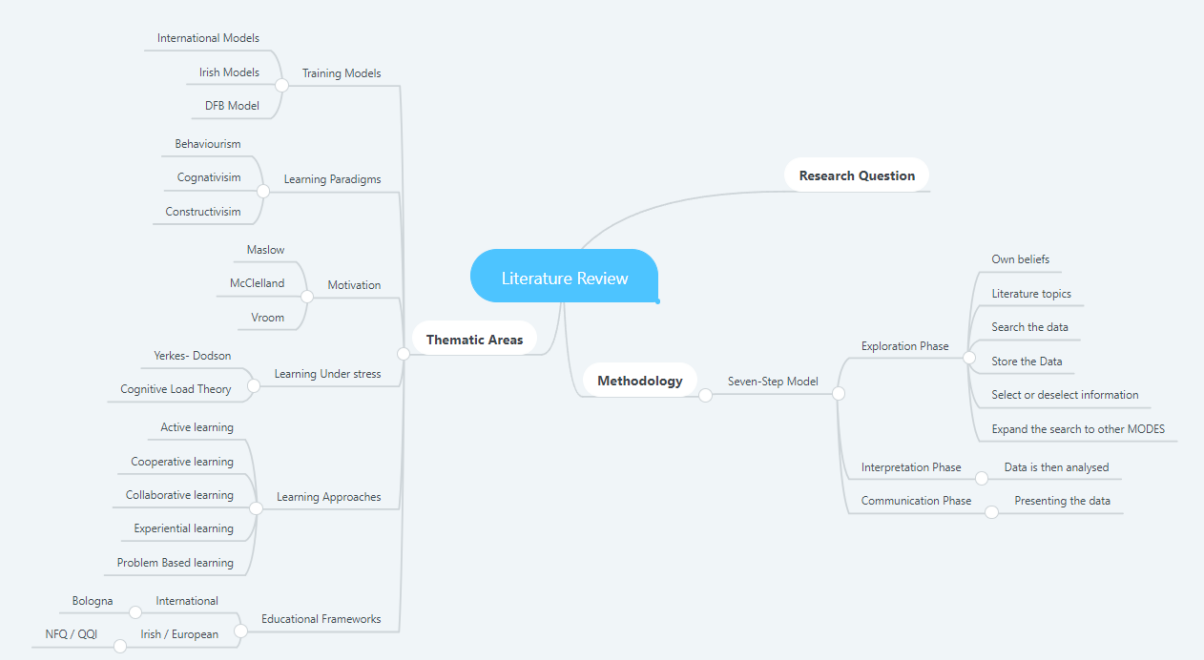


Figure 2.2 Mind Map – Overview of the literature research topics.

Throughout this research, great care was taken to conduct an extensive literature review to ensure its complete and comprehensive nature. To achieve this, I used a variety of resources, including multiple databases and search engines and made physical visits to review articles and books within the DCU libraries. I focused my attention on the period from 1940 to 2023, using both the DCU Library research tool and the Google Scholars search engine. The initial literature reviews returned quite an overwhelming number of articles, books, reviews, and other academic writings. I knew from the outset this research would concentrate on firefighter education and training models. As I continued my research, I found it logical to utilise combinations of search terms such as *firefighter*, *studies*, *training*, *education*, *models*, and *pedagogy*. The following section presents the review of literature on fire service training models.

2.4.1 Training Models Studies

A review of the literature focusing on fire service training models was conducted. Based on the search results, one hundred and forty-eight studies were identified as relevant to firefighter education and training. These studies were carefully reviewed to determine if any pertinent information was relevant to the research questions offered in this thesis. It's worth pointing out that there was a global context to the studies on firefighter education and training returned from the literature review. Some of the countries that had conducted such

studies included South Korea, the Netherlands, Japan, Canada, and the United States of America (USA). The focus of these firefighter studies also centred around a smorgasbord of topics ranging from mental health, fitness, and trauma to risk assessment at wildland fires. The review of the studies revealed a broader trend towards integrating technology into firefighting over the past few decades, focusing on operational and educational technologies. Out of the one hundred and forty-eight studies, six studies were identified as being potentially relevant to the thematic area of this research, as they claimed to focus their investigations within the scope of firefighter education and training. However, as is discussed below, the first two didn't detail the firefighter training models, and thus are presented here as examples of the challenge in conducting this review. The latter four cases are the only studies identified that researched the firefighter training models.

2.4.1.1 Study 1 – Selection Test and Physical Abilities

The first study identified for discussion was conducted by Henderson et al. (2010) from Oberlin College in the USA. This study observed seventy-four firefighters (male n=64, female n=10) from one academy training class over a twenty-three-year period, starting from their selection test, which was completed before training started. This study focused on the selection test and physical fitness abilities over this period. The initial test was conducted in 1983 and consisted of cognitive and physical ability components (Henderson et al., 2010, p.1004). The cognitive ability test had six sections with one hundred and twenty questions. These sections included recalling information from fire training manuals, reading comprehension of technical materials such as mechanical diagrams and graphs, following commands to navigate a five-by-five letter grid, performing computations related to firefighting, drawing conclusions from written statements, and identifying a set of numbers, letters, or symbols that differed from the others. These sections were based on cognitive factors such as associative memory, meaningful memory, visual memory, reading comprehension, visualisation, mechanical knowledge, integrative processes, sequential reasoning, numerical facility, quantitative reasoning, and induction. The selection test for physical abilities consisted of two-timed events. The first event required candidates to simulate a fire scene arrival where they had to drag two lengths of hose over fifty meters, carry a ladder a certain distance, and climb five flights of stairs in an identified period. The recommendations from this study discuss that those responsible for creating entry-level firefighter tests must demonstrate the validity of each screening component, such as

cognitive and physical abilities. The study goes on to advocate that it is crucial to determine the value of each element in the selection process as it is easier to ensure the validity of General Cognitive Ability (GCA) and Specific Cognitive Ability (SE) compared to establishing and maintaining justifiable weights for each component during the screening process (Henderson et al., 2010, p.1009). As can be seen from the subject area of this study, it is relevant to firefighter training, and although this study provided some valuable insights into the selection process to become a firefighter in the USA, it did not include any information relating to training models or underpinning educational and or training philosophies.

2.4.1.2 Study 2 - Freezing

The second study identified was conducted in the Netherlands by Ly et al. (2017, p.10). They focused on the defensive response called 'freezing'. This study was chosen for review as it investigated how threat-induced freezing manifests in high-risk professions, such as firefighting. Forty firefighters took part in this study, comparing experienced and inexperienced firefighters on a passive viewing task involving neutral, pleasant, related-unpleasant, and unrelated-unpleasant pictures to determine freezing responses (Ly et al., 2017, p.10). The context of their study allowed for optimal assessment of freezing as a spontaneous response to unpleasant images. Additionally, both profession-related and unrelated stimuli were included to explore the effects of incident experience on freezing.

Freezing can be described as a natural response to perceived threats in animals, characterised by heart rate deceleration and immobility (Ly et al., 2017, p.10). Research has shown that freezing can be induced in humans through a passive viewing task involving aversive stimuli. These previous studies consistently found that passively viewing unpleasant pictures decreases heart rate and postural sway, indicating a freezing response. Additionally, research has found that freezing is active rather than passive. For example, in the Ly et al. (ibid) study, when participants anticipated an opportunity to counter a threat, their heart rate and postural sway reductions were more pronounced than when they were in a helpless condition without such an opportunity. These findings suggest that freezing plays a vital role in action preparation. Mental imagery has also been found to increase freezing upon exposure to anticipated aversive pictures, possibly reflecting action preparation after mental imagery of the anticipated aversive pictures. While it appears that freezing is essential for

active coping, it's also crucial to be able to regulate this primary defence response for adaptive responding, especially in a firefighting context. The findings from this study indicated that firefighters with more experience in incidents are less likely to freeze when faced with a threat. They did not find that threats related to the job of firefighting significantly impacted their response. Ly et al. (ibid) concluded that while more research was needed to understand the mechanisms at play fully, these findings suggested that experience and training can affect natural defensive reactions. This could have important implications for high-risk professions such as firefighting and inspire new research. Another of their findings was that they found that animal-to-human translational approaches could pave the way for fresh procedures to test and train risk assessment abilities, which could be especially valuable for those in high-risk professions such as firefighters. This study was included as I was intrigued if any link between freezing and behaviourist training models would emerge. Unfortunately, this study did not discuss this correlation, it would be interesting to explore the thematic area of freezing and extraneous cognitive load during firefighter training. This concept was outside the scope of this research; however, it could be considered an area for future research.

2.4.1.3 Study 3 – Fire Service Training Models USA

The third study was conducted by Cassidy in 2020, this study explored the area of fire service training models in the USA. Cassidy (2020, p.115) noted that providing ongoing training and professional development in the fire service was challenging given the need to maintain effective response forces; manage overtime budgets; and in the case of large departments, cycle hundreds of recruit classes through training. In his study, Cassidy (ibid) discussed three aspects of firefighter training, moving from recruit training to the probationary year and ongoing training in the Northwest Fire Department, USA. Cassidy (ibid) highlighted the tension between developing competency versus mastery of critical skills within the initial training of firefighters, noting, “The recruit academy intends to get firefighters to a place where they can function as a member of the team. That means they are competent; it does not mean they have mastered anything ... yet”. Cassidy (ibid) outlined the fifteen-week training programme in the article but provided sparse detail concerning course content or pedagogical models. Cassidy (2020, p. 116) did however, give some valuable insights when they moved from an eight-hour day to a ten-hour training day by observing “We typically had those two extra hours to get in more skill work while the instruction was still fresh in

the recruit's memory. This led to better muscle memory and proficiency". In addition, he noted that having the recruits' complete quizzes before face-to-face instruction enhanced personal accountability. According to Cassidy (ibid), "This may seem backwards, but this process puts the onus on the recruits to come to class having already read the information so that it isn't completely foreign to them. It eliminates the scenario where recruits rely on classroom information being fed to them and gives them some personal accountability". Cassidy further described the students being rotated through their skills "Specific skills are rotated each week to keep current on all skills. At the beginning of [the] academy, recruits are assigned as teams; these teams rotate through each station, sometimes multiple times, until training is concluded". This model is similar in its concept to the Station Rotation model, discussed later in this chapter, as it encourages students to rotate through different skill stations during their recruit training. The study does not elaborate or offer the reader any further details of the stations within the training model, other than the model did not incorporate online or collaborative learning elements in its constructs. One thematic area not captured in the study conducted by Cassidy was educational psychology or educational theories. It was, however, encouraging to discover that the Station Rotation model was beneficial to the firefighter training in this study. This study provided inspiration for the structuring of the proposed Tine model, developed during the design stage of this research study.

2.4.1.4 Study 4 - Firefighting Education using Virtual Reality

The fourth study was conducted by Reis et al. from 2017 to 2019; this study utilised action-based research methods and involved two iterations of firefighting training courses. The Reis et al. (2019) study was significant for two reasons – firstly, it successfully applied principles from the Keskitalo (2015) model in training for firefighters, and secondly, it researched a fully immersed technological innovation in the form of a Virtual Reality (VR) simulator of emergency fire events. The research focused on firefighting education using Virtual Reality to assist the firefighter or officer in decision-making while responding to an emergency. The first iteration was a pilot training course for a group of eight internal and external trainers from the Portuguese National Fire Service School, while the second iteration was for eight fire officers from different firefighter corps. The exercises in the study covered a variety of challenging scenarios, including urban and industrial fires, forest fires, accidents with a high number of victims, and accidents involving hazardous materials. The scenarios were based

on actual situations and the trainers' operational experience, which allowed participants to make critical decisions in complex situations. Each trainee was able to perform formative and summative assessment exercises, with the eight exercises randomly assigned to ensure fairness. It's important to note that no trainee performed the role of Incident Commander in both formative and evaluative exercises for the same scenario. The results from the study indicated that VR could be a valuable tool for enhancing decision-making competencies in managing operational incidents. According to Reis et al. (2019, p.6) “the data collected and the comparative analysis on the performance of the two groups of trainees, as well as the trainers' and trainees' perception in terms of evaluation of the training course, allowed to identify corrections and introduce changes, in the logic of continuous improvement of the training product”. The trainees who participated in the VR training found it highly effective and relevant to their jobs. They reported feeling more confident in their decision-making abilities and believed that the skills they gained could be applied in real-life situations. Reis et al. (ibid) concluded that VR technology could be an extremely useful tool for firefighter training, as it allows for creating realistic scenarios that challenge learners and promote engagement. Reis et al. (ibid) discussed how the principles of a model developed by Keskitalo (2015) initially designed for a healthcare setting were successfully applied to this firefighter training model, as seen in Figure 2.5.

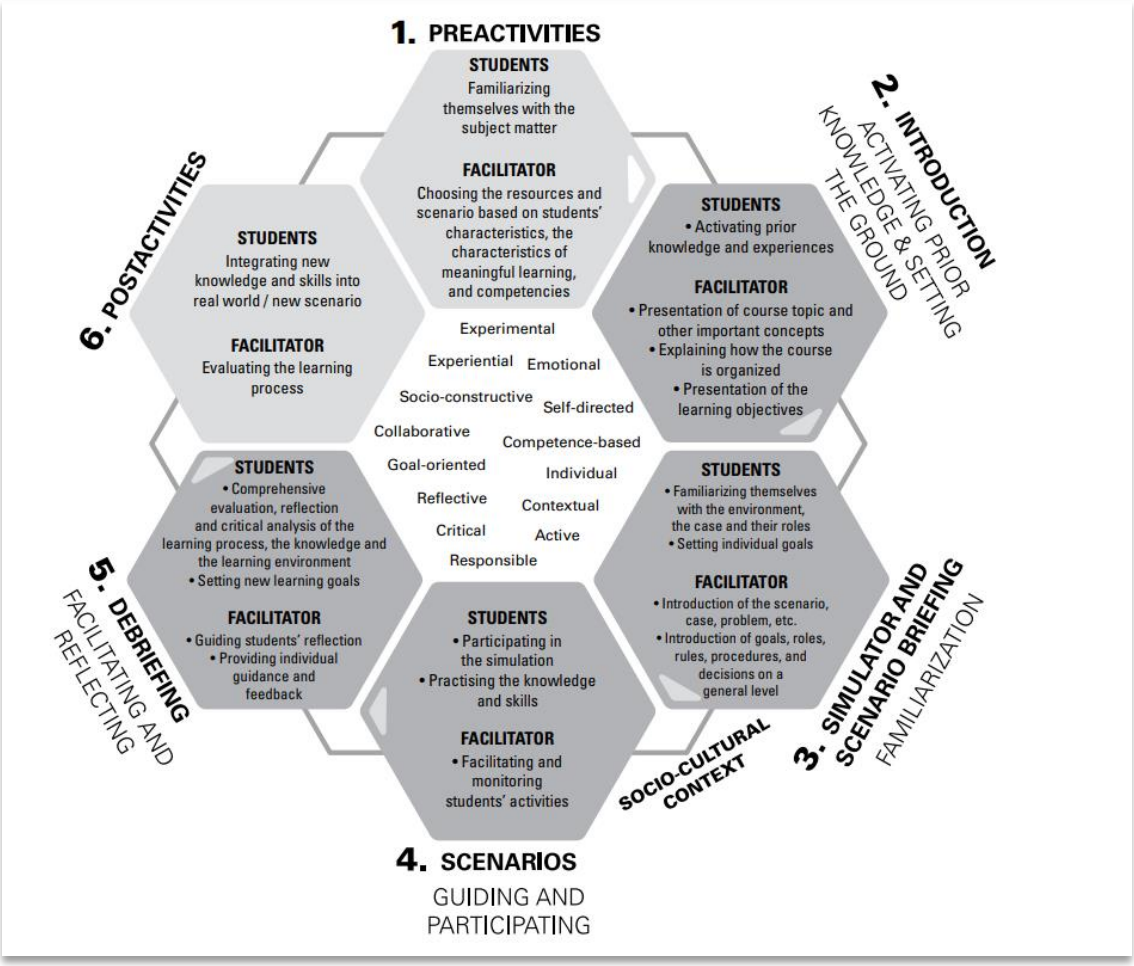


Figure 2.5 The pedagogical model for simulation-based health education (Keskitalo, 2015, p.66)

The pedagogical model designed by Keskitalo has six stages. Stage one – ***Preactivities***, where the facilitator designs the learning process and environment with specific learning objectives and student characteristics in mind. The facilitator considers meaningful learning when planning, realising, and evaluating student activities. The interaction with the students includes an introduction, simulator and scenario briefing, scenarios and debriefing. Stage two – ***Introduction, active knowledge and setting the ground***, where at the beginning of a simulation-based learning process, the facilitator introduces the course topic and its objectives, along with the advantages and disadvantages of simulation. The learning objectives are presented as abstract statements. The purpose of this introductory phase is to activate learners' previous knowledge and experiences, which will serve as a foundation for new knowledge. Activating prior knowledge can be done through writing, questioning, discussing, sharing experiences, making analogies, constructing concept maps, and other activities. The goal is for learners to reflect on their previous knowledge and experiences and become familiar with the topic, learning objectives, simulation-based learning,

pedagogical models, methods, ground rules, and confidentiality. In Stage three - ***Simulator and scenario briefing - Familiarisation***, participants are introduced to the simulation by the facilitator. This includes the case scenario and the technology used during the simulation-based learning environment. To help participants get in the right mind-set for the exercise, the facilitator can use real-world examples or problems as learning triggers. To create an understandable scenario, asking questions such as who is acting, what is being done, where the situation occurs, and why this evolved is suggested. The fourth stage is ***Scenarios – Guiding and Participating***. In this stage, students are guided and encouraged to participate actively. This stage is the core of the learning experience and involves treating the patient [in a healthcare setting] through a simulation. The facilitator takes a step back during this phase, allowing students to take the lead. The facilitator needs to establish clear start and end times for the scenario. During the penultimate stage, stage five, ***Debriefing- facilitating and reflecting***, the students are responsible for reflecting on their learning experience and identifying gaps in their knowledge. The facilitator's role is to encourage students to analyse the entire experience and ask questions such as, "How did the scenario go?" and "What problems did you encounter and why?" (Keskitalo, 2015, p.69). It is also important to compare the simulation to the real world so that students understand how their skills translate. According to Keskitalo (2015, p.69) personalised feedback is important, noting that "Individualised feedback and emotional support should be provided to aid in developing expertise". Video recordings are often used during debriefing, but other tools and methods, such as learning diaries, are also available. And finally, stage six, ***Post-activities***. In this stage, the facilitator needs to evaluate the entire process during the post-activities phase. This includes considering the facilitation process, the student's activities, and whether the learning objectives were met. This evaluation is crucial for the development of simulation-based education and for the facilitator's role as the facilitator. For students, it is suggested that it is beneficial to have the opportunity to apply their learned knowledge and skills in a new scenario or in real life during their post-activities. The study conducted by Reis et al. (2019) aimed to enhance the teaching methods used for virtual reality training of Portuguese firefighters and improve the skills of fire brigade leaders in managing operations. The research resulted in valuable guidelines that can be applied in similar training contexts involving simulation techniques or technologies, such as recruit firefighter training. The study conducted by Reis et al. (ibid) concluded that it was essential for learners to be placed in authentic situations that simulate reality and were related to the problems, responsibilities, and tasks inherent to their role. Virtual reality simulators can create realistic scenarios that

challenge learners and help them react as if they were in a real-life situation. Whenever possible, virtual scenarios should be based on actual events, and the learner's decision-making should guide the scenario's evolution to better match the demands of real life. Training that involves virtual reality simulation should follow a pedagogical model that outlines the different phases needed to complete the exercises. Decision-making skills should be evaluated against scenarios that represent the situations trainees may encounter in their work. The study concluded that the training activities designed to develop decision-making skills in operations management were effective. However, not all competencies were developed equally and effectively through training, which requires ongoing research and improvement.

2.4.1.5 Study 5 - VR control devices and human factors

The fifth study reviewed was conducted by Seunggon et al. (2021). This study focused on the relationship between VR control devices and human factors in fire fighter training. This research involved thirty experienced firefighters and tested the connection between perceived presence and cognitive load. Perceived presence refers to the sense of being in a virtual environment, attention to both real and virtual environments, and the degree of reflection of reality. Conversely, cognitive load refers to the amount of information that working memory can hold. The study created three groups with different conditions: two standard VR controllers, four real tools, and a hybrid of one real tool and one standard VR controller. Results showed that the hybrid group had higher perceived presence and lower cognitive load than the control and real tool groups. The study concluded that increasing realism using more realistic devices may lead to a better user experience. However, using a combination of fundamental tools and standard VR controllers is more effective in optimising user experience and achieving training goals. It was interesting to discover that the firefighters in this study preferred using real tools, ones that had a genuine haptic feel augmented with a realistic scenario.

2.4.1.6 Study 6 – Training methods

The final study to be discussed was conducted by Templeman (2021), this study explored training methods employed in the Queensland Fire and Emergency Service firefighter training program. The investigation began by reviewing the literature available in relation to firefighter education and training models. As found in the literature review process for

this study, Templeman (2021, p.1) noted the scarcity of studies in fire fighter training "Remarkably, there has been limited research conducted in relation to recruit firefighter training throughout the world. Currently, there is no published literature on recruit firefighter training in an Australian context". This study focused on the thematic area of adult learning within the context of fire fighter training, recognising that adult learners' needs differ from those of children and, therefore, the educational approaches needed to vary. A core component of adult learning theory is based on Knowles's theory of andragogy, defined as "the art and science of helping adults learn" (Knowles et al., 1980, p.23). According to Knowles et al. (1980, p.23), the theory of andragogy proposes six basic assumptions: The need to know, the learner's self-concept, the role of the learners' experiences, readiness to learn, orientation to learning and motivation. In a summative format, as adults, we are self-directed learners who actively participate in decision-making. Adults possess autonomy and are responsible for their own learning. Their backgrounds, learning styles, needs, and goals differ, which affects the learning experiences. Adults have valuable prior experience that can benefit both teachers and learners. They are eager to learn what is needed to succeed and require practical and relevant knowledge. Adults find gratification and pleasure in learning. They are interested in learning to solve problems, and learning should focus on tasks, issues, and real-life situations, rather than being structured around the subject matter. Adults' primary motivation stems from internal factors such as increased self-esteem and job satisfaction instead of external factors. Templeman (2021, p.17) suggests that these andragogical assumptions are broadly aligned with social constructivist orientations to learning, where social constructivist theory emphasises learning by constructing knowledge through experiences with people and the environment.

In contrast to the aforementioned principles of adult learning theory, this study found that recruit firefighter training in the Queensland Fire and Emergency Service had a paramilitaristic instructional philosophy. It was suggested that instructors significantly influenced the training approach, which varied across courses. The paramilitary approach was sometimes poorly implemented and shifted focus from discipline to abuse of power (Templeman, 2021, p.55). The impact on recruits was mixed, with some reporting positive experiences and others negative experiences. Although the training prepared recruits with fundamental firefighting skills, Templeman (2021, p.56) advocated that there needed to be more development of soft skills. Applying adult learning principles to the training approach was generally agreed upon, but there was a preference for retaining some paramilitary

aspects. Recruits indicated a desire for instructors to show more respect, remove inappropriate gaming - games being played by the instructor such as hiding equipment as described by Templeman (2021, p.31), aspects of training, and make training more relevant to the actual role of firefighters.

2.4.1.7 Summary

Childs (2005, p.558) calls for a "paradigmatic shift in the approach taken by educators who work with firefighters", one that moves training away from didactic methods based on rote learning, chalk and talk, and show and tell, which he perceives as "insufficient as a means of developing firefighters capable of responding and adapting to complex demands". The literature reviewed on fire service education and training models for this study seems to point to some experimentation, particularly with technology, in training approaches, suggesting an emerging realisation of the need to shift from the traditional face-to-face pedagogical models that most fire services have historically used in favour of integrating technological-based solutions. Technology has always been a crucial aspect of firefighting at a practice level, which includes passive and active fire suppression systems and equipment like thermal imaging cameras that help firefighters locate casualties or identify the source of a fire. Regarding technology integration in firefighter training, the recent studies by Reis et al. (2019) and Seunggon et al. (2021) suggest that VR could serve as an essential tool for bridging the gap between education and emergency response and they both agree that VR is emerging as a possible educational tool within firefighter training.

From this literature review process, it was evident that there was scant research and information on the effectiveness of firefighter training models. Given the dearth of scholarly studies and literature on fire fighter training models, there was a need to conduct a more general review to get a sense of how firefighter training was structured and delivered in different jurisdictions, and to examine whether there were any in-house evaluations that might inform the study. This dimension of the review focused on gathering information from non-scholarly sources, thus published outside the traditional publishing houses. In this regard, it refers to information gleaned from reports and websites produced by fire services authorities referring to fire fighter training courses and initiatives. The following section presents an overview of international fire fighter training programmes, and then moves to describe the DFB fire fighter training programme in Ireland. It is important to note here that evaluations of in-house training were not uncovered during this review process, and thus the

following sections present general information on fire service training structures, content and models in particular jurisdictions.

2.4 International Models

This section of the review focuses on international fire service training models, exploring the course design, duration, and integration of online learning.

How we train, and the models and techniques used, can determine the outcome and mitigate the risks our firefighters face when responding to emergencies. For example, according to the Department of Safety and Professional Services, USA (Wisconsin Standard Operational Guidelines, 2016, p.2) when responding to a structure fire (such as a house fire) the weight of response in protection and salvage of the structure by utilising an "offensive" firefighting technique is high. This technique encourages incident commanders to direct their firefighters to use internal firefighting techniques, where a firefighter will enter the affected building and fight the fire from inside or on top of the structure. In contrast, according to the UK Fire Service Manual Volume 2. (2008, p.74) their default tactical mode is a "defensive". During this tactical firefighting mode, the incident commander will instruct their firefighters to start their firefighting from outside the building or structure. These contrasting techniques are not confined to operational procedures, from the literature reviewed, international training models, course duration, and delivery methods often differed from state to state and country to country. This process started by reviewing information on fire service training within the United Kingdom before extending the review to Sweden, Denmark, the Netherlands, New Zealand, Canada and Sweden.

European countries

In the United Kingdom (UK), the Civil Contingencies Act (2004) underpins the provision of fire service training in the British Isles. London Fire Brigade (LFB, 2016, p.1) states "that to become a firefighter, the student must complete three stages of training". Stage one, the student must complete a ten-week self-directed pre-course that is delivered online in modules in their own time. These modules are based on the foundation course and offer the student an introduction to fire service operations and course content. Stage two is a ten-week foundation course covering the basic skills of pumps, ladders, lines, breathing apparatus, road traffic collision, hazardous materials, working on water, and immediate care.

This instruction is conducted face-to-face in training centres across the UK. All courses are approved by the Qualification Regulators who provide qualifications in England, Wales and Northern Ireland. The awarding body is Skills For Justice. The UK has become the first centre in Europe to achieve Pro Board accreditation to certify to the US-based National Fire Protection Association (NFPA) Standards. The standards included in the introductory firefighting course include NFPA 1001 Standard for Firefighter Professional Qualifications, NFPA 472 Standard for Competence of Responders to Hazardous Materials Incidents Awareness Level and; NFPA 472 Standard for Competence of Responders to Hazardous Materials Incidents. Stage three is a probationary nine months of on-the-job firefighting training, followed by a final review. The last review is conducted by an independent assessor who has not been involved with the recruits probationary training. The recruit will become a full-time firefighter when all three phases are complete.

When it comes to international training models for the fire service in the Netherlands, the Institute for Safety (NIFV) plays an essential role in preparing professionals for incidents, crises, and disasters by providing primary education in firefighting, breathing apparatus, road traffic collisions, hazmat, and first-aid. They also provide a ten-week program with a review and mentoring system in place to ensure the effectiveness of their training. In contrast to the Dutch model, Denmark has outsourced its fire provision to an independent company called FALCK. This company offers a five-week face-to-face firefighting course, after this course the student is placed in an operational role. The training is accredited to the National Fire Protection Association (NFPA) Standard 1401. According to Thain (2019, p.1) "While many organisations choose to invest in their own Fire and Rescue Service, which includes the provision of a Fire Station(s), personnel, vehicles and equipment, others have turned to outsourced service providers to enable them to meet their operational and compliance needs." The NFPA standard outlines how a fire service should conduct the administration for a recruit training programme; however, it omits to outline the course content, course design and delivery methodologies. Variances in implementation, course design and delivery methods at local levels could impact the integrity of training provision, and lead to inconsistency of firefighter training in this jurisdiction.

In Sweden, the government offers a more holistic firefighting educational system. Rather than providing instruction on only firefighting skills, they offer inclusion to the EU Civil Protection Programme; this training programme was created for civil protection and

emergency management personnel to enhance prevention, preparedness and disaster response by ensuring compatibility and complementarity between the intervention teams and other intervention support as well as by improving the competence of the experts involved. The foundation firefighting course offers eighty credits or two years of full-time study, where one credit is equivalent to one week of full-time study. Successful completion of the programme results in a degree in Safety and Emergency Response work [European Qualifications Framework (EQF) Level 5]. The learning outcomes are clearly defined as providing the prerequisites in knowledge, abilities and competence required for a professional role in civil protection. The programme outline can be seen in Table 2.3

Course	Credits
Working with municipal safety and emergency response	6
Emergency phases	14
Risks with hazardous substances	5
Safety work performed in a systematic and safe manner	10
Municipal safety	5
The incident site	5
Learning by working (LIA)	15
Major incident	6
Robust society	8
In-depth project	6

Table 2.3 Programme outline: The Swedish firefighter foundation course (Civil Protection Programme (SMO), p.5)

New Zealand

The New Zealand Fire Service (NZFS) offer a twelve-week training course comprising theory and practical training. (NZFS - Recruitment Overview, 2016, p.2). The core skills that a student is exposed to are comparable to European skills, such as Breathing Apparatus and Basic Firefighting techniques, however in NZFS, once a Firefighter has completed their basic training, they are enrolled into a Qualified Firefighter (QF) programme. This programme is aligned with the National Framework Qualifications Authority (NFQA) and takes an average of twelve to fifteen months to complete. Basic training is mainly positioned in levels 2 and 3 of the NZQF [similar to the Irish NFQ, there are ten levels on this framework]. As the firefighter progresses through their career, they can obtain credits up to and including level 6. For example, the unit "Manage Fire Officer Duties" is situated at level 6 and offers 12 credits.

Canada

According to the Fire Protection Research Foundation of Canada (2015, p.1), the level of training provided to recruit or initial firefighter candidates in the Canadian Fire Service training institutions widely vary in terms of curricula and the number of hours in the structured training programs. The career firefighter is offered two hundred and seventy hours of theoretical and skills-based training. The National Fire Protection Agency (NFPA) delineates the professional qualifications standards, augmented by two other international accreditation agencies, Pro Board and the International Fire Service Accreditation Congress (IFSAC). These agencies require that training institutions meet or surpass the training suggested within the NFPA 1001 standard for accreditation consideration. NFPA 1001 is broken into two sections: Firefighter I and Firefighter II. While the NFPA 1001 standard lists the specific Job Performance Requirements (JPR) and information necessary to complete these tasks, the standard must discuss the time required to address these requirements. In addition to the variances in training times because of the vast size of Canada, the Fire and Emergency Services Training Institute (FESTI) offers a blended National Fire Protection Association (NFPA) 1001 Level I - II Firefighter training programme that integrates online learning on theoretical dimensions with face-to-face instruction for skills aspect to address its recruitment needs. According to FESTI (2017, p.2) "An online platform has been developed utilising a blended learning strategy that incorporates a variety of learning tools and aids to assist students in completing the

theoretical portion of the program". After completing the online portion of this course, the student must then attend a four-week, skills-based course.

2.5 Irish National Fire Service Training Models

This section examines the fire service training model employed in the Republic of Ireland and will then focus on the Fire and EMS training model used by Dublin Fire Brigade. In the Republic of Ireland, all local authorities must provide a fire service (Fire Services Act, 1981). Section 15(1) (2003, p.9) of the Act states, "It shall be the duty of a fire authority to make arrangements for the efficient training of the personnel of its fire services". The act does not specify the content, nature or duration of this training, and as such, Ireland has two distinct fire service training models. Firstly, we will explore the national training model for fire service personnel [excludes Dublin].

The national training model is based on a fire-only training model. This model has been aligned to the NFQ as a special purpose award [level 5]. According to the (QQI, 2016, p.1) "The purpose of this award is to enable the learner to acquire the relevant knowledge, skill and competence to effectively and safely apply firefighting and rescue skills in various operational environments, as part of a fire service team". As stated, this programme is aimed at level 5 on the NFQ, and the student will receive a special purpose award with 45 ECTS credits. The five core skills identified are outlined in Table 2.5 below.

Modules – Core Skill Sets	Credit Value
Using Breathing apparatus	15
Fire Fighting Skills	15
Transportation Incidents	5
Hazardous materials	5
Fire Service Pump Operations	5

Table 2.5 QQI Special Purpose Award Firefighting Operations [NFQ – Level 5]

Given that building a core skill set, as mentioned, is fundamental to becoming a competent firefighter, there may be a place for rote learning within the fire service. However, as Childs observed (2005, p.54) firefighters require specialist training, as "no longer are firefighters manual labourers relying on a basic trade certificate; the role of a firefighter has dramatically changed over the past few years and will continue to do so". A standard model for most

apprenticeships is on-the-job training, and within this vein, the fire services in Ireland have adopted this schema. Post basic recruit training, a firefighter will receive on-the-job training, where skills learnt are put into practice under the watchful eye of a mentor. This mentorship lasts one year, then a review occurs, and a final evaluation is conducted. Within this year, the firefighter will respond to operational activities, and their competency will be reassessed by their line manager(s).

Dublin Fire Brigade Recruit Training Programme

The Dublin Fire Brigade Basic Recruit Programme has two main components, firefighting and paramedic training. Paramedic training is outside the scope of this research, still, it is important to identify that Paramedic training is awarded by the Royal College of Surgeons Ireland and is situated at a level 8 special purpose award on the NFQ. It takes a successful firefighter two years to complete this programme's undergraduate and postgraduate phases while being supervised and mentored by their peers in an operational setting. The firefighting programme comprises seven unique courses: Basic Training, Breathing Apparatus, Road Traffic Collisions, Pump Operations, Emergency First Responder, Swift Water Rescue Technician and Hazardous Materials, as outline in sub-sections below. Each course is divided into subjects, and each subject is further broken down into two subsets, cognitive lessons and psychomotor skills. Basic Training is completed over a five-week period where the student is exposed to various subjects that form the foundation of a firefighter's education. These subjects were developed with best practices from the British fire services and have remained the same over the past twenty years. The educational philosophy is centred on demonstration and imitation, typically through face-to-face lessons and practical skill sessions. It's worth noting that the Swift Water Rescue Technician module, which covers the necessary knowledge and abilities to perform bank-based and shallow water rescues in water incidents such as floods and swift water incidents, has not yet been incorporated into the online learning curriculum of DFB but is globally recognised and accredited by Rescue 3. This certification is the fundamental level for all operational personnel responding to flooding incidents.

Breathing Apparatus Module

Firefighters must protect their respiratory systems from toxic gases and irrespirable atmospheres. The Breathing Apparatus training is aimed at preparing the student for operational incidents that a firefighter will encounter during their professional career. Health

and Safety must provide staff with the correct Personal Protective Equipment (PPE) to ensure their safety during an incident. All lessons are delivered face-to-face and supported with online learning content; all content has been developed in-house and focuses on giving the learner a locally branded interactive experience. Compartment Fire Behaviour is a relativity new topic; as a result, new content and video-based information that the learner can review in their own time has been developed. This programme is a three-week intergraded Breathing Apparatus and Compartment Fire Behaviour Training (CFBT) course where learning is heavily weighted on the student's skill set.

Road Traffic Collision Module

Road Traffic Collisions (RTC) are an unavoidable reality. As a vital part of a firefighter's operational role, they must use rescue equipment at the scene of an RTC. The equipment used during the emergency response to such an incident is heavy and dangerous. For example, the hydraulic cutters operate at 720 bar, which is 35 times the pressure of the tyres in a family car. Protocols and procedures are vital for the safety of the operator and members of the public. This module is delivered over two weeks, with lessons and skills-based learning; online learning is focused on equipment and its operation.

Pump Operator Module

This module's duration is one week. The delivery method is based on face-to-face cognitive and skills-based learning. This module aims to equip the learner with the relevant knowledge, skill, and competence to operate and maintain fire service pumps as a member of a fire service team, cognisant of one's safety, the safety of team members and the public effectively and safely. The Learning and Development team in DFB have created several interactive Pump Operations elements, focusing on fire service gauges and their tests.

Emergency First Responder

An Emergency First Responder (EFR) is a person trained in cardiac first response that possesses additional knowledge and skills in assessing and managing patients in a pre-hospital environment. In addition to essential life support cardiopulmonary resuscitation and automated external defibrillation skills, the EFR possesses defined skills in further assessing and managing common medical emergencies and trauma, including common paediatric emergencies and aiding during childbirth. The EFR has appropriate knowledge and skills in administering certain prescribed medications. According to Clinical Practical

Guidelines (CPG) emergency first responders are skilled in assisting patients' movement and can practice critical rescue skills under special authorisation. In Dublin Fire Brigade, after recruit training, the firefighter will return to the training centre for further medical training at the Paramedic level, which, as discussed above, will allow them to fulfil their joint EMS and firefighting role. All EFR lessons are conducted on a face-to-face basis. The Pre-Hospital Emergency Care Council (PHECC) sets out the training standards for all EMS training in Ireland, and as a result, each centre of learning cannot deviate from these standards. PHECC have developed their online learning environment, the online academy, which practitioners must interact with to maintain their skills.

Swift Water Rescue Technician

The course covers the necessary knowledge and abilities to perform bank-based and shallow water rescues in water incidents, such as floods and swift water incidents. In addition, it guides first responders to help Swift Water and Flood Rescue Technicians handle these events. This certification is considered the fundamental level for all operational personnel who respond to flooding incidents. Rescue 3 is the globally recognised organisation responsible for accrediting this module, which still needs to be incorporated into DFB's online learning curriculum.

Hazardous Materials Module

DFB made changes to its Hazardous Materials training program in 2016. The previous two-day module has been replaced by a five-day individual module developed by the National Directorate for Fire and Emergency Management. While some elements have been captured in an online learning environment, face-to-face learning is still the primary method of instruction. DFB has submitted the new module to QQI for validation. It is worth noting that online learning is not a course requirement but only intended to reinforce the student's learning experience.

Online Content in Dublin Fire Brigade

The Sharable Content Object Reference Model compliant portal enables users to access their training records regardless of their role or location. The registration and completion of face-to-face and online learning for fire service personnel are tracked using the web-based application PDRPro. PDRPro plans, manages, and records training against the operational personnel's competence framework. A training planner is integrated into PDRPro to ensure

comprehensive training, with operational staff assigned specific modules every quarter over a three-year cycle. During their one-year probationary period, recruits are expected to utilise these systems and continue their professional development online. All DFB personnel have access to their training records, which move between stations and roles, providing a consistent and permanent record of their achievements and competence. Frequent entries by all operational personnel are required to achieve organisational objectives and comply with health and safety legislation.

2.6 Integration of Digital Technologies within Fire Service Training

While conducting the literature review for this research, it was evident that there were different framings and understanding of what constitutes online learning. Greenhow et al. (2022, p.137) define online learning as learning that "involves interactions that are mediated through digital, typically internet-based, technology". While Clark and Mayer (2016, p.152) infer that online learning (also called e-learning, digital learning, or computer-based learning) can be defined as "instruction delivered on a digital device intended to support learning". Singh et al. (2019) conducted research collecting definitions of online learning over thirty years; from one hundred and fifty-one articles, they identified forty-six unique definitions for the term online learning. They observed that the term online learning is a term that was first used in 1995 when the web-based system WebCT was developed as the first Learning Management System (LMS), which later became Blackboard (Singh et al. 2019, p. 289). Since then, online learning has included many distinct and overlapping terms such as e-learning, blended learning, online education, online courses, etc. According to Singh (ibid) "Scholars consistently discuss the ambiguity and confusion around the interpretation of the concept of online learning". From the research conducted by Singh et al., (2019, p.302) the following definition of the term online learning emerged as "Online learning is defined as education being delivered in an online environment through the use of the internet for teaching and learning. This includes online learning on the students' part that is not dependent on their physical or virtual co-location. The teaching content is delivered online, and the instructors develop teaching modules that enhance learning and interactivity in the synchronous or asynchronous environment". This definition was integrated into this research as the student exposed to the Tine model (later discussed in more detail) interacted asynchronously with online modules via a digital learning platform, with

the module content developed by in house subject matter experts and the platform hosted remotely.

In contrast, blended learning is a term that can encompasses various practices, both online and face-to-face modalities. The literature points to the fact that there needs to be a consensus outlining a clear definition. According to Smith and Hill (2018, p.383) definitions of blended learning are generally problematic. At its core, it refers to the thoughtful fusion of face-to-face and online learning experiences. However, this broad definition does not specify the scale and nature of that fusion, making it hard to see the essence of blended learning. Blended learning is often used interchangeably with terms such as hybrid, mixed mode, or flexible learning, and the lack of definition and cohesion is also apparent in blended learning research. According to Fedorova (2021, p.1) blended learning is a trend in modern education that is predicted to persist in the future, following the shift from online learning.

Many fire services are moving toward integrating online learning as a precursor to face-to-face training. Moreton-in Marsh in England, the National Fire Academy (NFA) in America and the fire service in Canada are forerunners in this field. Morton-in-Marsh's mantra is that "eLearning material is a mandatory part of our training and equips delegates with the knowledge and skills they need in the practical part of the course" (Morton-in-Marsh Fire Service College, 2016). The training is divided into modules based on the National Occupational Standards (NOS). Each student must complete all modules prescribed by their Fire Service before attending face-to-face learning to ensure "the delegate has grasped the theory and concepts that support the practical learning that then takes place at the Fire Service College" (Morton-in-Marsh Fire Service College, 2016).

In recent years, the National Fire Academy (NFA) in America has been exploring new approaches to firefighter training. Instead of relying solely on face-to-face teaching methods, they have been experimenting with a modular approach that takes advantage of technology and new delivery methods. This approach has been welcomed by many, as it offers a more flexible and convenient way for fire and emergency services personnel to receive career-enhancing training. The NFA Online platform hosts sixty-two self-study classes that reach an estimated 40,000 students each year. Additionally, the NFA is experimenting with asynchronous mediated learning, where students can participate in college-level education through combined electronic discussion boards, email, and NFA

online courses. According to the Federal Emergency Management Agency, Continuing Education Units or college credits are available for most courses offered through NFA Online. This means that fire and emergency services personnel can enhance their skills and knowledge in a way that is both flexible and convenient. The NFA's modular approach to online learning has been praised for its ability to take advantage of technology and new delivery methods while still maintaining the traditions of the NFA. The Canadian Fire Service agreed with the NRA when they reported that "our front-line crews appreciate chewable chunks of information, video footage of our own people telling our stories and concisely written, graphically rich messages" (Davison-Vanderburg, 2016, p.2). Davison-Vanderburg (ibid) also noted the benefits of integrating online modules, noting that "eLearning dramatically improves fire-service training, which, in turn, allows us to serve our communities more effectively".

In 2009, the Swedish fire service started incorporating digital technologies into their fire service training. According to Holmgren (2015, p.220), distance and blended learning have been alternatives to traditional campus-based learning for many years. These new technologies have brought about new challenges for training, such as designing for learning and communication with students and training content. Holmgren et al. (2015) conducted a five-year study focusing on implementing a technology-supported distance firefighter training programme in Sweden. The study found that the expansive learning process eventually stagnates due to limited instructor support and low demands placed on the students, reducing the incentive for continued active and self-directed learning. The study also revealed that many technology-inexperienced instructors became involved, creating challenges that drive the development of alternative learning strategies for students and instructors. In the field of incident command, new emerging technologies are being explored and incorporated into the Incident Command System (ICS), which is used during every DFB response.

2.7 Emerging New Technologies

At any emergency response, there must be command and control with different levels of hierarchical responsibilities. The Incident Command System (ICS) was initially developed in the 1970s by fire services in California and Arizona as a management method to clarify command relationships for large-scale incidents. The Incident Command System is used

during every DFB response, ranging from a bin on fire to a large-scale industrial fire. Although initially developed to address fires, the ICS concept is now applied to other incidents. According to FEMA (2017, p.1) "The overarching goal of ICS is to foster cooperation between local, regional and national agencies with maximum flexibility for achieving strategic goals". During an emergency response, ICS allows the transition to large and multi-agency operations with minimal adjustment for the agencies involved. While the ICS structure may be small initially, its flexibility will enable it to expand and adapt to real-time. The ICS is utilised at every incident in Ireland; the difficulty faced by fire services nationally during the implementation stage of ICS was how to train for scaled-up incidents, which places a substantial burden on resources. For example, how could an organisation train for a major emergency such as a train derailment? Historically a tabletop exercise with miniature fire engines and unlimited resources would be offered. However, the question must be asked; Does this capture realism or even a first-person view of a situation? Some brigades have turned to virtual reality software to bridge the gap between real-world events and an unrealistic view of the real world. Chittaro and Zangrando (2010, p.58) observed that "Virtual reality (VR) is a powerful simulation tool that can allow users to experience the effects of their actions in vivid and memorable ways". In Dublin Fire Brigade, management with strategic responsibilities at operational incidents utilises a program called XVR (eXtreme Virtual Reality) to train for the roles of an Incident Commander at significant incidents. This method has become so successful that it is now used in assessments tool for officer promotion; an officer is put into a real-world scenario and asked to resolve a significant incident using the ICS via XVR.

A further step in creating student engagement would be gamification and/ or game-based learning. According to Huang and Soman (2013, p.52) "One specific goal that behavioural scientists have in helping people attain better outcomes is to design interventions that get people engaged in activities such that their likelihood of completion is increased". Research has shown that games create engagement as a necessity for any learning experience (Wu, 2016, p.471). Arnold (2014, p.1) further observes that "Gamification is the process of adapting an experience like purchasing bread, mastering a handwriting recognition program or learning math with game-like elements". Games-based learning and gamification of learning may provide opportunities to engage recruits and operational firefighters in simulated firefighting exercises. Still, there is no evidence of integrating these in fire service training to date.

Virtual Reality simulators, 360-degree cameras and new technologies have started to engage with the development of applications for training and education within fire services. In 2016 the BBC commissioned a virtual reality film depicting a terrifying Christmas Day fire. The film, Fire Rescue, immerses viewers in the dramatic real-life story of a crew of firefighters who rescued six children from a house fire on Christmas Day in 2012. The user steps aboard a fire engine to try the immersive experience; viewers are transported via VR headsets to a flame-filled bedroom, witnessing the sights and sounds of the roaring fire taking hold and the screams of the children inside. The user can interact realistically with the virtual reality head-mounted display called "Oculus Rift" and control it with a custom controller. This technology is still out of reach for most fire services. Still, as technology costs decrease and the appetite for such technologies increases, it could be argued that such technologies could become the norm in future firefighter training.

2.8 Outcomes-Based Education

Singh et al. (2021, p.87) observe that Outcome-based education is a performance-based approach that provides a powerful and appealing way of reforming and managing education. The focus is on the outcomes that is, what sort of student will be produced, rather than the educational process. In outcome-based education, the outcomes are clearly and unambiguously specified, which determines the curriculum content and its organisation, teaching methods and strategies, courses offered, assessment process, educational environment, and timetable. This approach provides a framework for curriculum evaluation and emphasises relevance in the curriculum and accountability. It encourages both the instructor and the student to share responsibility for learning, and it can guide student assessment and course evaluation. However, some issues need to be addressed, such as what sort of outcomes should be covered in a curriculum, how they should be assessed, and how outcome-based education should be implemented. The loss of focus on content and traditional testing of student mastery of content has been a concern for educators, and there is community pressure for accountability in education because the present educational system has failed to adequately prepare students for life and work in the 21st century according to Singh et al. (2021, p.89). As a result, many countries are exploring new ways of designing their educational system by advocating for a shift from traditional learning methods to a new method of learning, which is now called outcome-based education. The outcome-based education vision affirms that all learners will be able to have good quality

education adapted to the country's needs. Therefore, there must be a shift from the current educational practices and policies to a new approach to learning outcomes to reflect the nation's expectations.

The shift towards adopting learning outcomes was at the fore of discussions in higher education since the first Bologna seminar on the subject 2004, according to Adam (2008, p.4). Since then, numerous conferences and seminars have been held across Europe on the topic. Learning outcomes are now recognised as one of the foundational elements of higher education reform in Europe. Essentially, learning outcomes are statements that describe what a learner should know or be able to do at the end of a period of study. They focus on the learner's achievements rather than the teacher's intentions and can encompass a wide range of knowledge, skills, and attitudes. Ultimately, learning outcomes help ensure that learners get the most out of their educational experiences. Learning outcomes are not just statements that describe learners' achievements after a period of study but also serve as a methodological approach for expressing and describing the curriculum. They are a significant part of the Bologna qualifications frameworks, which include level, cycle, and qualifications descriptors associated with the new style of Bologna. According to (Adams, 2008, p.4), "the importance of learning outcomes has gradually increased since they were first mentioned in the Prague Communiqué 2001 and have since appeared in every new ministerial Communiqué, with four separate references made in the most recent London pronouncement". By exploring these ministerial mentions, the role of learning outcomes in the current stage of the Bologna Process and its relevance to firefighter training, can be understood.

The European higher education system has undergone significant curricular reform and innovation recently. One of the key drivers of this change has been the emphasis on accumulation (ECTS) credits and the promotion of student-centred outcomes-based learning. Learning outcomes have become a central device to achieve this reform and are now expressed through modules and study programmes. The Bologna reforms have played a significant role in this process, with learning outcomes embraced in several ways. The whole Bologna Process represents a complex systemic application of learning outcomes. The Dublin Descriptors provide guidance on creating "new style" national qualifications frameworks that employ outcomes-based approaches, using level descriptors, national generic qualification descriptors, and subject benchmark/sectoral statements. All these

efforts aim to promote a more effective and efficient higher education system that better prepares students for the challenges of the 21st century. By focusing on learning outcomes, universities and other institutions of higher learning can help ensure that their graduates are well-equipped to succeed in their chosen fields and contribute to society. The shift towards learning outcomes in higher education has been driven by a desire to better prepare students for the challenges they will face in the 21st century. By focusing on what a learner knows and can do at the end of a learning process, universities and other institutions of higher learning can ensure that their graduates are well-equipped to succeed in their chosen fields and make meaningful contributions to society. According to Adams (2008, p.5) this shift was also aimed at providing greater precision and transparency for qualifications and qualifications frameworks, tailoring education to individual needs, improving links to the labour market and employment, advancing recognition, and reforming the curriculum. These changes were expected to result in better qualifications and a more efficient and effective higher education system overall.

In a firefighter educational context, the relevance of competencies and learning outcomes needs to be clear, as the two have distinct differences. Competencies refer to the specific abilities that a firefighter develops, while learning outcomes are more general and describe what a firefighter should be able to do after completing a course or program. Hartel and Foegeding (2004, p.69) define competency as a "general statement that describes the knowledge, skills, and behaviours that a student should have upon graduating from a program or completing a course". They further suggest (ibid) that a learning outcome can be defined as "a very specific statement that describes exactly what a student should be able to do measurably. Each competency may have multiple measurable outcomes". Research has shown that competencies and learning outcomes are unique when designing educational programs. However, there is a significant move towards an outcome-based focus on learning that the fire service should consider incorporating into its future training models.

2.9 Learning Paradigms and Theories

The Greek Philosopher Plato (circa 430 BC) is widely believed to have posed the initial question exploring how we learn something new. Locke (circa 1660) suggested that we start from an initial blank slate, and our experiences accumulate into learning. Since then, numerous paradigms and theories have emerged. This section will discuss the foundation

paradigms of behaviourism, cognitivism, and constructivism, starting with behaviourism. The fundamental concept of behaviourism is that all behaviour can be observed without considering internal mental states or consciousness. Behaviourists believe everyone starts from a clean slate, tabula rasa, and any new knowledge learnt comes from a stimulus and reaction to that stimulus. The foundations of this theory were first reported by the Russian scientist Ivan Pavlov, who conducted the Pavlov's Dog experiment (Dewsbury, 1997, p.934). This experiment observed that if you bond two stimuli, in this case, a bell and food, when you remove one, i.e., the dog will still salivate when he hears a bell ring even when the food has been removed. So, what does this mean in a fire service context? In recruit training, it could be argued that when a firefighter is given an order (stimulus) without thinking, there should be a hardwired automatic response. As Schuman (1996, p.24) observes, "Behaviourism is based on observable changes in behaviour; behaviourism focuses on a new behavioural pattern being repeated until it becomes automatic". These methods work for simple tasks such as rolling out a hose or putting up a ladder. However, the modern-day firefighter needs to problem-solve and adapt to dynamic risks faced in an emergency, not just react to a stimulus.

In contrast to behaviourism, cognitivists such as Piaget (1921) would argue that humans are not robotic creatures that solely react to their surroundings based on programming. The cognitivist would say that people are rational beings whose actions are a consequence of thinking. As a result, cognitivism focuses on inner mental activities, opening the "black box" of the human mind. As Good et al. (1990, p.76) observe "Cognitivism recognises that much learning involves associations established through contiguity and repetition". One of the first criticisms of the behaviourist learning approach came from Gestalt psychologists spearheaded by Austria-Hungarian Max Wertheimer in 1912. The German word gestalt can be translated to mean form, pattern or configuration. The Gestalt views on learning influenced new approaches extending beyond behaviourism and set the basic principles of what is today known as cognitive learning theories. These theories see learning as actively acquiring new knowledge and developing adequate mental constructions. They set the learner as the focus of control and not just as a passive participant in the process of learning. These theories also set out to address learning regarding insight, information processing, memory, and perception, emphasising the role of prior knowledge and experiences for learning outcomes and seeing learners as organised information processors. Reigeluth's Elaboration theory (1979, p.8) suggests that the content being taught should be organised

starting from the simplest and then increasing the order of complexity so that the learner must develop a concept in which new ideas will be meaningful and well accepted. Within the fire service, all skills-based lessons are taught using small incremental learning steps to support the learners' acquisition of new knowledge, which is suggestive of alignment with cognitivism and, to some extent, with Reigeluth's Elaboration Theory.

The final paradigm reviewed was constructivism. The philosophical assumptions underlying behavioural and cognitive theories are that the world is real and external to the learner (Ertmer et al., 2013, p.55). Ertmer et al. (ibid) further suggest that "Even though constructivism is considered to be a branch of cognitivism, it distinguishes itself from traditional cognitive theories in several ways" and according to Jonassen (1991, p.5) "Most cognitive psychologists think of the mind as a reference tool to the real world; constructivists believe that the mind filters input from the world to produce its own unique reality". Constructivism focuses on learnt behaviours with the addition of own thinking and using the mind as a reference tool. Constructivism is "an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner" (Elliott et al., 2000, p. 256). In elaborating constructivist ideas Arends (1998, p.75) states that "constructivism believes in personal construction of meaning by the learner through experience, and the interaction of prior knowledge and new events influences that meaning". The first principle of constructivism is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning. The second principle is that learning is an active rather than a passive process. Constructivism observes that learners construct meaning only through active engagement with the world. And finally, learning is a social activity, according to Dewey (1938, p.10) "It is something we do together, in interaction with each other, rather than an abstract concept". For example, Vygotsky (1978, p.78) believed that community plays a central role in the process of "making meaning". For Vygotsky, the environment in which children grow up will influence how they think and what they think about. Thus, all teaching and learning is a matter of sharing and negotiating socially constituted knowledge. Vygotsky (1978, p. 86) further noted that "cognitive development stems from social interactions from guided learning within the zone of proximal development". Vygotsky further offers a definition of proximal development as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more

capable peers" (Vygotsky, 1978, p. 86). During initial fire service training, the recruit firefighter is actively encouraged to learn from their own experiences by actively engaging and collaborating with peers, such as in drill yard exercises, while being supported by skilled instructors.

2.9.1 Learning Approaches

The literature has suggested there are several learning approaches that can be utilised in an educational context. In this section Active Learning, Reflective Learning, Problem-Based Learning, Case-Based Learning and Transformative Learning are examined. According to MacVaugh and Norton (2012, p.74) "Active Learning is the generic term for teaching pedagogies that require the educator to privilege the learner's participation over his or her own declarative knowledge of the subject". This learning approach is framed by a constructivist perspective where competencies, including knowledge, attitudes and skills, cannot be taught but must be actively acquired by the learner. The learner must elaborate on knowledge, rethink it critically and integrate it into the student's own framework. Within learner-centred approaches, students are perceived as autonomous learners responsible for setting and achieving their learning targets by choosing how, when and where they learn (Harkema and Schout, 2008; Jones and English, 2004). Students' prior knowledge and their social experiences are the starting points for stimulating the learning processes of students who define their learning target and construct their own knowledge base (Barth, 2015, p.92). Reflective learning is another approach that relies on competence development and the active construction of knowledge through reflection. Contents and experiences are deeply elaborated, rethought and integrated into existing frames of reference. Reflection is an abstract, higher-order cognitive skill requiring extra time and space.

According to Gillies (2007, p.1) "Cooperative learning involves students working together in small groups to accomplish shared goals", with the ideal number of students per learning group being three or four (Lou et al., 1996, p.44). Cooperative learning involves having students work together to achieve a common goal and has been recognised as an effective teaching strategy for promoting socialisation and learning among students of all ages (Cohen, 1994, p.2). It has also been suggested that cooperative learning comprises five key elements, these being; positive interdependence, promotive interaction, individual accountability, social skills, and group processing. In terms of positive interdependence, the

literature has suggested that positive interdependence is where all group members work together to achieve their goals (Johnson et al., 2019, p.8). When this is achieved, students recognise the value of each member's unique contribution to the group's success. The next element, promotive interaction, involves students working closely in small groups where they can see each other and engage in face-to-face discussions about the group task. When this occurs, Gillies (2007, p.33) observes that students understand they must actively encourage each other's equal participation in the discussion. As students work together in a group, they must understand the concept of individual accountability. This means that each group member is responsible for contributing to the group's success. As Gilles (ibid) has points out, there can be no freeloading. In order to effectively communicate with one another, students must be taught social skills and small-group skills. This includes learning how to express ideas, acknowledge the contributions of others, and manage conflicts. The instructor must closely monitor this element, as it can be difficult for students to master these skills, especially if they have never had many opportunities to interact with their peers. Finally, group processing is valuable for assessing how the group manages their learning processes. Through reflection, students can identify areas to improve to achieve their goals. Johnson et al. (1999, p.69) maintain that when groups learn to engage in such processing, it enables them to validate students' contributions and focus on maintaining positive working relationships. Gilles and Ashman, (1998, p.747) noted that when all "five key elements of cooperative learning are evident, the groups are generally referred to as being structured", otherwise the groups are considered "as unstructured". . This distinction is important because research has consistently shown that students who work in structured cooperative groups work more productively and attain higher learning outcomes than those who work in unstructured groups (Johnson et al., 1999, p.70). Cooperative Learning can also be viewed as an instructional strategy that simultaneously addresses students' academic and social skill learning. The teachers then must play a critical role in establishing cooperative learning pedagogy in their classroom. As Gilles (2007, p.34) observed, the teacher is responsible for ensuring that the groups are well structured so students will cooperate and promote each other's learning and that the group task is relevant and open and discovery-based, requiring students to dialogue.

In contrast to cooperative learning, collaborative learning is commonly illustrated when groups of students work together to search for understanding, meaning, or solutions or to create an artefact or product of their learning. Collaborative learning redefines traditional

student and teacher relationships in the classroom because activities can include collaborative writing, group projects, joint problem-solving, debates, study teams, and other activities in which students collaborate to explore a significant question or create a meaningful project. According to Watkins et al. (2007, p.90) "the essence of the term collaboration is to labour together, not with a sense of hard toil we hope, but with a sense of creating something greater between us than would have been achieved separately". Although the literature is inconsistent, some writers distinguish between cooperation and collaboration. The distinction suggests that people cooperate when they adjust their actions so that each person achieves their individual goals. In contrast, people collaborate when their actions are adjusted to achieve a shared goal. As a first step in collaboration, many studies show that when learners explain their meaning to each other, their learning is richer and more profound. Collaborative learning is the act of having to make sense to a peer and to challenge someone to clarify and communicate in such a way that their own understanding is enhanced. As can be seen in Figure 2.6, both Collaborative and Cooperative learning have common themes. However, the implementation and outcomes of these similar paradigms may be argued set to address different audiences. Collaborative learning appears to suit learners who are self-directed and who want to explore new ideas, new knowledge and collaborate to solve problems. These groups could be called 'blue sky' thinking groups, working together to create unique and innovative ideas. Whereas cooperative learning may suit group activities such as firefighting where every student must play a pivotal role when conducting a task to its completion.

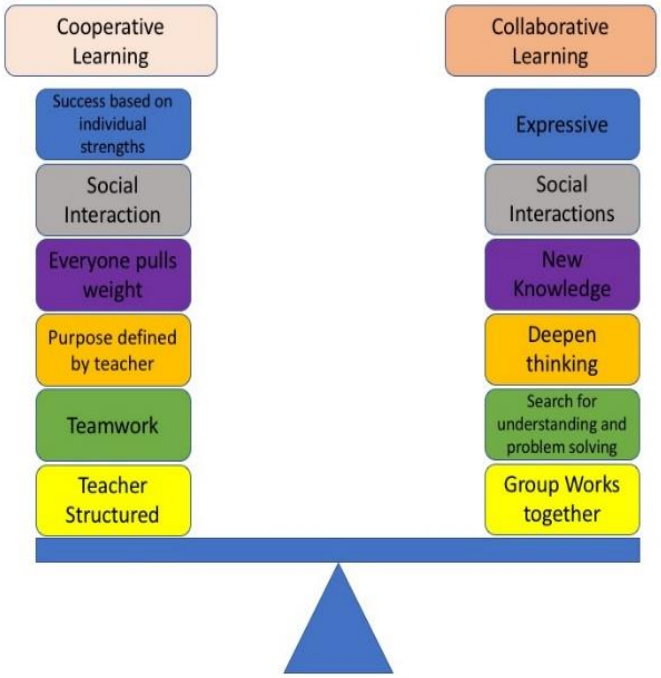


Figure 2.6 Cooperative Learning vs Collaborative Learning
Adapted from "The Difference in Cooperative Learning and Collaborative Learning" (Clare, 2015, p.3)

In experiential learning, the student is encouraged to engage in and reflect on personal experiences related to the course content (Slavich and Zimbardo, 2012). Experiential learning goes back to Kolb's experimental learning cycle fist developed in 1984. This approach has four stages, these are experiencing, reflecting, thinking and acting (Kolb and Kolb, 2018, p.8).

Figure 2.7 The Experiential Learning Cycle,
adapted from "Eight important things to know about the experiential learning cycle"
Kolb and Kolb (2018, p.8)

It could be argued that Kolb's paradigm points to a constructivist approach to learning as it is entrenched in the social constructs of education while navigating towards the pole of lifelong iterative learning. Kolb's Experimental Learning theory could be utilised within and beyond recruit firefighter training as suggests that learning is not just a one-time event, but a continuous process that involves a constant exchange between one's own internal world and the external environment.

While Kolb and Kolb's model encourages the students to engage in and reflect on personal experiences related to the course content, Problem-Based Learning (PBL) describes a learning process sets out to understand and solve problems of complex real-world situation - "Students actively engage with meaningful tasks and complex scenarios, determine what they need to know and how and where they can find it" (Barth, 2015, p. 93). Instead of the teacher framing the problem, researching relevant information and presenting these results, the student is encouraged to actively take part in this process (Dobson and Tomkinson, 2012). PBL is linked to a specific context and situation in that it addresses an authentic scenario instead of only dry theory (Barth, 2015; MacVaugh and Norton, 2012; Wiek, Xiong, Brundiers, and van der Leeuw, 2014). Therefore, it is said to have "a strong motivating effect" (Barth, 2015, p. 94) given the assumption that learners want to become involved.
Case-Based Learning (CBL) involves students engaging typically in groups to examine case studies or scenarios that allow them to apply their knowledge and skills to real-world scenarios. According to Williams (2005, p.577) CBL allows for deep inquiry in the consideration of the integration of knowledge and practice, while promoting intrinsic and extrinsic motivation and critical self-reflection. CBL differs from PBL in that the CBL leans more on the instructor for guidance whereas PBL tends to be more open-ended and self-directed in nature.

The final approach to be discussed is Transformative Learning. The keyword for Transformative Learning, is "frame of reference". Frames of reference describe how we perceive the world, including habits of mind (e.g., habitual ways of thinking) and opinions and values (Slavich and Zimbardo, 2012). Frames of reference are shaped through social

and cultural influences but can be changed through new problem-solving experiences, problem discussions, or critical reflections on assumptions and interpretations. Four possible strategies in a learning setting are postulated for modifying frames of mind: 1. Elaboration of existing frames, 2. Learning new frames, 3. Transformation of habits of mind, 4. Transformation of opinions (Slavich and Zimbardo, 2012). Transformative learning is defined by its aims and principles, not by a concrete teaching or learning strategy. Sipos et al. (2008, p.34) relate transformative learning to the teaching principle of "head, hands and heart" which means that all three psychological dimensions (affective, behavioural and cognitive) should be considered and involved in learning processes.

2.9.2 Motivation

There are many reasons for a learner not being motivated, such as anxiety, unfocused, distracted or just not interested in the subject or the outcome. The learner can be intrinsically or extrinsically motivated; according to Dirksen (2016, p. 30) "Intrinsically motivated learners are interested in the topic for its own sake or have a specific problem they are trying to solve". In contrast, extrinsically motivated learners are motivated by an outside reward or punishment. "Any kind or learning that is required is likely to be extrinsically motivated" (Dirksen, ibid). In the context of training and education within the fire service, most, if not all training is "required" mainly due to statutory requirements.

Maslow (circa 1984) believed that a person is motivated when all their needs are fulfilled. He believed that people do not work for security or money, but they work to contribute and to use their skills. Maslow created a pyramid to show how people are motivated, this pyramid is hierarchal in nature, and you must fulfil a lower level to transcend to the next. According to Maslow (1987, p.64) the first need is fundamentally a physiological need, such as the biological requirements for human survival, e.g., air, food, drink, shelter, clothing, warmth, sex, and sleep. The following need concerns safety, where protection from the elements, security, order, law, stability, and freedom from fear is important. The third need is love and belongingness after fulfilling physiological and safety needs. The penultimate need is for esteem, esteem for oneself (dignity, achievement, mastery, independence) and the desire for reputation or respect from others (e.g., status, prestige). According to Maslow (ibid) the final need is a self-actualisation need, realising personal potential, self-fulfilment,

and seeking personal growth and peak experiences. A desire "to become everything one is capable of becoming" Maslow (ibid).

McClelland's (1987) motivational theories further affirm that we all have three motivating drivers, which do not depend on gender or age. One of these drives will be dominant in our behaviour. The dominant drive depends on our life experiences. The three motivators are achievement, a need to accomplish, and demonstrating competence. Affiliation is a need for love, belonging and social acceptance. Power is a need to control own work or the work of others. At the same time, Vroom's expectancy theory of motivation (1964) articulates that an individual's motivation is affected by their expectations about the future. In his view, expectancy, instrumentality and valence affect an individual's motivation. Vroom (ibid) observed that Expectancy is the belief that increased effort will lead to increased performance. Instrumentality is the belief that if you perform well, the outcome will be personally valuable. Valence can be best described as how much importance the individual places upon the expected outcome. For example, if someone is motivated by money, they might not value offers of additional time off as a motivation factor. Vroom's expectancy theory of motivation can be captured using the following formula. Motivation = V x I x E, where in Figure 2.9 motivation equals valence by expectancy and instrumentality. If any of the three factors is nil, the overall score will be zero, and there will be nil motivation.

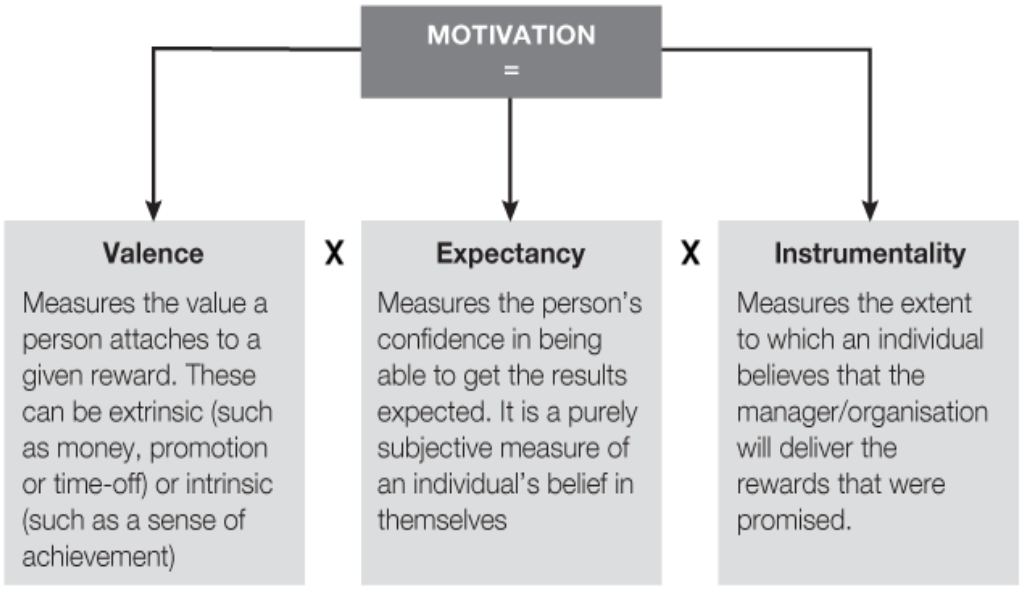


Figure 2.9 Vrooms Expectancy Theory (1964) adapted from "The little book of big management theories" (McGrath and Bates, 2017, p.34)

2.9.3 Learning in a stressful environment

The firefighter recruit training environment is constructed to replicate fast-paced, dynamic incidents that a student may face in a real-world setting. This environment can often be stressful as time constraints and inadequate information are unkind bedfellows of an operational firefighter. As mentioned before, how we train and prepare for the response phase of an emergency can often affect the outcome of an incident. The literature investigated pointed to some interesting theories on why people operating in a stressful environment can fail to retain information and or not perform (choke) when needed. The first of these theories is called the Yerkes-Dodson law.

The Yerkes-Dodson Law

According to what is known as The Yerkes-Dodson law, performance increases with physiological or mental arousal (stress) but only up to a point (Gino, 2016, p.16). When the level of stress becomes too high, performance decreases. The Yerkes-Dodson law suggests that elevated arousal levels can improve performance up to a certain point.

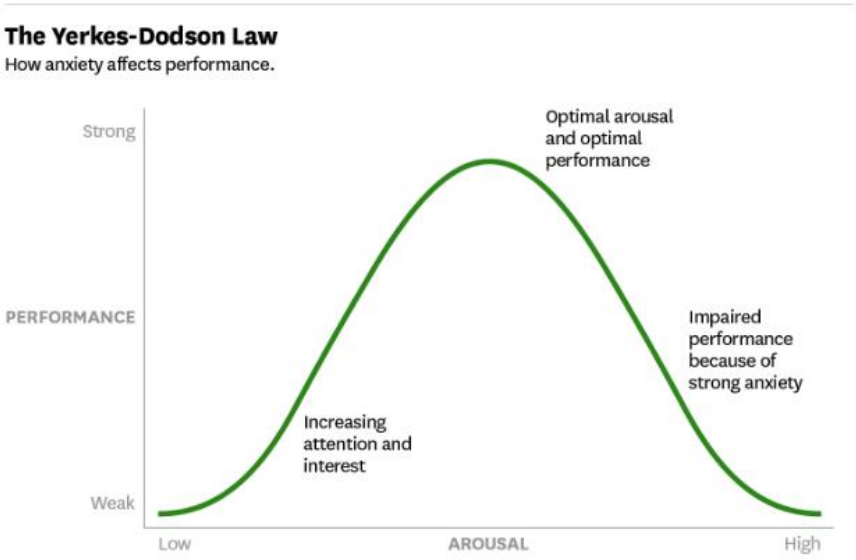


Figure 2.8 The Yerkes-Dodson law (1908) adapted from "Are you stressed to be productive? Or not stressed enough?" (Gino, 2016, p.16).

This law was first described in 1908 by psychologists Robert Yerkes and John Dillingham Dodson. They discovered that mild electrical shocks could motivate rats to complete a maze, but when the electrical shocks became too strong, the rats would scurry around in random

directions in attempt to escape. Athletic performance offers a great example of the Yerkes-Dodson Law. When a player is poised to make a significant move, like making a basket during a basketball game, an ideal level of arousal can sharpen their performance and enable them to make the shot. However, when a player gets too stressed out, however, they might instead "choke" and miss the shot (Yerkes and Dodson, 1908, p.460). The Yerkes-Dodson law has been extensively used to explain the effects of emotional arousal on performance, assuming that high levels of emotional arousal are necessarily maladaptive and detrimental to information processing, decision making and performance. This law could have significant implications within the firefighter training scenario, where the instructor continually places the student in a training scenario that mirrors a stressful real-life environment. It is therefore important to note that placing a student in a stressful learning environment will only increase their performance to a certain level, after this level has been reacted the firefighters', performance can level or even decrease.

Cognitive Load Theory

Cognitive Load Theory (CLT) is a psychological theory that attempts to explain psychological or behavioural phenomena resulting from instruction (Moreno and Park, 2010, p.12). Psychological theories concern the possible relationships among psychological constructs or between a psychological construct and an observable phenomenon of practical consequence. A psychological construct is an attribute or skill in the human brain. In CLT, the primary constructs of interest are cognitive load, hence the name of the theory, and learning. CLT was developed to explain the effects of instructional design on these two constructs. CLT has focused chiefly on how the objective characteristics of the task affect cognitive load and, in turn, learning. The only individual characteristic explicitly included in its theoretical framework is students' prior knowledge (Kalyuga et al., 1998, p.2). Other individual characteristics that are highly predictive of learning, such as cognitive abilities and styles, self-regulation, motivation, and effect, are not considered within the CLT framework (Moreno, 2006). According to the central tenet of CLT, working memory capacity is limited, and any instructional design should aim to reduce unnecessary working memory load to free capacity for learning-related activities, that is, schema construction. Working memory load is divided into "intrinsic cognitive load and "extraneous cognitive load" (Chandler and Sweller, 1991, p.352). Intrinsic cognitive load refers to the load imposed by cognitive processes evoked by task inherent characteristics, or the load related to task complexity. How complex a task is perceived to be, in turn, depends on prior knowledge as well as on element interactivity. At the same time, the extraneous cognitive load is imposed by cognitive processes evoked by the instructional design of a learning task that does not contribute to learning. For instance, when a task contains many seductive but task-irrelevant details, cognitive resources are "wasted" by paying attention to those details (Park et al., 2011). They are thus not available for learning-related activities. In a fire service context, CLT needs to be considered in training models as there appears, from the literature reviewed, to be a strong link between excessive cognitive load and failure to learn

2.10 Ebbinghaus Forgetting Curve

The Ebbinghaus forgetting curve is a graphical representation of the natural forgetting process. The curve shows the rate at which information is lost if no effort is made to remember it. This concept was first described by German psychologist Hermann Ebbinghaus in his book "Memory" in 1885. Ebbinghaus recorded his findings

mathematically to discover patterns of forgetting and memory retention. Ebbinghaus' experimental method consisted of conducting extensive tests on himself. He created hundreds of three-letter words, or nonsense syllables, like "wid", "zof", and "qax". The psychologist then tried to memorise lists of these words and determined how long he could remember them after different time intervals. He plotted his results in a graph we know today as the forgetting curve.

Ebbinghaus discovered that when new information is learned, the student tends to forget a significant amount of information within the first hour. Without intervention, the student will forget about seventy-five percent of what they have learned after one or two days. After a week, Ebbinghaus' results show that almost all information is lost and cannot be recalled. It should be noted that after a day or so, the forgetting rate slows down, and the student will retain essential details in their long-term memory. It is interesting to note that the rate at which the student loses information does not differ much between individuals, according to Ebbinghaus. However, certain factors can influence this rate, such as prior knowledge and how meaningful the subject is. Ebbinghaus discovered that if students can link new information to things they already know, they are more likely to remember it. Similarly, if the student believes that the information has meaning, whether they have prior knowledge of it or not, the information is likely to be remembered.

When acquiring new skills or knowledge, Ebbinghaus suggested using two methods: mnemonic techniques and repetitions. Mnemonic techniques involve creating associations with something that is easier to remember, such as using images, emotions, patterns, or rhymes. Repetitions of information are also necessary, as they strengthen our memory. According to the forgetting curve pattern, the initial repetition should ideally occur within the first day of learning. It is necessary to periodically review the information for optimal retention, with at least three recommended reviews. Ebbinghaus also noted that each subsequent repetition increases the time needed before the next one, known as spaced learning.

As noted above, Ebbinghaus used himself as the only subject in all the forgetting curve experiments he conducted. It could be argued a single-subject design makes it unclear how forgetting would occur with multiple subjects. Dros and Murre carried out a similar single-subject study in 2015 that reproduced Ebbinghaus' forgetting curve. The experiment

consisted of a single participant who spent seventy hours studying lists and then relearning them at various intervals, for up to thirty-one days. The study's findings closely aligned with Ebbinghaus' original research, indicating that his insights remain applicable and valid even after several years. According to Dros and Murre (2015, p.1), "the Ebbinghaus forgetting curve has been successfully replicated, and it exhibits a slight jump upwards, most likely starting at the 24-hour mark". Anderson and Schooler conducted a further study investigating whether "human memory is behaving optimally with respect to the pattern of past information presentation" (1991, p.396). To achieve this, they utilised Ebbinghaus' retention and practice functions, which are fundamental to the forgetting curve. The researchers analysed analogue information gathered from the New York Times over one hundred days. They investigated the likelihood of recalling an item on the one hundred and first day based on the length of time it had been since its last appearance in the hundredth-day window.

2.11 Meta Models for Teaching and Learning

Across the literature reviewed, a wide variety of models from preschool education to national frameworks for education were identified. Most fire services offer a traditional pedagogical model, which advocates a sage-on-the-stage style of instruction. As seen from the review of international training models, some fire services are diverging from the traditional models and are now seeking alternative models to augment or replace their current practices. As technology advances, online learning is traversing into the fire service curriculum. Online learning, as an umbrella term "encompasses a range of technologies such as the world wide web, email, chat, news groups and texts, audio and video conferencing delivered over computer networks to impart education. It helps the learner to learn at their own pace, according to their own convenience" (Dhull and Sakshi, 2017, p.32). The literature also points to moves toward blending face-to-face traditional models with online learning, a blended learning model. Staker and Horn (2012, p.2) offer a preliminary categorisation scheme for the blended learning landscape in the format of Figure 2.11 below.

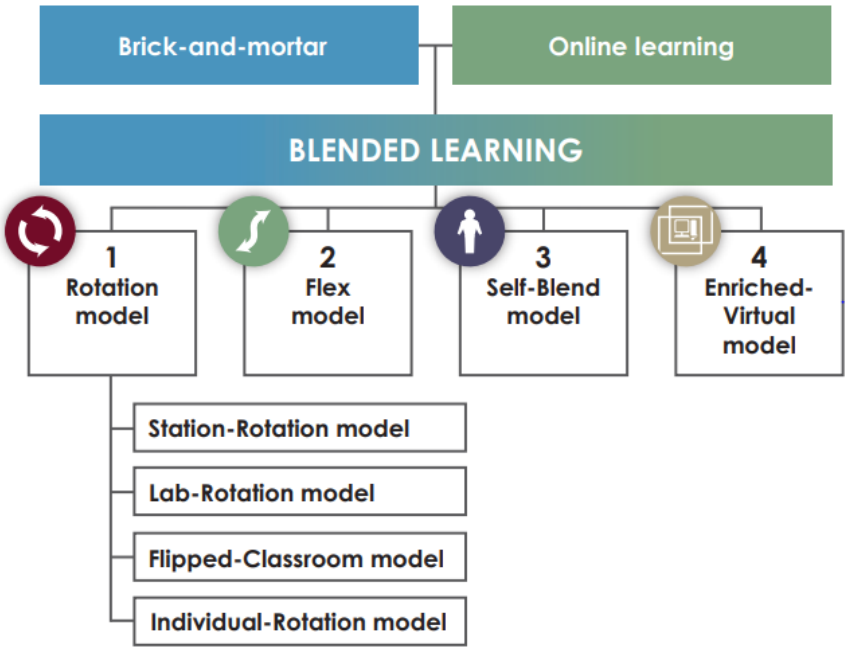


Figure 2.11 Blended learning taxonomy "Classifying K-12 blended learning" adapted from Staker and Horn (2012, p.2).

Staker and Horn (2012) describe the rotation model as an educational program that allows students to switch between different learning modes within a particular subject or course. This approach involves a fixed schedule or teacher's discretion, where students can rotate between online learning and other activities such as small-group or full-class instruction, group projects, individual tutoring, and pencil-and-paper assignments. The aim of this model is to provide students with a variety of learning experiences that can help them develop their skills and succeed academically. The rotational model is subdivided into four models; Station Rotation, Lab Rotation, Flipped Classroom and Individual Rotational models.

In the Station Rotation model of blended learning, students in a particular course or subject rotate through various classroom-based learning modalities on a fixed schedule or at the teacher's discretion. At least one station is dedicated to online learning, while others may involve activities like small-group or full-class instruction, group projects, individual tutoring, and pencil-and-paper assignments. Some implementations have the entire class rotating together, while others divide the class into small groups or one-by-one rotations. In the Station-Rotation model, students rotate through all stations and not just the ones on their custom schedules. According to Staker and Horn (2012, p.4) "This approach to blended learning offers flexibility and tailored instruction to meet the diverse learning needs of

students". In the Lab Rotation model, students can move around different locations. These rotations can be scheduled or at the teacher's discretion. One of the locations is typically a learning lab for online learning, while other classrooms are used for other learning methods. This differs from the Station-Rotation model, where students stay in one classroom for the blended course or subject.

The Lab Rotation model allows for more flexibility and variety in learning environments (Staker and Horn, 2012, p.5). In a Flipped Classroom, students rotate between face-to-face teacher-guided practice in a brick-and-mortar setting and online delivery of content and instruction of the same subject from a remote location, in advance of face-to-face instruction. The primary delivery of content and instruction is online, which differentiates a Flipped Classroom from students who are merely doing homework practice online at night. Staker and Horn (2012, p.5) advocate that this allows for greater student control over the pace and location of learning, as students can choose where they receive content and instruction online and move through the online elements at their own pace. Moving to the Individual Rotation model, students can rotate on a customised, fixed schedule among learning modalities within a given course or subject. This model includes online learning as one of the modalities, and an algorithm or instructor is responsible for setting individual student schedules. The key difference between the Individual Rotation model and other Rotation models is that students do not necessarily rotate to each available station or modality. This approach ensures that students receive a personalised learning experience and can focus on the areas that require more attention (Staker and Horn, 2012, p.5).

The other three models discussed by Staker and Horn (2012) were the Flex, Self-blended, and Enriched-virtual models. The Flex model allows students to access online content and switch between different learning methods, with face-to-face support available. The level of support varies, with some models offering daily support from certified teachers. The Self blended model refers to students taking one or more courses entirely online as an addition to their traditional courses, with the online teacher serving as the teacher-of-record. Students have the option of taking online courses either on campus or off-site. This model is distinct from full-time online learning and the Enriched-Virtual model because it does not provide a complete school experience. Instead, students blend some individual online courses with face-to-face classes taught by in-person teachers at a brick-and-mortar campus. Moreover, finally, the Enriched Virtual model is a unique approach to education that provides students

with a whole-school experience. In this model, students divide their time between attending a brick-and-mortar campus and learning remotely using online delivery of content and instruction. Unlike the Flipped Classroom, students in Enriched Virtual programs do not attend the campus every weekday. Additionally, this model differs from the Self Blend model as it offers a whole-school experience instead of a course-by-course model. Many Enriched Virtual programs started as full-time online schools and then developed blended programs to provide students with the best of both worlds.

From the blended learning landscape and following extensive literature review, the Station Rotation blended model was deemed the most suitable model in an Irish fire service context, as its fundamental cornerstone is to personalise learning by using an array of teaching styles and modalities. The American Institute for Research, AIR, (2020, p.3) states, "In station rotation classrooms, groups of students rotate among different types of learning modalities, such as computer-based instruction, group projects and individual tutoring". The American Institute for Research (ibid) suggest that there are four key components that the Station Rotation model should foster, these are;

1. ***Integrated digital content***: To enhance school performance, it is essential to combine online and teacher-led resources and teaching methods.
2. ***Targeted and differentiated instruction***: Customising instruction to meet the unique needs of each student can be a powerful tool to boost learning outcomes. It's important to ensure that the curriculum is based on established standards and that the instruction is tailored to the individual student's learning style and level of understanding. By combining online and in-person resources and teaching methods, educators can create a more dynamic and effective learning environment that engages students and helps them achieve their full potential.
3. ***Student reflection and ownership***: Allowing students to have more control and flexibility over their learning can give them a sense of ownership and encourage reflection, leading to higher levels of engagement.
4. ***Data-driven decisions***: It is important to evaluate student learning through formative assessments and other data to ensure that they have truly mastered the learning standards and competencies before moving on to new topics. This way, students can have a deeper understanding of the subject matter and feel more confident in their abilities.

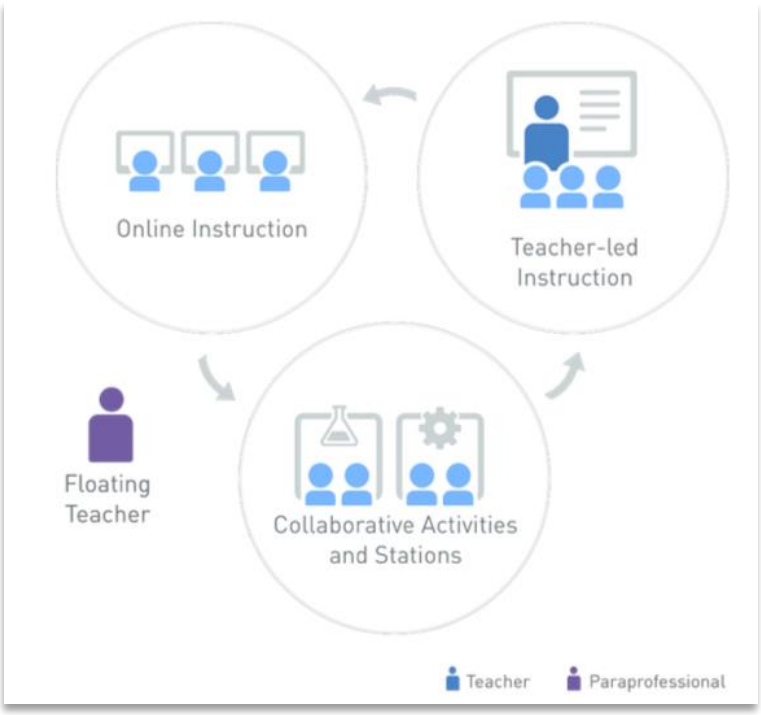


Figure 2.10 Station Rotation Model, adapted from "Personalizing Student Learning with Station Rotation: A Descriptive Study" (AIR, 2020, p.3).

According to AIR (2020, p.3) Figure 2.10 depicts how station rotation might work in some classrooms. The approach does not necessitate significant alterations to the school day, schedule, or building infrastructure. In contrast to the Station Rotation model, students take on more responsibility for their own learning in the flipped classroom model. Instead of traditional lectures in the classroom, students receive content presentations at home, and homework is done in class. This approach allows teachers to focus on helping students with their learning process and engaging them in other activities such as discussions, problem-solving, and hands-on learning. The teacher becomes more of a guide, helping students along the way while students take ownership of their own learning pace. This approach creates a more interactive and engaging learning environment where students are encouraged to think critically and learn through action.

2.12 Conclusion

This literature review process took inspiration from the Seven-Step Model of the Comprehensive Literature Review in its framing and implementation. During the exploratory phase, it was discovered that there were only a handful of research studies that

explored training approaches for recruit firefighters. Many studies in this field concentrated on other factors related to training, such as the well-being and health of firefighters, without explicitly exploring the education and training approaches that might influence this. Out of the six studies that were identified as potentially relevant to firefighter education and training, just four retained a sustained focus on firefighter training models. From the extended review of information available online in various jurisdictions, it was evident that the structure, content and delivery of firefighter training varies considerably across fire services globally and that most training primarily relies on face-to-face instruction in a brick-and-mortar setting. However, there was some evidence of change - the UK and Canadian fire services for example had integrated blended learning within their modes of training. Furthermore, other fire services, such as the Netherlands, have started to incorporate VR into their training, and indeed Dublin Fire Brigade used this modality during its officer promotional system.

The literature suggests that the critical characteristics of, and core training processes employed within, the Traditional firefighter training model implemented within DFB training for recruit firefighters is embedded in a behaviourist learning approach. In this regard, the traditional model in firefighter training prioritises didactic instructor-led presentation and demonstration of core knowledge and skills, followed by drills and practice of core skills by recruit firefighters, with the understanding that the necessary competencies would be developed and internalised over time. The literature also points to challenges in knowledge and skills retention by firefighters, which provides a warrant for examining alternative models of firefighter training, such as those that seek to promote constructivist learning opportunities and integrate digital technologies to scaffold and support recruit training. Regarding the latter, the need to further explore technology integration within firefighter training, particularly to connect with and simulate real-world scenarios, came to the fore, with some literature supporting the use of VR and other technologies.

The research set out to investigate the traditional training model used within recruit training and to design and trial two adapted training models, each incorporating a fully immersed online module at the outset and instructor-led demonstrations and assessments. The first of the adapted models, the Blended model, included online modules that recruits completed before the traditional training by instructors was implemented (in essence a form of blended learning that aligned with the Flipped Learning model). The second training model, Tine

embodied a station rotation model by offering opportunities for recruits to engage in online modules, followed by staged engagement of recruits in instructor-led learning, peer learning, problem-based learning, and assessment of learning by instructors. The articulation of the key characteristics of the traditional model and the design of the two aforementioned alternative models were informed by the broader literature review on learning approaches and models, and this is further discussed in Chapter 4.

The broad intent of this research study was to explore various training approaches that might enhance knowledge retention among fire service personnel. Therefore, it was essential to consider the effects of a stressful environment on learning when creating a training model for firefighters. This was a key consideration when developing the Tine model. Reducing unnecessary distractions and considering the Yerkes-Dodson Law was essential to support a positive learning environment. Additionally, the use of the Ebbinghaus Forgetting Curve was deemed essential in ascertaining whether or not, the alternative training models enhanced knowledge retention.

Chapter 3

3.1 Overview of Research

This chapter sets out the worldview and philosophical assumptions underpinning the research approach research methods, and tools employed in this study of fire fighter training models. This research set out to explore pedagogical models that could be used within Dublin Fire Brigade training settings to enhance the quality of teaching and learning for new recruits, examining recruit learning interactions, engagement, learning experiences, and learning outcomes, with a specific focus on knowledge retention. The research took inspiration from the Design-Based Research approach to investigate the traditional pedagogical model used within recruit training and to design and trial two adapted pedagogical models, each incorporating a fully immersed online module at the outset and instructor-led demonstrations and assessment. The rationale for using the mixed methods approach, and the accompanying data collection and analysis processes are discussed herein.

3.2 Focus of Study

This research set out to explore pedagogical models within Dublin Fire Brigade training settings, focusing on examining learning interactions/ engagement, learning experiences, and learning outcomes vis-à-vis knowledge-building and skills retention for heuristic decision-making of firefighters in the context of critical incidents. The research involved the review of the traditional didactic training model used with new recruits and the study of two adapted training models, each of which incorporated a fully immersed online module at the outset, as well as instructor-led demonstrations and assessments. The first of the adapted models, the Blended model, included an online module that recruits completed before the traditional didactic training by instructors was implemented. The second pedagogical model, Tine, was structured into six phases, the first of which involved completion by trainees of the aforementioned online module, with the remaining five phases offering opportunities for recruits to engage in instructor-led learning, peer learning, problem-based learning, followed by assessment of learning by instructors. The Road Traffic Collision thematic area was selected as there were authentic opportunities for generating critical-incident scenarios for problem-solving within this part of the fire service training curricula.

3.2.1 Research Questions

According to Onwuegbuzie et al. (2016, p.60), a "research question is an interrogative statement that the researcher attempts to answer using research techniques", and these questions respond to gaps identified in the literature. The main research questions were as follows.

1. What are the key characteristics of, and core pedagogical processes employed within, the Traditional pedagogical model implemented within DFB training for new recruits?
2. What impact does the integration of Blended and Tine pedagogical models have on learning interactions/ engagement, learning experiences, and the retention of knowledge of DFB recruit trainees?
3. What design principles and contextual factors are pivotal to the successful implementation of Blended and Tine models?

3.3 Overview of Research Philosophy

The "Research Onion" framework (as illustrated in Figure 3.1) has been adapted from Saunders et al. (2016, p.124) to present the research philosophy underpinning this study and to explain the assumptions underpinning decisions on the research process across six dimensions, namely, philosophy, methodology, strategies, approaches, time-horizons and data collection and analysis. In this study's context, the diagram's outer-most level presents pragmatism as the research philosophy supporting the broad research study. In the next level, inductive reasoning is highlighted as bracing the frame for analysis on the basis that the study of implementing these two training models was exploratory in nature, as opposed to striving to prove or disprove a pre-determined hypothesis. The Design-Based Research model was the strategy that inspired the frame and boundary of the study, as noted within the third level of the Research Onion. As shown on the fourth level, this research was primarily qualitative in nature and leaned, for the most part, on qualitative techniques and tools to gather and analyse data. However, as is discussed further within this chapter, it is important to note that a quantitative tool was used to generate mainly descriptive statistics to investigate one aspect of the study, which informed context-based findings on the technology readiness of a broader cohort of participants. Furthermore, the Ebbinghaus Forgetting Curve was used to examine knowledge retention of recruit firefighters across the

three models, Traditional, Blended and Tine. In terms of level five, this study mainly focused on examining the experiences of and outcomes for fire service recruits who engaged with the Traditional, Blended and the Tine model in fire service training during a fixed period from June 2020 to August 2020. The primary study was preceded by a pilot study in 2019 which implemented the Tine Model with two groups of paramedic students. Therefore, the study has been classified as having a cross-sectional time horizon on level five of the diagram. Finally, as shown in the innermost level six, the data collection tools and analysis included the thematic analysis of observations, interviews, surveys and focus groups, and the generation of descriptive statistics from surveys.

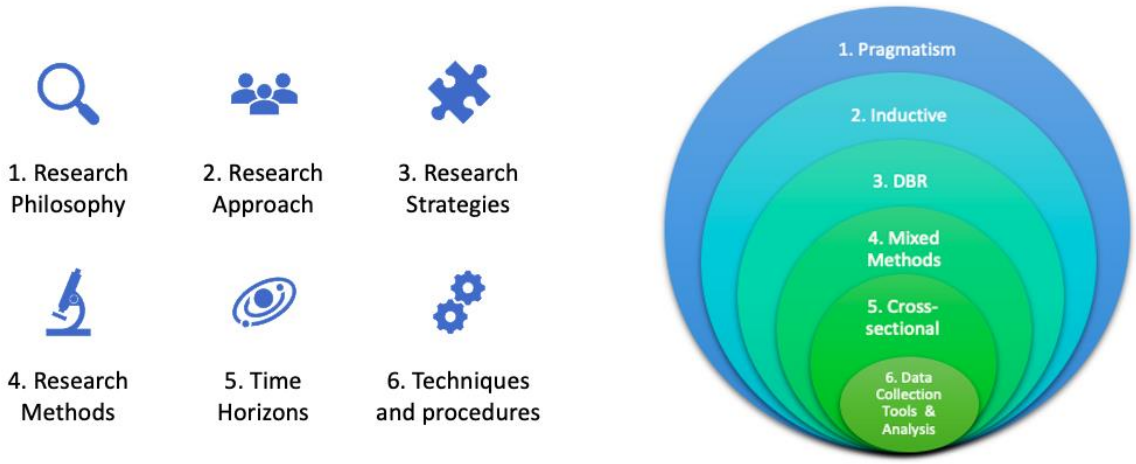


Figure 3.1: Summary of the Research Philosophy, adapted from "The Research Onion" by Saunders, Lewis and Thornhill (2016, p.124).

3.3.1 Research Philosophy - Pragmatism

According to Saunders et al. (2016, p.124) "research philosophy is an over-arching term related to the development of knowledge and the nature of that knowledge". Saunders et al. (ibid) further point out that the research philosophy that is adopted contains important assumptions about how the researcher views the world "Whether you are consciously aware of them or not, at every stage in your research you will make a number of assumptions" (Burrell and Morgan 1979, p.8). According to Saunders et al. (2016, p.122) these include assumptions about human knowledge (epistemological assumptions) and about the realities encountered in your research (ontological assumptions). According to Byrne (2017, p.2) ontology comes from the Greek "ontos", which means being, and "logos", meaning study. It is the study of being. Your "ontology" is how you answer the question: "What is reality?"

this is important to note as your ontological stance or assumption affects how you approach your research. When designing your research, it's important to consider your ontology or how you see the world. This can be either objective or subjective. Blaikie (1993) defines ontology as "the science or study of being," and MacIntosh and O'Gorman (2015) suggest that articulating your ontology is the first step in formulating your research design. Saunders et al. (2016) note that objectivism views social entities as existing, in reality, external to social actors, while subjectivism holds that social phenomena are created from the perceptions and actions of those social actors concerned with their existence. I believe knowledge is created through interactions with the training participants, observation, and reflection. Therefore, I explored, interpreted and articulated the key features and impacts of the traditional pedagogical model, as well as the Blended and Tine models in DFB firefighter training through this subjective ontological lens. Understanding the nature of reality and how we can make knowledge claims of any kind is a complex philosophical question. Epistemology is the branch of philosophy that deals with how we know and the relationship between the knower and the known. It concerns the varieties and validity of our knowledge of different aspects of the world. Epistemology is, in essence, about how we know what we know. There are many different epistemological approaches, and in this research, I took a subjective approach to understanding knowledge construction. I observed that knowledge is both constructed and based on the reality of the world we live in and that it is created through interactions with the training participants, observation, and reflection. In doing so, I developed an understanding of the key features and impacts of the traditional pedagogical model used by DFB in firefighter training and of integrating Blended and Time pedagogical models on learning interactions, engagement, learning experiences, and knowledge retention of DFB recruit trainees.

Now that I have acknowledged my worldview and philosophical assumptions, aligning this to a research paradigm is necessary, as previously mentioned. Many different philosophical paradigms underpin research studies, which can arguably be positioned on a continuum with positivism to the extreme left, followed by interpretivism, critical realism, and pragmatism to the far right, as depicted in Table 3.1.

Positivism	Interpretivism	Critical realism	Pragmatism
Positivism relates to the philosophical stance of the natural scientist and entails working with an observable social reality to produce law-like generalisations	Interpretivist approaches focus on the meanings attributed to events, places, behaviours and interactions, people, and artifacts	Critical Realism focuses on explaining what we see and experience, in terms of the underlying structures of reality that shape the observable events	Pragmatism is concerned with action and change and the interplay between knowledge and action

Table 3.1 Philosophical Paradigms adapted from Saunders et al. (2016, p.135 -144)

When conducting research, it is essential to consider the philosophical stance being taken. Understanding different approaches, such as positivism and interpretivism, can help researchers establish their knowledge claims and make informed decisions about their research methods. Positivism involves working with a social reality that is perceived to be observable with a view to producing law-like generalisations (Saunders et al., 2016, p.135). While Given (2008, p.1) observes that interpretivism highlights that human create meaning and cannot be studied in the same way as physical phenomena, rather this paradigm acknowledges the differing meanings that can be attributed to activities, actions, interactions by actors. Within interpretivism, researchers can ensure that their methods are sound and effective by using various factors and approaches, such as determining cause and effect thinking and narrowing focus on select variables (Slife and Williams, 1995, p.2). Critical realism aims to explain observable events by looking at the underlying causes and mechanisms that shape everyday life. As Saunders et al. (2016, p.138) point out, understanding the world involves two steps - the sensations and events we experience and the mental processing after the experience. The paradigm that was best suited to this study was identified as pragmatism. According to Goldkuhl (2012, p.136) "Pragmatism is concerned with action and change and the interplay between knowledge and action". This makes it appropriate as a basis for research approaches intervening in the world and not merely observing the world (Goldkuhl 2012). For a pragmatist, research starts with a problem and aims to contribute practical solutions that inform future practice. According to Saunders et al. (2016, p.143) "It [Pragmatism] strives to reconcile both objectivism and subjectivism, facts and values, accurate and rigorous knowledge and different contextualised experiences". Saunders et al. (ibid) emphasise that "reality matters to pragmatists as practical effects of ideas, and knowledge is valued for enabling actions to be carried out

successfully". An overview of the worldview, values and typical methods used while conducting research within the pragmatic paradigm can be seen in Table 3.2. As a worldview, pragmatism recognises the complexity in reality, where knowledge arises out of actions, situations, and consequences rather than antecedent. Instead of focusing on methods, researchers emphasise the research problem and use all approaches available to understand the problem. Individual researchers have the freedom of choice. In this way, researchers are free to choose the research methods, techniques, and procedures that best meet the needs and purposes of their study, with an emphasis on the development of workable solutions with beneficial outcomes in terms of problem-solving and informing practice.

Pragmatism

Ontology *(nature of reality or being)*	Complex, rich external. "Reality" is the practical consequences of ideas. Flux of processes, experiences and practices.
Epistemology (what constitutes acceptable knowledge	Practical meaning of knowledge in specific contexts. "True" theories and knowledge are those that enable successful action. Focus on problems, practices, and relevance. Problem solving and informed practice as contribution.
Axiology *(role of values)*	Value-driven research Research initiated and sustained by researchers doubts and beliefs Researcher reflexive
Typical Methods	Following research problem and research question Range of methods: mixed, multiple, qualitative, quantitative, action research Emphasis on practical solutions and outcomes

Table 3.2 Pragmatism - adapted from Saunders et al. (2016, p.136) Research paradigms.

3.3.2 Research Approach

Saunders et al. (2016, p.154) identified two critical research approaches, "the deductive and inductive theories". Saunders et al. (ibid) observe that "deduction is the development of a theory that is subjected to rigorous tests", and that the induction theory is based on the researcher "getting a feel of what was going on, to understand better the nature of the problem". As previously articulated, I explored the potential of two adapted pedagogical models in enhancing learner interaction and engagement, learner experiences and learning outcomes vis-à-vis higher retention of knowledge and skills. It was rooted in data collation and analysis from the group upwards, i.e., from the recruits' interactions, perspectives and performance, as well as from researchers' observations of the training interventions.

Therefore, the research questions were answered by adopting an inductive approach instead of declaring a particular hypothesis at the outset and seeking to prove or disprove these hypotheses.

3.3.3 Research Methodology (Design-Based Research)

The key focus of this research was to identify appropriate training models that could be deployed to enhance DFB recruit interaction and engagement, as well as their retention of knowledge and skills. Saunders et al. (2009, p.134) note "All [research methodologies] have an important role to play while conducting research; the choice of strategy must mirror the research questions expectations". This research involved the examination of various pedagogical models within a dynamic DFB training setting, using surveys, interviews, focus groups and classroom observations with recruits and trainers. Many research methodologies were available, including but not limited to narrative, case study, grounded theory, phenomenological, ethnographic and action research methodologies. The following synopsis explains why Design-Based Research was chosen as inspiration for the framing of the research methodology.

Narrative research was initially considered as a framework for this study. Narrative research takes many forms, uses various analytic practices, and has roots in different social and humanities disciplines (Daiute and Lightfoot, 2004, p.14). According to Creswell and Poth (2018, p.70). "It starts with individuals' experiences expressed in their stories". Gudmundsdottir (2001, p.228) further notes that "narrative research is the study of how humans experience the world" and researchers collect these stories and write narratives of experience. Creswell and Poth (ibid) suggest that this research involves "studying one or two individuals, gathering data through the collection of their stories, reporting individual experiences, and chronologically ordering the meaning of those experiences (or using life course stages)". However, this methodology was deemed unsuitable as solely collating narratives of DFB recruit experiences of the various pedagogies employed within the training setting would not be sufficient to respond to the research questions posed in their entirety.

Whereas a narrative study reports the stories of experiences of a single individual or several individuals, a phenomenological study describes the common meaning for several individuals of their lived experiences of a concept or a phenomenon (Creswell and Poth,

2018). Creswell and Poth (2018) observed that "phenomenologists focus on describing what all participants have in common as they experience a phenomenon (e.g., grief is universally experienced)". Moustakas (1994, p.134) gives examples of possible phenomenological research as insomnia, being left out, anger, grief, or undergoing coronary artery bypass surgery. According to Creswell and Poth, (2018), the researcher gathers data from those who have experienced the phenomenon and "develops a composite description of the essence of the experience for all of the individuals". This methodology was deemed inappropriate for this research study as although it would capture the participant's experiences; it did not allow for examination of factors such as the extent of knowledge retention.

As per Creswell and Poth's (2018, p.83) research, "Grounded Theory aims to go beyond individual stories and shared experiences to generate or discover a theory". Grounded Theory focuses on participants' experiences and uses them to explain or provide a framework for further research. Interestingly, Creswell and Poth (ibid) also pointed out that while narrative research concentrates on individual stories and phenomenology emphasises everyday experiences, grounded theory intends to move beyond description and generate or discover a theory. The participants in a Grounded Theory study would all have experienced the process, and the development of the theory might help explain practice or provide a framework for further research. The key idea is that this theory development does not come "off the shelf" but instead is generated or "grounded" in data from participants who have experienced the process (Strauss and Corbin, 1998). Grounded Theory relies on a qualitative research design in which the inquirer generates a general explanation (a theory) of a process, an action, or an interaction shaped by the views of many participants. Although a Grounded Theory researcher develops a theory from examining many individuals who share in the same process, action, or interaction, in such a study, participants are not likely to be located in the same place or interact frequently that they develop shared patterns of behaviour, beliefs, and language. I considered using this methodology as, at first glance, it appears fit for purpose; however, after further investigation into the different methodologies on offer, Grounded Theory did not offer the iterative and incremental improvements needed to examine the efficacy of the Tine model.

An ethnographer is interested in examining shared patterns, and the unit of analysis is typically larger than the number of individuals involved in a grounded theory study. An

ethnography focuses on an entire culture-sharing group. This methodology was discounted, as while findings in relation to culture with a small "c" (such as group culture) might emerge, this study was more interested in exploring whether the adapted pedagogies led to enhanced learning interactions, experiences and outcomes for the recruits.

Robson (2002, p.178) defines a case study as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence". When conducting a case study, data can be collected through questionnaires, interviews, observation, and documentation. According to Saunders et al. (ibid, p.91), this approach allows for challenging existing theories and generating new hypotheses. Remenyi et al. (2008, p.51) note that case studies allow for detailed examination of specific instances and identification of crucial interactive processes. As data from this research was not framed from one case and this research was not challenging an existing theory, this methodology was not deemed suitable for this study.

The next methodology considered was Action Research; Lewin first used the term Action Research in 1946. Action Research is a collaborative inquiry process that develops solutions to real organisational problems using different forms of knowledge (Coghlan 2011: Coghlan and Brannick 2014). As shown in Figure 3.2 below, Action Research is iterative in nature. Each research stage involves diagnosing, planning, taking, and evaluating those actions. In cycle one the action research strategy starts to test the specific context and purpose derived from the research question; after an evaluation, this information is then submitted into cycle two where a better understanding of the student and project is sequenced. The outputs from cycle two are then fed into cycle three where the strategy acts on this knowledge to complete the action research spiral.

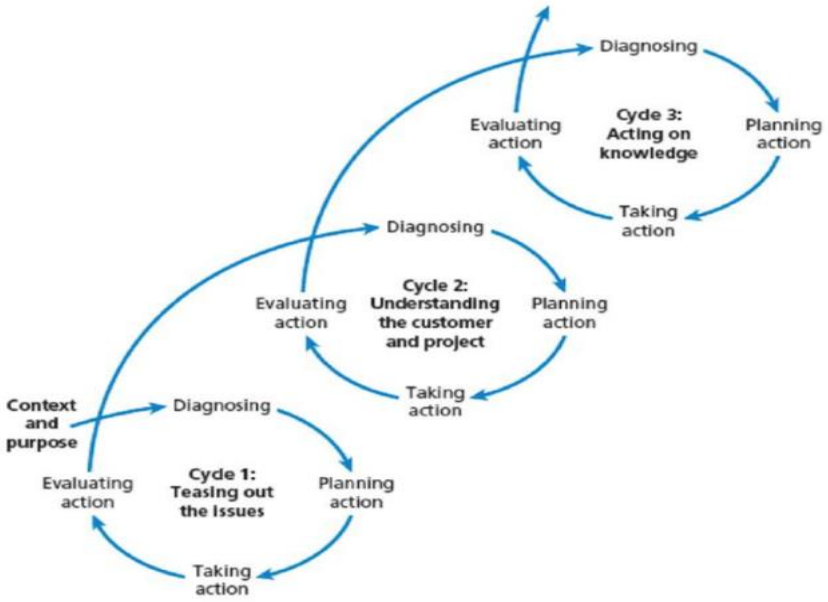


Figure 3.2 The three cycles of the Action Research spiral. Saunders et al. (2016, p.191)

Winter et al. (2001) also suggest that Action Research is a methodology that aims to promote change while scientific knowledge is produced in collaboration between recipients and researchers. This study did not use Action Research as the iterative approach within Design-Based Research offered better opportunities to capture the design of the pedagogical models and the interactions, experiences and outcomes for the DFB recruits.

In summary, the methodologies above were discounted based on the need to adopt a process that allowed for iterative design and development whilst responding to the research questions. The first decade of this century has seen acceleration of a new research methodology within education research, namely Design-Based Research According to Anderson and Shattuck, (2012, p.16), DBR is pivotal to better understanding practice, noting that "DBR as heralded as a practical research methodology that could effectively bridge the chasm between research and practice in formal education". Ann Brown, recognised as a DBR founder, believes that DBR advances understanding of practice in authentic learning contexts "If one believes that context matters in terms of learning and cognition, research paradigms that simply examine these processes as isolated variables within a laboratory or other impoverished contexts of participation will necessarily lead to an incomplete understanding of their relevance in more naturalistic setting" (Brown, 1992, p.142).

Design-Based Research allows the researcher to remain grounded through interdisciplinary approaches, and by "drawing on multiple theoretical perspectives and research paradigms to build understandings of the nature and conditions of learning, cognition, and development" (Barab and Squire, 2004, p.1). Barab and Squire (ibid) argue that "Design-Based Research is not so much an approach as it is a series of approaches, with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic settings". Cobb et al. (2003, p.9) also suggest that Design-Based Research has several common features, including the fact that they result in the production of theories on learning and teaching, are interventionist (involving some design), take place in naturalistic contexts, and are iterative. Crippen and Brown (2018, p.2) suggest that "DBR begins with the exploration, analysis, and subsequent identification of a practical problem that is to be addressed by a designed intervention that is developed in collaboration with stakeholders and then deployed and evaluated in the rich, real-world contexts". This observation by Crippen and Brown is a tenet of this study and helps conceptualise the iterative process of developing pedagogical architecture. This research took inspiration from Reeves's (2006, p.59) four phases of DBR, as shown in Figure 3.3, which included analysis of practical problems concerning DFB fire service training approaches, the development of solutions informed by existing design principles and technological innovations, followed by iterative cycles to test and refine the framing of the pedagogical models, and finally, reflection to articulate the core design principles and contextual factors impacting the implementation of these models.

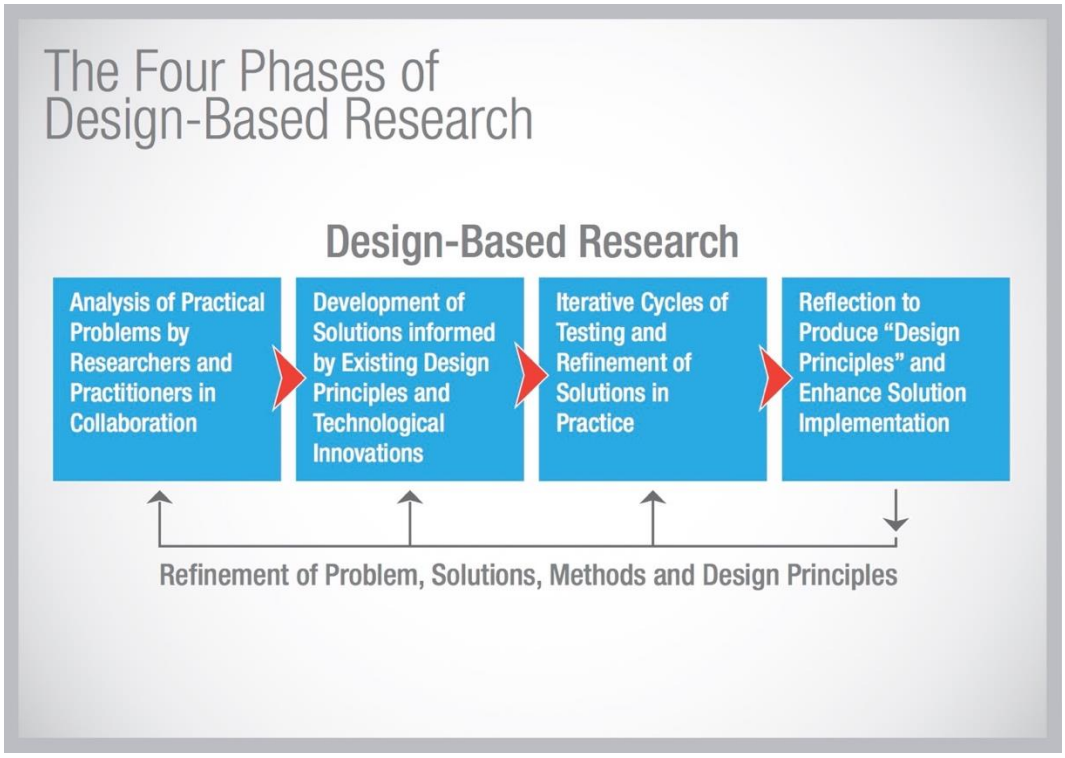


Figure 3.3 Reeves (2006. p.59) Four Phases of Design-Based Research.

In addition, Wolcott et al. (2019, p.309) note that DBR affords exploration of ways in which intervention impact on learning outcomes and in doing so, "shift the focus from whether interventions affect learning outcomes to how interventions affect learning outcomes", which can be useful in informing "more effective future interventions". DBR was used as inspiration for the framing of this overall research study, as it afforded opportunities to examine the interactions, engagement and experiences of participants across the Traditional, Blended and Tine models, while also allowing for examination of outcomes in terms of knowledge retention, and capture of design principles that contributed to quality experiences.

3.4 Research Methods

There are many ways to collect data, the two main approaches are quantitative and qualitative. Saunders et al. (2016, p.86) point out "that quantitative data is randomly used as a synonym for any data collection technique, such as a questionnaire or data analysis that generates or uses numerical data". According to Collins and Hussey (2009, p.22) qualitative data collections are generally transient, understood only within context and are associated with interpretive methodology that usually results in findings with a high degree of validity. From a quantitative perspective, I disseminated a standardised survey which included the

students' demographics and their disposition to the use of technology using a Technology Readiness Indicator (TRI) with the students. In addition, the students' summative results were collated and compared to the projected results using Ebbinghaus' forgetting curve. The qualitative data collected in this research was compiled using data collection tools including interviews, focus groups and observations.

As this research gathered data from both qualitative and quantitate perspectives, the approach could be described as mixed method approach. According to Johnson and Onwuegbuzie (2004, p.15), "Mixed methods research offers great promise for practising researchers who would like to see methodologists describe and develop techniques closer to what researchers use in practice". Saunders et al. (2016, p.169) explain that mixed-method research involves quantitative and qualitative data collection tools, and it can be done concurrently, in parallel, or sequentially. This approach has become increasingly popular recently, as Lyons and Coyle (2021, p.27) note that using both qualitative and quantitative methods can enrich the research outcomes.

Creswell and Creswell (2022, p.5) discuss four mixed method designs: ***convergent mixed methods design***, which combines quantitative and qualitative data, which are collected simultaneously and then merged to provide a complete picture of the research problem. According to Creswell and Creswell (ibid), researchers can better understand the topic under investigation by integrating these two data forms. Any inconsistencies or discrepancies between the data are carefully examined and explained to provide a more accurate interpretation of the results. Next is the ***explanatory sequential mixed methods design***; this design involves conducting quantitative research, analysing the results, and then using qualitative research to explain the findings further. This design is frequently used in fields with a strong focus on quantitative data analysis. The main advantage of this approach is that it provides a more in-depth understanding of the results obtained from the quantitative research phase. However, it is essential to note that this design presents challenges, such as identifying the quantitative results and explaining the selection process for the study sample.

In contrast to the explanatory sequential mixed methods design, the ***exploratory sequential mixed methods design*** involves starting with a qualitative research phase to gather participants' perspectives and then analysing the data obtained. This information is then incorporated into a second phase of quantitative research. The qualitative phase can be

utilised in various ways, such as creating an instrument that best suits the study's sample or identifying suitable tools for the follow-up quantitative phase. It can also be used to design an application or website or to specify variables that should be included in a subsequent quantitative study. However, Creswell and Creswell (2022, p. 235) point out that some challenges arise when selecting appropriate qualitative findings for the quantitative design and a sample for both research phases. And lastly, according to Creswell and Creswell (ibid), a ***complex mixed methods design*** involves embedding one or more core designs into a framework or a process. One way to enhance an experiment is by incorporating the core designs, which can assist in obtaining qualitative data that complement the quantitative findings. These designs can be employed in a case study format to record and analyse cases systematically or to generate cases for further examination. These core designs can also inform a theoretical study that encompasses social justice as a comprehensive viewpoint and encompasses both quantitative and qualitative data.

During my research, I used a convergent mixed methods design, allowing me to gather quantitative and qualitative data simultaneously. For instance, I used the Technology Readiness Index survey and the RTC summative assessment to collect quantitative data, while the focus group observations and interviews helped me gather qualitative data.

The framing of the overall research process is detailed in Figure 3.4, where the research process was inspired by Reeves (2006, p.59) four phases of Design-Based Research. The initial step was to analyse the practical problem to hand in collaboration with fire service training staff and the researcher; this was done by talking with colleagues to see if they had identified the same issues; further to this, a literature review was conducted to establish studies in this field and experiences of training models within other fire services internationally. The output from this initial analysis broadened my knowledge and informed the refinement of the research questions and scope of this research. The second step was to develop a solution informed by existing design principles and technological innovations. A thorough review of learning theories, pedagogical models, and technologies used in online learning within a fire service was prepared. A tentative pedagogic design solution was developed with a critical review of the recruit training materials; this new model was identified as the Tine model. The Tine model would need to be tested and refined to offer a practical solution. Cycle 1 commenced in November 2019 during paramedic recruit training, where an EMS pilot study was conducted. All students in the pilot had access to the skills-

specific online learning modules before moving through each phase of the Tine model. The findings from the pilot suggested that the students found value in the peer-to-peer cooperative learning element of this model. Cycle 2 commenced in June 2020 with a new set of recruit firefighters. These recruits were divided into three distinctive groups: A, B and C. Group A was offered the traditional RTC pedagogic model based on a face-to-face didactic approach. Group B received the traditional in-house model however, they had to complete specific online models before training commenced. Group C received the Tine pedagogic model, where the student had access to online modules and was further supported by peer-to-peer and scenario-based learning. This cycle was focused on the outputs of recruit training interactions and engagements, which allowed me to view first-hand the performance outcomes during the assessment stage and during problem-based learning. Furthermore, the level of readiness of DFB recruit trainees, trainers and officers in integrating technology within the fire service, and level of preparedness of DFB trainers for transitions toward student-centred and problem-based learning was also examined. The fourth phase in this research process encouraged me to reflect and produce the design principles and contextual factors pivotal to the successful implementation of Blended and Tine models.

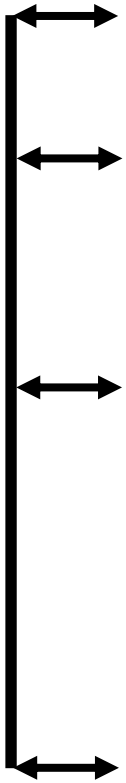
Knowledge Flows	Process Phases	Data flows/ tools & research questions addressed where relevant (RQ)	Outputs
	**Analysis of Practical Problems by Researchers and Practitioners in Collaboration**	• Literature Review • Informal discussions with colleagues • Critical reflection on personal experiences as fire service training practitioner	• Refinement of Problem – Research Questions & Research Proposal.
	Development of Solutions Informed by Existing Design Principles and Technological Innovations	• Literature review of theories of learning and pedagogical models • Review of technologies used in online/ blended learning within fire service contexts • Critical review of DFB recruit training materials	• Tentative Pedagogic Design Solutions i.e., Initial detailing and framing of e-Learning Model and Tine Model
	Iterative Cycles of Testing and Refinement of Solutions in Practice ***Cycle 1***: EMS Pilot Study (Nov. 2019) • EMS Group: Tine Model	***Cycle 1***: EMS Pilot Study • Refinement of Tine Pedagogic Process (RQ2) • Focus Group with EMS participants • Observation of 2 syndicates • Questionnaires/ Surveys	***Cycle 1***: EMS Pilot Study • Findings on EMS engagement, and experiences of Tine Model • Refinement of Tine Pedagogic Model
	Cycle 2: Recruits Study (May to August 2020) • Group A: Traditional Model • Group B: Blended Model • Group C: Tine Model	***Cycle 2***: Recruits Study (RQ1, RQ2 and RQ3) • Technology Readiness Survey of Recruits & Trainers (RQ3) • Observations – Researcher Observation, GoPro Recordings (RQ1; RQ2) • Recruit Focus Groups (RQ1; RQ2) • Instructor Interviews (RQ2, RQ 3)	***Cycle 2***: Recruits Study - Findings on: • Recruit Trainee Interaction/ Engagement • Recruit Trainee Experiences • Recruit Trainee Performance Outcomes • DFB Officer/ Trainer/ Recruit readiness for technology integration • DFB Officer/ Trainer/ Recruit readiness for transition to student-centred learning and problem-based learning.
	Reflection to Produce "Design Principles" and Enhance Solution Implementation	Data from critical review and analysis across all data sets (RQ3)	Pedagogic Design Principles for e-Learning and Tine Models Contextual factors necessary to support e-Learning and Tine Models

Figure 3.4 Overview of Research Process, inspired by Reeves (2006, p.56) Four Phases of Design-Based Research

3.5 Time Horizons

According to Saunders et al. (2016, p.200) "an important question that must be answered by the researcher is should the research reflect a snapshot in time or should a longer time frame be examined in order to answer the research question". A cross-sectional study would reflect a snapshot style of research, while a longitudinal study, according to Remenyi et al. (2008, p.47) "should be utilised to describe a study that extends over a substantial period of time and involves studying changes over time". Within the research period, I conducted a pilot study of the Tine model with EMS personnel in 2019 to test key features of this model and inform the subsequent structuring of the pedagogical intervention with new DFB recruits. However, in terms of responding to the main thrust of the research questions, the study adopted a cross-sectional approach by exploring the Traditional, Blended and Tine model with three separate groupings of new recruits over a time period spanning from June to August 2020.

3.6 Data Collection and Analysis

The central, totally indispensable part of real-world research is the collection of data - "No data – no project" (Robson, 2002, p.385). Quantitative and qualitative data were gathered in this study; however, data in its raw form does not speak for itself. According to Robson (ibid) the message stays hidden and needs careful teasing out. Saunders et al. (2016, p.567) liken data analysis to the process of completing a jigsaw puzzle, in which the pieces of data and the relationships between them help us create a picture and an understanding of what the data tells us. How we compile and sort the data can vary; however, as with a jigsaw, we try to fit similar pieces together. Eventually, a clearer picture emerges, as with the data in this research; a clear understanding of the data analysed is imperative to answering the research question. As the research questions explores an educational model in DFB, it was important to obtain data from the appropriate population, i.e., the people who will be doing and participating in the training. For this reason, the target audience was EMS and RTC instructors and, most importantly, the EMS trainees and recruit firefighters.

3.6.1 Focus Groups

According to Kamberelis and Dimitriadis (2013, p.887) "focus groups have become a part of the collective consciousness of the qualitative research community and of the public imagination". Focus groups are perfect sites for empirical investigations of these theoretical

formulations of self. In particular, they give us opportunities to see whether and how "self," "other," and "context" seems to be co-emergent phenomena, getting us to the very heart of the social processes social theorists argue constitute reality or the world we live in (Kamberelis and Dimitriadis, 2013, p.888). Hennink (2013, p.701) suggests that "the name of the method defines its key characteristics, in that it involves a focus on specific issues, with a predetermined group of people, participating in an interactive discussion, thereby a focus group discussion". The method may be described as an interactive discussion between six to eight pre-selected participants, led by the researcher and focussing on a specific set of issues. A focus group discussion aims to gain a broad range of views on the research topic and to create an environment where participants feel comfortable expressing their views (Hennink et al., 2011, p.2). The focus group method differs from other qualitative methods in its purpose, composition, and the group nature of data collection. Focus group discussions have several characteristics that distinguish the method, including the following;

- "Focus groups typically consist of 6 to 8 participants but can be anywhere between 5 and 10 depending on the purpose of the study.
- Participants are pre-selected and have similar backgrounds or shared experiences related to the research issues.
- The discussion is focused on a specific topic or limited number of issues to allow sufficient time to discuss each issue in detail.
- The aim is not to reach consensus on the issues discussed but to uncover a range of perspectives and experiences.
- Discussion between participants is essential to gather the type of data unique to this method of data collection.
- The group is led by a trained moderator who facilitates the discussion to gain breadth and depth from participants" responses.
- Questions asked by the moderator are carefully designed to stimulate discussion, and moderators are trained to effectively probe group participants to identify a broad range of views.
- A permissive, non-threatening group environment is essential so that participants feel comfortable to share their views without the fear of judgment from others."

(Hennink et al., 2011, p.2)

The focus groups were used to gather participants' perspectives and experiences of processes and engagement in both the EMS pilot and the Recruit studies.

3.6.2 Observations

Given (2008, p.2) states that "observation is considered as fundamental to good qualitative research. Observation can be used to collect various sorts of behavioural or interactional data". Observations can vary along a continuum from participatory, where the researcher is accepted as someone who is regularly present and a member of the study community, to non-participatory, where the researcher is an outsider who conducts systematic observations without interacting with anyone (Given, 2008, p.2). Krueger (2017, p.1) adds that "observation has a unique niche among evaluation methods". Those who study human behaviour indicate that there is often a gap between what people say they do and what they actually do. As this research is knowledge and skills based, the students needed to be observed during the Traditional, Blended and Tine Model interventions, firstly to see if they were doing what they were assigned to be doing; and then to document the previously undocumented interactions and engagements within firefighter training, with a view to articulating the opportunities and challenges for further iterations that may not have been captured if this process has not been observed.

In addition, this research also required observation of a subset of instructors while they taught face-to-face and interacted within drill yard session(s). Saunders et al. (2016, p.354) stated that "observation is a somewhat neglected aspect of research." There are two types of observation models, participant observation and structured observation. Participant observation is qualitative in nature; its emphasis is on discovering the meanings that people attach to their actions. In contrast, structured observations are quantitative and are more concerned with the frequency of those actions. The participant observation model was utilised in this research study as the focus was on capturing the nature of interactions and engagement in authentic fire service training contexts.

Sentiment Analysis (SA) was also used to interpret the participant observations for the instructors during the EMS Pilot Study. Sentiment Analysis is a growing field of research in the text mining industry, according to Medhat and Hassan (2014, p.1093). SA involves using computational methods to examine opinions, sentiments and subjectivity in text. One way to determine the emotional tone of a written piece is through sentiment analysis, also known as opinion mining. Many businesses employ this technique to classify opinions about their products, services, or ideas. Sentiment analysis can determine the sentiment and

polarity (the level of positivity or negativity) subject and opinion holder in the text. This analysis can be applied to different text parts, such as an entire document, paragraph, sentence, or sub sentence. As part of the EMS Pilot study, this research utilised Sentiment Analysis to determine the level of positivity expressed by instructors during two semi-structured interviews. The interviews were transcribed and common words were identified and color-coded to highlight recurring themes. The top ten words used by the instructors were analysed by cross-referencing them with their corresponding interview quotes to identify any significant themes.

3.6.3 Interviews

Like observations, qualitative interviews can range from unstructured to highly structured, but all interviews are open-ended in that respondents can answer in whatever way and to whatever extent they wish and in that there is some interaction with the interviewer who may probe, extend questions, or raise new topics. According to Kahn and Cannell, 1957, as cited by Saunders et al., (2009, p.136), an interview is "a purposeful discussion between two or more people". According to Saunders et al. (ibid), using interviews can help the researcher gather reliable data relevant to the research question and objectives. According to Ritchie and Lewis (2008, p.17) "classic ethnographers such as Malinowski stressed the importance of talking to people to grasp their point of view". The interview type used in this research was semi-structured; according to Saunders et al. (ibid) semi-structured interviews are non-standardised, where the researcher will have a list of themes and questions to be covered, although these questions may vary from interview to interview. The instructors in the recruit study engaged in the semi-structured individual interviews. I found the semi-structured interview method invaluable as it allowed me to alter the question set and explore alternative topics uncovered during the interview process. Once all the interviews had been transcribed for data analysis purposes, I used the "NVIVO" application to code the relevant themes of the interviews, observations and focus groups.

3.6.4 Questionnaires

Questionnaires are a commonly used method of collecting data. They can be distributed through various modes like post, email, online, or face-to-face, typically consisting of open and closed questions. Unlike interviews, questionnaires are designed to be completed without direct interaction with the researcher. They can ask respondents about facts or

personal experiences and beliefs and are most commonly used in surveys to gather responses from many people in various locations. Additionally, these types of questionnaires may be called self-completion, self-administered, or postal or mail questionnaires. According to De Vaus (2002, p.94) “Questionnaires are the most common method of collecting survey data”. However, before data collection can occur as De Vaus (ibid) points out questionnaires must be designed; this design involved thinking ahead about the research problem, what the concepts mean and how we will analyse the data. I identified that the focus of the questionnaire would capture five major components, these being: Student demographics, Access to technology, Usage of technology, Attitude towards ICT and online learning, and Perspectives on Blended and Tine models. Before the questionnaires were given out, I asked all students and instructors to sign the Informed and Plan Language forms, an example of these forms can be viewed in Appendix, A.2 and A.3.

To obtain the necessary quantitative data for analysis, I used the Likert scale and dichotomous response format in framing the question responses. The initial part of the questionnaire explored the demographics of the class, including age, sex, and experience in working for a fire service, which was important in terms of understanding the background of participants. Additionally, understanding the participants' access to technology and their attitude towards using such technologies was necessary, as a negative or highly positive attitude could create bias in the results. Finally, I inquired about the students' thoughts on the Blended and Tine model and their experience of online or blended learning in general.

3.7 Data Collection Process

Several factors can influence a researcher while they collect their data. In this instance, political and environmental constraints resulted in considerable delay in the implementation of this research study. A breakthrough was made when it was agreed that an EMS pilot would be beneficial in enabling the organisation to decide whether the Tine Model should be offered to firefighters during their recruit training. This EMS pilot was conducted in October 2019, and the initial findings were presented to the Chief Fire Officer for consideration. The Chief Fire Officer recommended that further research into this model be conducted with the next intake of recruit firefighters. In May 2020, the Tine model debuted and was incorporated into the Road Traffic Collision Course (RTC) for recruit class 1-2020. This pilot study and the data collected during the RTC training intervention allowed me to

implement the iterative approach favoured in Design-Based Research. This section will discuss the data collection for the two iterations conducted using the Tine model.

3.7.1 Cycle 1: The EMS Pilot

This Pilot study involved engagement with the Tine model by a cohort of recruit firefighters, external students and current in-service personnel undertaking in-service EMS training. The Tine model was framed around a series of stations, the first of which involved completing blended learning. Blended learning was offered through an external software solution provided by "*Training-Online.eu*", an example of the Graphical User Interface can be seen in Appendix I. The rationale for using an external software platform was that I had complete autonomy when choosing or creating online modules. The online modules used in the pilot study were developed in-house and focused on delivering a medication called Pentrox.

Fifty-two students were in the class, forty-six returned their plain language consent forms. Forty-one completed survey one, a pre-survey that focused on their demographics and service history and use of technology. Survey one was disseminated via a link shared on WhatsApp. The post-intervention survey focused on the students' online and technological experiences and was completed by forty students. I piloted the Tine model with two syndicates; each syndicate comprised six students; all had completed survey one and returned their consent forms. After the intervention, a focus group was formed to examine their experiences with this model.

Number	**Description**
52	Number of Students
46	Returned Plain Language Statement / consent form
41	Completed Survey 1
40	Completed Survey 2
2	Syndicates Observed (12 Students in total)
1	Focus Group

Table 3.3 EMS Data Collection

EMS Pilot Survey

During the EMS intervention, two surveys were disseminated; survey one was offered to the students before the Tine Model intervention and survey two was given to the same set of students after they had completed the training using this model. There were twenty questions

in each questionnaire; the table below outlines the questions asked of the students pre and post-intervention.

Question	Survey 1 [Pre training]	Survey 2 [Post training]
1	I agree to participate in this research study	I agree to participate in this research study
2	Security Question	Security Question
3	What is your age?	What is your age?
4	What is your gender?	What is your gender?
5	How many years" service do you have?	How many years" service do you have?
6	What is the highest level of education you have completed?	What is the highest level of education you have completed?
7	Which organisation do you work for?	Which organisation do you work for?
8	What watch are you currently assigned to?	What watch are you currently assigned to?
9	What district are you currently assigned to?	What district are you currently assigned to?
10	What is your current rank?	What is your current rank?
11	Types of Technology used?	I feel that the e-Learning software for the Pentrox module was easy to use
12	How skilled are you in using the following technologies?	How would you rate the e-Learning content of the online Pentrox Module?
13	Please select the option that best reflects your frequency of Internet usage?	Rate your experience of the e-Learning Pentrox Module out of 10, with 1 being the lowest score and 10 being the highest.
14	Please indicate what technology you use to access the Internet	I feel confident that I could use the knowledge and skills presented in this e-learning module to administer Pentrox to a patient.
15	I feel e-learning should form part of fire fighter training.	I feel e-learning should form part of fire fighter training.
16	I believe that e-learning gives me the opportunity to acquire new knowledge.	I believe that e-learning gives me the opportunity to acquire new knowledge.

Question	Survey 1 [Pre training]	Survey 2 [Post training]
17	I believe that e-learning enhances the quality of my learning experience.	I believe that e-learning enhances the quality of my learning experience.
18	I believe that e-learning should only be used for refresher training.	I believe that e-learning should only be used for refresher training.
19	I feel that e-learning is not a suitable platform for my own learning.	I feel that e-learning is not a suitable platform for my own learning.
20	I prefer face to face lessons in a classroom rather than e-learning modules.	I prefer face to face lessons in a classroom rather than e-learning modules.

Table 3.4 EMS Survey Questions

Questions one to ten set out the demographic profile of the group. The next set of questions, eleven to fourteen inclusive (coloured in grey in Table 3.4 above) are intentionally split between surveys one and two. The rationale was first to capture the student's interaction with technology and then find out how they interacted with the online module post-intervention. The next set of questions, fifteen to twenty, were posed to ascertain the student's attitudes before and after completing the online module.

EMS Pilot Observation

I observed two syndicates while they were engaged in the EMS pilot using the Tine model training intervention. The observation template was adapted from Silverman (2008, p.227) template. These observations focused on what people were doing, what the students and instructors hoped to accomplish, what assumptions the students were making, and what assumptions I was making. What was going on in the classroom, what I saw going on in the classroom, and lastly, I focused on my own bias by recording how I felt and why I recorded the observations. Each iteration of the model took an average of two and a half hours to complete.

Syndicates A and B were chosen to be observed in this pilot EMS study as they had completed their online module before commenting on their face-to-face training. Each syndicate comprised six recruit firefighters. The first cycle started after the students had completed their online learning. The students were then observed rotating through each station of the Tine model, as depicted in Figure 3.5. The students completed the first station remotely before commencing the face-to-face instruction. In skill station number two, the students were observed asking the instructors questions related to the module they had completed; there was also time allocated to allow them to study at their own pace before starting the face-to-face instruction. The following skill station, skill station three, was divided into two sub-groups which rotated internally; this skill station had a student-to-instructor ratio of 1:3. This skills station was instructor lead, where the instructor demonstrated each of the skills that the student would be expected to complete in the next station. Skill station four offered the student time to practice each skill they had previously observed. The students were observed using their OSCE skill sheets when completing skill rotation four of the Tine model. During skills stations five and six, the students were observed using the Pentrox medication while being given different scenarios by the

instructors. In skills station five, the scenarios reinforced when the medication delivery was indicated. In skills station six, the students faced scenarios where the medication delivery was contraindicated. Moving onto skill station seven, the students were observed discussing their choices in the previous skills station and identifying where lessons were learnt. Station eight was designed as a summative assessment. However, as an external statutory body examined students, this assessment occurred post-intervention.

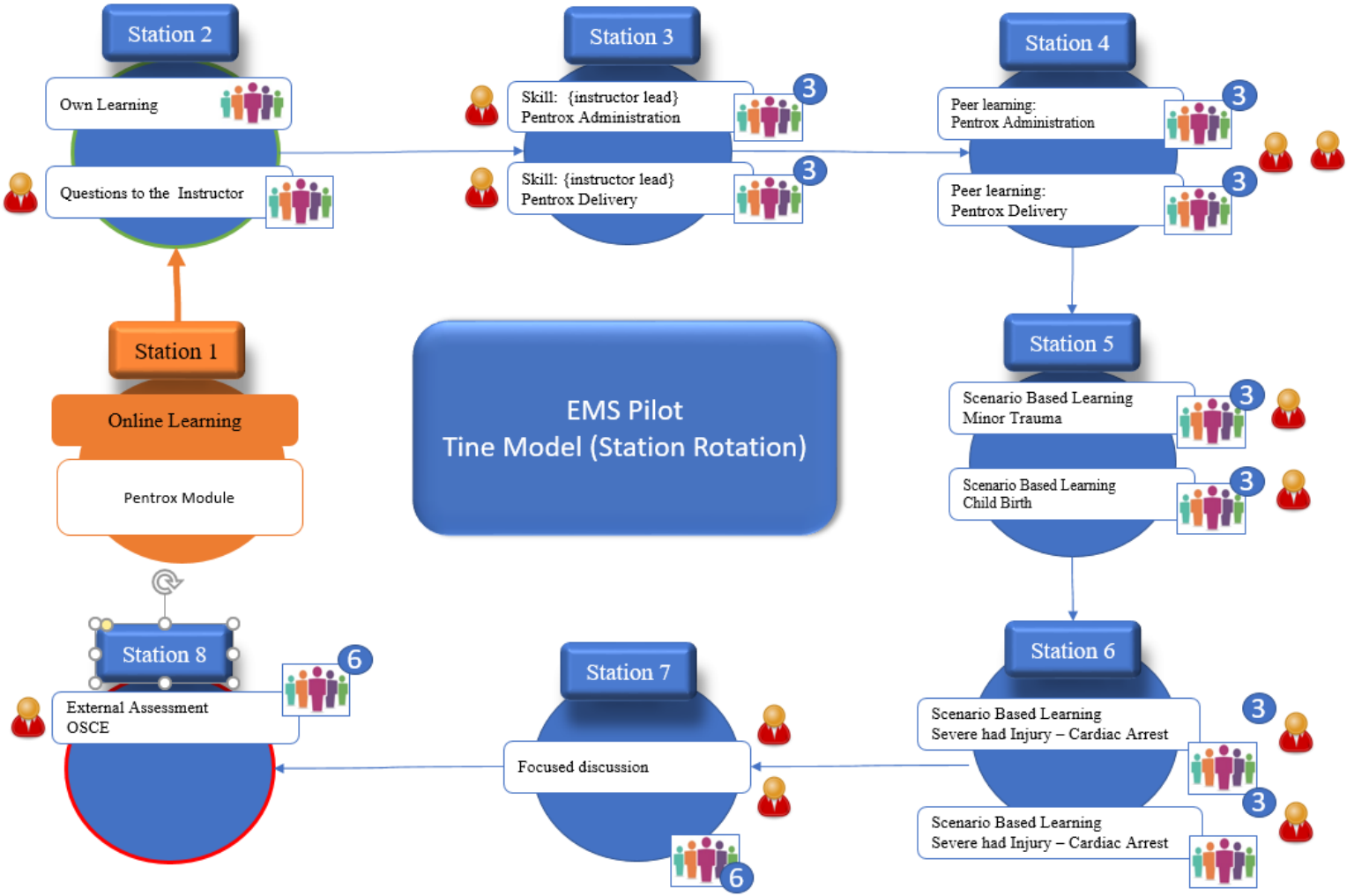


Figure 3.5 Tine Model – (Station Rotation) EMS Pilot

Both syndicates A and B were asked to partake in a focus group post-intervention; the students were asked how they felt about the Tine model, what were the good and bad points and if was there anything they would improve. The focus groups were unstructured and consisted of six students in each syndicate. The timeframe for each focus group varied; 30 minutes was the average time spent with each syndicate.

EMS Pilot Focus Group

A focus group discussion took place with the EMS students who had participated in the Station Rotation intervention. The total number of students in the group numbered twelve, as the students were on their own free time the duration of these discussions was limited to twenty minutes. The focus group was a somewhat last-minute event and to this end was not as well-structured or documented as one would have liked. The key areas of discussion mainly focused on attitudinal queries focused on what the student liked or disliked about the model. From handwritten contemporaneous notes captured on the day, the overwhelming sentiment was that of positivity. One student stated that they particularly liked the fact that they knew what subject they were going to be doing the next day. Another student said that having the eLearning module before the skills session gave them an opportunity to replay the indications and contraindications of Pentrox administration before they had to do the skill for real. The same student also said that the [eLearning] module offered consistent instruction, this comment evoked further discussion around how the group disliked the fact that sometimes if you asked two separate instructors for a point of clarification you may get two opposing views.

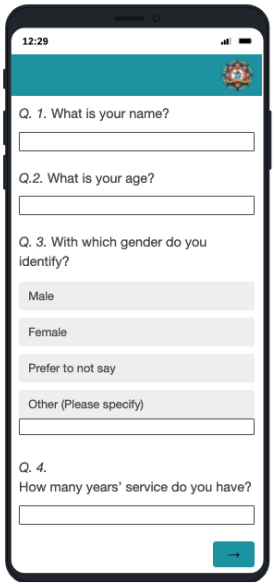
3.7.4 Cycle 2: RTC Blended and Tine Model Interventions

Recruit Class 1-2020 were the first students exposed to the Blended and Tine models for fire service training. The class comprised 49 students split into three groups, Group 1(n=17), Group 2 (n=15) and Group 3 (n=17). Each group was assigned to a different RTC course on alternate dates.

Group Number	***Date of Course***	***Training Received***
1	02/06/2020	Traditional model: Standard face to face training
2	29/06/2020	Blended Model: Access to online modules prior to traditional face to face training.
3	13/07/2020	Tine Model: Access to online modules prior to traditional face to face training and participation in Station Rotation Model.

Table 3.6 RTC Course 1-2020 - Tine Model Intervention

The quantitative data was collected using a survey tool hosted by Qualtrics. A sample of thirty-eight students returned their questionnaires from a set of forty-nine students. The qualitative data was collected utilising focus groups, observations and one-to-one interviews with a subset of Instructors. The qualitative data was examined and grouped into codes, categories and themes using NVIVO software, an example can be viewed in Appendix D. The following offers an overview of the quantitative and qualitative data collected during this intervention.



<u>Questionnaire Responses</u>
49 students surveyed

Responses by Group
Group 1 - 14 students
Group 2 - 15 students
Group 3 - 09 students

Total Responses
38 valid responses

*Survey hosted by Qualtrics

Figure 3.6 RTC Questionnaire and responses.

The questionnaire was broken up into three distinct areas of research focus; questions one to nine inclusively queried the participant's demographics and offered me an optic into the levels of education and previous engagement with other fire services. Question 10 solely focused on the Technology Readiness Index 2.0; a scale developed by Parasuraman et al. (2015). Questions eleven to seventeen queried the participant's access, use, frequency and attitude towards technology to gain a holistic view of the student's prior interactions and experiences with ICTs. The participants were asked if they had access to various technologies, such as laptops and smartphones. They were asked if they had access to a computer at work; this question was posed to see if the student's previous experience with technology was routed in the work environment. The next set of questions focused on the means of ICT access and frequencies of use over twelve months. The last question was presented to the participant to glean their attitudinal response to online learning, as follows:

Online learning gives me the opportunity to acquire new knowledge.
Online learning gives me the opportunity to acquire new skills
Online learning enhances the quality of my learning experience.
Online learning should be a part of firefighter training.
Online learning should be used for refresher training on station.
Online learning should be used for recruit training.
Online learning should be available to me when I am not in work.
Online learning is not my preferred mode of learning.
I prefer face-to-face lessons in a classroom rather than online learning modules.

3.7.5 Focus Groups

All students participated in the focus groups; there were nine focus groups in total. The students' questions were focused on their prior employment, previous learning experiences and prior knowledge and experience of online learning. Each focus group started with an introduction and rationale of the study; this was then followed by asking each student to tell me where they worked previously and what motivated them to become a firefighter. The question set then moved from an initial one-to-one questioning to more of a discussion. In this discussion, I asked the group open-ended questions and followed up with probing questions to encourage further discussion. These questions focused on motivation, educational models, previous educational experience and, where appropriate, attitudes towards the Blended or Tine model. The transcripts were coded into first- and second-level codes, and the categories in Table 3.5 emerged from reiterative data analysis.

Categories	Codes
Prior work and fire related experiences of recruits	Prior fire service training experience
	Prior occupation
	Prior RTC training
Stimulus for registering for fire service recruit training	Motivation to join Fire Service (Extrinsic)
	Motivation to join Fire Service (Intrinsic)
Instructor background and training experience	Work and Educational Experience
	Course Design
	Course Content
	Course Delivery
	Course Assessments
	Instructor Motivation
Course Design for each model	Accessibility of course content
	Consistency of course content
	Relevance of course material

Categories	Codes (Continued)
	Resources and Tool Allocation
	Sequencing and Structuring of course content – theory-practice
	Time allocation for theory lessons, practical and online sessions
	Variety within Course Content
Recruits experience with each model	Dispositional factors - Internal Factors
	Motivational factors
	Pedagogical factors
	Situational factors - External Factors
Recruits' perspective on face to face and blended online learning	Accessibility of course content in face-to-face blended online learning
	Dispositions towards face-to-face, blended and online learning
	Motivating factors within face-to-face blended online learning
	Prior Online Learning knowledge experience
	Sequencing of face-to-face blended online learning

Table 3.5 Focus Categories and Group Codes

3.7.6 Observations

Observations were conducted for three groups in 2020 during their Road Traffic Collison (RTC) course. These observations were captured with a GoPro video camera attached to a recruit firefighters' PPE when in the drill yard. All groups were observed in a classroom setting receiving traditional face-to-face learning, an example of an observation captured during face-to-face instruction can be viewed in Appendix B.1. Group 2 and Group 3 were also given access to the RTC online material and were asked to complete three modules, Glass Management, Vehicle Stabilisation and Reciprocating Saws, before starting their RTC course. In addition, Group 3 participated in the Tine Model, which was explained to the group and their instructors before training started. The location of the GoPro camera on firefighter helmets meant that quite a lot of the visual footage pointed up in the air or at unusual angles. Hence, the researcher felt that it was more appropriate to capture a holistic description of what could be heard and seen in GoPro footage in terms of fire fighter engagement in the task at hand, as opposed to a line-by-line transcription of the GoPro footage. The researcher constructed an observation form based on Silverman's (2008, p.227) observational template for each observation. This template included simple questions which included what people were doing and incorporated my analytical observational view, which was used to compare groups during the data analysis of this research and can be seen in Figure 3.7.

Figure 3.7 Whiteboard collection of data from observations RTC Class 1-2020

3.8 Data Analysis

As previously mentioned, a mixed method approach was utilised in this research; the data was collected using several instruments, and a triangulation method of making sense of the data was offered. Braun and Clarke (2021, p.42) state that a "reflexive TA offers a six-phase process that systematically builds from data familiarisation through to coding and theme development and refinement". This process is depicted in Figure 3.8.

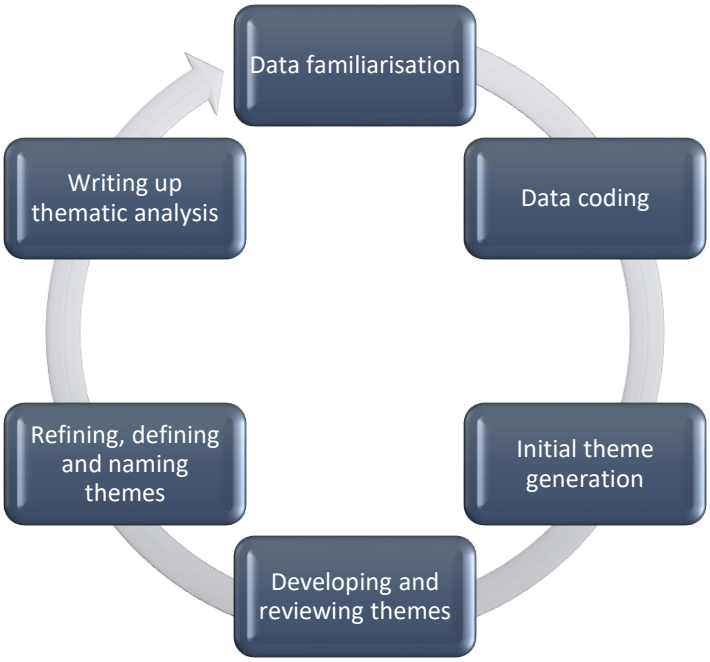


Figure 3.8 Six-Phase Thematic Analysis adapted from Braun and Clarke (2021, p.41)

Braun and Clarke (2021, p.42) would advocate that when conducting qualitative analysis, it's important, to begin with the familiarisation phase, Phase One. This phase involves reading and re-reading the entire dataset to become well-acquainted with the data. This is necessary to identify relevant, valuable information to the research question(s). This phase can be time-consuming and requires patience, but it's important to consider the entire dataset equally. According to Braun and Clarke (2021, p.42) "skipping over this step can be tempting, but it should be avoided". At this phase, I set about familiarising myself with the data by first listening and watching each interview, class and focus group recording once before transcribing that recording. This first playback of each recording required "active listening", so I did not take any notes. I performed this active listening to develop an understanding of the primary areas addressed in each interview before transcription. This also provided me with an opportunity, unburdened by tasks such as note-taking, to recall gestures and mannerisms that may or may not have been documented in interview notes. I manually transcribed each interview immediately after the active-listen playback. When the transcription of all interviews was complete, I read each transcript numerous times. At this point, I took note of casual observations of initial trends in the data and potentially interesting passages in the transcripts. I also documented my thoughts and feelings regarding the data and the analytical process.

Following Phase One, Braun and Clarke (ibid) suggest the next phase should focus on generating initial codes. Codes are the fundamental building blocks of what will later become themes. The coding process is undertaken to produce succinct, shorthand descriptive or interpretive labels for information relevant to the research question(s) Braun and Clarke (2021, p.147). They also suggest it is vital to approach the dataset systematically and give each data item equal attention when conducting research. This includes identifying interesting aspects of the data that may be useful in developing themes. When coding, it is recommended to keep the codes brief yet detailed enough to stand alone and reveal underlying commonalities among the data items related to the research subject. Through repeated iterations of coding and further familiarisation, I could identify which codes are conducive to interpreting themes and which can be discarded. Braun and Clarke (2021, p.48) would recommend "that the researcher document their progression through iterations of coding to track the evolution of codes and indeed prospective themes". I found it helpful to track the evolution of my coding process in a spreadsheet, documenting data items and iterations of codes. All codes developed during the first iteration of coding were transferred into this spreadsheet along with a label identifying the respective participant. Subsequent iterations of coding were also documented in this spreadsheet while regularly consulting the original transcripts to assess existing codes and examine for the interpretation of new codes.

During the Third Phase of the Thematic Analysis model, I had to carefully analyse and interpret the data once all relevant items had been coded. This involved examining the bigger picture and identifying themes or sub-themes from the aggregated data. Sometimes, multiple codes needed to be combined based on shared meanings, while other times, one code represented an overarching narrative and was promoted as a sub-theme or theme. According to Braun and Clarke (2021, p.47) by taking these steps, "researchers can gain a deeper understanding of the data and draw meaningful conclusions from it". It's important to remember that themes don't simply exist in the data waiting to be discovered. The researcher must actively construe the relationship among the different codes and examine how this relationship may inform the narrative of a given theme Braun and Clarke (ibid). What is important is that the pattern of codes and data items communicates something meaningful that helps answer the research question(s) (Braun and Clarke 2013, p.48).

Phase Four asks the researcher to conduct a review of potential themes. According to Braun and Clarke (2021, p.148) the researcher needs to take a recursive approach, considering how

the candidate themes relate to the coded data items and the entire dataset. During this phase, it may become apparent that some themes could be more helpful in interpreting the data or addressing the research question(s). Additionally, it was necessary to revise some of the codes that informed these themes as they were incongruent. Phase Five suggests that the researcher should define and name the themes. All themes should create a straightforward, informative narrative consistent with the dataset's content. The names of the themes may also be subject to revision at this point. At this point, I analysed the underlying data items thoroughly and defined themes. The final phase, Phase Six, involved a recursive approach to report writing, I documented any changes and reflections in informal notes, memos, and a research journal that was important. The final inspection of the report involved establishing the order in which themes were reported. Connecting themes logically and meaningfully was essential to build a cohesive narrative that accurately represents the data.

3.8.1 RTC - Technology Readiness Index 2.0

From a quantitative perspective, the Technology Readiness Index component of the survey was analysed using SPSS. The Technology Readiness Index 2.0 (TRI 2.0) is a 16-item scale to measure people's propensity to embrace and use cutting-edge technologies. The scale is broken down into four categories, optimism, innovativeness, discomfort and insecurity.

Optimism - a positive view of technology and a belief that it offers people increased control, flexibility and efficiency in their lives (Parasuraman et al., 2015, p. 60). The students were asked about their level of agreement with the following four statements coded OPT1, OPT2, OPT3 and OPT4 respectively, the Likert scale used ranged from Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree and Strongly Disagree. OPT1: New technologies contribute to a better quality of life. OPT2: Technology gives me more freedom of mobility. OPT3: Technology gives people more control over their daily lives. OPT4: Technology makes me more productive in my personal life.

Innovativeness – a tendency to be a technology pioneer and thought leader (Parasuraman et al., 2015, p. 60). The students were asked about their level of agreement with the following four statements coded INN1, INN2, INN3 and INN4 respectively. The Likert scale used ranged from Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree and Strongly Disagree. INN1: Other people come to me for advice on new technologies. INN2: In

general, I am among the first in my circle of friends to acquire new technology when it appears. INN3: I can usually figure out new high-tech products and services without help from others. INN4: I keep up with the latest technological developments in my areas of interest.

Discomfort – a perceived lack of control over technology and a feeling of being overwhelmed by it (Parasuraman et al., 2015, p. 60). The students were asked about their level of agreement with the following four statements coded DIS1, DIS2, DIS3 and DIS4 respectively. The Likert scale used ranged from Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree and Strongly Disagree. DIS1 When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do. DIS2 Technical support lines are not helpful because they don't explain things in terms I understand. DIS3 Sometimes, I think that technology systems are not designed for use by ordinary people. DIS4 There is no such thing as a manual for a high-tech product or service that's written in plain language.

Insecurity – distrust of technology, stemming from skepticism about its ability to work properly and concerns about its potential harmful consequences (Parasuraman et al., 2015, p. 60). The students were asked about their level of agreement with the following four statements coded INSI, INS2, INS3 and INS4 respectively. The Likert scale used ranged from Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree and Strongly Disagree. INS1 - People are too dependent on technology to do things for them. INS2 - Too much technology distracts people to a point that is harmful. INS3 - Technology lowers the quality of relationships by reducing personal interaction. INS4 - I do not feel confident doing business with a place that can only be reached online

Firstly, descriptive statistics were generated from the online survey. Then analytical statistics allowed for a closer examination of the data collected using the TRI 2.0 16-point survey tool. A technology readiness score was generated by averaging each category and further data analysis was based on the technology readiness beliefs namely.

- Skeptics: tend to have a detached view of technology, with less extreme positive and negative beliefs
- Explorers: tend to have a high degree of motivation and low degree of resistance
- Avoiders: tend to have a high degree of resistance and low degree of motivation
- Pioneers: tend to hold both strong positive and negative views about technology

- Hesitators: stand out due to their low degree of innovativeness.

3.9 Rigor in Research Process

As a senior management team member within Dublin Fire Brigade, I was considered an inside researcher in this study. I had direct access to the student population, who were new entrants. Therefore, it was crucial for me to pay attention to the ethical considerations of being an inside researcher. According to Bannick & Coghlan (2007, p.59) "Insider research has been described as research which is undertaken within an organisation, group or community where the researcher is also a member". As Fleming (2018, p.311) observes "staff members involved in work-integrated learning (WIL) are often well-positioned to gain an in-depth understanding of the program situated within the organisations where they are actively involved and currently employed". As this research aimed to explore the knowledge retention of a firefighter during their recruit training, it was crucial for me to have an intimate understanding of the recruit program. However, it was also imperative that any bias was noted and rigor was implemented throughout this research. Fleming (2018, p.313) points out that "one of the initial challenges of conducting insider research is to ensure that the research design has rigor and transparency in the methods of data collection". To ensure that the data collected had rigor and transparency any bias was noted in my reflective diary and acknowledged in this research.

There have been many debates amongst scholars arguing the significance of rigour in the research process. Rigor is widely acknowledged as one of the most crucial aspects of the research process. Rigor, in qualitative terms, and reliability and validity, in quantitative terms, are, according to Thomas and Magilvy (2011, p.151) "ways to establish trust or confidence in the findings or results of a research study". To achieve high-quality research, maintaining consistency in methods is crucial. This is where rigor plays a crucial role; by implementing rigorous standards in your research, you can accurately represent the population studied and enable the replication of the study with a different research sample. Rigor ensures the necessary details to establish a reliable and valid study. Rigor is essential to qualitative research, ensuring the study is thorough, exhaustive, and accurate (Thomas and Magilvy, 2011, p.151). This quality of being highly rigorous means that researchers can accurately represent the population studied, and the study can be replicated with different research samples. The term "rigor" may imply strict precision, inflexibility, and harshness, but it is crucial to establish the necessary details to create a reliable and valid study. In the

next section, I will discuss the four components of qualitative research rigor according to Guba and Lincoln (1985).

Qualitative research rigour

Guba and Lincoln (1985, p.290) in their work, posed the fundamental question of qualitative research rigour as "How can an inquirer persuade his or her audiences (including self) that the findings of an inquiry are worth paying attention to, worth taking account of?". It's interesting to consider the idea that there is no one universal truth that everyone can agree on. Everyone has a unique perspective shaped by a variety of factors. While this can make it challenging to conclude research, it's essential to trust the evidence presented to make informed decisions. As Guba and Lincoln (1985, p.290) state "the researcher needs to have confidence and trust in the research findings presented". Their model offers four components to address trustworthiness relevant to qualitative research. These components are listed as credibility, transferability, consistency and neutrality.

Thomas and Magilvy (2011, p.152) describe credibility as "the element that allows others to recognise the experiences contained within the study through the interpretation of participants' experiences". When conducting this research, it was crucial to achieve credibility by carefully examining the data. This involved reviewing individual transcripts for similarities within and across the study participants. Some researchers use reflexivity, member checking, and peer debriefing or examination strategies to ensure credibility. Member checking involves returning to the people who provided the data to confirm that their experiences have been accurately represented. As Krefting (1991, p.218) notes "A qualitative study is considered credible when it accurately describes human experience in a way that others who share the same experience can immediately recognise".

Thomas and Magilvy (ibid) describe transferability as "The ability to transfer research findings or methods from one group to another". To establish transferability, one effective strategy is to provide a detailed description of the population being studied. This can be achieved by providing information on the demographics and geographic boundaries of the study. In a study by Thomas and Usher in 2009, the first author replicated her findings using the same data collection methods with two different groups of women - African American and Hispanic women. Both groups had the same recruitment inclusion criteria, and the study yielded similar results. This suggests the study's findings can be applied to other populations

with similar characteristics. The concept of transferability was observed during this research when the Tine model was utilised in two separate thematic areas: the EMS pilot study and the recruit firefighter RTC study. In the context of this research, it would be hoped that other Irish fire services would experience similar outcomes utilising different iterations of the Tine and Blended model. Since the demographics and geographic boundaries would be similar, it seems reasonable to anticipate comparable results.

Thomas and Magilvy (2011, p.153) describe dependability as being related to reliability in quantitative terms and that dependability occurs "when another researcher can follow the decision trail used by the researcher". It is essential to follow specific steps to ensure a comprehensive audit trail. Firstly, it is important to describe the purpose of the study clearly. Secondly, participants must be selected based on specific criteria, and this process should be explained. Thirdly, the data collection process and duration should be detailed. Fourthly, describing how the collected data was reduced or transformed for analysis is important. Fifthly, the research findings should be presented and interpreted clearly and concisely. Lastly, techniques used to establish dependability should be communicated. These may include having peers participate in the analysis process, providing a detailed description of the research methods, or conducting a step-by-step repetition of the study to enhance the original findings.

Thomas and Magilvy (2011, p.154) state that confirmability occurs "when credibility, transferability, and dependability have been established". They say that qualitative research must be reflective, maintaining a sense of awareness and openness to the study and unfolding results. It was important in this research to maintain a sense of awareness and transparency to the study and unfolding results. This required a self-critical attitude about how my preconceptions affected the investigation. For example, after each focus group or interview, I captured my reflective journal's field notes regarding personal feelings, biases, and insights. Additionally, I made a conscious effort to follow the direction of the interviews by asking participants for clarification on a question if needed. This reflective research allowed new insights and interpretations into my research; it is hoped these insights lead to a sense of trust in the credibility of the findings and applicability of this study.

3.10 Conclusion

This chapter provided an overview of the research methods and methodology employed during this study. The Research Onion was used to structure the discussion around the approach, philosophy and methods chosen to answer the research questions. The rationale for choices made and an overview of how the chosen strategy was implemented was also provided. Finally, the processes that enhanced the rigor of this study, as well as the obstacles that were overcome during the training interventions and data collection, have been articulated.

Chapter 4: Data Analysis and Findings

4.1 Introduction

Saunders et al. (2009, p.481) liken data analysis to the process of completing a jigsaw puzzle, in which the pieces of data and the relationships between them help us to create a picture and an understanding of what the data is telling us. This research used a combination of qualitative and quantitative tools to gather data. While the compilation and sorting of the data varied, as with a jigsaw, "we try to fit similar pieces together" (Saunders et al., 2009, p.481). This chapter presents the analysis and findings from the data across the three phases, beginning with the Design Phase of the Blended and Tine Models and then presenting the findings from all three models.

4.2 The Design Phase: The Blended and Tine Models

4.2.1 Blended Model Design

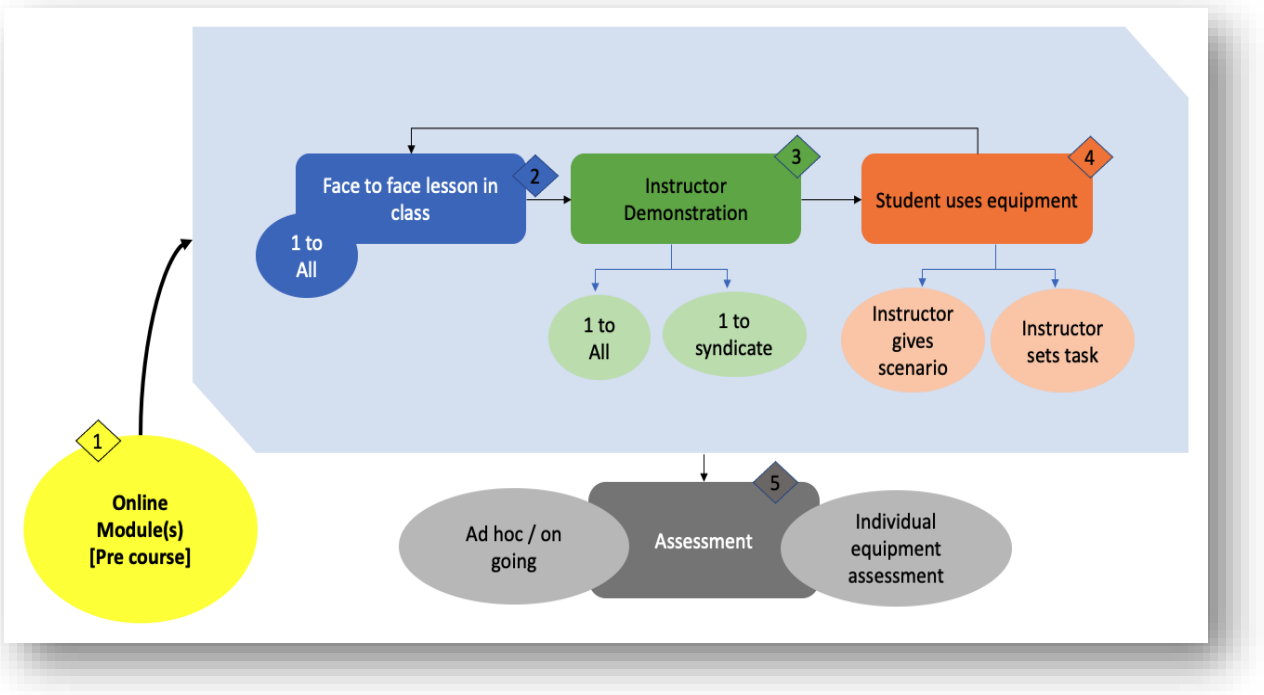


Figure 4.1 The Blended model

The genesis of the Blended model was born from the flipped classroom concept, where the student has access to course material in an external environment supported by online learning before (or during) face-to-face instruction. As a fundamental principle of this research

focused on the retention of knowledge and training models to support this concept, I scanned the literature for models which would allow the learner to construct their learning at their own pace while accessing traditional face-to-face instruction. By relocating elements of the Road Traffic Collision course to an online modality, it was conceptualised that this would allow the in-class time to be utilised for inquiry, application, and assessment. The flipped classroom model was chosen as most suited to these criteria. From a review of the blended learning taxonomy of Staker and Horn (2012) and other literature identified in chapter two, it was evident that there were various ways to support learning within a flipped-classroom model. For example, cooperative learning could be integrated to foster peer-to-peer learning across multiple groups during in-class time in a flipped classroom model. Within cooperative learning contexts, students learn from each other through peer-to-peer instruction by addressing misunderstandings and clarifying misconceptions before progressing to complete their component of the task. Case-based learning was also identified as an effective strategy within which students could develop analytical thinking and reflective judgment skills by reading and discussing complex, real-life scenarios (Williams 2005, p.577). Problem-based learning was also identified as an approach to the curriculum where students would be challenged to use problem-solving techniques, self-directed learning strategies, team participation skills, and disciplinary knowledge. The Tine model was designed to incorporate the use of cooperative (peer-to-peer), problem-based learning and case-based learning as a cornerstone of its flexible learning environment design.

The flipped classroom model emphasises the importance of a flexible learning environment. The Flipped Learning Network (2014) suggested the four pillars of the flipped classroom are; a flexible environment, a learning culture, intentional content, and a professional educator. They also indicated that the flipped classroom could be designed to facilitate a constructivist learning environment that promotes self-determined and internally motivated learning. According to Taylor et al. (1997, p.295) there are five dimensions of the constructivist learning approach; these are as follows. ***Personal relevance,*** which consists of out-of-the-class experiences that may be used as a context for developing students' scientific skills. ***Uncertainty,*** which relates to the provisional status of scientific knowledge that is socially or culturally dependent. A ***Critical voice,*** which assesses the extent to which it is acceptable to question teaching practices and the teacher's willingness to foster student criticism towards learning. ***Shared control,*** relating to sharing control with teachers over learning and consists of several indicators: learning goals, learning activities management,

and assessment criteria. Finally, ***Student negotiation,*** which assesses the opportunity for students to share their ideas with others, reflect on them, and attentively listen to others' ideas (Taylor et al., 1997, p.2). Hadžiahmetović (2021, p.310) has mapped where the flipped model and the constructivist learning environment align in Figure 4.2

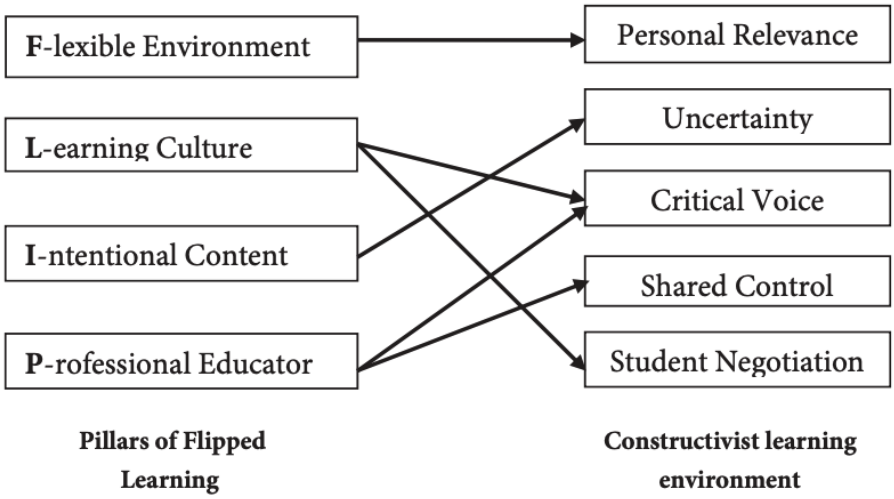


Figure 4.2 adapted from "The "ups" and "downs" of the upside-down: constructivist and self-determined learning in the flipped classroom during COVID-19". Hadžiahmetović (2021, p.310)

Hadžiahmetović's (2021, p.310) research suggested that the flipped classrooms' flexible environment could lead to better evaluation of the personal relevance of studying material. Personal experience-based learning was viewed as more constructivist than the traditional sage on the stage learning construct. Research into dynamic learning has also shown that personality is not correlated with learning potential or gain, indicating the importance of such learning in mitigating the negative effects of personality or other dispositions on learning. Additionally, instructor scaffolding and the constructivist approach in the flipped classroom can develop students' learning potential. The intentional content of flipped learning should be designed to create an environment that supports critical thinking. Fundamentally, the flipped classroom model was chosen as I hoped that the student would present to class with their own partially constructed knowledge, allowing classroom time to develop higher order thinking skills and apply the information learnt in the models to address complex problems.

During the RTC training programme, the Blended model included three online modules selected from the current RTC online modules available to DFB. These modules were

chosen because they were complete, approved by subject matter experts, and contiguous to the drill yard skills sessions. For instance, during the RTC course the glass management skill was demonstrated on the same day as the vehicle stabilisation and cutting equipment skills sessions. These skills are considered essential in the education of firefighters during RTC instruction. Moreover, each skill can be integrated into scenario-based learning and gradually built upon from its fundamental skill to enhance learners' knowledge. The modules contained knowledge checks in multiple-choice, drag-and-drop, or free-text summative assessments. Most modules took less than 15 minutes, and all results were recorded using LearnPro, the Learning Content Management System (LCMS) in situ at that time. An example of the screenshots from the system can be seen in Appendix F. The models were developed to engage the learner with the learning environment ensuring that all pages of the module were activated before the student could continue to the next page; this was developed to encourage the learner to engage with all the module content. All modules had text the learner could read; this text was augmented with additional information such as voice, pictures and video content. The learner was informed of their progress, and if, for operational reasons, the firefighter has to respond to an incident, the system remembers where the student was during the module. An example of the Glass Management Module can be seen in Appendix E.

4.2.2 Tine Model Design

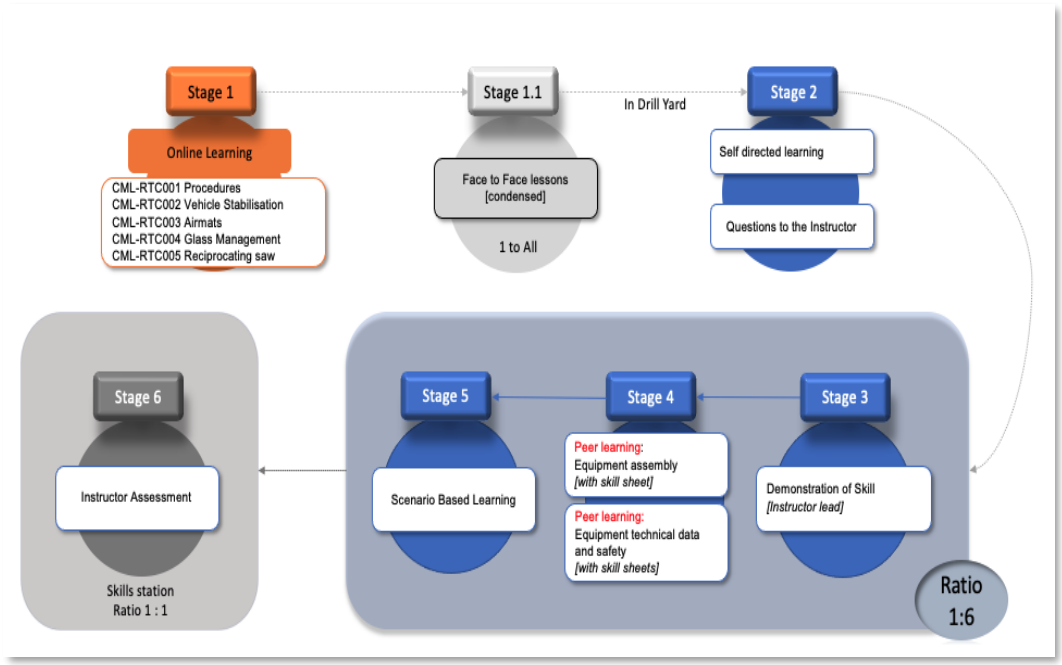


Figure 4.3 The Tine Model Design

The Tine model was designed to encompass the flexibility of the flipped classroom while being supported by the pedagogical models that promoted knowledge retention. Fundamental to its design was the Station Rotation model discussed in Chapter Two. The Station Rotation model has been shown to be an effective way to personalise learning, its approach of rotating through various learning modalities, including computer-based instruction, group projects, and individual tutoring, is backed by research and has proven to be successful (American Institute for Research 2020). Using the constructivist station rotational approach, the Tine model built on the concept of online learning as a modality for training in the fire service and further expands the station rotational model by introducing peer-to-peer and problem-based and case-based learning into its structure. One of the key elements of the Tine model is that it is important for students to not only learn information but also to put that knowledge into practice. In the Tine model, this was achieved through skills sessions following online or didactic instruction. These sessions allowed students to practice their newly obtained knowledge and solidify their understanding. In a real-world setting of the drill yard, the instructor would first demonstrate the skill, and then the students would break into smaller groups, usually three to four students and practice the skill that the instructor has just shown them. Demonstration followed by imitation could be described as a behaviourist approach to learning, however during the Tine model, the students would move from a behaviourist approach to a cognitivist peer-to-peer construct, one where the students would practice their new skills and have their peers review and assist with their skills and knowledge retention. Moving through the cognitivist paradigm, the Tine model also incorporated a constructivist learning approach where, at its core, the Tine model builds on the theory that the learners are central in the learning process and that learning is a social advancement that involves language, real-world situations, and interaction and collaboration among learners.

During the design of the Tine model, I reflected on the concepts of cognitive load and motivation and considered the Tine model's contribution, if any, to each of these. As discussed in Chapter Two, cognitive load refers to the amount of information the working memory can hold at any given time. Researchers agree that most people can handle a cognitive load of between three and seven separate pieces of information. In the context of information processing during an emergency incident, it is vital that our firefighters can form a decision tree from the heuristic pathways they have constructed in their initial recruit training. This consideration of cognitive muscle memory was integral to reflection in the

design of the Tine model's architecture during both the online and face-to-face elements of instruction. It was important for me to examine the Intrinsic, Extraneous, and Germane cognitive loads. For this study, Intrinsic load refers to how complex a task is, while Extraneous load refers to the distractions that can increase our cognitive load. Finally, Germane load refers to linking new information with the already stored in our long-term memory. The structuring of and access to online training material before the face-to-face element of the RTC course was central to addressing concerns relating to the intrinsic cognitive load for the student, where a subject or skill was broken down into bite-size modules; these modules were constructed to offer the student the knowledge that they would be presented in class and during face-to-face instruction. There was also time allotted to the students for their own learning prior to each skills session, allowing them to access information if needed. In addition, during each skill session, the instructor would demonstrate the skill or equipment the student was about to practice. This led to the student practising each skill in the format of peer-to-peer learning with the aid of skill or equipment data sheets. The extraneous load was reduced for the students by again offering them time to conduct their own learning, either onsite or remotely; the key to lowering the extraneous cognitive load was to provide a more humanistic learning environment during face-to-face instruction. Finally, the Tine model addressed the Germane load by linking information or skills to the information already stored in the student's long-term memory. This was an important element of the Tine model as I wanted to move away from the Pavlovian firefighter, who is conditioned to respond to basic instruction and is unable to link or build on information from their own experiences. Each skill station started by introducing equipment that a firefighter would be expected to use during their training and operational role. Once the basics of how to operate the equipment had been mastered, the instructor had a pivotal role in building on the student's basic knowledge, now hopefully stored in the student's long-term memory, and augmenting this information with case-based and problem-based learning; this learning would incrementally offer the student more complex problems to solve, thus building the fundament heuristic set that a firefighter will use to build on from in their operational career.

In a constructivist learning environment, students are encouraged to be active learners who participated in various activities that promoted learning. They collaborated with their peers during the learning process and took responsibility for their learning. Additionally, students were free to express their thoughts and ideas about the classroom environment. It was

hypothesised during the Tine model's development that using a constructivist teaching approach would positively impact student motivation to learn. The students' self-efficacy was tested during the online component of the Tine model. It was not determined whether the students were intrinsically or extrinsically motivated during the data collection for the online modules. During the focus groups, it was mentioned that the students were motivated to complete the RTC course for intrinsic and extrinsic reasons. They wanted to do it for themselves and others, and completing the course was also required to pass the overall recruit training programme. The next section of this research will discuss the EMS pilot of the Tine model during its first cycle.

4.3 Cycle 1: EMS Pilot of the Tine Model

The EMS Pilot involved engagement in a blended learning environment by recruits, external students and current in-service personnel during their Paramedic training in 2019. Figure 4.3 illustrates the equipment and skill sheets used during the face-to-face instruction element of the Tine Model during the EMS pilot study.

Figure 4.3 EMS Pilot – Equipment and skill sheets used during the face-to-face instruction element of the Tine Model

The platform for learning was offered in the form of a Learning Management System (LMS) external to the LCMS in situ at the time of the pilot study. There were fifty-two students in the class, forty-six returned their plain language consent forms and a further forty-one completed Survey One. Survey One was disseminated via a link shared on WhatsApp, Survey Two was completed by forty students' post-intervention using a hard or paper-based questionnaire. A comparison of both surveys can be viewed in Appendix G. In addition to the questionnaire, I piloted what was called at the time the Station Rotation model or what is now renamed as the Tine model, with two syndicates; each syndicate comprised six students, all completed Survey One. A focus group was formed after the EMS pilot intervention to investigate the students' interactions with the study. In addition to the students' interactions, the two tutors who performed the intervention were also interviewed. Table 4.1 depicts the dynamics of the training intervention; in the next section, we will discuss the findings of each data collection method and finally offer a conclusion to the EMS pilot [Station Rotation] Tine model.

Pre intervention	
52	Number of Students in the class
46	Returned Plain Language Statement / consent form
41	Completed Survey 1
41	Assigned eLearning Module with Knowledge Check
During intervention	
2	Syndicates Observed
Post Intervention	
40	Completed Survey 2
2	Tutors Interviewed
12	Focus Group
52	In house Skill Station
52	OSCE Skill Station
52	Knowledge Check - MCQ
52	Knowledge Check

Table 4.1 Dynamics of the training EMS pilot study

4.3.1 EMS Pilot - Focus Group

A focus group discussion occurred with the EMS students who had participated in the Tine [Station Rotation] intervention. The total number of students in the group numbered twelve. The key areas of discussion mainly focused on attitudinal queries on what the student liked or disliked about the Tine model. The overwhelming sentiment was positivity, captured from handwritten contemporaneous notes captured on the day. One student stated that they particularly liked that they knew what subject they would be doing the next day. Another

student said that having the online module situated before the skills session allowed them to replay the indications and contraindications of Pentrox administration before they had to do the skill "for real". The same student also said that the [online] module offered consistent instruction; this comment evoked further discussion around how the group disliked the fact that sometimes if you asked two separate instructors for a point of clarification, you might get two opposing views.

4.3.2 EMS Pilot - Questionnaires

As stated, two surveys were used in this study, one pre-intervention and one post. Questions one to ten set out the demographic stall. Over eighty percent of the class were between the ages of twenty-five and thirty-five; the class consisted of all male students, and these students had between one to four years of fire service. Their academic qualifications were mainly positioned at leaving certificate level, and a smaller cohort (n=17%) completed other qualifications such as FETAC level six or equivalent. Dublin Fire Brigade employed ninety percent of the class, and there was an even spread throughout the operational watch system from this set of students. The other ten percent of students were external from other local authorities or fire services. Interestingly nearly eighty percent of the students were operational firefighters who had been in service before this paramedic class; this would typically not be the norm as paramedic training would usually directly follow the firefighter recruit training programme before a student would enter service. The reason for this phenomenon was that there was a delay in employing firefighters, and put simply, there was a backlog in EMS training for the brigade. The next set of questions, eleven to fourteen, were intentionally split between surveys one and two. The rationale for this split was to firstly capture the students' current interaction with technology at then, post-intervention, enquire how the students interacted with the online learning module. From survey one, over seventy percent of the students indicated they have a high or moderate level of competence with technologies such as tables, desktop computers, smartphones and broadband internet connections. The data further suggests that the majority of the class (n=90%) mainly use their smartphones to access the internet.

In survey two, questions eleven to fourteen suggested that the vast majority of online users (n=80%) who completed the Pentrox modules agreed or strongly agreed that the software was easy to use and rated the module as good or very good. The data also was robust when

the students were asked if they would feel confident administering this medication after they completed this module; the majority (n=85%) said they agreed or strongly agreed with this statement. The next set of questions, fifteen to twenty, were posed to ascertain the students' attitudes before and after completing the online module. One of the most significant variances was from question fifteen, "I feel e-learning should form part of a firefighters training" in Survey One only a minority of 25% strongly agreed with this statement. In contrast, 45% of the respondents in Survey Two said that after completing the online module strongly agreed with the statement "I feel e-learning should form part of firefighters' training". In addition, when the class was asked if they "prefer face-to-face lessons in a classroom rather than e-learning modules" 25% of the students' responses changed from their original response towards disagreeing with this statement.

4.3.3 EMS Pilot - Interviews

In conducting the EMS Pilot study, I conducted two semi-structured interviews with the instructors and used sentiment analysis to identify the degrees of positivity from them. After transcribing the interviews, I identified commonly used words or codes and used a colour-coding system to highlight common themes. Finally, I analysed the top ten words from the instructors' responses (including associated negative words such as bad and poor) by cross-referencing them with their corresponding interview quotes to identify any themes, which can be viewed in Table 4.2.

The findings from the Sentiment Analysis of the EMS pilot interviews found that the Tine model was easy to use, the instructors responded positively to its structure and supported the concept of scenario-based learning during syndicate instruction. The instructors also viewed the model as being relevant to the course content, they endorsed the use of the skill sheets during the skills-based instruction and responded that it was important that the training material used in the Tine model utilised Dublin Fire Brigade staff and equipment. The online models were also viewed as a positive learning tool as the student could review the pertinent information at their own pace. The overall sentiment returned from the EMS pilot instructor interviews was that the model had merit and they could see the advantages of utilising the Tine model in future EMS instruction.

Word	Reference
Model	*I thought it was a very good model,*

	I thought the model was clear and easy to follow, I felt it gave me some structure as I've never done this before
Good	*Yep, all was good it was fine, it was it done exactly what it said on the tin* *The scenario-based learning was good with syndicate* *I thought it was a very good model* *So far so good... really enjoying it.* *I thought that was good, as you know the lads don't like it if they see other badges on our training material* *This was really good giving them hands on*
Excellent	*I thought it was excellent as well, cos nobody wants to be sitting there for a long time or periods of time* *I thought that was excellent, rather than being on the spot probing, they were able to you know point out when it came to the administration with the skills sheet it was excellent because it continued on and went on the knowledge of the medication and the contra indication and indication,* *I think syndicate A done excellent, they got through the three scenarios, and they worked their way through, and they dealt with each indication and contraindication correctly.* *I though the structure of it was excellent and it was all in place* *You know the one thing I though was excellent was that if I was a student, you play back the videos just to check if you got the information right.* *This was excellent, loved it, we get to see if what we have being talking about has sunk in.*
Bad	No Matches
eLearning	*The own learning, nobody really done it, it was already to them they felt they had achieved it by doing the primary learning, eLearning module beforehand.* *I did a practical demonstration which was basically a mirror of what was done with the eLearning verbatim*
Syndicate	*The scenario-based learning was good with syndicate* *I think syndicate A done excellent* *Syndicate B and because of personality lead within the group* *but happens chance syndicate B were quite junior, and they didn't have the confidence for a leader to step forward* *really looking forward to the next owe where I can be let free and have my own syndicate.* *overall, they did well, you could see that there can be such a difference between syndicates* *[name omitted] had to guide the second syndicate whereas the first ones just got down to it.*
Training	*As you know the lads don't like it if they see other badges on our training material* *Since 2008 I have been involved in EMS trainingit does highlight any lack of training beforehand that can be amended before the subject matter, so you cover everything*
Module	*Yeah, yes there were [questions] appropriate to the module so you could see that, it just continued with the same subject matter, it didn't go off on a tangent.* *they felt they had achieved it by doing the primary learning, eLearning module beforehand.*
Liked	*others liked to do both on screen and seeing it* *it's the hands on so they like* *I also liked that we used our own staff in the video* *lads don't like it if they see other badges on our training material* *I liked that the students were helping each other and reading off the CPG's and skill sheets*

Table 4.2 EMS Pilot – Instructor Interview coding

4.3.4 EMS Pilot - Skills Assessment

The skills assessment was conducted without the researcher being available to participate due to work commitments in late November 2019. The Paramedic Course Director informed me that all students passed their "Pain Management" skills assessment. On further investigation, I collected all the skills sheets, tabulated their results and compared them to

the rest of the class. Figure 4.4 identifies the average syndicate results, and it is clear that Syndicate Two and Syndicate Three (also identified in this thesis as Syndicate A and B) surpassed their fellow syndicates with their averaged results out of eighteen marks.

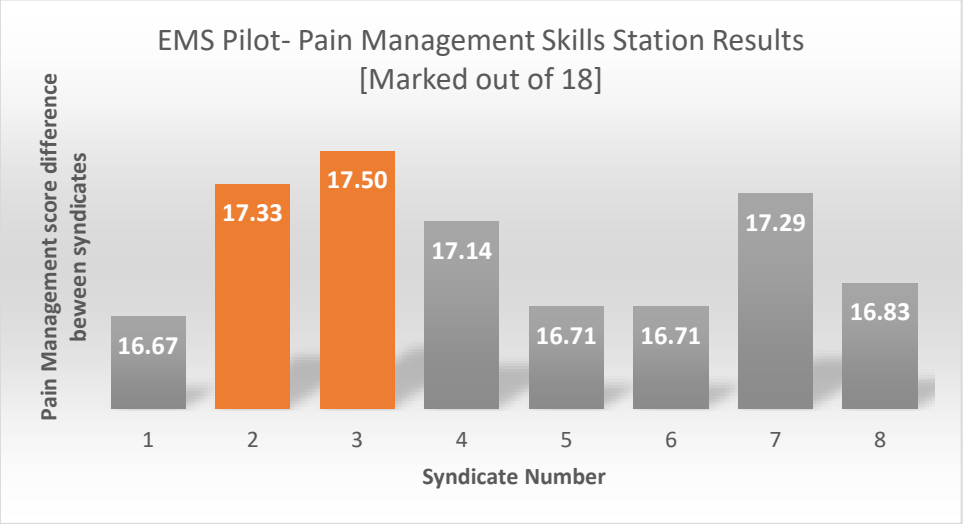


Figure 4.4 EMS Pilot- Pain Management Skills Station Results Columns 2 and 3

The official Paramedic skills exams were held in early December 2019 by the Pre-Hospital Care Council (PHECC) and all students passed their skills assessment. Unfortunately, I did not have access to the breakdown of these external results for comparison due to GDPR restrictions.

4.3.5 EMS Pilot - Knowledge check

The Pentrox EMS online module included knowledge checks, which were completed by the class. The average score for the knowledge checks was 90%, and there was no significant difference in scores between groups. For the summative EMS exam, ten questions from the knowledge checks were randomly selected and included in the one hundred-question set. The results for pain management questions showed a significant decrease in knowledge retention for the entire class, with a 15% loss of information over a six-week period.

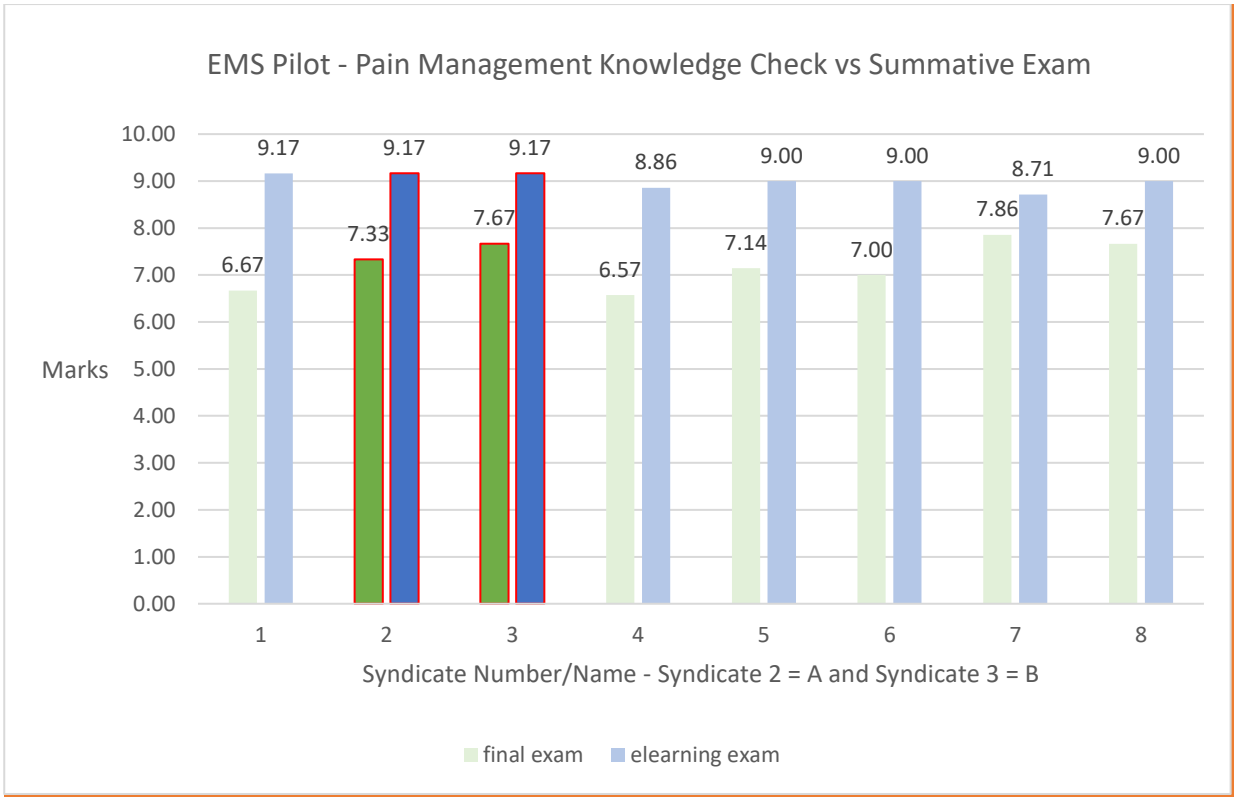


Figure 4.5 Comparison of eLearning [online] knowledge check and final in-house summative assessment. [Columns 2 and 3]

4.3.6 EMS Pilot - Conclusion

Although copious research went into the design and implementation of the EMS study, I was fortunate that this was in essence a pilot, the lessons learnt personally were immense. For example, the questions in both surveys needed further development for the RTC programme. The data collected indicated that most students found the software easy to use and rated the online module as good, very good or excellent. The data was robust when the students were asked if they would feel confident after administering this medication on completion of the online module; over eighty-five percent said they agreed or strongly agreed with this statement. One of the most significant variances was from question fifteen when asked "I feel e-learning should form part of a firefighters training" in survey one (n=25%) of respondents strongly agreed with this statement; in contrast, in survey two (n=45%) said they would now after completing the online module strongly agree with this statement. One overall observation from the online and in-house summative exam results shows a fifteen percent reduction in knowledge retention after six weeks. This was a concerning trend; even though syndicates two and three [A and B] initially did well after their exposure to the online

material, it was evident that all students lost on average fifteen percent of the knowledge they had known six weeks previous.

4.4 Cycle 2: Traditional, Blended and Tine Models

In Cycle Two, forty-nine students were in the Road Traffic Collision class. The class was split into three groups, each group comprising three syndicates; there were five to six students in each syndicate. The data collection instruments used during the RTC intervention comprised focus groups, questionnaires, instructor interviews, observation, and summative assessments. All students consented to partaking in the study and all students took part in the focus group sessions. The survey was broken into three distinct sections, the first focusing on the student's demographics, the second on the student's access to technology and finally, the student's attitude towards technology using the TRI 2.0 Technology index. Table 4.3 depicts the variety of data collection tools employed to gather data from a range of sources for the recruit level of the study.

Data collection tools	**Type / Name**
Observation of in-class face-to-face delivery (instructor and recruits)	Classroom Observations by Researcher • Glass Management • Vehicle Stabilisation • Reciprocating Saw Digital footage captured in the classroom
Focus Groups (recruits)	9 Focus Groups
Interview (instructors)	3 Instructor Interviews
Questionnaire (recruits)	Demographics TRI 2.0 ICT access
Observation of skills sessions (instructors and recruits)	Drill Yard Observations by Researcher • Glass Management • Vehicle Stabilisation • Reciprocating Saw Digital footage captured in the drill yard
Exam (recruits)	MCQ exam

Table 4.3 Recruits Data Collection Tools – Type and Name.

4.4.1 Traditional, Blended and Tine Models - Observations

Face-to-face Classroom Instruction

All face-to-face RTC lessons delivered in a classroom during the two-week training period were observed. The tuition on glass management, vehicle stabilisation and use of the reciprocating saw took place in classroom 5 of the DFB training centre. This large, carpeted room is twin aspect with several windows giving good light and air exchange. I sat at the rear of the classroom and had a similar view to that of a student. The classroom observations for these face-to-face lessons were based on Silverman's (2008, p.81) observation template and focused on the following.

- what people were doing
- what they [the instructor and students] were trying to accomplish
- how exactly did they do this
- how people characterised and understood what was going on
- what assumptions they [instructor and students] made
- what I saw going on in the classroom
- what I learned from these notes [observations]
- why I included them
- what else was happening in the classroom that was relevant to the research question
- how I felt collecting this data, and how this affected the data

Four instructors were assigned to each RTC Set; each instructor delivered face-to-face lessons in the classroom and taught skills in the drill yard. The instructors were numbered one to twelve, respectfully. All had access to audio-visual equipment and the RTC PowerPoint slide show, which were peer-reviewed by subject matter experts before training commenced. All lessons were instructor-led, where the instructor presented a PowerPoint slide show and dictated what was to be done when it was to be done, and how it was to be done. This approach is consistent across all DFB training and is evidenced by a instructor stating, “At the end of every lesson, we will bring other groups around to see what was done on that car. See what went right, see what went wrong and we can all learn from it. Although you’ll be separated into groups, you will all be learning the same thing” (F2F1, Line 15).

Set 1 - Face-to-face classroom instruction

All students wore DFB uniforms and were seated in a traditional four-by-five seat matrix; each table and chair were neatly situated behind the student in front. Students would only move from their seats when instructed by the instructor (as seen, for example, in F2F1-

GoPro). Students were required, on occasion, to circulate equipment to one another or asked to complete a sign-in sheet. The students were passive participants in the learning process; they rarely asked questions. The communication pathway in most lessons was instructor-led, where the instructor talked, and the students listened. The instructors did not consider that students might have had prior knowledge or skills-sets; this was observed during the introduction to Set 1 [day one] and was articulated by Instructor 3 as "You all know nothing, and it is our job to get you to the point that you can be a safe pair of hands out there" (F2F5, Line10). It could be argued that the instructor perceived the student's cognitive status as a blank slate (tabula rasa) and displayed a behaviourist approach to learning.

In contrast, Instructor 1 was observed on several occasions using verbal reinforcement, where the student was praised for performing well and answering a question asked by the instructor. Instructor 3 highlighted information or signposted what the students might see in a future exam. In this case, when the instructor explained the different weights and measurements of the reciprocating saw, the instructor highlighted to the class that they [the students] "would be seeing this information again in an exam setting" (F2F5, Line 15). The students were then observed taking notes and highlighting information relating to the reciprocating saw in their student handouts. I also noted that this behaviour was echoed in other lessons, where different instructors highlighted information, the students could expect to see in their final exam. For example, Instructor 1 was observed while explaining the term *team approach* as stating that "This is an important slide for you, so you want to take note of this, I'll let you all scribble it down before I move on because I know you are focused on it" (F2F1-GoPro and F2F1, Line 53). This finding was significant as it suggests a tendency to focus on what might appear on the examination rather than developing their knowledge or the learning experience.

In my own classroom observations (and additional video footage) some instructors ensured that the students had mastered early steps before progressing to more complex levels. They accomplished this by getting the correct response or action to target questioning. Instructor 1 was observed posing questions to the class and then asking one student for an answer. For example, Instructor 1 asked a random student, "Nice and easy, what's the Golden Hour?". The student gave the correct answer, this process was repeated when another student was asked a different question. It was also observed that Instructor 1 pointed out key sequential

learning objectives that the students would be expected to master. For example: "So every drill you go to, the first thing you do is stabilisation, the second thing you do is glass management, the third thing you do is expose for new car technology … so, just get that process into your own head. OK" (F2F2, Line 3). Instructor 1 was also observed stating that "We are going to take a break in a few minutes, we are just going to recap on everything we covered so far and make sure everyone is happy" (F2F7, Line 13). This instructor then asked the class about safety margins and posed a question about motorway safety; this question was "What else? [Pause] how many meters [of cones should be laid] per lane?" the correct answer is 100m metres per lane which a student offered as an answer, the instructor agreed and then went on to ask a further question "What if we have two lanes?" (F2F7, Line 26) the same student answered 200 meters, which was also correct. The instructor gave an example using a local motorway "So again it's per lane, 100 meters per lane. So, on the M50, we have the inside and three lanes, so 400 meters" (F2F7, Line 28). From this, we can see that Instructor 1 was observed building on the fundamental knowledge of lane safety during an operational RTC incident.

Set 2 - Face-to-face classroom Instruction

As with Set 1, all students were seated in a traditional four-by-five seat matrix, I conducted classroom observations while sitting at the rear of the class, and all lessons delivered were observed over two weeks. The classroom lessons for Set 2 were not digitally recorded on the bequest of the lead instructor of this intake. Four instructors were assigned to Set 2; one of the instructors had instructed in Set 1; however, they were given a new instructor number to preserve anonymity. All Set 2 students were given access to the RTC online material one week before the course started. All students accessed the LearnPro system; 92% had completed the three online modules, glass management, reciprocating saw and vehicle stabilisation, before the face-to-face instruction in the training centre. Online material was available during the didactic phase of education and remotely while the student was away from the training facility.

The lead instructor [Instructor 5] introduced the cohort of instructors for Set 2. Instructor 5 went on to set the tone for the course by stating, "The information and lessons learnt in this course can and will be used to save people's lives as soon as your little feet hit the ground, so listen up, work hard and we will get on just fine" (F2F8 Set2, Line 2). Instructor 5 then

asked an open-ended question if the students “had any questions?”. The students were not given time to answer as Instructor 5 dismissed the other instructors and immediately started the first lesson. This lesson lasted 40 minutes, the instructor asked no student a question, nor did any student ask the instructor a question. The lesson was concluded by Instructor 5 stating, “Next up, Health and Safety” and this instructor then gathered their notes and exited the classroom. This style of instruction was echoed by Instructors 6 and 7; Instructor 8 occasionally asked the students questions to confirm a transition of knowledge; however, the communication pathway for Set 2 was mainly instructor-led.

One observation that rippled through a significant subset of the face-to-face instruction in Set 2 was that the instructors often offered the class real-world or own experiences of Road Traffic Collisions. For example, Instructor 8 described an incident that occurred late at night where a car, with one person occupancy, had collided with an immovable object, a six-foot diameter stone wall; the vehicle allegedly travelled at speed before the accident. The incident, as the instructor recalled, was chaotic, there was a person confirmed as being trapped, and the instructor had to figure out ‘how to remove the car from the patient’ (F2F8 Set2, Line 37), which sent a rustle through the class, some students sat forward in their chairs and waited to hear the incident’s conclusion. Instructor 8 painted a picture of concurrent activity where each team was assigned a task to complete the casualty extraction. I wondered, in this example, whether the casualty survived or perished. However, the instructor never offered an answer to this question, and the students never asked the question to the instructor. Other examples were less dramatic. However, they all focused on a team-centred approach, safety while using the equipment and patient care.

I observed that Instructor 6 appeared nervous when teaching; he mostly faced the screen and could be viewed reading the PowerPoint slide show as if it were a book. On one occasion, while Instructor 6 was giving a lesson on reciprocating saws, I noted that two students appeared asleep at the rear of the class. It was later pointed out that this was Instructor 6’s first time instructing recruits, and he had never received a method of instruction; the absence of such a training course would be the norm for most, if not all instructors.

Set 3 - Face-to-face classroom Instruction

As with Set 1 and 2, all students were seated in a traditional four-by-five seat matrix, the researcher conducted classroom observations while sitting at the rear of the class, and all lessons delivered were observed over two weeks. The classroom lessons for Set 3 were not digitally recorded. Four instructors were assigned to Set 3, two of whom had instructed in Set 1; however, they were given new instructor numbers to preserve anonymity. All Set 3 students were given access to the RTC online material one week before the course started. All students accessed the LearnPro system; 85% had completed the three modules, glass management, reciprocating saw, and vehicle stabilisation, before the face-to-face instruction in the training centre. The online material was available both during the course and remotely to the students if they wished to access the online modules in their home environment.

During the first week of the course, I was told that all instructors in Set 3 had taught several other recruit courses in RTC and other disciplines, such as Breathing Apparatus (BA) or Pump Operations (PO). Instructor 9 made the point that he was an experienced instructor, and during his ten years of instruction, he had a 100 percent success record. He went on to say that even if the students did not display an interest in Road Traffic Collisions, the students would enjoy the RTC processes by the end of the course; he stated, "If you like cutting up things, this is the course for you, if you don't like cutting up things you will at the end of the course as I've never had a failure yet in over ten years" (F2F9 Set3, Line 10). Instructor 9 had over 22 years of experience in the fire service; he also instructed on the last four Breathing Apparatus courses for recruits. Instructor 9 would start every lesson by randomly asking the students to answer questions from previous lessons; it was observed that there was good student-instructor interaction, the communication pathway was still instructor centric, and the instructor used the sage-on-the-stage approach to lesson delivery. There was one exception where Instructor 9 invited a student to the top of the class; the instructor asked the student to turn around to face their peers. Instructor 9 then asked this student a question; this question was to list the steps in glass management, the student answered the question correctly, and the instructor then asked the student to nominate a peer to answer the following question. The student selected one of their fellow students, and this action was met with laughter by both instructor and students.

In Set 3, it was also noted that students appeared to ask the instructors a higher frequency of questions than in Set 1 or 2. For example, during the vehicle extraction lesson, one student put up their hand to ask a question and prefixed the query with "When I was doing the LearnPro module, it said to expose for new car technology, would this include gas struts on hatchbacks?" (F2F9 Set3, Line 32). The instructor replied that this was a good question and answered, "Yes, gas struts would be considered new car technology" (F2F9 Set3, Line 33). The instructor then reinforced this point by giving an example where a Firefighter in the UK had a career-altering injury when they failed to disarm this hazard during the initial examination of a vehicle during an RTC. This comparison to the RTC online modules and the information presented to the student during the face-to-face lessons was also observed in other classes. For example, a student asked Instructor 10 during the vehicle stabilisation lesson "In the eLearning module, it said to cut low, here in our notes, it says to cut high?" (F2F9 Set3, Line 41). Instructor 10 addressed this discrepancy and advised the class that the eLearning module was correct and that the student notes needed to be updated to reflect this change. The instruction method employed in Set 3 differed from the other two sets as it was observed that student-instructor communication was encouraged. It was also visible that the students had a foundation of RTC knowledge that enabled them to ask considered and probing questions to the instructor during face-to-face lessons.

Face-to-face Drill Yard (Skills) Instruction

The glass management, vehicle stabilisation and reciprocating saw lessons took place in the DFB drill yard. This drill yard is situated at the rear of the main building, where all classroom lessons were delivered. The surface of the drill yard is concrete in construction; a large grassed area is situated adjacent to the drill yard; this green area is approximately half the size of a football pitch. This grassed area has a road eclipsing its circumference, this road network is used in many of the RTC simulations that the students encountered during their RTC skills lessons. I observed all drill yard activity during the two-week RTC course. There were always four instructors in the drill yard, the lead instructor orchestrated the drill yard tempo and was responsible for the health and safety of both students and instructors while they completed their skills sessions. A volunteer cadre of students captured additional digital recordings which were used to assist with the data analysis phase of this research.

Set 1 and 2 - Face-to-face drill yard instruction

The data return from Set 1 and 2 was similar during the face-to-face drill yard instruction, so they will be considered together. The first task for any student doing an RTC course is to stock the fire engines with the appropriate equipment; I observed in Set 1 several students noted that the equipment was heavy and cumbersome. One student said, "How the hell am I going to operate this yoke" (Observation DY5, p.2). Their fellow recruits offered no reply; one student took the hydraulic cutters from the recruit and relocated them to its home on the top shelf of the fire appliance and said nothing. The fundamental observation was that the recruits were surprised by the equipment's weight. I was concerned by the lack of communication and empathy between students; demonstrating any emotive reaction was overshadowed by an innate sense of getting the job done quickly and at any cost. The students in Set 2 were also observed stocking the fire appliance, they did this in total silence; this occurrence could be considered unusual as most students had never seen or held cutting equipment before. I noted that the students appeared to be moving in zombie formation, slow and purposeful and that verbal communication between students was absent.

The instructors in Set 1 and 2 mainly used rote learning activities, expecting to see the students repeating an exercise or practising a skill several times. This behaviour was observed during the initial glass management demonstration in Set 1, where the instructor repeatedly shouted, "Visors down" when the recruits did not use their PPE correctly (Observation DY5, p.1). Figure 4.5 illustrates an instructor demonstrating a skill (Glass Management) to the students. The instructor demonstrated the skill, and then one student was asked to operate this equipment on the instructor's instruction.

Image 4.1 Instructor Skill Demonstration (Glass Management) – Set 1

As the skills sessions progressed and when the basics had been mastered, the instructors started linking concepts to prior knowledge and were observed using real-world examples to reinforce learning. Instructor 1 stepped the students through an oyster cut on a vehicle in the drill yard (Observation DY5, p.5). This demonstration could only be achieved once the students mastered basic skills such as vehicle stabilisation and glass management. If these basic skills had not been mastered, the instructor could not continue with a complex skill based on prior knowledge and experience of RTC processes and equipment. This observation was echoed in Set 2 when Instructor 5 placed a student in the car as a casualty. The students were then tasked with removing the casualty from the vehicle. If the students had not mastered the basic skills of patient care and casualty management, exposing a student to such hazards would have been unsafe.

At the end of week one, the instructors in Set 1 were observed placing two vehicles in a simulated road traffic collision; one vehicle was no longer on the road and had ended up on the grass verge. The students in Set 1 were given a scenario of a two-car RTC at the top of the drill yard where one car had left the road's surface and was in an unstable environment. The students were observed placing the equipment into an area where other team members could quickly and easily access it; they then went on to stabilise the vehicle, manage the glass in the vehicle and remove a casualty to safety (DY GOPRO5). I observed that students were layering skills to achieve the task of casualty removal; they also demonstrated

teamwork and problem-solving while completing complex tasks. For example, Student A identified that their teammate, Student B, needed help completing an extrication cutting manoeuvre; the problem was that the blade in the Milwaukie reciprocating saw was no longer sharp after prolonged use. Student A, who was not using the equipment, informed his teammate Student B that this was the case, and then Student B replaced the broken equipment and proceeded with the task at hand.

I noted in G1 DY OBSV, as seen in G1 DY GM that the students were slow to use new equipment and would often not volunteer to be the first to do a drill. I noted that the students in Set 1 or 2 rarely posed questions to the instructor and would typically wait to be asked a question. In addition, it was observed that the students waited for instruction before carrying out a task. In G1 DY GM students had to be told to use their PPE and often did not use the correct Health and Safety terminology, such as 'breaking glass' to warn other students of their intentions to expose a hazard.

Assessments were continual and ongoing across both Set 1 and 2, with the instructors regularly checking individual students' knowledge and skills. In Set 1, one assessment appeared to be a one-to-one tutorial rather than an assessment. During this assessment, a student was asked to assemble the Halmatro cutting equipment; the student tried to insert the incorrect hose line into the pump. When the instructor pointed this out, the student asked if the instructor had ever witnessed the high-pressure line fail. The instructor was then observed explaining the internal construction of this piece of equipment and told a story about a Firefighter in the UK who unfortunately suffered a catastrophic injury to their hand when this line failed at 720 bar, thus, contextualising the skills development with a relevant anecdote. The recruit firefighter was then observed assembling this equipment and operating it correctly. I observed that when this student could not complete a skill during their assessment, the student appeared to deflect from their assessment by asking the instructor a question. This technique allowed the student additional time to complete the skill, which they did to the instructor's satisfaction.

Set 3 - Face-to-face drill yard instruction

Face-to-face drill yard instruction for Set 3 differed in the delivery methods from Set 1 and 2 as the Tine model was employed during the delivery of the glass management, vehicle

stabilisation, and reciprocating saw skills stations. The skills session still occurred in the drill yard, and the instructor implemented the Tine Model. I met with all four instructors before the course started; this meeting was vital as it ensured that the instructors would participate and exercise the Tine Model. All instructors agreed to implement this model; the training schedule was altered to encompass the Tine Model. The "when", "where" and "how" we would implement the first iteration of the Tine Model were identified. Figure 4.5 depicts the stages of the Tine Model, and in the next section, I will offer a narrative of the observations collected during the RTC skills stations for Set 3.

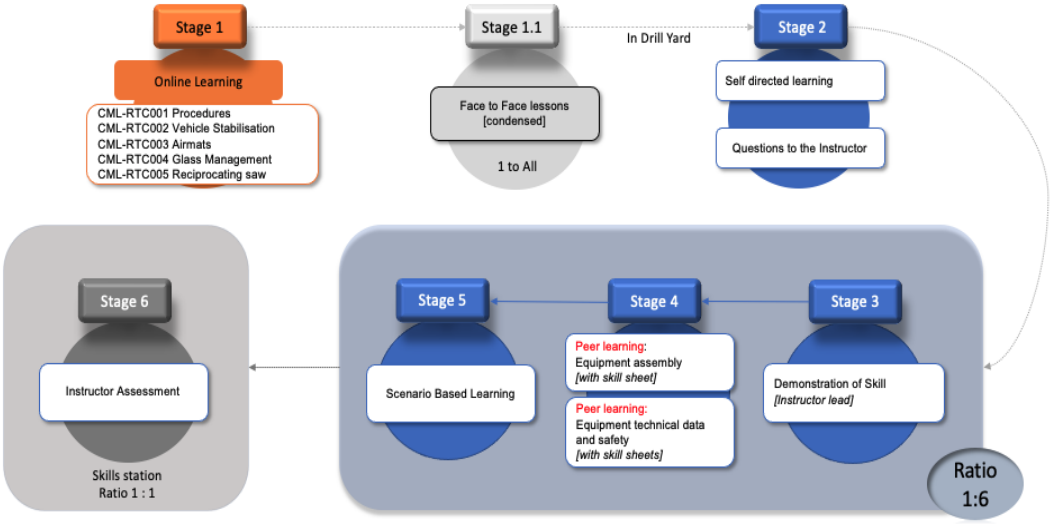


Figure 4.5 Tine Model

The first RTC drill yard instruction observation for Set 3 occurred when the students were directed to Stage 2 of the Tine Model. This Stage offered the student time to ask the instructors any queries they might have had; the students were also given their own time to complete any self-directed learning. It was hoped that students would see the equipment used during the skills station and ask the instructor or each other questions. In reality, the students and instructors needed to familiarise themselves with this concept and needed further instruction from the researcher. When the concept was explained again, the students started to source and examine the RTC equipment. This was most apparent during the Milwaukee reciprocating saws skills session, where students were observed opening boxes to reveal their content. Instructor 11 got involved by asking the students what they thought each piece of equipment was used for; this fostered a secure communication pathway for the skills lesson, where students were encouraged to ask questions, and the instructor was allowed to impart their knowledge and experience to the students. Following Stage 2, Instructor 11 moved on to Stage 3, where they offered the students an instructor-led

demonstration of the equipment set. This demonstration was observed by the researcher and captured digitally using a GoPro recording device. During one of the instructor-led demonstrations, Instructor 11 offered a student a piece of equipment and said “Here, you have a go” and offered the equipment to the student; the student changed the battery following this interaction successfully.

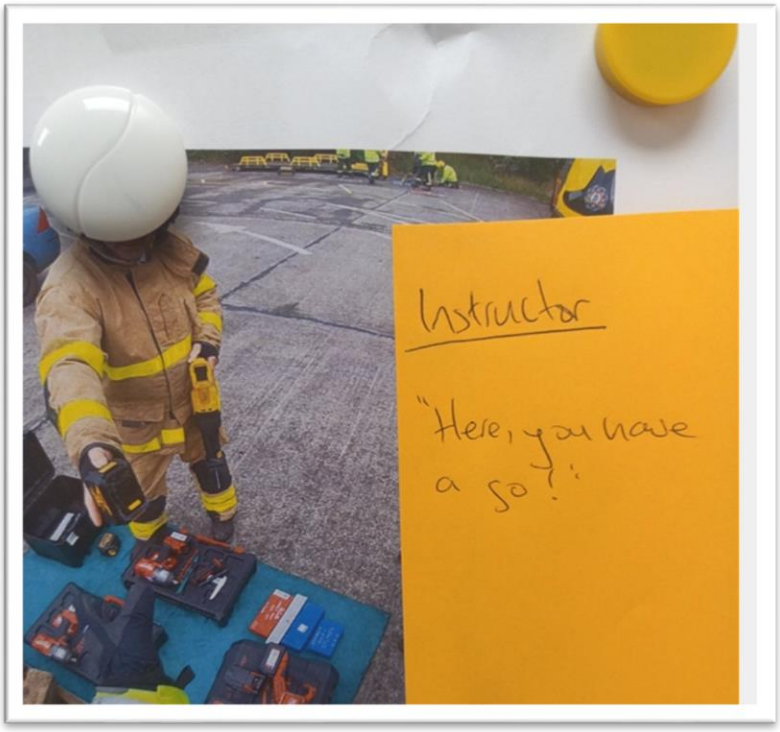


Image 4.2 Stage 3 – Instructor-led demonstration Set3

After the instructor-led demonstration, the students embarked on Stage 4 of the Tine Model, the students were given skills and knowledge sheets, and the students were encouraged to ask each other questions based on the information on the sheets provided. Image 4.2 shows two groups of students using the skills sheet for the Milwaukee reciprocating saw. I noted that students were very interactive with the equipment during Stage 4 of the Tine Model, one student was overheard questioning if they had been taught how to release the blade from this saw in class, and the other student responded that they didn’t think so. It was then observed that the two students in question used the skills sheet to complete the task and stated with exuberance “Now, that’s how it’s done” (G1DY Recip Saw - GoPro).

Image 4.3 Stage 4 – Peer-to-peer Learning Set3

Once the students had completed Stage 4, Instructor 11 moved to Stage 5 of the Tine Model, Scenario-based learning (framed within CBL). Instructor 11 offered the students a scenario where the occupants of a silver car were trapped, and they would have to start the process of removing the roof from the vehicle by operating the reciprocating saw. The instructor nominated two students and issued them with the task of removing the roof from the vehicle; the remainder of the students were designated as safety officers. As a point of reference, a car has six posts that connect the main body of the car to the roof of the vehicle. These posts are named A, B and C respectfully, each post is twinned with its opposing post on the other side of the vehicle so that you can have an A post driver's side and an A post passenger side. The first two students successfully removed the A post driver's side from the car, the instructor then asked the following two students to remove the opposing post (A post passenger side). These two students started well and had nearly completed the task when the reciprocating saw that they were operating ceased to work. I observed the students communicate that there was a problem; they identified that the blade was broken. Once they had identified the problem, they quickly solved the issue by changing the blade and continued to complete the task. There were several iterations of Stage 5 where the instructor

offered a scenario, and the students would either verbally or demonstrate how they would complete the scenario. One observation that I made was while a small number of students were problem-solving and operating the RTC equipment there was a significant amount of time when the remaining students would be left to observe the exercise or scenario. It could be argued that there are some pedagogical merits in the students observing each other while completing scenarios, I noted that this time could also be utilised in an alternative manner and would advocate that this could be the time that the students are exposed to Stage 6, instructor assessment. In the Tine Model currently, Stage 6 is completed post-scenario-based learning; however, it would be incorporated in some instances into Stage 5.

4.5 Questionnaire

The questionnaire was subdivided into three distinct areas. These were Demographics, ICT access and TRI 2.0 readiness, an example of the questionaries can be seen in Appendix B.4. The TRI 2.0 scale was employed to query the recruits "propensity to embrace and use cutting-edge technologies" (Parasuraman et al., 2015). A link to the survey was communicated to the students via WhatsApp; all students were informed that this was a voluntary and strictly confidential survey. Each student completed a consent form before they were given the digital link. Paper copies of the survey were also available to the students if needed; no student opted to take the survey using the paper format. 17 out of 17 (100%) students in Set 1 completed the questionnaire. 14 out of 15 (93%) students completed the questionnaire in Set 2 and 7 out of 15 (41%) students completed the questionnaire in Set 3.

4.5.1 Demographics

4.5.2 Set 1 - Demographics

One hundred per cent of the students from this Set 1 returned a complete digital survey (n=17). The average age in this set was 31 years of age, the youngest was 20 years of age and the oldest was 43 years of age. There were six females and eleven males in Set 1, it is worth noting that this would be an unusual statistic as there were only eight female recruits in the entire class population of 37. Most students in this Set 1 were recruits with less than one year's service [97%]. A high percentage, 82% had no watch assigned, meaning they had not previously worked in Dublin Fire Brigade. Two students from this Set 1 were employed by another fire service and had previous RTC experience. The educational entry criterion for DFB at the time of this research was a junior certification, two students or 12%

of the students had obtained this qualification. 47% obtained a leaving certification, 35% of the students received a level 7 or 8 degree, and one obtained a level 9 qualification. Of the female population, 65% had a level 7 or higher, whereas only 35% of the male recruits had received this level of education.

4.5.3 Set 2 - Demographics

93% of students from Set 2 returned the survey (n=14). The average age in this set was 31, the youngest was 21 and the oldest was 33 years of age. There were 2 females and 12 males in this set. Most students in Set 2 were recruits with less than one year's service [97%]. A high percentage, 92% had no watch assigned. 21% of the students had obtained the qualification of junior certification, 21% obtained a leaving certification, 50% of the students obtained a level 7 or 8 degree, and one obtained a level 9 qualification.

4.5.4 Set 3 - Demographics

41 % of the students from Set 3 returned a complete digital survey (n=7). The average age in this Set was 30, the youngest was 20 and the oldest was 47 years of age. There were no females and 7 males in this set. All students in the set were recruits with less than one year's service [100%]. All had no watch assigned. One student obtained the qualification of junior certification, 27% obtained a leaving certification, 29% of the students had obtained a level 7 or 8 degree, and 3 students (29%) had obtained a level 9 qualification.

4.6 Access to ICT technology

Regarding access to technology, it is important to note that at the time the data was collected for this research, firefighters in DFB were not provided with internet access at work. In addition, they did not have a work email address; all correspondence was delivered using the internal or external postal system. At this time there had been no real need for a firefighter to engage with ICT other than to complete a small subset of online modules hosted by a restricted cloud-based Learning Content Management System (LCMS).

4.6.1 Set 1 - Access to technology

100% of Set 1 students had access to a smartphone, 76% had access to a tablet, 82% had access to a laptop and 35% had access to a desktop computer. 100% of students surveyed said they use their smartphones to access the internet. 94% of students surveyed indicated

that they used their smartphones to access the internet several times a day, and the other 6% indicated that they would use their smartphones once a day to access the internet. When the students were asked how often they would access the internet when using a laptop or tablet, only 6% would access the internet using these devices several times a day, and 31% said they would use these devices once a week to access the internet. One student stated that they did not have access to a desktop computer, tablet or laptop but did use their smartphone to access the internet.

The students in Set 1 were then asked how often they had interacted with certain applications, such as Word, Excel or social media, in the last twelve months. 100% of Set 1 stated that they used word processing software in the previous 12 months, 47% reported using a digital spreadsheet in the last twelve months, and 23% indicated that they had used a database in the last twelve months. 94% of students surveyed reported sending or receiving emails in the previous 12 months, and 94% of Set 1 stated that they had used social networking software (e.g. Facebook, or Twitter) in the last 12 months. 94% of the students indicated that they had used an online streaming music service in the last 12 months the same percentage had watched a video online in the previous 12 months. At the time of this survey (June 2020) COVID-19 had been in the community from March 2020 to June 2020, 53% of students surveyed stated that they had engaged in an online meeting (ZOOM or Microsoft Teams) in the last 12 months. 97% of the students said that they had used or made video calls using, for example, Skype or WhatsApp.

59% of the Set 1 strongly agreed, 35% somewhat agreed and 6% were neutral when responding to the statement 'that online learning provided an opportunity to acquire new knowledge'. 47% strongly agreed, 41% somewhat agreed and 12% were neutral when responding to the statement 'that online learning allowed them to acquire new skills'. While 29% strongly agreed, 47% of students somewhat agreed, 12% were neutral and 6% somewhat disagreed that online learning enhances the quality of their learning experience. 23% strongly agreed, 53% somewhat agreed, 12% were neutral and 12% somewhat disagreed that online learning should be a part of firefighter training. 35% strongly agreed, 23% somewhat agreed, 24% were neutral and 18% somewhat disagreed when asked if online learning should be used for refresher training on station. Interestingly, 12% strongly agreed, 18% somewhat agreed, 29% were neutral, 24% somewhat disagreed and 6% strongly disagreed that online learning should be used for recruit training. This could suggest that

even though there are high levels of access and usage of ICT, there was some hesitancy when it comes to using online learning for recruit training. Similarly, 55% of the set somewhat or strongly agreed that online learning was not their preferred mode of learning. This sentiment was echoed again when the students were asked if they preferred face-to-face lessons in a classroom rather than online learning modules. Over 80% somewhat or strongly agreed with this statement, even though 65% of students surveyed stated that they had taken a course taught online in the last 12 months.

4.6.2 Set 2 - Access to technology

100% of Set 2 students had access to a smartphone, 57% had access to a tablet, 100% had access to a laptop and 36% had access to a desktop computer. 93% of students surveyed said they mostly use their smartphones to access the internet. 93% of students surveyed indicated that they used their smartphones to access the internet several times a day, and the other 7% indicated that they would use their smartphones once a day to access the internet. When the students were asked how often they would access the internet when using a laptop or tablet, only 7% would access the internet using these devices several times a day, and 36% said they would use these devices once a week to access the internet. 7% said they would never use these technologies to access the internet.

The students in Set 2 were then asked how often they had interacted with certain applications, such as Word, Excel or social media, in the last twelve months. 100% of Set 2 stated that they used word processing software in the last 12 months, 63% reported using a digital spreadsheet in the previous twelve months, and only 21% stated that they had used a database in the last twelve months. 100% of students surveyed reported sending or receiving emails in the last 12 months, and 93% of Set 2 stated that they had used social networking software (e.g., Facebook or Twitter) in the last 12 months. 93% of the students indicated that they had used an online streaming music service in the last 12 months and 100% had watched a video online in the last 12 months. 93% of students surveyed stated that they had engaged in an online meeting (ZOOM or Microsoft Teams) in the last 12 months. 100% of the students said that they had used or made video calls using, for example, Skype or WhatsApp. Over 79% of Set 2 strongly agreed, and the remaining 21% agreed that online learning provided an opportunity to acquire new knowledge. 72% strongly agreed, 21% agreed and 7% somewhat disagreed that online learning allowed them to acquire new skills.

While 36% of students strongly agreed, 43% somewhat agreed and 21% were neutral when asked if online learning enhances the quality of their learning experience. 36% strongly agreed, 57% somewhat agreed, and 7% were neutral when asked if online learning should be a part of firefighter training. 43% strongly agreed, 50% somewhat agreed and 7% were neutral when asked if online learning should be used for refresher training on station. 36% strongly agreed, 50 % somewhat agreed, 7% were neutral and 7% somewhat disagreed that online learning should be used for recruit training. 28% strongly agreed, 29% somewhat agreed, 14% were neutral and 29% somewhat disagreed that online learning is not my preferred mode of learning. Set 2, however did return a positive response when asked if online learning should be available to me when I am not at work where 50% strongly agreed, 36% somewhat agreed and 14% were neutral to this statement. And finally, when asked if they preferred face-to-face lessons in a classroom rather than online learning modules, Set 2 indicated that 22% strongly agreed, 57% somewhat agreed, 14% were neutral and 7% somewhat disagreed with this statement.

4.6.3 Set 3 - Access to technology

100% of Set 3 students had access to a smartphone, 71% had access to a tablet, 86% had access to a laptop and 14% had access to a desktop computer. 100% of students surveyed said they mostly use their smartphones to access the internet. 100% of students surveyed indicated that they used their smartphones to access the internet several times a day. When the students were asked how often they would access the internet when using a laptop or tablet, 14% would access the internet using these devices several times a day, 43% would use these devices to access the internet once a day, 29% said they would use these devices once a week to access the internet. 14% said they would never use these technologies to access the internet.

The students in Set 3 were then asked how often they had interacted with certain applications, such as Word, Excel or social media, in the last twelve months. 85% of Set 3 stated that they used word processing software in the last 12 months, 29% reported using a digital spreadsheet in the last twelve months, and only 29% stated that they had used a database in the last twelve months. 85% of students surveyed reported sending or receiving emails in the last 12 months, and 100% of Set 3 stated that they had used social networking software (e.g. Facebook, or Twitter) in the last 12 months. 85% of the students indicated that they

had used an online streaming music service in the last 12 months and 100% had watched a video online in the last 12 months. 57% of students surveyed stated that they had engaged in an online meeting (ZOOM or Microsoft Teams) in the last 12 months. 85% of the students said that they had used or made video calls using, for example, Skype or WhatsApp.

Over 66% of Set 3 strongly agreed, 26% somewhat agreed and 8% were neutral when asked if online learning provided an opportunity to acquire new knowledge. 43% strongly agreed, 28% agreed and 29% somewhat disagreed that online learning allowed them to acquire new skills.

While 28% of students strongly agree, 43% somewhat agreed and 29% somewhat disagreed when asked if online learning enhances the quality of their learning experience. 14% strongly agreed, 43% somewhat agreed, 29% were neutral and 14% somewhat disagreed when asked if online learning should be a part of firefighter training. 28% strongly agreed, 43% somewhat agreed and 29% were neutral when asked if online learning should be used for refresher training on station. 14% strongly agreed, 14 % somewhat agreed, 29% were neutral and 43% somewhat disagreed that online learning should be used for recruit training. 37% strongly agreed, 37% somewhat agreed, 13% were neutral and 13% somewhat disagreed that online learning is not my preferred mode of learning. Set 3 also returned a positive response when asked if online learning should be available to me when I am not at work where 14% strongly agreed, 43% somewhat agreed, 14% were neutral to this statement and 29% somewhat disagreed with this statement. And finally, when asked if they preferred face-to-face lessons in a classroom rather than online learning modules, Set 3 indicated that 43% strongly agreed, 43% somewhat agreed, and 14% somewhat disagreed with this statement.

4.6.4 All Sets - Access to technology

95% of all students had sent an email in the last 12 months; 95% of students had used social networking software in the past 12 months; 66% had used engaged in online meetings in the last 12 months; 58% had taken online courses in the last 12 months; 95% had streamed music in the last 12 months and 95% has made a video call in the last 12 months. The data shows that all three sets of students have immediate internet access on various devices. The majority of students access the internet using their mobile phones and they also access the

internet on their mobile phones several times a day. However, one student in set 2 preferred to use their home computer to access the internet. Accessing the internet using laptops or desktop computers was less popular, with the vast majority of students accessing the internet using their tablets or smartphones.

The most popular software used in the last 12 months was word processing software [n=57%], closely followed by spreadsheet software [n=29%] and then database software came in last [n= 14%]. Set 2 returned the highest value of strongly agree [n=79%] when asked if online learning 'gives me the opportunity to acquire new knowledge', they also returned the highest strongly agree value at 72% when they were asked if online learning gave the opportunity to acquire new skills. This favour towards technology in online learning for set 2 was continued as they returned the highest strongly agree value at 36% when asked if online learning should be part of firefighting training. Set 3 in contrast, returned the most significant negative response when asked if 'online learning is not my preferred mode of learning', 74% either strongly agreed or somewhat agreed with this statement. Set 3 also returned the lowest strongly agreed response to the statement that 'online learning gives me the opportunity to acquire new knowledge' [n= 57%]. Interestingly, the data returned from Set 1 would suggest that the frequency and use of ICT are high, this set was not exposed to any RTC online material. When asked in the survey if they preferred face-to-face lessons in a classroom rather than online learning modules, they returned the highest strongly agree value [n=59%] from all three sets.

57% of Set 3 had taken an online course in the last 12 months, from this subset of students it was interesting to note that there was close to a 50:50 spilt in terms of preference for online learning. In this regard, as illustrated in Figure 3, 20% strongly agreed, 20% somewhat agreed, 25% were neutral, 30% somewhat disagreed and 5% strongly disagreed with the statement that "online learning is not my preferred mode of learning".

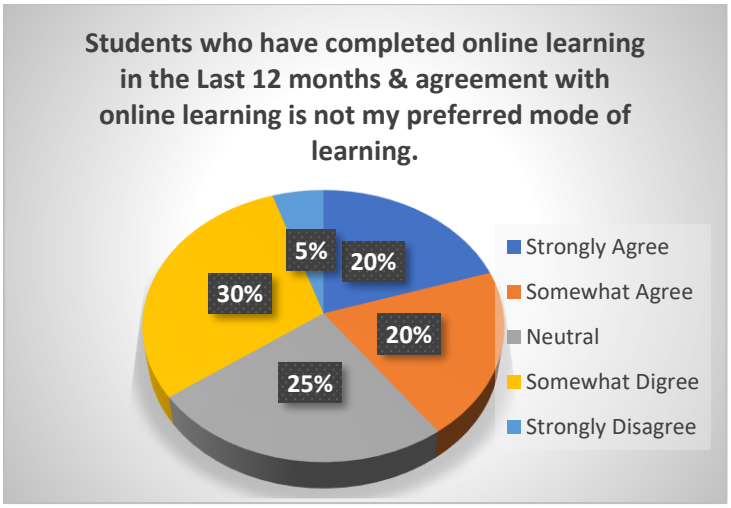


Figure 4.3 Online learning past 12 months vs mode of learning preference

4.7 Technology Readiness Index, TRI 2.0

According to Parasuraman et al., (2015, p.60), "TRI 2.0 is a 16-item scale assessment used to measure people's propensity to embrace and use cutting-edge technologies". The scale is broken down into four categories: optimism, innovativeness, discomfort and insecurity. The students were asked to record their level of agreement with the TRI 2.0 statements using a Likert scale which ranged from strongly agree, somewhat agree, neutral, somewhat disagree and strongly disagree. The overall data is summarised in Chart 1, in Appendix C.

4.7.1 Optimism

Parasuraman et al., (2015, p.60) classify optimism as "a positive view of technology and a belief that it offers people increased control, flexibility and efficiency in their lives". The students were asked their level of agreement with four statements; New technologies contribute to a better quality of life (OPT1); Technology gives me more freedom of mobility (OPT2); Technology gives people more control over their daily lives (OPT3); Technology makes me more productive in my personal life (OPT4). Each statement was coded OPI, OPT2, OPT3 and OPT4, respectively.

Set 1 - Optimism

29% of the students strongly agreed and 65% somewhat agreed that new technologies contribute to a better quality of life. 41% strongly agreed and a further 53% somewhat agreed that technology gave more freedom of mobility. 24% strongly agreed and 41%

somewhat agreed that technology makes them more productive in their personal life. 24% strongly agreed and 41% somewhat agreed that technology gives people more control over their daily lives.

Set 2 - Optimism

43% of the students strongly agreed and 57% somewhat agreed that new technologies contribute to a better quality of life. 43% strongly agreed and a further 57% somewhat agreed that technology gave more freedom of mobility. 43% strongly agreed and 43% somewhat agreed that technology makes them more productive in their personal life. 36% strongly agreed and 50% somewhat agreed that technology gives people more control over their daily lives.

Set 3 - Optimism

43% of the Set 3 students strongly agreed and 14% somewhat agreed that new technologies contribute to a better quality of life. 34% strongly agreed and a further 58% somewhat agreed that technology gave more freedom of mobility. 0% strongly agreed and 86% somewhat agreed that technology makes them more productive in their personal life. 14% strongly agreed and a further 43% somewhat agreed that technology gives people more control over their daily lives.

Optimism all Sets

In summary, Set 1 had a very optimistic perception of technology in terms of its contribution to the quality of life and acknowledged beneficial outcomes from its integration into their daily lives. Set 2 returned an even more positive optimistic response, believing that technology makes them more productive in their personal life and gives people more control over their daily lives. Set 3 did not echo the other sets optimistic response about new technologies contributing to a better quality of life. In contrast to the other two groups, Set 3 had considerably fewer optimistic views of technology in terms of its contribution to the quality of life but did acknowledge (albeit to a lesser extent) the benefits of its integration into their daily lives. As can be seen from Figure 4.6 below, all three groups mainly agreed with the TRI 2.0 optimism statements. Overall, the class was optimistic about the integration of technology into their lives and acknowledged the contributions it could make to the productivity of their day-to-day life.

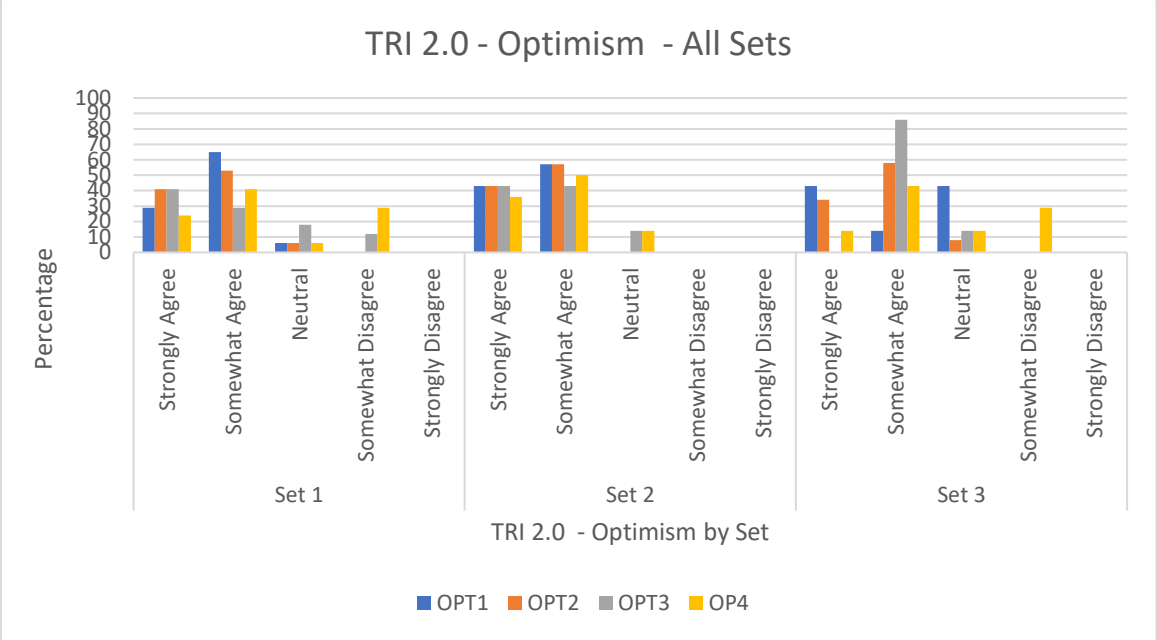


Figure 4.6 TRI 2.0 Optimism – All Sets

4.7.2 Innovativeness

Parasuraman et al., (2015, p.61) describe innovativeness as a 'tendency to be a technology pioneer and thought leader'. The students were asked about their level of agreement with the following statements; Other people come to me for advice on new technologies (INN1); In general, I am among the first in my circle of friends to acquire new technology when it appears (INN2); I can usually figure out new high-tech products and services without help from others (INN3); I keep up with the latest technological developments in my areas of interest (INN4). Each statement was coded INNI, INN2, INN3 and INN4 respectively.

Set 1 - Innovativeness

12% of Set 1 strongly agreed, 35% somewhat agreed, 35% were neutral, 6% said that they somewhat disagreed and 12% strongly disagreed with the INN1 statement that, "other people come to me for advice on new technologies". 8% strongly agreed, 8% somewhat agreed, 59% were neutral, 25% somewhat disagreed, and 0% strongly disagreed with the INN2 statement, "In general, I am among the first in my circle of friends to acquire new technology when it appears". 29% strongly agreed, 47% somewhat agreed, 18% were neutral, 6% somewhat disagreed and 0% strongly disagreed with the INN3 statement that "I can usually figure out new high-tech products and services without help from others". 29% strongly agreed, 35% somewhat agreed, 24% were neutral, 12% somewhat disagreed and 0% strongly

disagreed with the INN4 statement that "I keep up with the latest technological developments in my areas of interest".

Set 2 - Innovativeness

7% of Set 2 strongly agreed, 36% somewhat agreed, 36% were neutral, 14% said that they somewhat disagreed and 7% strongly disagreed with the INN1 statement that "other people come to me for advice on new technologies". 0% strongly agreed, 15% somewhat agreed, 39% were neutral, 46% somewhat disagreed, and 0% strongly disagreed with the INN2 statement, "In general, I am among the first in my circle of friends to acquire new technology when it appears". 21% strongly agreed, 43% somewhat agreed, 14% were neutral, 21% somewhat disagreed and 0% strongly disagreed with the INN3 statement that "I can usually figure out new high-tech products and services without help from others". 15% strongly agreed, 39% somewhat agreed, 38% were neutral, 8% somewhat disagreed and 14% strongly disagreed with the INN4 statement that "I keep up with the latest technological developments in my areas of interest".

Set 3 - Innovativeness

43% of Set 3 strongly agreed, 14% somewhat agreed, 43% were neutral, 0% said that they somewhat disagreed and 0% strongly disagreed with the INN1 statement that "other people come to me for advice on new technologies". In general, I am among the first in my circle of friends to acquire new technology when it appears'. 14% strongly agreed, 57% somewhat agreed, 29% were neutral, 0% somewhat disagreed and 0% strongly disagreed with the INN3 statement that "I can usually figure out new high-tech products and services without help from others". 57% strongly agreed, 29% somewhat agreed, 14% were neutral, 0% somewhat disagreed and 0% strongly disagreed with the INN4 statement that "I keep up with the latest technological developments in my areas of interest".

Innovativeness All Sets

Regarding innovativeness, the findings suggest that while most of Set 1 were late adopters of technology innovations, they were also interested in and open to experimentation with new technologies. Set 2 participants were also likely late adopters of technology innovations, this is evident when 63% of the students either strongly or somewhat agreed with the statement "I am among the first in my circle of friends to acquire new technology when it appears". Over half of the participants in Set 3 indicated were late adopters,

however, a majority considered themselves competent to figure out new technologies for themselves. Overall, the students across all three groups were not likely to be considered technology pioneers but the majority were willing to explore new technologies.

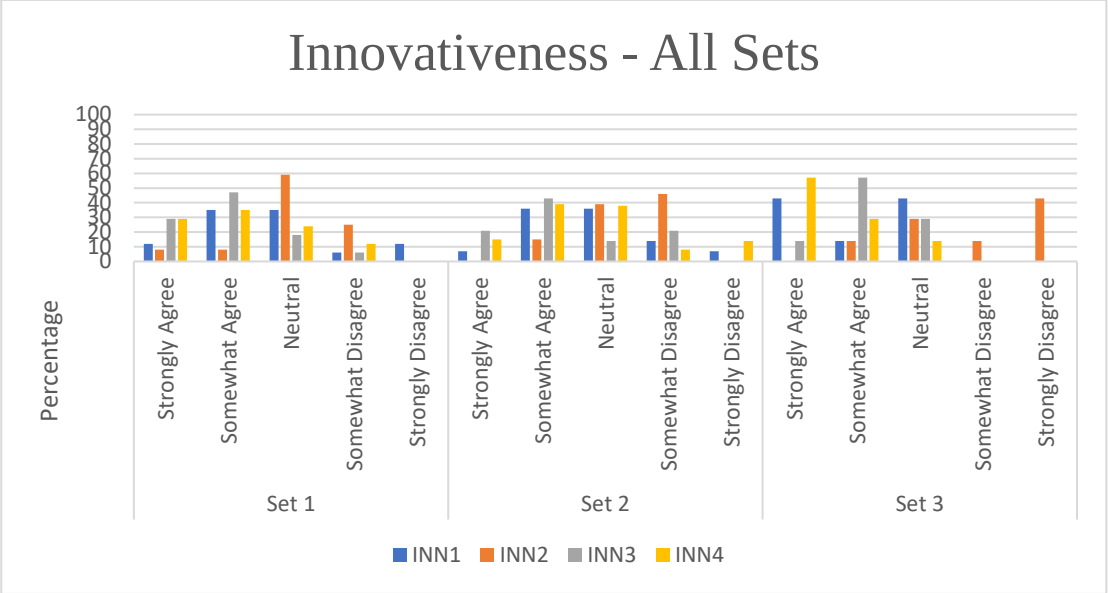


Figure 4.7 TRI 2.0 Innovativeness – All Sets

4.7.3 Discomfort

The penultimate TRI 2.0 category is discomfort, described as "a perceived lack of control over technology and a feeling of being overwhelmed by it" (Parasuraman et al., 2015, p.62). The students were asked their level of agreement with the following statements; When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do (DIS1); Technical support lines are not helpful because they don't explain things in terms I understand (DIS2); Sometimes, I think that technology systems are not designed for use by ordinary people (DIS3); There is no such thing as a manual for a high-tech product or service that's written in plain language (DIS4). Each statement was coded DIS1, DIS2, DIS3 and DIS4 respectively.

Set 1 - Discomfort

0% of Set 1 strongly agreed, 18% somewhat agreed, 47% were neutral, 35% said that they somewhat disagreed and 0% strongly disagreed with the DIS1 statement that "When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do". 0% of Set 1 strongly

agreed, 41% somewhat agreed, 35% were neutral, 24% said that they somewhat disagreed and 0% strongly disagreed with the DIS2 statement that "Technical support lines are not helpful because they don't explain things in terms I understand". 18% of Set 1 strongly agreed, 29% somewhat agreed, 12% were neutral, 41% said that they somewhat disagreed and 0% strongly disagreed with the DIS3 statement "that sometimes, I think that technology systems are not designed for use by ordinary people". 6% of Set 1 strongly agreed, 41% somewhat agreed, 41% were neutral, 12% said that they somewhat disagreed and 0% strongly disagreed with the DIS4 statement that "There is no such thing as a manual for a high-tech product or service that's written in plain language".

Set 2 - Discomfort

0% of Set 2 strongly agreed, 22% somewhat agreed, 21% were neutral, 43% said that they somewhat disagreed and 14% strongly disagreed with the DIS1 statement that "When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do". 0% of Set 2 strongly agreed, 7% somewhat agreed, 29% were neutral, 64% said that they somewhat disagreed and 0% strongly disagreed with the DIS2 statement that "Technical support lines are not helpful because they don't explain things in terms I understand". 0% of Set 2 strongly agreed, 31% somewhat agreed, 0% were neutral, 69% said that they somewhat disagreed and 0% strongly disagreed with the DIS3 statement "that sometimes, I think that technology systems are not designed for use by ordinary people". 0% of Set 2 strongly agreed, 16% somewhat agreed, 52% were neutral, 23% said that they somewhat disagreed and 0% strongly disagreed with the DIS4 statement that "There is no such thing as a manual for a high-tech product or service that's written in plain language".

Set 3 - Discomfort

0% of Set 3 strongly agreed, 28% somewhat agreed, 29% were neutral, 29% said that they somewhat disagreed and 14% strongly disagreed with the DIS1 statement that "When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do". 14% of Set 3 strongly agreed, 14% somewhat agreed, 43% were neutral, 29% said that they somewhat disagreed and 0% strongly disagreed with the DIS2 statement that "Technical support lines are not helpful because they don't explain things in terms I understand". 0% of Set 3 strongly agreed, 43% somewhat agreed, 28% were neutral, 29% said that they somewhat disagreed

and 0% strongly disagreed with the DIS3 statement "that sometimes, I think that technology systems are not designed for use by ordinary people". 0% of Set 3 strongly agreed, 29% somewhat agreed, 57% were neutral, 0% said that they somewhat disagreed and 14% strongly disagreed with the DIS4 statement that "There is no such thing as a manual for a high-tech product or service that's written in plain language".

Discomfort all Sets

The data returned indicated that the participants perceived lack of control over technology or their feeling of being overwhelmed by technology varies considerably within and across the sets. Overall, a significant majority of participants in Set 2 believed that technology systems were designed for use by ordinary people, however the majority in Set 1 and Set 3 did not believe this. In addition, there was variation in the overall response to the statement on technical support lines, with the majority in Set 2 indicating a valuing of technical support lines, the majority in Set 1 indicating dissatisfaction with technical support lines, and those in Set 3 divided on this. Furthermore, there appeared to be an underlying trust issue for a minority of participants across all sets, and in particular Set 3, relating to the imbalance in the level of technology knowledge of recruits and technical experts.

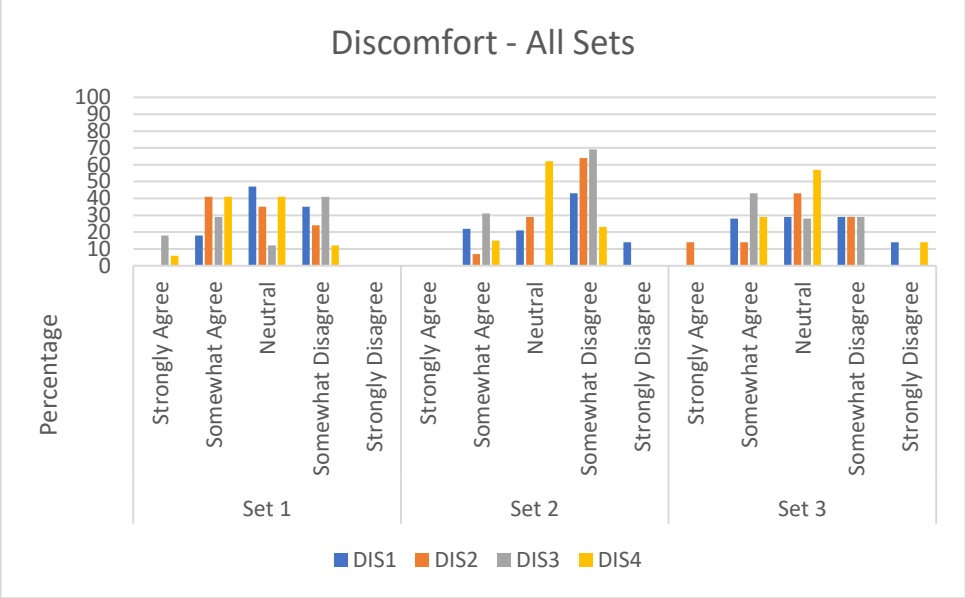


Figure 4.8 TRI 2.0 Discomfort – All Sets

4.7.4 Insecurity

In the last TRI 2.0 category, insecurity or distrust of technology is described as "stemming from skepticism about its ability to work properly and concerns about its potentially harmful consequences" (Parasuraman et al., 2015, p.62). The students were asked their level of agreement with the following statements; People are too dependent on technology to do things for them (INS1); Too much technology distracts people to a point that is harmful (INS2); Technology lowers the quality of relationships by reducing personal interaction (INS3); I do not feel confident doing business with a place that can only be reached online (INS4). Each statement was coded INS1, INS2, INS3 and INS4 respectively.

Set 1 - Insecurity

Most participants in Set 1 somewhat agreed (29%) or strongly agreed (53%) that people are too dependent on technology to do things for them. The majority of participants also somewhat (65%) or strongly agreed (29%) that, too much technology distracts people to a point that is harmful. The majority of Set 1 (44% strongly agree and 31% somewhat agree) believed that technology lowers the quality of relationships by reducing personal interaction. 34% of Group 1 somewhat agreed and 25% strongly agreed with the statement 'I do not feel confident doing business with a place that can only be reached online'.

Set 2 - Insecurity

In Set 2, 0% of students strongly agreed, 57 % somewhat agreed and 36% were neutral, 7% somewhat disagreed and 0% strongly disagreed with the statement 'people are too dependent on technology to do things for them'. In Set 2, 7% of students strongly agreed, 57 % somewhat agreed, 29% were neutral, 7% somewhat disagreed and 0% strongly disagreed with the statement 'too much technology distracts people to a point that is harmful'. In Set 2, 15% of students strongly agreed, 54 % somewhat agreed, 23% were neutral, 8% somewhat disagreed and 0% strongly disagreed with the statement 'technology lowers the quality of relationships by reducing personal interaction'. In Set 2, 0% of students strongly agreed, 46 % somewhat agreed, 8% were neutral, 46% somewhat disagreed and 0% strongly disagreed with the statement 'I do not feel confident doing business with a place that can only be reached online'.

Set 3 - Insecurity

In Set 3, 29% of students strongly agreed, 71 % somewhat agreed and 0% were neutral, 0% somewhat disagreed and 0% strongly disagreed with the statement 'people are too dependent on technology to do things for them'. In Set 3, 14% of students strongly agreed, 43 % somewhat agreed, 9% were neutral, 14% somewhat disagreed and 0% strongly disagreed with the statement 'too much technology distracts people to a point that is harmful'. In Set 3, 57% of students strongly agreed, 43 % somewhat agreed, 0% were neutral, 0% somewhat disagreed and 0% strongly disagreed with the statement 'technology lowers the quality of relationships by reducing personal interaction'. In Set 3, 29% of students strongly agreed, 29 % somewhat agreed, 14% were neutral, 14% somewhat disagreed and 14% strongly disagreed with the statement 'I do not feel confident doing business with a place that can only be reached online'.

Insecurity All Sets

Overall, the vast majority of Set 1 and 3 strongly agreed that there was an over-reliance on technology 'to do things for them' and that technology was a harmful distraction. In contrast, a considerably lesser majority of Set 2 believed this to be the case. A considerable majority of all groups agreed that the loss of personal interaction in technology usage negatively impacts on quality of relationships. There were indications that around half of students across all groups were distrustful of businesses that only operated online.

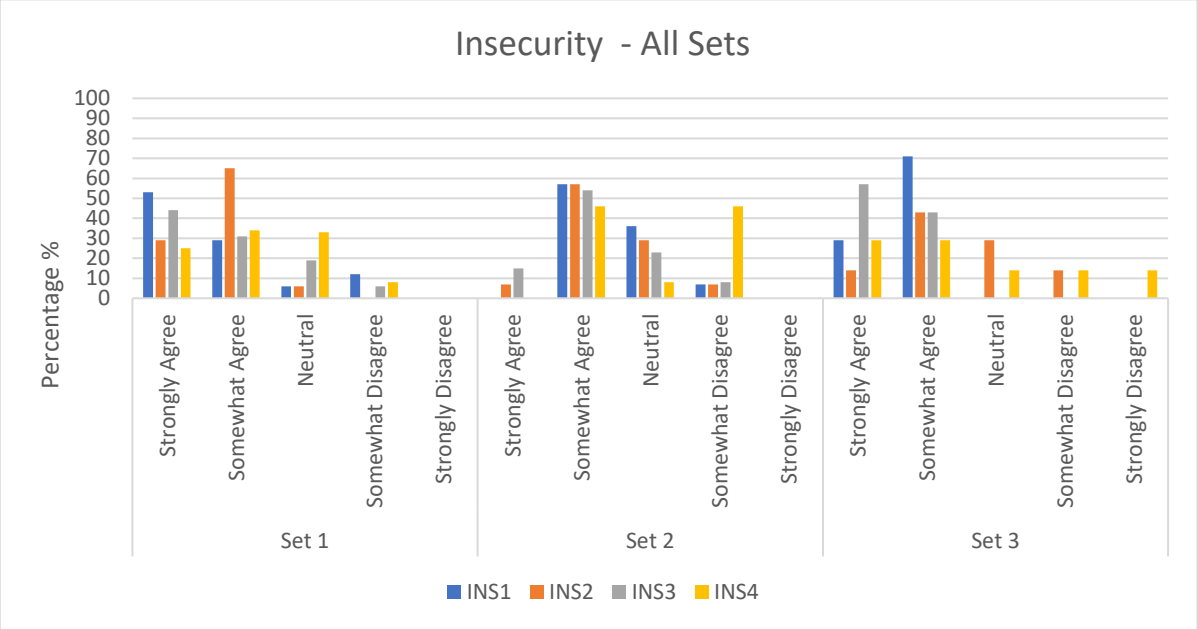


Figure 4.9 TRI 2.0 Insecurity – All Sets

4.8 Instructor Interviews

Face-to-face interviews with the lead instructor from each set were conducted during the data collection phase of this research in June 2020. The three instructors interviewed were numbered Instructor 1, 5 and 9, respectively. All interviews were held in the training centre in the instructor's office when no other students or instructors were present. Each interview was transcribed, and codes and categories were identified, an example of the questions asked can be viewed in Appendix B.3 The following themes emerged from the instructor interviews - motivation, course content, course design, course delivery, skill duration, peer-to-peer learning, assessments, and online and blended learning.

Interview 1

Instructor 1 was asked what motivated them to become an RTC Instructor; it was interesting to note that the instructor was motivated both intrinsically, stating that they "have a keen interest in heavy vehicle technologies" and extrinsically, saying that they "liked the interaction with the students. I like being able to teach something that can be applied operationally. I like things to be taught the right way, and I like the camaraderie that you develop in the drill yard" (RTC Instructor Interview 1).

Drawing on previous experience, Instructor 1 believed that the RTC course duration of two weeks was appropriate. The course used only to be one week, and he felt the additional time was needed to include new car technologies such as electric vehicles. However, he believed the course material could have been more consistent and would require peer review more regularly. He also mentioned that because the course has a lot of weights and measurement data, sometimes other instructors would use outdated information that would not be currently presented to the student in their notes or face-to-face lessons; Instructor 1 was concerned that students would not be receiving the correct information. When asked if the time spent in the drill yard is adequate or if there should be more or less time given to one or the other, the instructor indicated that because the RTC course is very practical "they [instructors] would always like more time practising skills in the drill yard" (RTC Instructor Interview 1, 2020). When asked what his opinion or perspective on the training methods used within the course from a learning point of view, the instructor pointed to issues in the training, teaching and learning approaches, noting that "we [DFB] rely too much on overhead PowerPoints" (ibid) and that, "In recruit training, there's not much time for discussion as it's very much

instructor-led, however, I would always encourage students to talk to each other and try to problem solve" (ibid). I then asked Instructor 1 if he was familiar with the term "peer-to-peer learning" but he was not; this was noted as it could be compared to Set 3's instructors who directly participated in peer-to-peer learning. Instructor 1 indicated that he favoured continual assessments stating, "We continually look at how the student is doing as per their skill sheets" (ibid). The instructor made it clear that there was an emphasis on enabling students to pass assessments, noting that he had "never failed anyone, you always get there in the end, some people are better than others, but we make sure that everyone is a safe pair of hands before they leave the course" (ibid). The instructor also noted that he would like the course to include case studies as they have in other disciplines in recruit training, such as in the Breathing Apparatus (BA) course. When asked about online and blended learning, the instructor was familiar with the concepts of online learning as he had completed an online learning course in a private capacity stating, "Well, I've done some online learning for extracurricular courses that I'm interested in, it was in the whiskey club, and now with COVID-19 looming I think it's something that we're going to have to look at" (ibid). However, the instructor was unfamiliar with the term blended learning, when this expression was explained the instructor appeared to be open to its integration, stating that he thought "that [blended learning] might be something to aim for in the future because one way is not always the best way and it's great for students to be able to go online and have a look at something for their homework or if they're not sure" (ibid). The instructor also added that he thought online learning could be something the student could complete before the students would start the didactic element of the course. However, the instructor appeared not as convinced with the notion that the students would have advanced access to online; he said that this learning might result in the students being more knowledgeable about the RTC content, and he did not want the students to become "smarty pants" (ibid) before tuition commenced. Instructor 1 was also happy to engage with online learning for instructors but emphasised the need for meaningful integration of online learning within the context of the RTC training programme in its entirety, adding that "as I said before, I would be happy to do it, but we need to know where it fits in because you can't do an RTC course online. You need the hands-on - you need to be in the yard" (ibid).

Interview 2

Instructor 5 was the lead instructor of Set 2; in this set, access was provided to the RTC online learning material pre, during, and after the RTC course. Instructor 5 had nearly 30

years of experience within DFB; when interviewed, he held the rank of Station Officer. For the past ten years, he has been a multi-disciplined instructor, as he has instructed on several other programs such as Breathing Apparatus and Pump Operation. He was intrinsically motivated to teach others and gain knowledge and experience in a pedagogical environment, stating that "if you want to know about something, teach it". This instructor considered face-to-face learning a necessity but preferred skills lessons where the students could use the equipment that was offered during the course "Time in the classroom is a little bit too long, in my opinion, I'd like to see less classroom and more hands-on the cars". He made the point that within recruit training, students were not encouraged to discuss points of learning; the emphasis was to promote teamwork and get the job done. He described their teaching style as "autocratic" and stated the focus would be "on drills and working together in our syndicates". He also went on to say that the style of assessment that is now used during RTC training is more holistic in nature. Rather than testing on each piece of equipment, as was the norm when he was a recruit, there is now more of a focus on recruit articulation of their understanding whilst demonstrating critical skills "We tend to take a more overall view and watch the recruit [firefighter] use the piece of equipment. Then we ask them to discuss the pros and cons of using the equipment and the processes associated with the health and safety of each piece of equipment". The instructor indicated that the course could be improved through smaller class sizes and encouraging ongoing Continual Professional Development (CPD). In terms of the latter, when the recruit moves into the operational phase, he would like to see them continue their learning by completing CPD courses; these courses would build on their RTC fundamental knowledge and then elevate their learning from novice to a level of mastery.

The instructor was asked if he was familiar with the terms online or blended learning. He said that online learning was used for CPD purposes within breathing apparatus modules, adding that these online modules are needed to maintain their instructor competency. He further did note that "the feedback [about online learning at station level- LearnPro] from the guys in the station is very good. There seems to be the consistency of material, which can be accessed anytime, day or night. Yeah, I think it's a start, it's been a positive start, and it seems to be the way forward. Sure, everything you do know is done online". This instructor intimated that he welcomed the idea of online learning. He did say that the current cohort of instructors would need further training to develop and engage with this technology. He guessed that blended learning was "a mix of classroom and eLearning".

Interview 3

Instructor 9 was the lead instructor of Set 3. He had 24 years of experience within the brigade, with the current rank of Station Officer and the highest level of education at level 8, degree level. He was also an experienced, multi-disciplined instructor as he taught BA and RTC courses and stated, "I've taught on too many courses to remember". He was motivated by the opportunities to gain new knowledge that could be used during the operational phase of an emergency. Regarding the course content and timeframe for recruit training, he was satisfied that the course duration was "sufficient" but stated that the course material needed updating, noting that "I give the students the PowerPoint slides and tell them not to look at the book". The instructor felt the ratio of the classroom to skills lessons was about right while highlighting the importance of experiential learning for recruits "The students need to get out and see the equipment in use to physically smell, touch, hear and use the spreaders or a ram, a picture paints 1000 words. It's also important that the students get the skills of using the equipment, it builds their muscle memory, so when they go to an incident, it's like oh yeah, I know how to do this".

Instructor 9 stated that he had completed a good deal of online learning in the past, where he used Blackboard and Moodle; he found online valuable learning in terms of its flexibility "I like it because it's convenient and suits my lifestyle. I like the fact that you can do modules in your own time and at your own pace; it's good. It suited me, and I think with the way we're going with COVID, there will be a lot more of it in our future".

Instructor 9 was then asked about the Tine Model used during this course in Set 3. He noted the benefits of the online component in preparing students before the session "I liked that it gave the students the information before they came to class. I could see from some of the questions some of the students had that they looked at the eLearning beforehand". He further pointed to the beneficial outcomes of the skills stations in drill yard exercises in terms of recruit engagement and problem-solving "I really liked the skill stations in the yard, the way that the students interacted, they were asking questions, and could problem solve, this appeared to be unique. I'd never seen that before". He noted that the "cheat sheet helped the recruits put the facts and figures to each piece of equipment". The instructor confirmed that there were particular challenges as an instructor in planning for or participating in the Tine Model, specifically its difference from the traditional model of fire service training "I

hadn't a clue [initially] what was going on. It was all new to me, but when you explained the theory and showed me the diagram of how it was to work it all clicked in and made perfect sense". The instructor also said that allowing additional time for problem-solving would be beneficial within the Tine Model "I think we could have given the students more time with the problem-solving aspect. They really seemed to enjoy that bit; I would have liked to have seen more of that".

Summary Instructor Interviews

The instructors interviewed demonstrated an innate passion for the subject matter being taught; all were intrinsically motivated by imparting their knowledge, skills and experience to the next generation of Firefighters. All instructors thought the RTC course content and duration were appropriate; however, many indicated that the student notes needed to reflect the information in other training materials accurately. The instructors agreed that there was a place for face-to-face learning during RTC instruction; however, their preferred teaching environment was in the drill yard, where students could see and use the RTC equipment in its natural environment. The instructors exposed to online learning appeared to be open to this concept; most instructors had used an online environment for their educational interests; There was an air of uncertainty concerning whether this approach would be best suited to recruit training. The Tine model was greeted with approval; most instructors welcomed a new educational approach and favoured incorporating syndicate work where the students would be allowed time to problem solve using peer-to-peer and scenario-based learning. It was noted that all instructors would like to see additional instructor training if this model was implemented in Dublin Fire Brigade.

4.9 Examination Performance

In this section, the performance of recruits was examined using a logarithmic scale called the "Forgetting Curve" developed by a German psychologist, Hermann Ebbinghaus, circa 1885.

Each student was required to complete an end-of-course exam. This exam was held on the final day of each two-week course. The exam included primarily Multiple-Choice Questions (MCQ), with some requiring the student to offer their handwritten answer in a paragraph format. A logarithmic scale called the Forgetting Curve, first developed by Ebbinghaus (circa 1885), was used to present the forecasted exam scores of each set after a period of 52

weeks (as shown in Figure 4.5). The goal of Ebbinghaus was to attempt a 'natural science' of remembering by applying its exact methods.

The formula used in this research was;

$$R = exp(-t/S)$$

- R symbolizing memory retention
- t symbolizing time [*over 52 weeks*]
- S the relative strength of the memory [*Output from previous week*]

	Forecasted result per week per set			
Week	Ebbinghaus	Set 1	Set 2	Set 3
2*	**89.191446**	**89.6874687**	**94.7892753**	**97.3641031**
3	82.26997	84.6249941	89.4388255	93.0922011
4	77.6261815	80.9120273	85.5146492	**89.77**
5	74.2202913	78.0245027	82.4628699	85.8312933
6	71.5715761	75.6862302	**79.52**	82.7682138
7	69.4266878	73.7361985	77.4711925	80.2877797
8	67.6379312	72.073252	75.7240119	78.2191906
9	66.1125167	70.6301146	74.2077746	76.4551407
10	64.7887324	**69.36**	72.8733243	74.9242639
11	63.6236611	68.2291815	71.6852259	73.5769292
52**	**48.3697814**	**52.5671757**	**55.2298852**	**55.9367367**

Table 4.5 Forecasted results per week per set

*exam done in week 2 of the course

** Forecasted to 52 weeks, weeks 12 to 51 omitted for presentation purposes

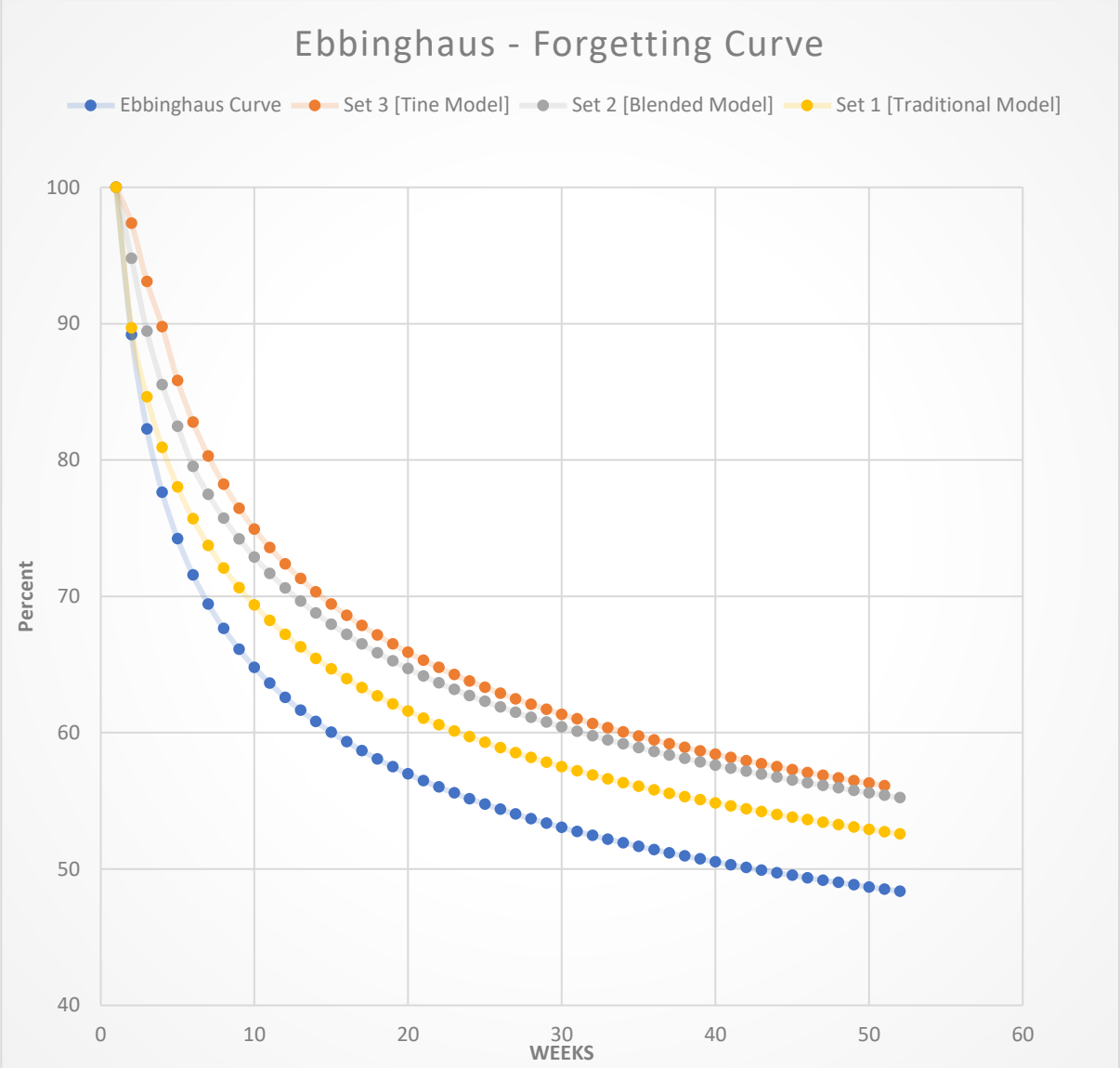


Figure 4.10 Ebbinghaus Forgetting Curve – All Sets

Set 1 vs Ebbinghaus

Set 1 completed their final exam and their average mark was 89.7%. Eight weeks after this initial exam I asked the same students to re-sit this exam. 100% of students resat this exam and the average mark returned was 69.4%. The 52-week forecasted result using an Ebbinghaus logarithmic scale was 52.6% as can be seen in Figure 4.10 above (Yellow Curve). The baseline Forgetting Curve (Blue Curve) estimated the result should be 48.4%, this would indicate a 4.2 percentage point (pp) increase for Set 1.

Set 2 vs Ebbinghaus

Set 2 completed their final exam and their average mark was 94.8%. Four weeks after this initial exam I asked the same students to re-sit this exam. 100% of students resat this exam and the average mark returned was 79.5%. The 52-week forecasted result using an Ebbinghaus logarithmic scale was 55.2% as can be seen in Figure 4.10 (Grey Curve). The baseline Forgetting Curve (Blue Curve) estimated the result should be 48.4%, this would indicate a 6.8 percentage point (pp) increase for Set 2.

Set 3 vs Ebbinghaus

Set 3 completed their final exam and their average mark was 97.4%. Three weeks after this initial exam I asked the same students to re-sit this exam. 100% of students resat this exam and the average mark returned was 89.8%. The 52-week forecasted result using an Ebbinghaus logarithmic scale was 56% as can be seen in Figure 4.10 above (Orange Curve). The baseline Forgetting Curve (Blue Curve) estimated the result should be 48.4%, this would indicate a 7.6 percentage point (pp) increase for Set 3.

Ebbinghaus Overall

This research utilised Ebbinghaus' forgetting curve to illustrate how information can degrade over time. The data collected from the RTC formative assessments were compared to each other and the forgetting curves projected results. The data suggested that all three models (Traditional, Blended and Tine) compared favourably and furthermore, the Tine model showed the highest knowledge retention over a 52-week period. However, precluding the use of the forgetting curve, it should be noted that data collected from the RTC formative assessments clearly shows a noticeable difference in the average score returned by each group; Group 1 (n=89.7), Group 2 (n=94.8) and Group 3 (n=97.4). This trend was also observed when the students retook the same exam a few weeks after the initial formative assessment, with Group 1 (n=69.7), Group 2 (n=79.5), and Group 3 (n=89.8) respectively. These results indicate that performance in terms of knowledge retention was better for those engaged with the Tine model, when compared to the Blended or Traditional models.

All sets of students performed above the forecasted expected results compared to the Ebbinghaus baseline. It is important to note that Set 3 were the Set leader after their exposure

to the Tine Model. It would have been interesting to ask all students in the Sets to retake this exam, however, DFB declined to make the option available to recruits.

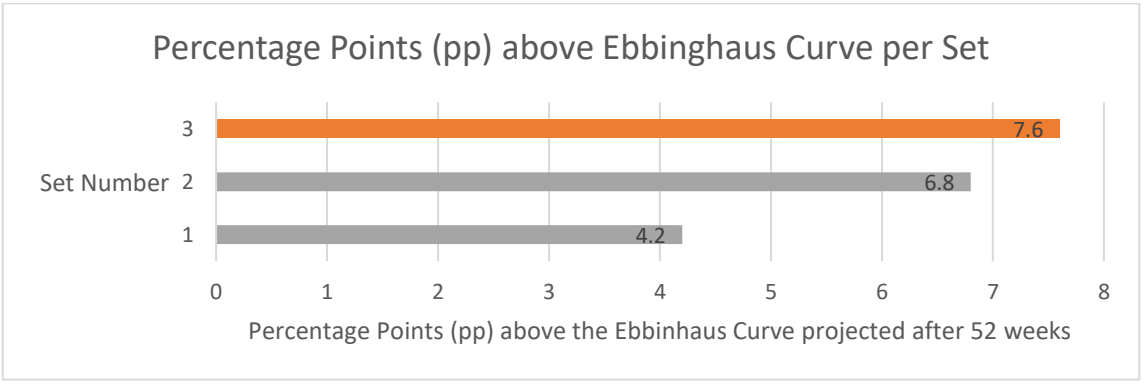


Figure 4.11 Percentage Points (pp) above Ebbinghaus Curve per Set

4.10 Focus Groups

According to Saunders et al. (2016, p.716) focus groups or group interviews are composed of a "small number of participants, facilitated by a moderator, in which the topic is defined clearly and precisely and there is a focus on enabling and recording interactive discussion between participants". The focus groups in this study were limited by the size of a recruit syndicate, which was always less than eight students. There were nine focus groups in total, three focus groups per set as depicted in Figure 4.12.

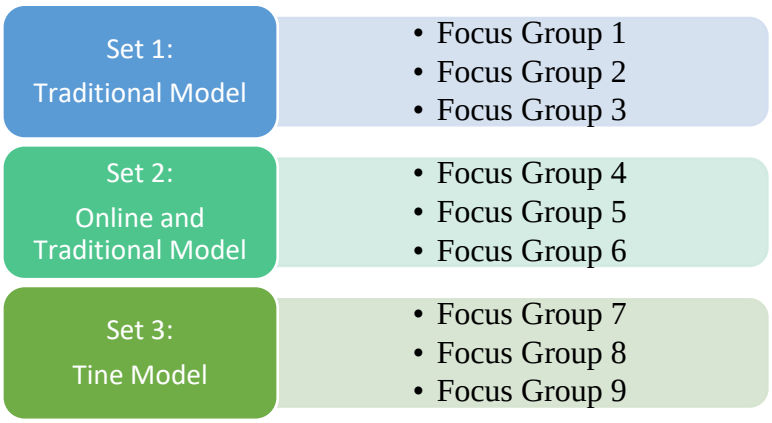


Figure 4.12 Focus Groups [Traditional, Online and Tine Models]

The series of questions poised within the focus groups directly focused on examining; student motivation, overall experience of the RTC course, RTC previous experience, course content and structure during both face-to-face and drill yard instruction, training

methods/materials and assessment tools (Appendix B.2). As the students in Set 2 and Set 3 were exposed to the online element of these models, they were asked further questions which focused on their experience of online or blended learning. Set 3 set was further asked about their experiences during the Tine Model. When all the data was collated and transcribed, each focus group was coded using NVIVO software (see Appendix D). From reiterative analysis of the data the following categories emerged in Table 4.4.

Categories	Codes
Prior work and fire related experiences of recruits	Prior fire service training experience
	Prior occupation
	Prior RTC training
Stimulus for registering for fire service recruit training	Motivation to join Fire Service (Extrinsic)
	Motivation to join Fire Service (Intrinsic)
Categories	**Codes**
Course Content and Structure	Course Design
	Course Content
	Course Delivery
	Course Assessments
	Preparedness for operational Duties
Course Design Tradition, Blended learning and Tine	Accessibility of course content
	Consistency of course content
	Relevance of course material
	Resources and Tool Allocation
	Sequencing and Structuring of course content – theory-practice
	Time allocation for theory lessons, practical and online sessions
	Variety within Course Content
Recruits experience Tradition, Blended learning and Tine	Dispositional factors - Internal Factors
	Motivational factors
	Pedagogical factors
	Situational factors - External Factors
Recruits perspective on Tradition, Blended learning and Tine	Accessibility of course content in face-to-face blended online learning
	Dispositions towards face-to-face, blended and online learning
	Motivating factors within face-to-face blended online learning
	Prior Online Learning knowledge experience
	Sequencing of face-to-face blended online learning

Table 4.4: Focus Group Codes and Categories

Set 1 - Focus Group (Traditional Model)

Set 1 comprised three focus groups, numbered one to three, respectfully. The student population for each group were as follows; Focus Group 1 contained five students (n=5), Focus Group 2 contained six students (n=6) and Focus Group 3 contained six students (n=6). Seventeen students voluntarily took part in the focus groups held for Set 1, this was 100% of the student population for Set 1. Set 1 was exposed to the traditional RTC model and they did not have access to any online RTC training material. Set 1 comprised novice firefighters with no previous RTC experience (n= 12) and students previously employed as firefighters with other organisations (n=5). Student 2 worked in another Irish Fire Authority for two years and in the East Regional Control Centre for one year. Student 4 had worked previously in another European country as a Firefighter. Students 5, 7 and 9 had also worked for another local authority as Firefighters for periods ranging from one to eight years, all in a retained capacity.

Motivation

One of the first codes identified by Set 1 was motivation, it was clear that students who had previously been exposed to RTC training were intrinsically motivated by completing the RTC training module of their recruit training. Student 2 stated "It was one of my favourite subjects in the [previous] fire service, I really enjoyed the RTC part of it, obviously it's part of a module that you need to do anyways, not that we volunteered to do it, but I really enjoyed it, I was happy we got to do it" (RTC Set 1 - Focus Group 1). Student 1, who had no previous experience, said that he was motivated by the practical course content – "Yeah, I was really looking forward to doing it, I've always enjoyed taking things apart, I liked cutting up the cars" (RTC Set 1 - Focus Group 1). Student 6 echoed the draw of the practical component of the programme and its focus on assisting others as motivating "Actually helping people, getting hands-on tools and stuff like that, that's what interested me" (RTC Set 1 - Focus Group 2). Student 17 also added that the training gave him a sense of achievement – "It just made sense to me, I was working in a job for no reason, now at this stage, there is a reason. It's like when I go home, I feel like I've done something good that day" (RTC Set 1 - Focus Group 3). Student 14 was motivated by the idea of working in a team "I like a challenge, I came from parks before, it was quite boring and I always had an interest in joining the fire brigade I liked a challenge and I loved the team aspect of it, working closely with people, where when I was in parks I was working on my own" (RTC Set 1 - Focus Group 3).

Course Content and Structure

The Course Content and Structure category emerged early in Set 1 when students who had completed a previous RTC course identified the similarities and differences between each course. Student 2, who had previously completed an RTC course with another organisation, observed that "I know the techniques are the same [in this and the other course I did], it's good to see there's a certain way of doing things and you learn that's the way to do it, back to the basics glass management, and make sure it's all done right" (RTC Set 1 - Focus Group 1). When the students were asked if they thought the time in the classroom could be altered, Student 8 stated "No, I think they were just bang on" (RTC Set 1 - Focus Group 2). Student 10 further noted a transition towards more drill yard practice in the past week – "We haven't been in the class much at all this week, have we? if at all, in the yard much more this week than last week" (ibid). Student 11 noted an appropriate balance between classwork and practising skills in the drill yard – "It was a good balance between the class in the morning and the practical in the afternoon." (RTC Set 1 - Focus Group 3). Student 6 would have liked to see a reduction in some of the theory elements of the coursework "The nice to know stuff can be a bit heavy, there can be a lot of numbers getting thrown at you, it's stuff that you don't necessarily need to know, do you know what I mean?" (RTC Set 1 - Focus Group 1). Student 10 pointed out that the structure and content of the course allowed the students to participate as a casualty during the drill yard exercise, noting "Listening to the casualty, listening to all the pops and the bangs, you need to have that experience, you need to be in the car." (RTC Set 1 - Focus Group 2).

Training Materials

When the students were asked about their training materials, Student 9 noted the book (of training materials) wasn't being utilised "To be quite honest with you, I haven't even opened my books that much, it's been more the slide show, it doesn't seem to correlate with what's in the book, even the figures are different aren't they?" (RTC Set 1 - Focus Group 2). Student 7 observed that the book was used for revision at home – "the books are more go home and read the book yourself, what you need to do is get the slide show, that's it" (ibid). Student 1 had issues with the structuring of content in the book "found the RTC book wasn't as good as our recruit book for the first four weeks, it was very scattered in parts" (RTC Set 1 - Focus Group 1) and Student 14 had issues with lack of coherence between book and in-

class presentations – “Sometimes the presentation didn't match our book, and if he didn't get it down the last presentation” (RTC Set 1 - Focus Group 2).

Course Assessment

The students were asked their opinions on their course assessments. Student 5 noted that the drill yard assessment was fair in that “we had to do a few assessments where the instructor would ask you to operate a piece of equipment and see how you got on with it” (RTC Set 1 - Focus Group 1). Student 4 also affirmed the value of continuous skills assessment in drill yard exercises “Like what was said, we were being assessed all the time, during the time we were cutting up the cars, only the one who was on the tools, and it was grand, don’t think any of the lads had a problem” (RTC Set 1 - Focus Group 1). The students noted that continuous skills assessment was preferred compared to assessment techniques used across the basic firefighter training. Student 2 stated he “much preferred this way, as we just got shouted at during our basic” Student 5 agreed “me too” (ibid). Student 1 stated, “I felt that I was being treated like an adult rather than a school child [in recent RTC training]” (RTC Set 1 - Focus Group 1). At the time of the interview, the examination had not been completed, so there is no commentary on this form of assessment.

Online Learning

There were mixed sentiments within the focus groups in Set 1 on whether online learning could assist or be of benefit to RTC training. Student 1 noted that online learning could help improve accessibility and accuracy of course materials “Yeah 100% we're all looking forward to a time where we can log on to just the one place and see what are the information and lessons that we need. Yeah, it would have been good on this course as we said the notes were different from the slides, this was confusing at times” (RTC Set 1 - Focus Group 1). Student 10 did not like the idea of online learning encroaching into the home environment, he stated “I would agree they [online learning] can't beat the face-to-face environment, you're in study mode, you know what I mean. There is like a definition home is home and that blurs the lines”. (RTC Set 1 - Focus Group 2). Student 6 thought that the success of online learning depends on the thematic focus of the programme – “like my wife is doing an online course for childcare, and it was brilliant she got her qualification out of it” (ibid). Student 13 who had used online learning in college thought it was of benefit, Student 16 noted online learning was useful for revision purposes “you can always look back on the lecture if you

need it, it really worked" (RTC Set 1 - Focus Group 3). Student 15 noted that while there was a place for online learning his preference was for face-to-face as queries could be answered "prefer face to face and then a module, cause if I didn't understand I could ask questions" (RTC Set 1 - Focus Group 3). Student 2 had completed the e-learning in the past and found it suitable for self-directed and self-paced learning "done eLearning before and I found it great as you can look at stuff in your own time when suits. I have two kids and doing this and homework is hard so it would be good if I could do it in my own time, whenever I have a sec" (RTC Set 1 - Focus Group 1). Student 17 commented on lack of coherence between book and in-class presentations "As [student name omitted] said the book doesn't match the slides it doesn't match up with that there is no going back to or repeating it back you know. Especially for me you know if I couldn't hear at the back, I couldn't refer to the book because the book didn't match what I saw, and my notes weren't there because I couldn't write them because it was too fast. Maybe that online could actually help me at home, so I could go back to it you know what I mean" (RTC Set 1 - Focus Group 3).

Blended Learning

The students mainly connected the term blended learning with online and class-based learning. Regarding the future role of blended learning in RTC training, the comments primarily focused on its benefits for revision purposes, with opportunities for self-testing and revision. For example, Student 7 said "Yeah, well, maybe if you had a little bank of questions, that you could access something if you choose, like an MCQ on your paramedic. Like if you were unsure of things, questions that might come up, I don't know, like a bank of questions from the whole course. Not like an official test but just yourself, like tonight you can sit down for an hour, and you can only access the questions on the modules you've done, maybe something like that I don't know" (RTC Set 1 - Focus Group 2).

Instructor

Regarding the teaching methods employed by instructors, students valued the careful scaffolding by instructors, and the experiential learning, particularly during skills sessions in the drill yard. During the session, Student 3 noted that the instructors were supportive. Student 16 pointed out that the instructors gave demonstrations when asked for clarifications "Anything that we didn't know, they brought us out and showed us" It was very good he got everyone to take it off and put the blade in individually and we were watching people but

then [we] got to do it ourselves" (RTC Set 1 - Focus Group 3). Student 12 pointed to some issues in understanding terms being used by instructors but did note that the instructors generally clarified these when asked "I was confused on some things like when they said to remove the battery, I'd remove the battery. Or what was the thing he was talking about yesterday, cut the, remember for the dash roll? The door sash, we didn't know what it was, stuff like that but they made sure that they showed us" (RTC Set 1 - Focus Group 3). Student 3 added that the class learning could be enhanced by showcasing equipment in class or entirely in the drill yard "If the instructor could bring the equipment into the class that would be good, so we can see it. Or even if the class could be out in the yard and we could teach the lesson as we see the tools being used, if that makes sense?" (RTC Set 1 - Focus Group 1).

Preparedness for operational duties

Generally, the students thought that this course prepared the learner for operational duties, with Student 5 noting: "Yeah definitely, obviously probably not your first incident you'll be a bit nervous, your training will kick in you know what to do" (RTC Set 1 - Focus Group 1).

Set 2 - Focus Group (Blended Model)

Set 2 comprised three focus groups, numbered four to six, respectfully. The student population for each group were as follows; Focus Group 4 contained five students (n=5), Focus Group 5 contained six students (n=5) and Focus Group 6 contained six students (n=5). A total of fifteen students voluntarily took part in the focus groups held for Set 2, this was 100% of the student population for Set 2. Set 2 was exposed to the online and traditional RTC model and they did have access to the online RTC training material. Set 2 comprised novice firefighters with no RTC experience (n= 11) and students previously employed as firefighters with other organisations (n=4). Student 21 had worked in another Irish Fire Service for the last five years. Students 24 and 25 worked in the retained fire service for four years. Student 29 had worked in another Irish Fire Service for the previous five years.

Motivation

The students in Set 2 were asked what motivated them to do the RTC course. Student 23 noted his boredom with the current role and felt engagement in the course offered more of a challenge (RTC Set 2 - Focus Group 5). Student 24 was intrinsically motivated having "just

always wanted to be in the fire service. I did an RTC course say three years ago, and I've been competing for four years with the [omitted] team for Rescue Organisation Ireland". Student 27 stated that a lifetime ambition to be a firefighter comes from a family tradition of serving in the fire service.

Course Content and Structure

In terms of the course content and structure, Student 18 valued the opportunity to learn experientially from the practical dimension "… we had plenty of opportunity to get hands-on and practice on the cars rather than actually in lectures you know, it's hard to figure out what you're doing in a PowerPoint presentation but when you're physically making mistakes and learning from them, it's really good" (RTC Set 2 - Focus Group 4). Student 19 echoed these sentiments by saying "The same as [name omitted], especially getting hands, especially getting hands on the tools, just saying how easy they can make a life for you, taking the roof off a car, taking the car away from the patient, yes, it's a good course. Enjoying it as well. (ibid). Student 20 stated that 'the classroom was tough" pointing to the challenge in primarily instructor-led content delivery. Student 21 who was a veteran of five years of previous fire service experience also valued the demonstrations and practical dimensions of the course that afforded more opportunities for individual learning, finding it more beneficial than a previous RTC course "On my last RTC course there were 16 of us and only two RTC instructors for the week, so it was a little bit jam-packed, fighting for the tools … and in terms of the way it was run here and the exercises, it was more showing us the cut and then hands-on and towards the end of the week more so it was exercised. I suppose comparing this one, it was more officer-led rather than responding to an incident on day one or day two last week I think it was really beneficial" (RTC Set 2 - Focus Group 4).

In terms of the classroom-to-skills time ratio, Student 24 found it appropriate "I think it's good, a little session in the morning, your kind of doing the theory of what you're doing for the day and then you're out there, doing it for the day" (RTC Set 2 - Focus Group 5). Student 25 added that he valued the revision sessions at the outset of each day – "the following morning they'd have a review session for half an hour, which was brilliant, we haven't done it in that format" (ibid). Student 29 found the emphasis on skills valuable – "it's way more practical, you don't spend as much time in the classroom and I thought that was brilliant ... I thought it was great spending the most time with the practical things, I thought that was a lot

easier to pick things up" (RTC Set 2 - Focus Group 6). Student 28 thought the classroom-to-skills ratio was just about right, going on to say "in the first couple of days there was a lot more classroom, but that's always going to be the case" Student 30 noted that some skills didn't require a classroom 'theory' component "…the likes of the use of the reciprocating saw, that may not need a classroom lecture, that can be a practical lecture and reiterating the safety steps on how to deal with the tool that may be something that could be looked at. The impact tool also may not need a classroom; that's something that can be done practically. The hydraulic rescue equipment, I suppose probably does need a bit of classroom as there are some safety features as regards the pump and the working mechanisms of the tools" (RTC Set 2 - Focus Group 6). Student 30 pointed out that the blend of classroom and skills training in the drill yard was appropriate, noting that "the classroom [instruction] is still good but you don't fall into the trap as in the leaving cert, where it's more memory than understanding" (ibid). Student 29 offered an example from the Breathing Apparatus programme where theory was contextualised in case of studies, followed by interactive activities "We had lectures in the BA where we had the case studies about Shirley towers and stuff, we do the lecture that day and then you put it on to the end of it some interactive thing where the group can get together and discuss what they do based on what they've done rather than some of the stuff they've done for tests just memorising it, step by step by step by step" (RTC Set 2 - Focus Group 6).

Training Materials

When asked about the training material provided, Student 19 mentioned that one negative aspect of the course was the use of course textbooks, which quickly become outdated "I think the book needs to get updated. Sometimes when you're trying to find something, it doesn't go along with the presentation that you're getting" (RTC Set 2 - Focus Group 4). Student 26 noted a lack of coherence between training materials and in-class notes, "I think it's like it's a little bit common with other courses as well the difference between the material shown in the classroom and the notes … there tends to be a disjoint" (RTC Set 2 - Focus Group 5). Student 23 echoed dissatisfaction with some of the RTC training material by stating "They're just not matching up with the current slides" (ibid). The frustration of non-aligned training materials was also commented on by Student 29 who noted "You're not listening to what he's saying cause you're trying to find it [in the book], so that's one thing I found very frustrating was the notes, or the book, the book" (RTC Set 2 - Focus Group 6).

Online Learning

Student 19 enjoyed the online component and found it useful for revision purposes – "I found the online learning that we got access to was brilliant … I found myself that I could take a lot more in as I could read and take a lot more of the information [in]" (RTC Set 2 - Focus Group 4). Student 21 also found the eLearning modules useful for revision – "it was great to refer back to, as with the books they might be missing something when you're using eLearning you can fill that gap, which is great" (RTC Set 2 - Focus Group 4). Student 22 noted that the content of eLearning modules was "sufficient for all we need to do at an operation level anyway" (RTC Set 2 - Focus Group 4). Student 22 was commenting on previous experience using the Moodle platform and noted an issue in engaging with the online learning context – "I found it, personally, when you have to do those things you tried to fly through as quick as you can. I wasn't really taken in the information that's just how I am when I was made to do those types of things, I tried to fly to the pages as quickly as I could and then answer, and they'd pass you and then you go back and remember the easier, rather than trying it again" (RTC Set 2 - Focus Group 4). Student 18 found eLearning the RTC modules excellent in terms of clarifying any queries on course content "we've only had access to for two or three weeks, you find yourself going to it, you have a question in your head because you're not in the environment to get an answer, you just log on yourself, and you can find the answer, brilliant tool" (RTC Set 2 - Focus Group 4).

Blended Learning

Some students in Set 2 had direct experience with blended learning, such as Student 18, who had used Moodle, which he found "quite good again for backup and additional support, adding videos supplementary information". Student 22 referred to a fire service instructor who had delivered blended learning using smartphone technologies and an online chat forum, which he found to be really good – "the Edmodo learning that we did for High Rise that was really good, D/O [name omitted], worked on a phone didn't even need a laptop, he chopped up a video and said this is what I was talking about earlier and then you'd think, ah now I got it" (RTC Set 2 - Focus Group 4).

Preparedness for operational duties

In terms of perception of preparedness for operational duties, Student 21 felt ready noting that the training model used (which included the eLearning component) was appropriate -

‘Yeah, yeah, I wasn't happy before, I wasn't happy in the [omitted] fire service, it [the training] wasn't enough, but here absolutely, absolutely.’ (RTC Set 2 - Focus Group 4).

Set 3 - Focus Group (Tine Model)

Set 3 comprised three focus groups, numbered seven to nine, respectfully. The student population for each group were as follows; Focus Group 7 contained six students (n=6), Focus Group 8 contained five students (n=5) and Focus Group 9 contained six students (n=6). Seventeen students voluntarily took part in the focus groups held for Set 3, this was 100% of the student population for Set 3. Set 3 was exposed to the Tine RTC model and they had access to online RTC training material. Set 3 comprised novice firefighters with no previous RTC experience (n= 12) and students previously employed as firefighters with other organisations (n=5). Student 34 worked in another Irish Fire Authority for four years. Student 20 was an ESC in the ERCC, Student 45 served in the Gardai, and Student 34 worked for another fire authority as a retained Firefighter.

Motivation

The students were asked what motivated them to become a Firefighter or to do this RTC course. Student 09 stated he joined the service as helping others was intrinsically motivating for him; he “had always thought what Dublin Fire Brigade did was great, and now I get to help people, I find that rewarding and that appealed to me” (RTC Set 3 - Focus Group 8). Student 39 was intrinsically motivated by the practical nature of the fire service “more hands-on job than other jobs and the fact that you’re helping people as well” Student 38 liked the security of employment that came with employment in fire service, noting: “It’s a stable job (ibid).

Course Content and Structure

The students in Set 3 were tasked if they felt the ratio of the classroom to skills sessions was appropriate, most replied that the ratio was correct, with student 39 stating, ‘It was pretty much spot on, hands-on tools all the time, it was great’. (RTC Set 3 - Focus Group 8). Student 46 echoed the overall satisfaction with the amount of time allowed for practice with the equipment by saying that “[The RTC Course] was probably one of the best courses for that [hands-on tools]” (ibid). Student 20 thought it may have been beneficial to allow some additional time to look at the equipment before the class as otherwise – “You have no

reference to any of the stuff you are learning on PowerPoint" (RTC Set 3 - Focus Group 9). Student 35 also thought that an immersed experience such as being a patient in the car gives the student a sense of realism and every student should be offered the opportunity to experience the trauma of extrication, noting: "We did one day of the casualty in the car … it would have been nice to have a few more goes at that, having people in the car and getting people to see how it feels sitting in the car, cuts going by you" (RTC Set 3 - Focus Group 7).

When asked if the students felt they had enough time to practice on the equipment used on the course, student 41 noted that yard time allocation was appropriate for him – "It just about right, the amount of time out in the yard" (RTC Set 3 - Focus Group 7). The students in the Set 3 were asked their opinion on the method of classroom instruction. Student 48 valued the experiential engagement in the drill yard, recognising that the classroom instruction was "ok, but getting out to the yard was the best". Student 9 also added that there were no barriers to asking questions in the drill yard, and the information given during the skills sessions was consistent. Student 20 went on further to say that all the face-to-face classroom instruction should be removed and replaced with skills sessions in the drill yard.

Training Materials

Regarding feedback on the training materials, Student 36 noted disjoints between the student notes and slides used in classroom sessions. He pointed to a need to update the book as "the book doesn't run in coordination with the slides" (RTC Set 3 - Focus Group 7). Student 35 made a comparison to a prior training session, the pump course, where the students were provided in advance with the PowerPoint slide show, which he valued as "you could see what was coming up next, and you could start it because it was there" (RTC Set 3 - Focus Group 7). Students 39 and 48 echoed their peers' sentiments when student 39 noted "The D/O was talking about glass management, and it should be in the books, and it's not even in the books" and student 48 concurred "Again, the books were terrible" (RTC Set 3 - Focus Group 8).

Online Learning

Student 37 stated that he had accessed and valued the online modules provided for pre-session preparation within the programme, noting the online content was "very beneficial

for the BA, there was a lot of stuff on slides and in notes. And if a couple of courses started off like that, it would simplify the lectures, and the lads would be like, oh yeah, let's look at LearnPro, they could use LearnPro as a platform of learning before the class rather than just the notes in class you know" (RTC Set 3 - Focus Group 7). This was an exciting finding, as it was noted that another course, in this case the Breathing Apparatus (BA) course, had started to use online learning to support the students by providing online modules during BA training. It was also interesting to find out that the students favoured online training material when used to support their learning. Student 34 expressed their concern that he didn't have time to complete online learning at home during recruit training, stating "It's such a long day here .. I've two kids at home as well, so you are trying to maintain that balance in life to your home life as well. And trying to get your uniform ready and look over the notes you've got I don't think I'd have enough time to squeeze in an online module as well" (ibid). Student 41 thought online learning would be most suited to training at station level, he said "I suppose just to keep you up to date depending on what station you are in. If you are getting certain calls, it will keep information fresh in the head" (ibid). And student 44 thought online learning could be used for reference purposes stating "It's nice to have something to go to for reference. We are going to do our ambulance course after this and we won't see tools for months, so it will be good to refresh before we go operational" (RTC Set 3 - Focus Group 9). Student 20 expressed their dislike for online learning in general, citing prior negative experiences with online college modules and noting "I hated it" (ibid).

Tine Model

The students in Set 3 were asked their opinion on the Tine Model. Student 44 noted that he preferred the Tine model and "definitely preferred this model" (RTC Set 3 - Focus Group 9). Other students within this set concurred, noting that the Tine model "keeps it fresh" (student 7) and had "more structure" (student 44). Student 20, comparing the Tine Model to more passive, traditional fire service, noted "Some courses do that where the whole three sections stand and watch one person and it takes all day and people switch off" (student 20). Student 34 liked that the students were rotated through the equipment within the Tine Model, noting "It was good to get a good variety, one day you could be on spreaders and the next day you could be on the saw, so it's good to get that rotation" (RTC Set 3 - Focus Group 7). When asked if the students were in favour of the skills sheets used during the skills stations, student 45 reported finding it challenging to complete the demonstration of all tasks listed

"Finding the time to get through it would be hard, to get through a checklist. No doubt it would be good but where to fit it in?" (ibid). Student 34 expressed concerns that the peer-to-peer learning approach (utilised within the Tine Model) could cause animosity among the students when he said, "You are always going to get certain personalities that are going to talk, and everyone goes ah no, do you know that sort of way. Does he think he knows everything, you might switch off, not like if it's an instructor" (ibid). Student 41 found that the smaller groups within the Tine model allowed for greater individual recruit demonstration of skills, noting, "It was great, having smaller groups which allowed you to get your hand in" (RTC Set 3 - Focus Group 8). These students had first-hand experience of the Tine model, they liked the structure, which allowed syndicates to move through the learning environment using a peer-to-peer approach; all students were encouraged to participate in an inclusive training atmosphere which assisted in their cognitive interaction and student engagement during skills sessions.

Focus Group Overall Findings

All students participated in the focus groups; most students were intrinsically motivated to become a firefighter to help others. All students thought the course content and design was good, and students who had completed other RTC courses externally indicated that the DFB course duration and design were preferable to previous instruction they had received. Most students preferred time practising their skills in the drill yard versus face-to-face classroom instruction. A common thread among the students was that the RTC student notes needed to be updated, with most indicating that they would rely on the PowerPoint slide handouts in a classroom setting.

When asked about the use of online learning during RTC instruction, students who had completed previous online learning had strong opinions, both negative and positive. Some students indicated that online learning would not suit the recruit environment. Others indicated that online learning would be suited to the recruit environment because the online modules would allow you to access course material prior and additionally look back if needed as a revision tool. Some concerns were raised about completing online modules in a non-work environment; some students indicated this would not work for people with children and other external commitments. The students who completed the first iteration of the Tine Model liked its structure and smaller syndicate sizes and valued being engaged in

learning while completing their rotational skills session using peer-to-peer and scenario-based learning.

4.11 Summary

All recruits who participated in this research displayed an optimistic view towards technology. They had access to technology and used it daily. The consensus was that technology assisted them with daily activities and was something that could be integrated be during firefighter training. The data from the classroom observations and video footage indicated that the traditional RTC model currently being taught in DFB favours a behaviourist approach manifested as face-to-face learning, where the instructor is a sage on the stage, and the student does what is asked and expected. Some elements of the cognitivist approach can be found in the classroom when the instructor links concepts to prior knowledge or uses real-world examples to support learning. The instructors focused on classifying or chunking information; they delivered information in a structured fashion where the topics were covered sequentially. This model changed slightly when the students were asked to complete skills in the drill yard, however, the students were required to respond to instructions and are still very much considered passive contributors by the instructors. Within the Tine model, the skills lessons were framed to support a cognitivist-constructivist approach to learning; During the skills sessions, it was observed that the instructors facilitated discussions and used problem-solving approaches to learning throughout all sets, which shows progression towards constructivist practice.

When the instructors were asked about course design, delivery and timescales, most indicated that the traditional model could be improved. The instructors in general seemed to prefer a behaviourist- cognitivist approach to learning. One instructor said they would like to see project work (in the form of a case study) given to the students. When observed delivering skills in the Blended or Traditional models, some instructors did use a constructivist approach by using scenario-based learning and asking the students to brainstorm to develop real-world extrication solutions. However, most instructors did not favour this approach; they were firmly from the school of demonstrate, imitate and repeat.

In terms of performance, there was a notable difference in the exam scores of participants across the three sets. The Ebbinghaus Forgetting Curve was used to ascertain knowledge

retention across the three observed models of fire service training; Traditional, Blended and Tine. The projected 12-month scores for each model were higher than the baseline Ebbinghaus amount and pointed to enhanced knowledge retention across all sets. Furthermore, there was a significant percentage point difference in knowledge retention from the Traditional, Blended and Tine models. These findings indicate that knowledge retention was higher within the Blended and Tine models when compared with the traditional model, with the Tine model being most successful in enhancing knowledge retention during RTC training.

Chapter 5 Conclusions and Recommendations

5.1 Introduction

This mixed methods research study explored the integration of the existing and two alternative training models within recruit firefighter training in Dublin Fire Brigade. This chapter presents the study's conclusions, recommendations, and plans for further research.

5.2 Responding to the Research Questions

This research explored three training models within DFB, namely the Traditional, Blended, and Tine models. Each model was investigated during Road Traffic Collision training, and the findings have informed the responses to the meta-level research questions. The Traditional model employed didactic teaching and behaviourist training practices. The Blended model offered a traditional face-to-face learning experience augmented with self-directed access to an online suite of RTC modules. Finally, the Tine model offered students face-to-face instruction and access to online training material complemented with cooperative, problem-based and case-based learning during rotational skills lessons. The Tine model was designed to encourage a constructivist pedagogical approach where students could build on their previous knowledge and examine real-world scenarios in structured peer-to-peer learning environments.

The research questions for this study were as follows.

1. What are the key characteristics of, and core pedagogical processes employed within, the Traditional pedagogical model implemented within DFB training for recruits?
2. What impact does the integration of Blended and Tine pedagogical models have on learning interactions/ engagement, learning experiences, and the retention of knowledge of DFB recruit trainees?
3. What design principles and contextual factors are pivotal to successfully implementing Blended and Tine models?

The following discussion summarises the key findings from exploring each question regarding recruit training models within Dublin Fire Brigade.

5.3 Research Question 1

What are the key characteristics of, and core pedagogical processes employed within, the traditional pedagogical model implemented within DFB training for recruits?

This study analysed the RTC training's traditional delivery model, which was based on behaviourist learning theories, but also utilised cognitivism in class and drill-yard activities. Instructors primarily used PowerPoint presentations for face-to-face, instructor-led lessons in a classroom setting, but did not encourage student interaction. This approach could be described as a "sage on the stage" teaching method. King (1992, p.112) describes this concept as a "transmittal model" where students are passive learners rather than active ones. The instructor assumes that "the student's brain is like an empty container into which the professor pours knowledge" King (ibid). Behaviourists believe everyone starts from a clean slate (tabula rasa), and any new knowledge results from stimuli and reaction to that stimulus. This approach was evidenced during face-to-face instruction in the classroom, where students sat and listened to the instructors imparting their knowledge to the class. However, some instructors did attempt to build on prior knowledge and structured learning units to scaffold the recruits through the RTC training content, which points to practices that align with cognitivist theories of learning.

The practices observed during skills instruction in the drill yard also reflected behavioural psychology, where it is believed that behaviours can be learned from reinforcement and or punishment. Skinner (1963, p.503) identified that "behaviour can be predicted or controlled simply by identifying or manipulating stimuli". This psychology can be best seen in the Traditional model during drill yard instruction, where the instructor was observed repeatedly giving the same safety critical command, such as "Breaking Glass" or "Visors down". By repeatedly giving these commands, the student is conditioned to complete a safety-critical task automatically; failure to complete this behaviour could lead to punishment such as repeating the task, or injury. This method of instruction worked well, as was evidenced when the students automatically placed their visors into the correct position without instruction or peer involvement as the course progressed. This approach has been described by Moore (2011, p.1) as "skill and drill", where learning a new skill is suited to rote learning. The students in the focus groups and through feedback during observation stated that they favoured the didactic face-to-face instruction, followed by psychomotor skills sessions. This

behaviourist approach was a fundamental characteristic of the Traditional model. However, there was evidence of some instructors posing questions to the students to identify their level of understanding before moving on to more complex knowledge and moving away from the "empty box" behavioural concept. This scaffolding of knowledge was mainly observed during scenario-based learning in the drill yard when students had mastered a basic skill and would then move on to a more complex task that asked the students to problem-solve as needed. This approach arguably leans towards a constructive pedagogy where the student's environment and own learning is perceived as an active process. According to Bruner (1976, p.90) "When students are provided with the support while learning a new concept or skill, they are better able to use that knowledge independently". This was noted during drill yard instruction, where the instructor had given the students the knowledge on how to remove the glass safely, and now they were asked to complete a similar task. The Lead Instructor supported and encouraged the students and actively instructed the students to take turns managing the glass until the students were able to complete this task independently. In some cases, the students overcome obstacles, such as glass management while a vehicle was inverted (car upside down) or glass management while two cars are side-by-side without instruction.

The method of assessment utilised in the Traditional RTC model was both summative and continuous. A Multi Choice Question (MCQ) summative assessment was conducted on the final day of the two-week course; the results returned a ninety percent average for the students who had completed this model. In a comparative assessment of academic performance between the projected traditional model data and the baseline Ebbinghaus Forgetting Curve the Traditional model provided better retention of information to that of the Ebbinghaus expected 52-week outcome. This was an encouraging discovery as it pointed to the benefit of the traditional RTC model in enhancing knowledge retention. However, a key finding during the data collection stage of research was that during face-to-face classroom instruction, the students were often signposted to information that would later be offered in a summative assessment. As Petty (2014, p.242) states, signposting is "linking key learning points to specific learning outcomes or transitions between activities". During the Traditional model, instructors were observed highlighting rather than linking key learning points the students would see during their summative assessments. By highlighting a narrow curriculum scope, the student would not be encouraged to obtain a holistic understanding of the subject matter. This would not only mean that the students may not

revise the entire course in preparation for their assessment, but it could also mean that the assessment scores collected during the data collection phase of this research may not be a true reflection of the knowledge learnt during the RTC course.

RTC skills have an associated competency against which the student is benchmarked. Assessment of learning was the objective during the Traditional RTC model. According to Schellekens et al. (2021, p.20), the purpose of Assessment of Learning (AoL) is summative in nature in terms of assessing whether knowledge or skills have been demonstrated whereas Assessment for Learning (AfL) seeks mainly to improve the learning (and arguably teaching) processes. There is evidence from the literature that suggests assessment for learning is beneficial. It was noted from the Traditional RTC assessments that there were occurrences where the competency assessment tool was not used; it appeared that the instructor was assisting the student during their assessment and offering additional information to expand their breadth of knowledge or skills. Therefore, at least one instructor has unconsciously demonstrated some of the key elements outlined in Assessment for Learning, and in doing so is arguably broadening the students' knowledge by identifying knowledge gaps and supporting this deficit with the pertinent information required to achieve competence in the skill being assessed. This represents a shift from assessment of learning to assessment for learning, which has been noted in other educational contexts (Martinez and Lipson, 1989). Further testing of the "assessment for learning" needs to be explored and developed in DFB.

5.4 Research Question 2

What impact does the integration of Blended and Tine pedagogical models have on learning interactions/ engagement, learning experiences, and the retention of knowledge of DFB recruit trainees?

The Blended and Tine models were designed to incorporate online learning material before face-to-face instruction commenced. In their pre-intervention responses to the Technology Readiness Index (TRI 2.0), recruits who participated in the Blended and Tine models indicated frequent interaction with ICT at a personal level on a daily or weekly basis and a desire for integrating online or blended learning within recruit training. All accessed the internet daily using several hardware devices and platforms, and all had access to a

smartphone. Interestingly at the outset, the Tine model group were the least optimistic about the use of technologies and the advantages of their integration in fire service training. It was also noted that some students wished to access the online RTC training material available only to operational DFB staff. Some pointed out that the best place for online learning was during continual professional development during working hours in a fire station, not during recruit training. They thought this information could assist in self-directed learning as part of the training programme, allowing them to fill in the knowledge gaps and aid with their revision.

In terms of online learning, students were expected to complete three self-directed online modules followed by a short summative knowledge check. The Blended model was predominantly underpinned by a behaviourist approach, particularly in terms of the approaches used to deliver the content and the skills elements of this online model. In contrast, the Tine model was underpinned by both cognitivist and constructivist approaches to learning. Regarding the latter, both approaches were used to encourage student-instructor interactions and foster a positive learning experience during RTC training to support the retention of knowledge and skills for the recruit firefighter.

5.4.1 Blended Model

As previously mentioned, students enrolled in the Blended model were expected to complete three online modules before face-to-face instruction could start. Student-instructor interactions were noted during all the subsequent face-to-face sessions. The students asked questions in the classroom on course content connected to material accessed in the online modules. The students indicated that having access to online training material gave them the flexibility to complete their learning at their own time and pace. Songkram et al. (2015, p. 647) echoed this sentiment and said, “Flexibility is another major advantage of e-learning as it provides learners with the benefit to take classes anywhere and anytime”. Feedback through the focus groups’ qualitative data showed that while most students favoured access to the online RTC content, some were concerned that the additional time to access the online content could lead to additional extracurricular work that might negatively impinge on their work-life balance. This observation was compelling; it highlighted the need to consider the student’s needs and adopt a humanist approach when creating a blended learning environment. A recommendation from this study will point to the need for careful consideration, particularly of the basic requirements, familial needs and broader needs of

recruits, as articulated within Maslow's Hierarchy of Needs circa (1943) in the future integration of online learning within DFB. A further concern expressed by instructors was that students who had completed the online modules would carry that knowledge into the classroom setting and negatively impact the tempo and delivery of instruction to the class as a whole. Some RTC instructors favoured students having no prior knowledge of the thematic area and perceived the integration of pre-course online modules as a threat to their positioning as "sage on the stage".

A logarithmic scale called the Forgetting Curve, first developed by Ebbinghaus circa (1885) was used to present the forecasted exam scores of each model after a period of 52 weeks. All students were required to complete an end-of-course exam which provided the baseline data for this enquiry. Students who completed the Blended model returned an average mark of 94.8% in their first exam. Four weeks after this initial exam the same students re-sat the same exam. The average mark returned on the second exam from the Blended model was 79.5%. The Forgetting Curve was used to forecast the 52-week knowledge retention score; the baseline score was calculated as 48%, the Traditional model's score was 53.5%, and the Blended Model forecasted was 55%. When comparing the Traditional and Blended model to the benchmark of the Forgetting Curve, it can be seen that the Traditional and Blended model 52-week knowledge retention score increased by 5.5 percentage points (pp) and 7pp, respectively. These results are encouraging for two reasons: firstly, the Traditional model's data is above the estimated Forgetting Curves forecasted results and secondly, the Blended model has also shown an even higher increase in the projected knowledge retention for recruit firefighters.

5.4.2 Tine Model

Fundamental to the Tine model is the concept of peer-to-peer learning, where students are asked to engage in learning experiences rather than passively receive information. A key feature of peer-to-peer learning is outlined by Iserby (2012, p.56) - "Reciprocal learning is an instructional model in which students work in pairs to master lesson content". Peer-to-peer learning was observed while pairs of students asked each other pre-designed questions from the skill sheets provided during their station rotation skills sessions in the drill yard. Another critical element of the Tine model was scenario-based or case-based learning; according to Errington and Meldrum (2011, p.86), scenario-based learning "bridges the gap

between theory and practice". Instructors created scenarios that mirrored real-life incidents in order to support case-based learning.

Each scenario was based on the student's prior knowledge and skills. The students were encouraged to problem-solve during these scenarios; for example, if an equipment failure or extraction method did not work, the group had to adapt to the scenario and solve the problem to achieve the task. Johnson et al. (2018, p.65) notes that "students who work in structured cooperative groups work more productively and attain higher learning outcomes than those who work in unstructured groups". Significant qualitative evidence from the focus groups emphasised that the students liked being hands-on during skills sessions with their teammates. The opportunity to be linked with their peers practically to complete a task or scenario proved to be very satisfying in terms of achievement. The Tine model's main feature that actively contributed to cooperative learning was peer-to-peer learning during the station rotations. Students were observed assisting, praising, encouraging, and supporting each other's learning efforts. Evidenced by the researchers' observation in the drill yard; when a student wasn't sure if they had been shown how to replace a battery on a piece of equipment, another student in their syndicate demonstrated the process and went on to ask additional questions that had been included on the skill sheet. This promotive interaction underpinned the concept that when a student had insufficient knowledge for task completion, the barrier to requesting help was removed.

As mentioned above, cooperative learning was a vital element of the Tine model. Team members were frequently asked to pose questions about the skill to the other syndicate members. During the knowledge check, a risk identified by the recruits related to personality types and the impact of an "alpha" personality taking on the role of instructor. This behaviour has been observed in the literature as Middlecamp (1997, p.1) states, "One of the biggest problems of a group situation [in cooperative learning] is the balance of power. Not all people are given an equal voice in a group. Usually, there is one group leader that everyone defers to". The students felt that if one of the recruits displayed alpha-person traits, it could be perceived that this student was stepping into the instructor role, which could negatively impact the group experience within the Tine model.

Students who completed the Tine model returned an average mark of 97.4% in their first exam. Four weeks after this initial exam, their average mark returned on the second exam

was 89.8%. The Tine model forecasted 52-week knowledge retention score was calculated as 56%. When compared to the Traditional model, it can be seen that the Tine model's 52-week knowledge retention score increased by eight percentage points. It was interesting to note that the participants in the Tine group returned the highest forecasted retention of knowledge during their assessment compared to the baseline Ebbinghaus Forgetting Curve.

5.4.3 Conclusion – Research Question 2

In conclusion, the learning experiences of the Blended and Tine models, as recounted by the participants in the focus groups and witnessed during the observations, moved beyond the behaviourist approaches foregrounded within the Traditional model and instead supported opportunities for cognitivist-constructivist learning. The students were observed using their prior knowledge and experience to assist their peers during RTC scenarios in both the Blended and Time Models. The students engaged in the Time Model were further observed mastering their skills before moving on to more complex skills; they appeared to be linking skills together, such as glass management and vehicle stabilisation. The linking of skills is fundamental to the Tine model, and there was evidence that it fostered interactive heuristic approaches to learning. Overall, the Tine model was the most effective in knowledge retention in RTC training, followed by the Blended model and then the Traditional model, which was above the highest forecasted retention of knowledge during their assessment compared to the Ebbinghaus forgetting curve baseline.

5.5 Research Question 3

What design principles and contextual factors are pivotal to successfully implementing blended and Tine models?

5.5.1 Design Principles

The design principles that framed the Blended and Tine models were informed by recognition of the need to support learning by recruits through online and face-to-face instruction in ways that supported knowledge retention. Pre-course online modules followed by face-to-face instruction were fundamental to the design of the Blended model. In contrast, the Tine model incorporated an online module and a station rotation aspect to the design of its model. The learning objectives for both models were clearly outlined, and there was a formative assessment for the online modality, followed by a traditional in-class summative

assessment, and finally, a skills assessment conducted by the instructor in both models. Table 5.1, adapted from the "Blended Synchronous Learning Design Framework" by Bower et al. (2015), highlights the design and implementation framework of the Blended model and Tine model, and outcomes from these.

1. Design	***Pedagogy***	***Technology***	***Logistics/setup***
	Blended Model		
	○ Clearly define online course content and learning outcomes ○ Online, formative assessment ○ In-class, summative assessment	○ Match modules to online content and learning outcomes ○ Off-site access	○ Be highly organised in advance ○ Solicit the right institutional support ○ Prepare students ○ Communication to all stakeholders
	Tine Model		
	○ Clearly define online course content and learning outcomes ○ Design for active learning ○ Online, formative assessment ○ In-class, summative assessment ○ Station Rotation model ○ Iterative online content ○ Peer to Peer learning ○ Learning while active	○ Match modules to online content and learning outcomes ○ Off-site access	○ Be highly organised in advance ○ Solicit the right institutional support ○ Prepare students ○ Prepare self ○ Equipment for skills stations ○ Skill Sheets ○ Communication to all stakeholders
2. Implementation	**Pedagogy**	**Technology**	**Logistics/setup**
	Blended Model		
	○ Identify the focus of learning	○ Know how to use the technologies ○ Advise students on how to use the technology ○ Ensure students have the correct permissions ○ Online content accessed in a classroom and remotely	○ Instructor support
	Tine Model		
	○ Identify the focus of learning ○ Draw upon existing pedagogical knowledge	○ Know how to use the technologies ○ Advise students on how to use the technology ○ Ensure students have the correct permissions ○ Online content accessed in a classroom and remotely	○ Tine model - Time Management between Station Rotations ○ Instructor support

3. Outcomes	**Pedagogy**
	Blended Model
	○ More flexible access to learning ○ Preloading the student with knowledge prior to face-to-face instruction
	Pedagogy
	Tine Model
	○ Knowledge retention/ performance comparison ○ Preloading the student with knowledge prior to face-to-face instruction ○ Increased student to student communication ○ Increased Instructor to student communication ○ Problem solving

Table 5.1 The Learning Design Framework for Blended Model and Tine Model, adapted from Bowers et al. (2015)

The design of the Blended model was similar to that of the Traditional model with one fundamental difference; the Blended model supported the students learning with access to the RTC suite of online modules before the course started. Good communication between students, instructors and management needed to be fostered to embed this concept. An essential component to the design of the Blended model was identifying the appropriate online models that could support the student's knowledge during their skills lessons in the drill yard. Three online modules were identified for the Blended model as their learning outcomes best matched three skills that would be taught during drill yard instruction. The Tine models were supported by the Blended models pre-course online material; however, the design, implementation and outcomes differ from the Traditional and Blended model, as discussed in the next section of this chapter.

Pedagogical design principles of the Tine model

The Tine model opened with self-directed learning by recruits in prescribed online modules in thematic areas of RTC. Rotating groups of students organised the subsequent pedagogic interaction through different activities (station rotation). The pedagogical design of the station rotation for the Tine model can be understood as a form of personalised learning as follows, "In station rotation classrooms, groups of students rotate among different types of

learning modalities, such as computer-based instruction, group projects, individual tutoring, or paper-and-pencil assignments" American Institutes for Research (2020, p. 1). In the Tine model, all students rotated sequentially through each skills station. The students were encouraged to use the peer-to-peer skill sheets provided at each skill station to query each other's knowledge. This active learning method was a fundamental design principle that proved effective in the Tine model. This Tine was underpinned mainly by a constructivist theory of learning where the students were encouraged to participate in cooperative learning and construct their own learning. Carr (2015, p.179) defines active learning as "students" efforts to construct their knowledge actively". This approach further promoted peer-to-peer learning.

Other design factors highlighted were that the learning objectives and course content ensured alignment between the face-to-face and online training material. It was essential that learning could be measured, to this end, a formative assessment tool was used during the online learning modules in the form of knowledge checks, these assessments were done before the students started their face-to-face instruction within the station rotations.

Technological design principles of the Tine model

All students needed to have access to the internet in order to engage in the Tine model. If a student required internet or computer access to complete their online learning, DFB provided several laptops, which were made available for student use. This information was communicated to the students before their online learning modules were activated. It was also vital to communicate that there was remote assistance available if any students had login difficulties, no students during this study availed of this service. It was also deemed a key requirement that access to the course was device and platform-independent.

Logistical/setup-related aspects of the Tine model

It was necessary to assign the students with the relevant access rights and login details to the online modules well before the RTC training, facilitated through meetings with the Learning Content Management team. These meetings were also critical in identifying the appropriate module to align with the learning outcomes of the Tine models. Another design principle that proved vital to the implementation was that the instructors were introduced to the online and in-class training material. As the Tine model took inspiration from the K12 Station

Rotation model, the instructors needed to be familiar with the inherent concepts of peer-to-peer and scenario-based learning during each skill rotation.

5.5.2 Implementation factors relating to the Tine model

The implementation factors are explored in relation to pedagogical aspects, logistical and set-up related aspects and outcomes in relation to enhanced active engagement and knowledge retention.

Pedagogical aspects

Regarding delivery, instructors noted that the students exposed to the Blended and Tine model would offer regular contributions in the form of questions to the instructor or peer communication during face-to-face instruction and skills lessons. An instructor in set 3 was observed posing questions based on the pre-course information that the students had consumed. Not all instructors liked that the students had prior knowledge before their instruction. However, all instructors agreed that completing pre-course online learning was advantageous to the students learning and that the Tine model offered consistency during the delivery of the skills sessions.

Logistical/setup-related aspects

Access to the Blended and Tine model before and during face-to-face instruction benefited the students. All students had remote online access, and only one student, as mentioned, had access issues in set 3. As this was the first iteration of the implementation of the Tine model, it was noted that time management of the rotation between stations needed to be re-aligned to allow students sufficient time for peer-to-peer learning at each station.

5.5.3 Outcome

In the Tine model, it was evident that students were actively engaged within the skill sessions as they were observed assembling equipment in their small groups and were observed problem-solving during the instructor-led scenarios. It is a recommendation from this research that active learning is embedded into the curriculum as it encourages communication while learning and builds on the fundamentals of teamwork while overcoming obstructions to task completion.

Knowledge Retention / Performance Comparison

The summative assessment was conducted at the end of each course for all RTC models. The Ebbinghaus Forgetting Curve logarithmic function was to be used as a tool to forecast projected knowledge retention data, and this showed more enhanced knowledge retention within the Tine model when compared with the baseline Ebbinghaus Forgetting Curve and knowledge retention across the Traditional and Blended models. This finding aligns with the research conducted by Truitt in 2016, where following the implementation of the Station Rotation model in their study, the student's state scores in reading, comprehension and mathematics improved.

5.5.4 Contextual factors

This study also examined contextual factors likely to impact the implementation of the Blended and Tine Models. In this regard, the readiness of DFB management, trainers and recruits for technology integration within fire service training was explored, and outcomes from their engagement in the Blended and Tine Models, as summarised below.

Readiness of DFB management and trainers for technology integration within fire service training.

According to Burnes (2005, p.369) "Change is an ever-present feature of organisational life, both at an operational and strategic level. Therefore, there should be no doubt regarding the importance to any organisation of its ability to identify where it needs to be in the future and how to manage the changes required getting there". As with any organisation, DFB can be slow to adapt to change; and making large-scale changes in training practices, such as integrating technology, has historically been a challenge. In relation to this research study, access to the recruit cohort based on the proposal to integrate online learning was initially denied. At the time, circa 2016, online learning was used to support the continual professional development of operational firefighters but not used within recruit training. Furthermore, operational firefighters were only permitted to complete online modules at self-directed times scheduled during work hours, as agreed with the firefighter trade unions. This curtailment of online learning to fixed times and places within DFB settings spoke of the culture of resistance by management and unions to integrating technology in DFB training and, thus, suggested a lack of support for the meaningful integration of technology within fire service training at an institutional level.

The emergence of the COVID-19 pandemic in 2020 disrupted the status quo, and DFB, along with many other organisations, had to adapt and embrace digital communication solutions within the workplace. The use of applications such as Teams and Zoom was welcomed by DFB management and was widely used for daily communications and collaborations within the organisation. However, in the context of the training environment, the landscape remained somewhat unchanged. The exception was this study through which ten instructors engaged with the Traditional, Blended and or Tine models, the latter two of which integrated online learning at the outset. From this study of all three models, there needed to be more evidence that DFB instructors were ready to transition towards incorporating technology in a meaningful way in teaching and learning contexts. Technology was solely used in didactic approaches in classroom contexts in all models, with the instructor's use of technology limited to basic presentations and no use of digital technologies, such as online quizzes or online activities, to promote interactivity and engagement. As previously mentioned, while self-directed online learning was integrated into the Blended and Tine models, some instructors feared the recruits having knowledge in advance of the session in that it might challenge their authority as the knowledge provider. A transformation from behaviourist to constructivist approaches would require training on digital learning pedagogies by DFB instructors and raising awareness of the benefits of technology integration within recruit training contexts.

Readiness of DFB recruits for technology integration within fire service training.

In advance of the training, recruits engaged in a survey to ascertain their usage of technologies and undertook the Technology Readiness Index survey. Regarding personal usage, the recruits overall expressed high levels of technology usage in their daily lives, accessing online materials frequently, mainly using smartphones. The Technology Readiness Index was used to indicate the recruit readiness for adoption and use of cutting-edge technologies more generally. The recruits recorded their level of agreement with statements in four categories; optimism, innovativeness, discomfort and insecurity; this gave an overall indication of their dispositions, sense of agency and comfort levels in technological advancements and integration in daily life. The research findings indicated that across the entire cohort of recruits, there was an overall sense of optimism about integrating technology into their lives and acknowledgement of the contributions it could make to the productivity of their day-to-day life. However, when contrasting the three

groups, the recruits undertaking the Tine model had considerably fewer optimistic views of technology regarding its contribution to the quality of life but did acknowledge (albeit to a lesser extent) the benefits of its integration into their daily lives. Regarding innovativeness, the recruits across all three groups were not likely to be considered technology pioneers, but the majority were willing to explore new technologies. The recruits' perceived lack of control over technology or their feeling of being overwhelmed by technology varied considerably within and across the three groups, with some evidence of underlying concerns about the negative impact of technology on relationship building. These findings suggested that the cohort of recruits was open to engagement with technology integration on entry to the fire fighting training programme. The findings from post-study interviews with recruits showed generally positive experiences with integrating online modules at the outset of training, with their use for revision purposes also highlighted. However, concerns were raised about completing online modules in a non-work environment, with some recruits indicating that this would not work for people with children and other external commitments. Therefore, in the context of fire service training, particularly post-COVID, there is evidence to support the readiness of recruits to embrace the integration of technologies, but work-life balance concerns in the case of self-directed online learning need to be carefully addressed.

Readiness of DFB trainers for transitions toward student-centred and problem-based learning.

Across all three training models in this study, there was little evidence that DFB instructors were ready to transition towards student-centred and problem-based learning. The prevailing practice of instructors employing mainly a didactic, sage-on-the-stage method of instruction is deeply rooted in the model of training within DFB. A transformation from behaviourist to constructivist pedagogies would require organisational support and recognition of the benefits that accrue from the blended, station rotation model foregrounded within the Tine model. The instructors who engaged with the Tine model clearly expressed support for this type of training and noted the value of an integrated model, which included blended learning, peer learning and problem-solving through scenario-based learning. Moving forward, there is an opportunity to utilise these instructors to re-orientate DFB training to embrace student-centred and blended learning.

5.6 Contributions to Knowledge and Research

This thesis makes the following important contributions to knowledge and research in the field of emergency management education:

1. In terms of new knowledge, this research study has captured the current practices in DFB firefighter training, and issues therein that may contribute to deficits in knowledge retention and skills development. Therefore, it represents the first comprehensive study of firefighter training practices in Ireland, and as such provides a unique insight into an under-researched domain within Ireland, and beyond.
2. This study provides evidence of enhanced knowledge retention in the use of the Blended and Tine models within recruit training. This provides a warrant for DFB to move away from the behaviourist-cognitivist approaches embodied with the Traditional model of RTC training.
3. This study articulates the key design principles and further provides evidence of the beneficial outcomes for fire service training in terms of enhanced student engagement and knowledge retention, in the deployment of the Tine model; a learner-centred approach to fire service training that includes peer-to-peer and scenario-based learning. In this regard, the study presents evidence of the benefits of scaffolding knowledge and skills development by including blended learning, promoting constructivism by rotation through self-directed, peer-learning, cooperative learning and case-based learning.
4. This study provides evidence to support the integration of technology within recruit training at DFB, particularly in terms of the readiness of recruits for technology integration. The data collection for the new recruit training dimension of this study was undertaken during the first throes of the COVID-19 pandemic, which resulted in many developing familiarity with online technologies as a necessity. The TRI 2.0 Index showed recruits were mainly optimistic in their outlook on technology, and focus group interviews indicated their willingness to embrace blended learning while recognising that firefighter training must include in-person component for practical skills development (in drill yard exercises) and work-life balance must not be comprised in any such development. However, the study also shows the lack of readiness of DFB instructors and trainers for technology integration and moves towards constructivist learning approaches, which will need to be addressed.

5.7 Limitations of the Research Study

The limitations of this research study are as follows:

1. Within Design-Based Research, there is generally an expectation of several cycles of implementation and review of proposed new practices or artefacts, such as the Blended and Tine Model. However, there was just one opportunity to access new recruits during the time-frame of this study, as just one cohort of recruits was enlisted in DFB in the period after ethical approval was granted by DCU, which meant the mainstay of research took place in 2020. As explained, the Tine Model was trialled in 2019 with a cohort of operational firefighters and paramedics undertaking EMS training, and this was considered the first iteration (Cycle 1) of the Tine Model. Cycle 2 was the second iteration of the Tine Model and this was conducted with new recruits. In an ideal world, these cycles would take-place with the same target group i.e. recruit fire fighters rather than a mix of experienced and recruit firefighters. However, the principles of ideating and iterating design aspects of the Tine model across these cycles still aligns with DBR practice. Therefore, while recognising the limitation of not being able to iterate and implement the Tine/ Blended model with the same target group, overall there is still validity in taking inspiration from DBR for the framing of this research study.
2. This research study employed a suite of data collection tools to gather data during Cycle 2, including researcher observations, video capture of practices using GoPro cameras, focus groups with recruits, interviews with instructors and survey questionnaires. The GoPro footage was invaluable in terms of corroborating or enriching findings relating to the researcher observations. The focus groups and surveys/ questionnaires provided useful insights from recruit participants. However, the interviews with instructors were not as informative as expected, and this was likely influenced by the limited time available for these. The interviews time-slots had to fall within a specified time period and this was regulated by DFB.
3. While the dearth of previous studies on firefighter training provided a warrant for engaging in this study, it was challenging to show how this study advanced on the previous field research given there were just 4 relevant studies from the field of firefighting. The articulation of contributions to new knowledge thus primarily leans on the findings from this study.

5.8 Dissemination and Future Research

This study examined the integration of blended and peer learning within the recruit phase of firefighter training in Dublin Fire Brigade. The dissemination plans are to publish academic papers from this study, the first of which will present the findings vis-à-vis the Tine model to those researching in the field of emergency management, and the second of which will present experiences from taking inspiration from using Design Based Research in the context of researching the design and deployment of the Blended and Tine models. In addition to this, the findings will be shared at emergency management conferences nationally and internationally. Finally, the findings from this research will be presented to the Chief of DFB and the executive team responsible for fire service training.

5.9 Recommendations for Future Research

The following recommendations are for future research:

- There is a need for further research on the instructional design of online learning within DFB training, with a focus on exploring instructor engagement in online content creation and delivery, and identifying training requirements for their transitions towards training in blended learning contexts.
- There is a need for deep review of the integration of emergent technologies such as augmented reality and virtual reality for recruit training and the continuing professional development of operational firefighters and officers.
- The effectiveness of the Tine Model for recruit training has been shown in this study. Further research is needed to ascertain its suitability for CPD training of operational firefighters and post-recruit training.
- A key issue impacting heuristic decision making in fire events is stress, which can impact knowledge retention and application. Further research into the impact of learning under pressure within firefighter training, focusing on the implications of stress-related factors on cognitive retention at recruit training level would be beneficial.
- More research in the sociological aspects of technology integration, focusing on its impact on work-life balance, and models of technology integration that support humanistic approaches to future learning.

- Research on modes of assessment within firefighter training is needed, with a focus on exploring the potential contributions that assessment for learning might make within firefighter training.
- Firefighters need to be equipped with essential skills to handle challenging situations they may encounter during emergency situations. For instance, removing a critically injured patient from a vehicle can be a stressful situation, and proper training can significantly impact the outcome. In this research, three models were analysed to assess knowledge retention. Research has shown that when learning a new skill, contextual interference during practice has been found to be beneficial. Although this topic is outside the scope of this research, it warrants further investigation as it could explore how stress and contextual interference affect a firefighter's skills during training and responding to emergency incidents.

5.10 Conclusion

This research started from an inherent curiosity about learning theories and pedagogical models that might foster the retention of knowledge and skills for fire service personnel. At the start of this research, it was evident from the literature that there were only a few research studies on training models used within the fire services globally. The scope of this study was narrowed, and it was decided to develop a model for the Irish fire service that would foster knowledge retention post-initial recruit training. The initial concept for a new model included pre-course learning, face-to-face instruction and a learning style that would nurture a peer learning environment. Online learning was identified to support the pre-course element of a new model. The station rotation model emerged from the literature to strengthen the Tine model's learning environment. A comparative study of the Traditional, Blended and Tine models was undertaken. The findings point to the potential of the Tine model in enhancing knowledge retention. It is also clear from this research that organisational change within the fire service is needed; this change needs to be top-down in approach to move from the sage-on-the-sage philosophy to a more humanistic guide-on-the-side approach in the context of recruit firefighter training.

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Appendices

Appendix A Research Ethics

A.1 REC Letter confirming approval from DCU

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Ms Barbara Cahill
School of STEM Education, Innovation and Global Studies
DCU Institute of Education

10 May 2017

REC Reference: **DCUREC/2017/071**

Proposal Title: **Transitioning towards a blended online model of training within Dublin Fire Brigade**

Applicant(s): **Ms Barbara Cahill & Dr Charlotte Holland**

Dear Barbara,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this project.

Materials used to recruit participants should state that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Donal O' Gorman

Dr Dónal O'Gorman
Chairperson
DCU Research Ethics Committee

DCU
Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

A.2 Informed Consent Form

DUBLIN CITY UNIVERSITY
Informed Consent Form

I. Research Study Title

Transitioning towards a blended online model of training within Dublin Fire Brigade.
School: School of STEM Education, Innovation & Global Studies
Principle Investigator: Barbara Cahill, Dublin Fire Brigade Training Centre, Marino.
Phone 087-6001186, babscahill@gmail.com
Supervisor: Charlotte Holland, School of STEM Education, Innovation & Global Studies, DCU Institute of Education, Dublin City University.

II. Clarification of the purpose of the research

The main aim of this research is to explore pedagogical models and practices that will enable the transition from face-to-face model of training to a blended model of online teaching and learning within Dublin Fire Brigade (DFB).

III. Confirmation of particular requirements as highlighted in the Plain Language Statement

Participant – please complete the following (Circle Yes or No for each question)

I have read the Plain Language Statement (or had it read to me).	*Yes/No*
I understand the information provided.	*Yes/No*
I have had an opportunity to ask questions and discuss this study.	*Yes/No*
I have received satisfactory answers to all my questions.	*Yes/No*
I am aware that training sessions will be video/audio-taped.	*Yes/ No*
I am aware that my interview and/ or focus groups will be video/audio-taped.	*Yes/No*
I am aware that my user interactions online will be tracked.	*Yes/No*
I am aware that an observer will take notes during face-to-face sessions.	*Yes/No*
I am aware that I may be anonymously quoted in reports or academic papers.	*Yes/No*

IV. Confirmation that involvement in the Research Study is voluntary
Your involvement in this Research Study is entirely voluntary. You may withdraw from this research study at any point. There will be no penalty for withdrawing before all stages of the Research have been completed.

V. Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

Data will be securely held within Dublin Fire Brigades' Training Centre for two years after research is completed and accessed only by the named researchers within this study. The data will be securely disposed of after this time. Confidentiality of information is subject to legal limitations. Should an extract from your response to interviews, observations, focus groups or survey be used for research purposes, any information that would identify you will be removed.

VII. Signature:
I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project

Participant Signature: _____

Name in Block Capitals: _____

Witness: _____

Date: _____

A.3 Plan Language Statement

DUBLIN CITY UNIVERSITY
Plain Language Statement

Title: *Transitioning towards a blended online model of training within Dublin Fire Brigade.*
School: STEM Education, Innovation & Global Studies, DCU Institute of Education
Principle Investigator: Barbara Cahill, Dublin Fire Brigade Training Centre, Marino. Phone 087-6001186, babscahill@gmail.com
Supervisor: Dr. Charlotte Holland, School of STEM Education, Innovation & Global Studies, Dublin City University. Phone: 01-8842018 Email: charlotte.holland@dcu.ie

This research study, examining the process of transitioning towards a blended online model of training with Dublin Fire Brigade, will take place over a four-year period from September 2017 to June 2021. This research project will involve engagement in a blended learning environment by new entrants into the Brigade and fire service personnel involved in in-service training. The foundation for learning will be offered in the form of a Learning Management System (LMS). Dublin Fire Brigade has two eLearning systems, LearnPro and PDRPro which will be used to present a new integrated training programme for fire service personnel, and to track performance of each participant in both online and offline (real-world) fire service training activities. All participants will be asked to partake in one pre and one post eLearning surveys to ascertain their attitudes, opinions and levels of exposure to and experience of online learning/Information and Communications Technology (ICT) usage in pre-surveys, and their perspectives of learning within the LMS in post-surveys. The blended training sessions (online and face-to-face) will be video and audio-taped for research purposes. Up to forty participants will be asked to partake in one to one thirty minute interviews before and after eLearning, the purpose of these interviews is to compare and contrast participant's attitudes and perspectives to online learning pre and post course - the interviews will take circa 30 minutes. Once the surveys and interviews have taken place two focus groups will be convened (each focus group comprising circa five participants) to discuss ways in which the LMS can be improved. Participants will benefit directly from this study through the acquisition of new skills in online learning. Furthermore, participation in this study will give you a 'voice' in matters concerning the future integration of online learning within Dublin Fire Brigade.

Participation in this research study is completely voluntary and engagement within this research project will not affect progression within Dublin Fire Brigade. You may withdraw from this research study at any point. There will be no penalty for withdrawing before all stages of the research have been completed. Confidentiality of participants in this research is assured. Confidentiality of information is subject to legal limitations. Should an extract from your response to interviews, observations, focus groups or survey be used for research purposes, any information that would identify you will be removed. The data collected will be securely held within a password protected laptop held securely in a locked drawer of desk in the private office space for the Lead Trainer in Dublin Fire Brigades Training Centre. The data will be securely disposed of after this time by deletion of the electronic folder containing the data files, and any copy or trace thereof of related files on the laptop, by experienced IT data administration services unit within Dublin City Council. You will be sent a Project Leaflet highlighting the main findings of the research on completion of this project.

If participants have concerns about this study and wish to contact an independent person, please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail *rec@dcu.ie*

Appendix B Data Collection Tools

B.1 Class Observations (sample)

DFB RTC Station Rotation Group 1 - Classroom face-to-face instruction

Fire name	**OB F2F G1**
Lessons	**Vehicle Stabilization**
Location	**OBI – Room 6**

Observation completed by	Barbara Cahill
Recording equipment used	GOPRO 7

Questions

What are people doing?

Instructor

Introduction of the topics to be covered
Describing the principles of the RTC, Golden hour, Hazards when dealing with an RTC.
Describing the methods for vehicle stabilisation and glass management.
Describing the reciprocating impact tools and safety considerations when using the equipment.
Recapping on previous lessons
Highlighting key areas for student focus for exam purposes

Students

Students listening to lesson
Some students are taking notes
One student at rear of class appears to be tired

Students Questions

Does the octopus steering wheel device come in different sizes?
Are there different gloves to be worn at an RTC incident?
How long does the battery last for on the Milwaukie impact tool?
Is there a difference in stabilising Electric cars?
Do you always have to remove all glass at every incident?

What are they trying to accomplish?

Impart knowledge regarding hazards while dealing with RTC's, vehicle stabilization operation of reciprocating and impact tools.

How exactly do they do this?

The instructor presented PowerPoint presentation(s).
The instructor asked the students questions regarding the material just presented.
The instructor reinforces the principles of the lesson.

How do people characterise and understand what is going on?

They could answer the questions posed by the instructor.

What assumptions do they make?

That the instructor is going to give them exams hints

Analytical Query

What do I see going on here?
One instructor talking, reading from slides and asking questions to the class.
Instructor instructing on how the course will be delivered.

What did I learn from these notes?

Only some students asked questions
Very few students asking questions.

Why did I include them?
Notices general lack of enthusiasm in class.
Sense of boredom.

What else is happening in this site that is relevant to my research question(s)?
No pre-course reading is available to the student.
No online content is available to the student for reference.

How do I feel about collecting this data? Comfortable, imposter etc – how will this affect the data (reflexivity)?
Felt comfortable.

Note
The instructor engaged with the class, gave clear lesson outcomes, asked students questions and recapped information at the end. Highlighted need-to-know information as "You might be asked this point in an exam".
A lot of external noise in the classroom.

B.2 Focus Group (sample)

RTC GROUP 1 Focus Group 1

Date: 11/06/2020
Location: Class 6: OBI DFB
Time Start: 09:10
Time Stop: 09: 30

Focus Group Led: Researcher. All students have completed their plain language form and consent to taking part in this focus group.

Student Number
Student 01
Student 02
Student 03
Student 04
Student 05

Researcher: I'm going to start off by introducing myself as Third Officer Barbara Cahill, as I just mentioned there, this is research for a PhD examining the transition between face-to-face learning and online learning. I'm just going to ask you a few questions in relation to the course you are after doing. So just before I start can you introduce yourself and who and what you did before you came into the fire brigade?
Student 05: [Name], [omitted] Fire service.
Student 01: [Name] before I came in here, I installed water systems, boilers and stuff like that
Student 02: [Omitted] fire service retained, I worked in the control room for the last year and a half and now I'm here.
Researcher: OK very good, thanks.
Student 04: My name is [name], I was in the [omitted] fire service.
Researcher: [Omitted]? Very, good, did you enjoy that?
Student 04: Yeah, it's good yeah, enjoyed it.
Researcher: Different, so you speak [omitted]?

Student 04: Yeah, a little bit, not conversationally.
Researcher: Very good, that's interesting and yourself.
Student 03: My name is [name] I worked as a healthcare assistant in the sports surgery clinic.
Researcher: Thanks [name].
Researcher: Ok, so I'll just start off by asking a really easy question, what motivated you guys to do the RTC course? Jump in.
Student 02: It was one of my favourite subjects in the fire service, I really enjoyed the RTC part of it, obviously it's part of a module that you need to do anyways, not that we volunteered to do it, but I really enjoyed it, I was happy we got to do it.
Student 01: Yeah, I was really looking forward to doing it, I've always enjoyed taking things apart, like cutting up the cars.
Student 03: Yeah, it's been one of the most enjoyable weeks of the course so far, definitely, everyone enjoys cutting up cars. It was really good really enjoyed it. Yeah, it was really enjoyable, yet so much to learn, one way to cut up a car there's so many different ways.
Researcher: So some of you will have done an RTC course before? So, who hasn't, just two? So, there was three who have, so what was the comparison, or what was the difference, or was there a difference?
Student 02: I know the techniques are the same, it's good to see there's a certain way of doing things and you learn that's the way to do it, back to the basics glass management, and make sure it's all done right.
Researcher: And is there a difference in the courses that you have done before?
Student 02: Before it was only a week,
Student 03: I only did the basic RTC course, which was only three days, so obviously you get your hands a lot more on the tools, like 3 days wasn't enough.
Researcher: But they were the same tools?
Student 03: Same tools, Halmatro, everything else the same very basic only three days, here it's very focused on getting the basics right, there it was more like dive in and cut up the car, more so than getting the basics, glass management and stabilization stuff like that.
Researcher: So, would you say this course prepared you better than other courses that you have done?
ALL: Definitely, yeah definitely … hands on more tools anyway. More confident coming in with the tools, yeah, in the evening when doing drill, jumping in knowing how to cut the roof off, B post rip.
Researcher: That's interesting, and do you feel like you are now prepared for going out there, say something happened out on the road outside here, would you be prepared?
Student 05: Yeah definitely, obviously probably not your first incident you'll be a bit nervous, your training will kick in you know what to do.
Student 04: Yeah, I think RTC … see you see the team really come together, the five of us, but everyone works together as a team has their job and is sticking to their job and everyone knows what they're doing, yeah.
Researcher: And what was the hardest part of the course?
Student 04: Probably standing back and the theory, trying to remember all the measurements of the spreaders and the rams.
Student 01: I found the RTC book wasn't as good as our recruit book for the first 4 weeks, it was very scattered in parts.
Researcher: Yeah, that's good, that's good feedback.
Student 02: Probably cause all the tools have different specifications, it was hard for just one set of tools in the book, we were given different set of dimensions for tools from the board.
Researcher: So would it be fair to say the face to face learning was different than what you had in your manuals.
ALL: Yeah, yeah, yeah
Student 05: Yeah 'cause if you said it was on page 161 of your book and everything that you said is just there, yeah you were just flicking through the book and it wasn't very clear.
Student 03: Yeah, just the numbers on the tools.

Researcher: Yeah, we need that feedback 'cause if we don't know we can't change, thanks for that. Anything else regarding face to face in the classroom that you could think could be improved?
Student 03: No not really, I think the instructors are really good.
Researcher: Do you think the time spent in the classroom was good?
Student 04: I think this particular course is more hands-on anyway. I think you'd benefit more being out in the yard doing the skills rather than sitting in the classroom.
Student 05: Sometimes you will be sitting through a lecture and you'd be looking at it saying I thinking this makes no sense, but then when they went out and showed you with the tools and you were more hands-on is more beneficial.
Student 01: Like that, when you're in the classroom, if they had little clips like the B post rip, a 30 second clip of where they're cutting to show you where they're cutting, it gives a much better visual, like imagine the car here and you're cutting there, do you know what I mean?
Researcher: Yeah, that's a good point so you're saying in a face to face setting if there is a video segments put in.
Student 02: It would only have to be 20 seconds, literally just where you are cutting, even if it was marked just where you're cutting, or just showing you, you know.
Researcher: Good, so then out in the yard, do you think there was anything that was good or was bad. What you'd like to see different?
Student 05: Sometimes I think some people were saying the same thing, sometimes there were too many people trying to work on the one thing, you know what I mean.
Student 02: I think we were very happy only five of us, so, like everybody from the start knows each other, all you have to do is look over and you know something is doing something like, like you don't have to be like get in here on this tool like, the lads will see you're struggling and one of them will be straight in to help you out.
Student 02: Or if they saw you didn't have time on the tools they would be making sure you got equal time on the tools, a few other people said they found it a little bit more disorganized, like other drills in recruit training where you're numbered off and you have a position, but I know that's different in RTC.
Student 04: Yeah, I was going to get to that point, even in the first week, yeah the officer, the officer in charge is at every scene. If he turned around and delegated lads, you're on peak and reveal you're on stabilization, like it was right you're going to the scene, and we're like who wants to do what? I'll do stabilization, three people doing stabilization and not enough people on the tools you know what I mean.
Student 03: Even in the first week what we got our heads around, number 2 does a certain job on the truck, if you're sitting as number 2 in the truck you know exactly what you're doing
Researcher: Good point, just to let you know when you are on the trucks number 2 and number 4 use the tools, so just in case nobody says that to you between now and then. I'm sure they will, number 2 and number 4 do everything. So that's good feedback, so out in the yard is it fair to say if you have specific numbers and maybe a smaller group there will be less standing off time?
Student 01: It's just like the lads were saying, you feel like even though it's better to stand back off the drill, you feel like if you stand back that's everyone like, Oh yeah he's lazy, but if you see something then you can go and jump in.
Student 02: You find yourself running around trying to make jobs, so you're not standing there when people are looking at you kind of going, Saying why is [name] just standing there doing nothing, you know that sorta of feeling.
Researcher: I know, I don't want to keep you too long as I'm conscious of the time, so the face to face in the classroom, skills in the drill yard, emm, I'm looking at an online modules to give to the RTC class and I'm going to be doing it with the next recruit class. Do you think this would be of benefit to your learning in this type of training?
Student 01: Yeah 100% we're all looking forward to a time where we can log on to just the one place and see what are the information and lessons that we need. Yeah, it would have been good on this course as we said the notes were different than the slides, this was confusing at times.

Researcher: Just before we get there, there are few more questions for the group. What did you think of the training methods used within the RTC course, like is there other ways of teaching that we could use?
Student 05: Eh, I would have liked more time to play around with the tools on my own, it felt like sometimes it was there you are, now let's go, too much explaining and not enough time with the gear.
Student 03: If the instructor could bring the equipment into the class, that would be good, so we can see it. Or even if the class could be out in the yard and we could teach the lesson as we see the tools being used, if that makes sense?
Researcher: That's a new approach, hadn't thought of that one myself [laughs]. Anyone else like to add anything about the teaching methods used.
Student 03: No, the instructors were really good and helpful.
Researcher: Ok thanks, so like anything, we must have some sort of assessment. What did you think of the way the RTC course was assessed?
Student 05: Well, we haven't had our exam yet, but the assessment in the yard was fair, we had to do a few assessments where the instructor would ask you to operate a piece of equipment and see how you got on with it.
Student 04: Like what was said, we were being assessed all the time, during the time we were cutting up the cars, only the one who was on the tools and its was grand, don't think any of the lads had a problem.
Researcher: Did you like that style of assessment, compared to how you were assessed during your basic training.
Student 02: I much preferred this way, as we just got shouted at during our basic.
Student 05: Me too
Student 01: I felt that I was being treated like an adult rather than a school child.
Researcher: Ok that's great feedback. So, moving along, has anyone heard of the term online or blended learning?
Student 04: Well online, is like eLearning, I had to do some for college, not sure what blended is, maybe online and in the class like you said this project was about.
Researcher: Very good, someone was listening to my introduction in class, anyone else?
Student 03: Haven't heard of blended before, primary schools are looking at something like this aren't they for COVID. I haven't used it myself.
Researcher: My research is looking at it, as we talked about, a face to face model mixed with an online module(s) to help retain our skills. Do you think online module(s) would have helped on your RTC course or in the fire brigade in general and why?
Student 03: Yes, absolutely, I would have loved to have been able to look over videos and the lessons at home during the weekend. Sometimes the lessons in class go too fast or you just can't catch what they [the instructor] are saying, and some instructors say different numbers.
Student 02: I've done eLearning before and I found it great as you can look at stuff in your own time, when suits. I have 2 kids and doing this and homework is hard so it would be good if I could do it in my own time, whenever I have a sec.
Student 04: I know DFB have eLearning at the station and the lads like it, when I was in the control-room we got access and it was helpful getting ready for the course.
Researcher: Awh, so you had access to LearnPro before?
Student 04: Yeah
Researcher: What did you think, was it any good?
Student 04: Yeah, it was easy to get around and you can access it on your phone. Some of the lads logon on the way back from a turnout, to get their lessons done.
Researcher: Not sure, I'd recommend that. [laugh]. Has anyone else used LearnPro?
Student 02: No but can we get access for our next course?
Researcher: Not sure, I'll ask. So folks, is there anything else anyone would like to add, share? No, well thanks very much for your input and best of luck with the rest of the course.

B.3 Instructor Interview (sample)

RTC Interview 2

Researcher:
Instructor 2:
Researcher: How are you?
Instructor 2: Good, good, not looking forward to this [laughs].
Researcher: Thanks for coming in, I'll try to make it as painless as I can. As explained, this is an interview that will help my research into education within the fire service
Instructor 2: No worries, whatever you need.
Researcher: OK, can you just start by saying what your name is?
Instructor 2: [Name omitted].
Researcher: How many years of service do you have?
Instructor 2: 29 going on 30
Researcher: What is your current rank?
Instructor 2: Station Officer.
Researcher: And what is your educational background? Leaving cert, college?
Instructor 2: Leaving cert and firefighting for dummies.
Researcher: [Name omitted] how many years have you been an instructor and what courses have you done or delivered?
Instructor: Oh, let me think, I have been an instructor for the last eight years in RTC, I'm a BA and Pump instructor as well going back about 10 years. Time flies.
Researcher: Can I ask you what you liked most about your RTC instructors' course?
Instructor 2: Well, you know me Babs, I like to be out and about in the yard with the lads getting my hands dirty. Also, if you want to know about something teach it [laughs].
Researcher: Very true, and what did you like least about your RTC instructor course?
Instructor 2: It wasn't the course it's the 9 to 5 for me; it's hard to get away from the shift pattern. It's hard being away from the books for so long, I did my leaving in the 80's so the hands-on is easy it was the opening of the books that was a challenge.
Researcher: Have you been an instructor in previous RTC courses if so, how many?
Instructor 2: Yeah, I have been on three or four to the best of my knowledge.
Researcher: Do you think the RTC recruit course has enough time, is it adequate?
Instructor 2: Yeah, I think the duration is fair; it's two weeks long, bits in the classroom and then out to the yard, I think it flows quite well.
Researcher: Do you think the RTC course material is fit for purpose?
Instructor 2: The course material, as books or what?
Researcher: The students learning material PowerPoint books and things like that.
Instructor 2: Yeah, I think it's fit for purpose and it could always use a bit of an update, if I was that Brigade Training Officer, I think I'd like to see less book work a more hands-on
Researcher: Do you think the amount of time spent in the classroom delivering face-to-face lessons is about right or appropriate?
Instructor 2: Yeah, like I said, I think the course material is good. Time in the classroom is a little bit too long in my opinion, I'd like to see less classroom and more hands-on the cars.
Researcher: Do you think the amount of time spent in the drill yard is adequate?
Instructor 2: It's adequate, but I'd like to see more.
Researcher: What is your opinion or perspective on the training methods used within the RTC course, i.e. PowerPoints, Discussions, Drills, Group Work, Peer-to-Peer).

Instructor 2: Well, I think there's a lot of focus on PowerPoints, emmm because it's recruit training there is not a lot of discussion, it's more and autocratic learning style. We would be very much focused on drills and working together in our syndicates, in our groups and focusing on teamwork to get the job done.
Researcher: what is your opinion or perspective on the assessment methods used within the RTC course?
Instructor 2: I personally like the way we do the assessments in the RTC course. When I was a recruit, there was an assessment on every piece of equipment, how it worked how to was used this and then a demonstration of skills. Now we tend to take a more overall view and watch the recruit [Firefighter] using the piece of equipment. Then we ask them to discuss the pros the cons of using the equipment and the processes that are associated with the health and safety of each piece of equipment.
Researcher: Would you change anything in the RTC course?
Instructor 2: I would like to see smaller groups, a larger focus on one-to-one instruction. I think the course could be extended or a follow up CPD to encompass heavy vehicles and the extrication techniques needed to manage these incidents. I don't think recruit training is the place to expand basic RTC skills. I feel that there isn't a lot of knowledge thrown at the recruits and I would like to see a focus on need-to-know information rather than nice to know information being offered to the students.
Researcher: What does the term online learning mean to you what does the term blended learning mean to you?
Instructor 2: Online learning means to me eLearning, within Dublin Fire Brigade we use LearnPro. Firefighters at station level login every day and do their modules. I've never heard of blended learning, I presume it's a mix of classroom and eLearning.
Researcher: Have you ever engaged in online learning or blended learning as a students or instructor?
Instructor 2: Yes, I'm required to complete my modules as a BA instructor and also I need to run training reports at station level for my Firefighters.
Researcher: What is your perspective on the integration of online learning and blended learning within the fire service?
Instructor 2: I think online learning within Dublin Fire Brigade is already there. The feedback from the guys in the station is very good. There seems to be consistency of material and it can be accessed anytime, day or night. Yeah, I think it's a start, it's been a positive start, it seems to be the way forward. Sure, everything you do know is done online.
Researcher: Have you any thoughts on where online learning my best be integrated within the RTC course?
Instructor 2: I like the idea of giving the students the modules before the course, I'd be interested to see if their exam results are any better [laughs]. I think it can always be used as a reference tool as long as the modules are designed well and easy to use.
Researcher: What additional supports will be needed to be put in place to prepare students for engagements in online or blended models of learning?
Instructor 2: I don't think any additional supports would be needed. I think because we've started people are happy to engage.
Researcher: Do you think specialist training is needed for instructors to deliver online or blended courses.
Instructor 2: Absolutely, I wouldn't have a clue where to start, I'd be happy to help but I would need a loss of assistance.
Researcher: Is there anything else you would like to add.
Instructor 2: No.

Researcher: [Omitted], thanks again for all your time and help.

B.4 Questionnaire Recruit Class 1/2020 RTC Course - Survey 1

This research is part of a PhD in Education that is exploring the use of technology to support online learning within Dublin Fire Brigade. This research project will focus on current educational models being offered by the fire service and explore the challenges and opportunities that a blended educational model may offer. This research will require engagement in a blended online learning environment and participation in surveys, interviews and focus groups. An observer will also observe how online learning components are implemented in a face-to-face setting. Participants will benefit directly from this study through the acquisition of new skills in online learning. Furthermore, participation in this study will give you a 'voice' in matters concerning the future integration of online learning within Dublin Fire Brigade.

The processing of data gathered in this study complies with the General Data Protection Guidelines (GDPR). All information is confidential and is for research purposes only. The anonymity of participants is guaranteed.

If you require further information, please contact

Barbara Cahill barbara.cahill@dublincity.ie

Thank you for participating in my survey. Your feedback is important.

I have read the Plain Language Statement and signed the Informed Consent and agree to participate in this doctoral research study.

- ○ Yes
- ○ No

Q. 1 What is your name?

_____

Q.2 What is your age?

_____

Q. 3 With which gender do you identify?

- ○ Male
- ○ Female
- ○ Prefer not to say
- ○ Other (Please specify) _____

Q. 4 How many years' service do you have?

_____

Q. 5 What is your current rank?

- ○ Recruit firefighter
- ○ Firefighter
- ○ Sub Officer
- ○ Station Officer
- ○ District Officer
- ○ Other _____

Q. 6 What is the highest level of education you have completed?

- ○ Junior Certificate
- ○ Leaving Certificate
- ○ Level 7 or 8 (Degree)
- ○ Level 9 (Masters)
- ○ Other _____

Q. 7 For which organisation do you work?

- ○ Dublin Fire Brigade
- ○ Louth Fire Service

Q. 8 To what watch are you currently assigned?

- ○ A
- ○ B
- ○ C
- ○ D
- ○ No Watch assigned
- ○ N/A

Q. 9 To what district are you currently assigned?

- ○ A
- ○ B
- ○ C
- ○ D
- ○ E
- ○ F
- ○ No District assigned
- ○ N/A

Q. 10 Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
New technologies contribute to a better quality of life.					
Technology gives me more freedom of mobility.					
Technology gives people more control over their daily lives.					
Technology makes me more productive in my personal life.					
Other people come to me for advice on new technologies.					
In general, I am among the first in my circle of friends to acquire new technology when it appears.					
I can usually figure out new high-tech products and services without help from others.					
I keep up with the latest technological developments in my areas of interest.					
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.					
Technical support lines are not helpful because they don't explain things in terms I understand					
Sometimes I think technology systems are not designed for ordinary people.					
There is no such thing as a manual for a high-tech product or service that's written in plain language.					
People are too dependent on technology to do things for them.					
Too much technology distracts people to a point that is harmful.					
Technology lowers the quality of relationships by reducing personal interaction.					
I do not feel confident doing business with a place that can only be reached online.					

Q. 11 Please indicate your current access to each of the following technologies.

	Have Access	No Access
Smart phone (iPhone, Blackberry, Android)	○	○
Tablet Computer (like an iPad)	○	○
Portable music player (eg. MP3 player)	○	○
Portable media player (plays video mp4)	○	○
Television that is connected to the Internet	○	○
ebook reader (eg. Kindle)	○	○
Digital 'point and shoot' camera	○	○
Digital video camera	○	○
Cell phone without Internet capabilities	○	○
Laptop	○	○
Stationary (Desktop) Computer	○	○

Q. 12 Do you have access to the Internet in work?

○ Yes

○ No

Q. 13 How would you rate the quality of the Internet connection at work?

○ Very good quality Internet connection – Fast streaming of training videos, and /or downloading or uploading of documents.

○ Good quality Internet connection – Fast streaming of training videos but it can take longer sometimes to download or upload files.

○ Poor quality Internet connection – The Internet connection frequently drops so streaming training videos can be interrupted, takes a long time to download or upload documents.

○ I have not used the internet connection in work.

○ Other - Please elaborate _____

Q. 14 Please indicate which technology you mostly use to access the Internet

- ○ My smart phone.
- ○ My home computer [desk-top computer / laptop / tablet].
- ○ A work computer.
- ○ Other (Please specify) _____

Q 15 Please indicate how often you access the Internet using the following

	Several times a day	Once a day	Once a week	Once a month	Never
I use my phone to access the Internet	○	○	○	○	○
I use my home computer [desk-top computer / laptop / tablet] to access the Internet	○	○	○	○	○
I use a work computer to access the Internet	○	○	○	○	○

Q. 16 Please indicate whether you have undertaken the following online activities in the past 12 months:

	Yes	No
Sent or received emails	○	○
Used social networking software (e.g. Facebook, or Twitter	○	○
Engaged in an online meeting (e.g. using ZOOM, or Microsoft Teams)	○	○
Taken a course taught online	○	○
Used an online streaming music service	○	○
Watched a video online	○	○
Downloaded songs / movies or books online	○	○
Made a phone call with a video collection online (eg. Using Skype, Whatsapp)	○	○

Q. 17 Please indicate whether you have used the following applications in the past 12 months *(You can choose multiple answers)*

- ☐ Word Processing software (e.g. Word)
- ☐ Digital Spreadsheet (e.g. Excel)
- ☐ Database (e.g Access)

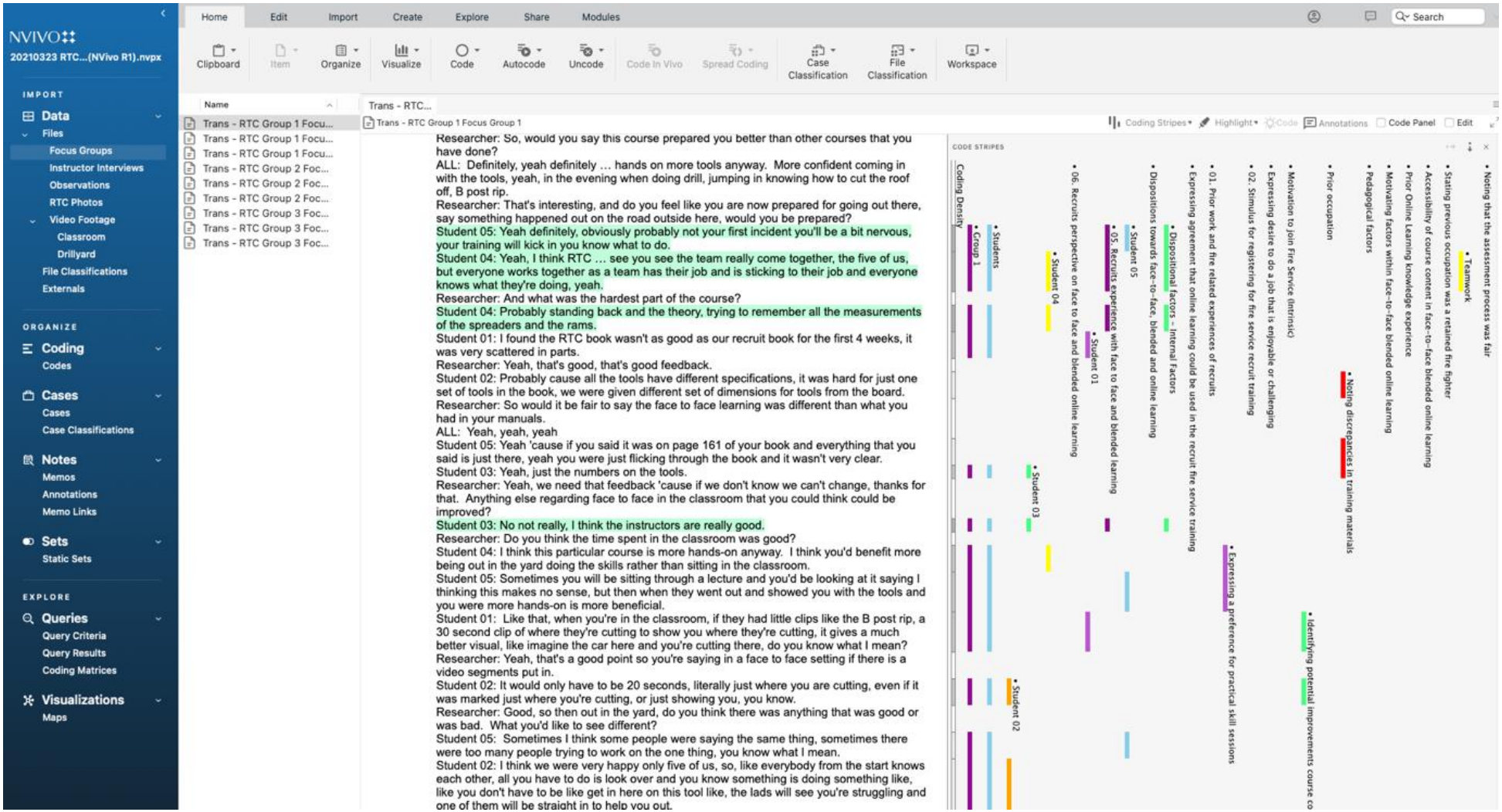
Q. 18 Please indicate your level of agreement with the following statements.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Online learning gives me the opportunity to acquire new **knowledge.**	○	○	○	○	○
Online learning gives me the opportunity to acquire new **skills.**	○	○	○	○	○
Online learning enhances the quality of my learning experience.	○	○	○	○	○
Online learning should be a part of firefighter training.	○	○	○	○	○
Online learning should be used for refresher training on station.	○	○	○	○	○
Online learning should be used for recruit training.	○	○	○	○	○
Online learning should be available to me when I am not in work.	○	○	○	○	○
Online learning is not my preferred mode of learning.	○	○	○	○	○
I prefer face to face lessons in a class room rather than online learning modules.	○	○	○	○	○

Appendix C TRI 2.O Technology Index Chart

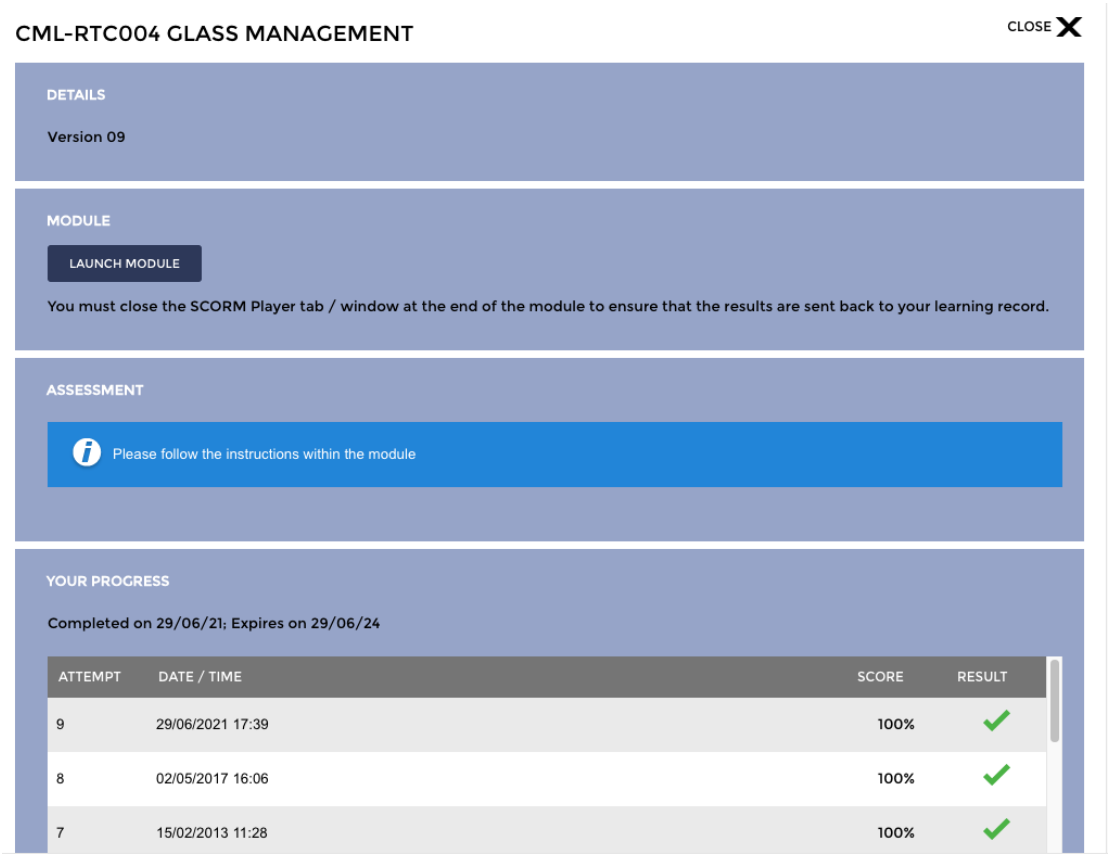
	Set 1 Strongly Agree %	Set 2 Strongly Agree %	Set 3 Strongly Agree %	Set 1 Somewhat Agree %	Set 2 Somewhat Agree %	Set 3 Somewhat Agree %	Set 1 Neutral %	Set 2 Neutral %	Set 3 Neutral %	Set 1 Somewhat Disagree %	Set 2 Somewhat Disagree %	Set 3 Somewhat Disagree %	Set 1 Strongly Disagree %	Set 2 Strongly Disagree %	Set 3 Strongly Disagree %
OPT1	29	43	43	65	57	14	6	0	43	0	0	0	0	0	0
OPT2	41	43	34	53	57	58	6	0	8	0	0	0	0	0	0
OPT3	41	43	0	29	43	86	19	14	14	12	0	0	0	0	0
OPT4	24	36	14	41	50	43	6	14	14	29	0	29	0	0	0
INN1	12	7	43	35	36	14	35	36	43	6	14	0	12	7	0
INN2	8	0	0	8	15	14	59	39	29	25	46	14	0	0	43
INN3	29	21	14	47	43	57	18	14	29	6	21	0	0	0	0
INN4	29	15	57	35	39	29	24	38	0	12	8	0	0	14	0
DIS1	0	0	0	18	22	28	47	21	29	35	43	29	0	14	14
DIS2	0	0	14	41	7	14	35	29	43	24	64	29	0	0	0
DIS3	18	0	0	29	31	43	12	0	28	41	69	29	0	0	0
DIS4	6	0	0	41	15	28	41	62	57	12	23	0	0	0	14
INS1	53	0	29	29	57	71	6	36	0	12	7	0	0	0	0
INS2	29	7	14	65	57	43	6	29	29	0	7	14	0	0	0
INS3	44	15	57	31	54	43	19	23	0	6	8	0	0	0	0
INS4	25	0	29	34	45	29	33	8	14	8	46	14	0	0	14

Appendix D NVIVO – Example coding Set 1

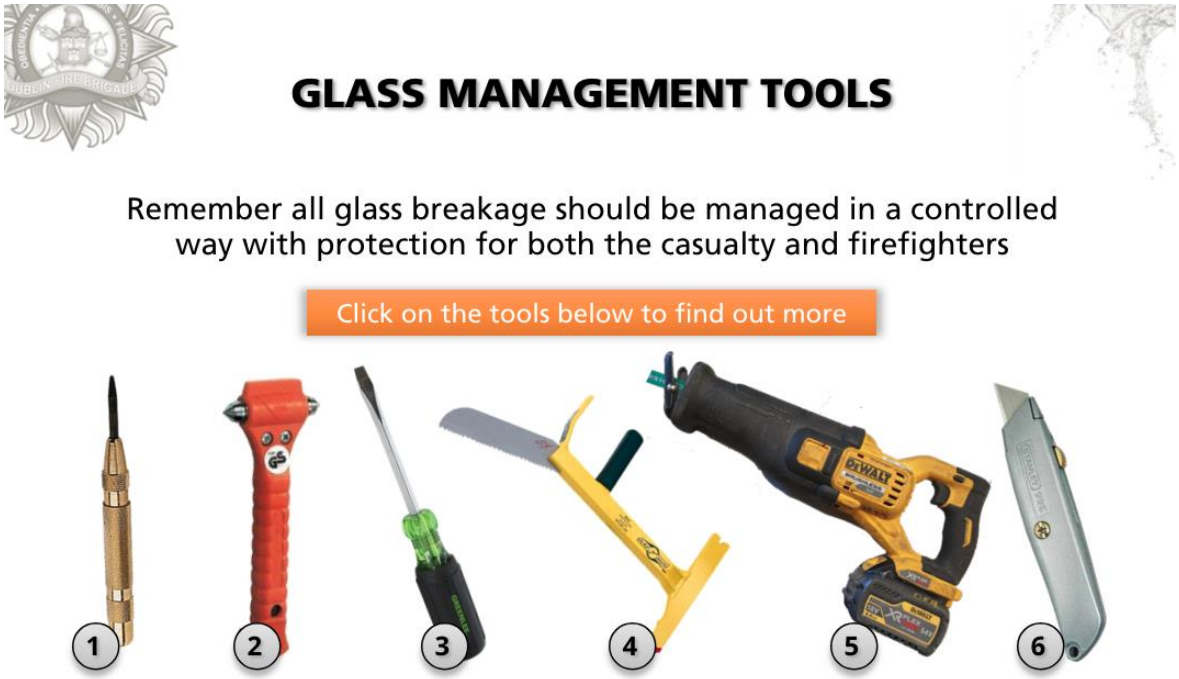


Appendix E Glass Management online module

Module: Glass Management



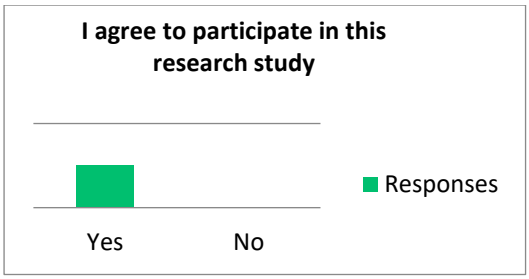
Appendix F LearnPro RTC Glass Management Module



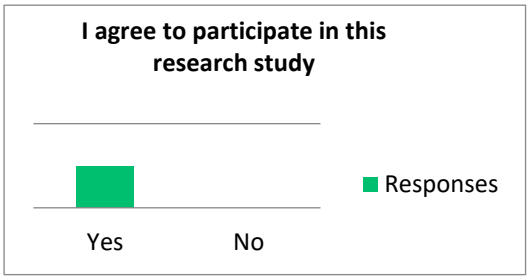
Appendix G: Survey 1 compared to Survey 2 results

Question 1

Survey 1		
I agree to participate in this research study		
Answer Choices	Responses	
Yes	100.00%	41
No	0.00%	0
	Answered	**41**
	Skipped	**0**

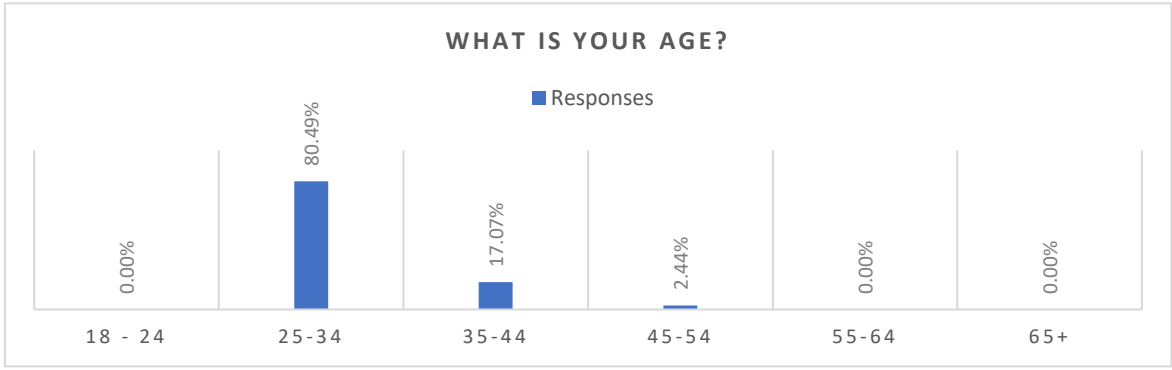


Survey 2		
I agree to participate in this research study		
Answer Choices	Responses	
Yes	100.00%	40
No	0.00%	0
	Answered	**40**
	Skipped	**0**

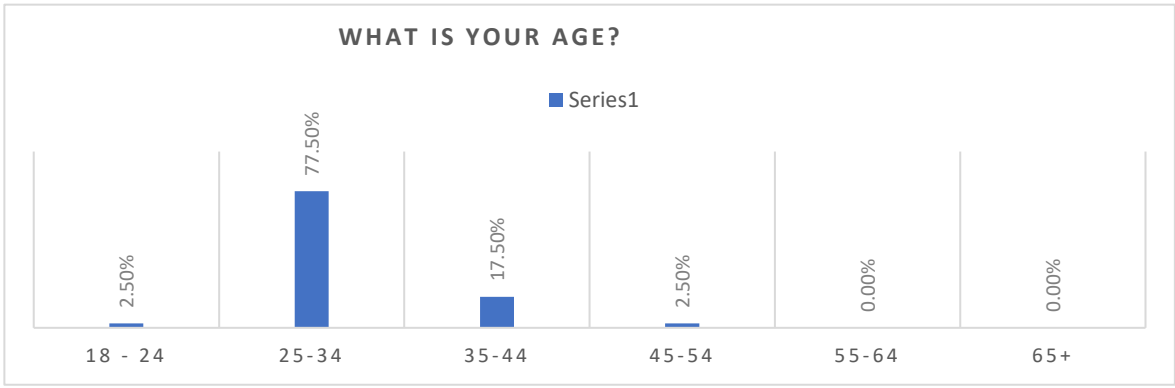


Question 3

Survey 1		
What is your age?		
Answer Choices	Responses	
18 - 24	0.00%	0
25-34	80.49%	33
35-44	17.07%	7
45-54	2.44%	1
55-64	0.00%	0
65+	0.00%	0
	Answered	**41**
	Skipped	**0**

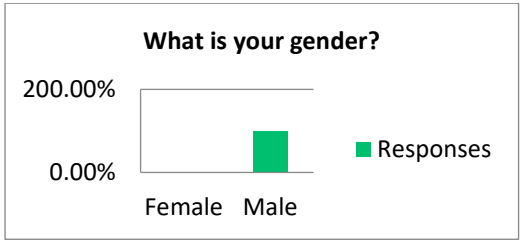


Survey 2		
What is your age?		
Answer Choices	Responses	
18 - 24	2.50%	1
25-34	77.50%	31
35-44	17.50%	7
45-54	2.50%	1
55-64	0.00%	0
65+	0.00%	0
	Answered	**40**
	Skipped	**0**

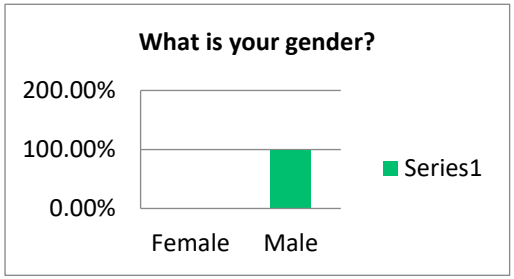


Question 4

Survey 1		
What is your gender?		
Answer Choices	Responses	
Female	0.00%	0
Male	100.00%	41
	Answered	**41**
	Skipped	**0**

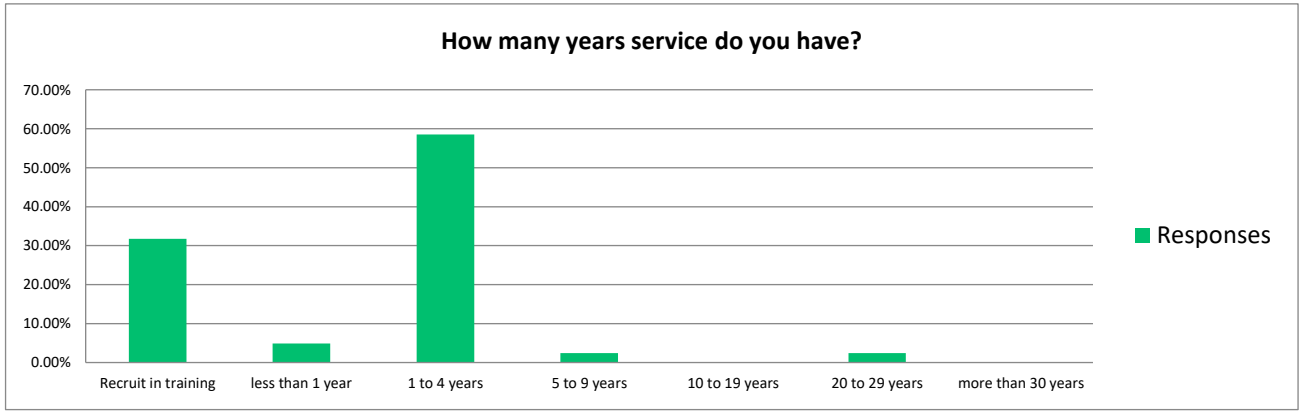


Survey 2		
What is your gender?		
Answer Choices	Responses	
Female	0.00%	0
Male	100.00%	40
	Answered	**40**
	Skipped	**0**

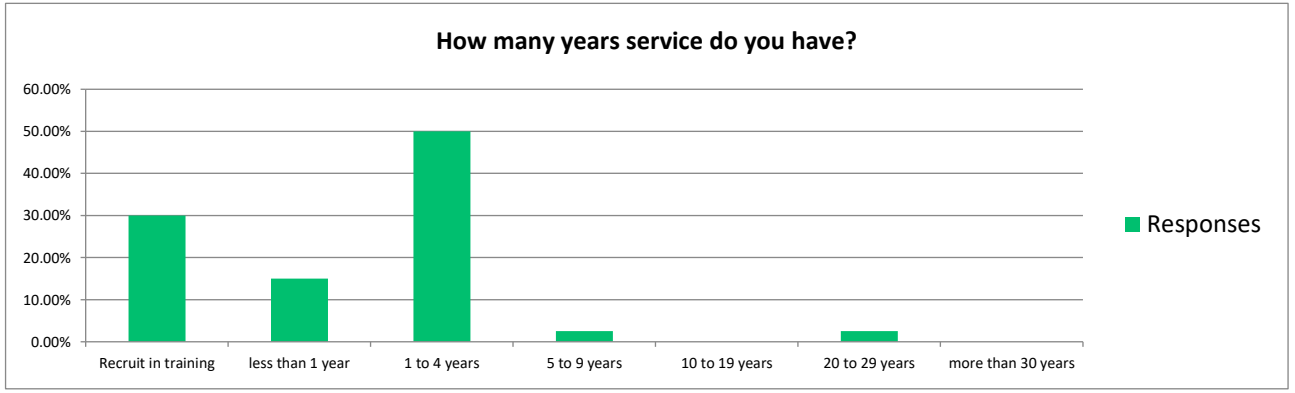


Question 5

Survey 1		
How many years' service do you have?		
Answer Choices	Responses	
Recruit in training	31.71%	13
less than 1 year	4.88%	2
1 to 4 years	58.54%	24
5 to 9 years	2.44%	1
10 to 19 years	0.00%	0
20 to 29 years	2.44%	1
more than 30 years	0.00%	0
	Answered	**41**
	Skipped	**0**

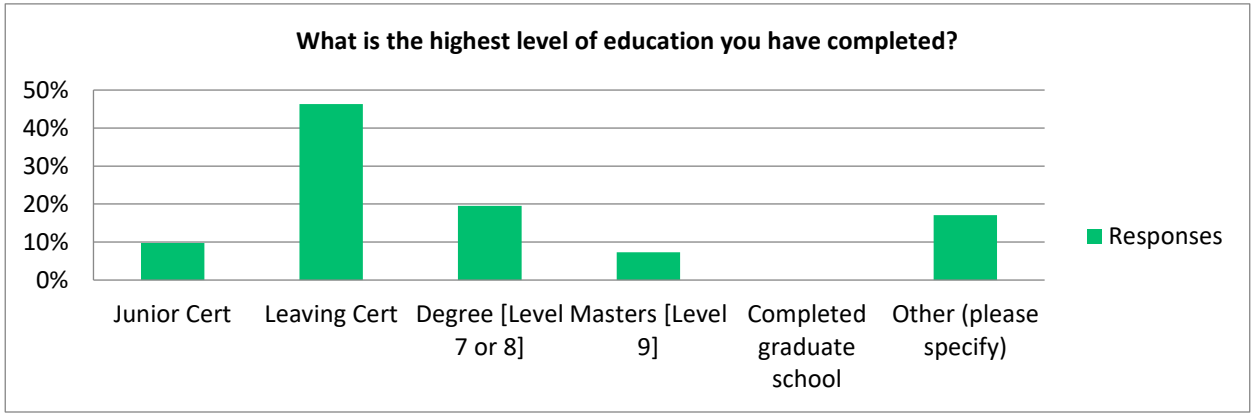


Survey 2		
How many years' service do you have?		
Answer Choices	Responses	
Recruit in training	30.00%	12
less than 1 year	15.00%	6
1 to 4 years	50.00%	20
5 to 9 years	2.50%	1
10 to 19 years	0.00%	0
20 to 29 years	2.50%	1
more than 30 years	0.00%	0
	Answered	**40**
	Skipped	**0**

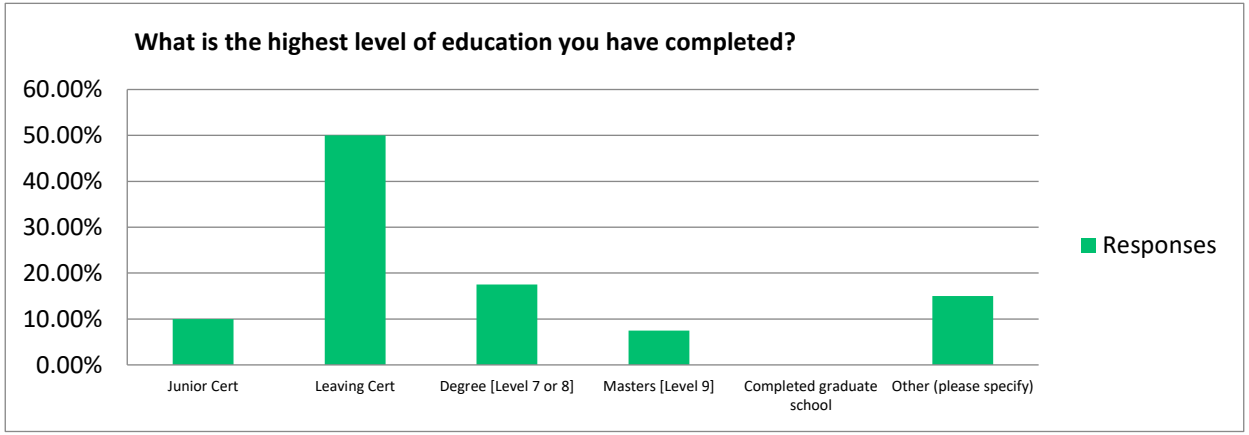


Question 6

Survey 1		
What is the highest level of education you have completed?		
Answer Choices	Responses	
Junior Cert	9.76%	4
Leaving Cert	46.34%	19
Degree [Level 7 or 8]	19.51%	8
Masters [Level 9]	7.32%	3
Completed graduate school	0.00%	0
Other (please specify)	17.07%	7
	Answered	**41**



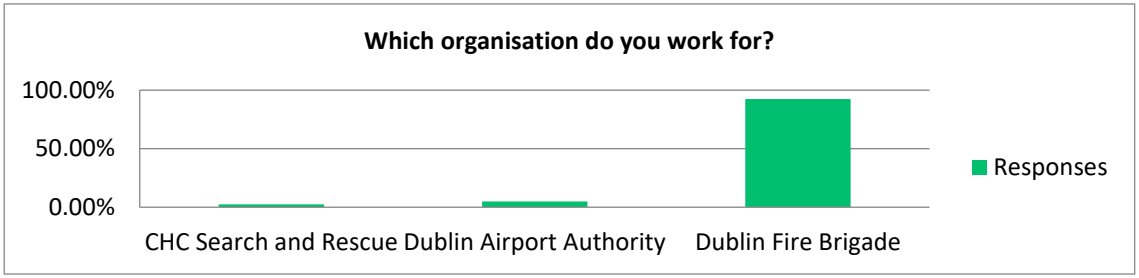
Survey 2		
What is the highest level of education you have completed?		
Answer Choices	Responses	
Junior Cert	10.00%	4
Leaving Cert	50.00%	20
Degree [Level 7 or 8]	17.50%	7
Masters [Level 9]	7.50%	3
Completed graduate school	0.00%	0
Other (please specify)	15.00%	6
	Answered	**40**
	Skipped	**0**



Question 7

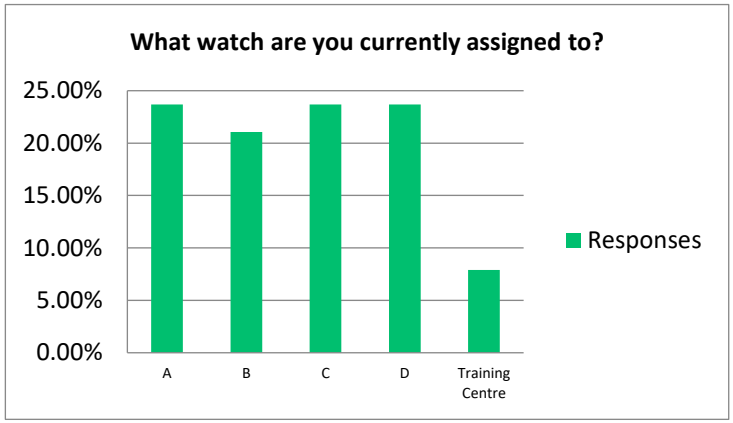
Survey 1		
Which organisation do you work for?		
Answer Choices	Responses	
CHC Search and Rescue	2.44%	1
Dublin Airport Authority	4.88%	2
Dublin Fire Brigade	92.68%	38
	Answered	**41**
	Skipped	**0**

Survey 2		
Which organisation do you work for?		
Answer Choices	Responses	
CHC Search and Rescue	2.50%	1
Dublin Airport Authority	5.00%	2
Dublin Fire Brigade	92.50%	37
	Answered	**40**
	Skipped	**0**

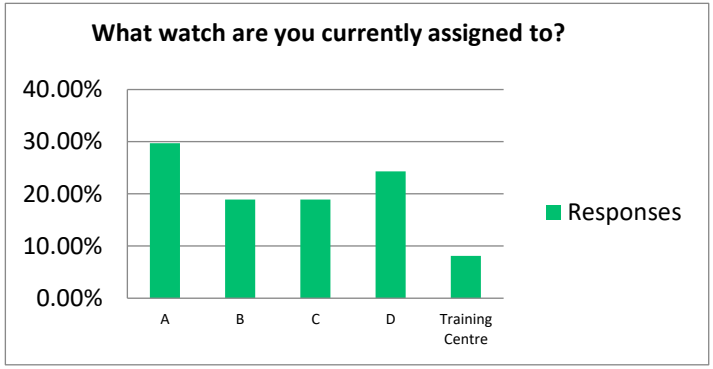


Question 8

Survey 1		
What watch are you currently assigned to?		
Answer Choices	Responses	
A	23.68%	9
B	21.05%	8
C	23.68%	9
D	23.68%	9
Training Centre	7.89%	3
	Answered	**38**
	Skipped	**3**

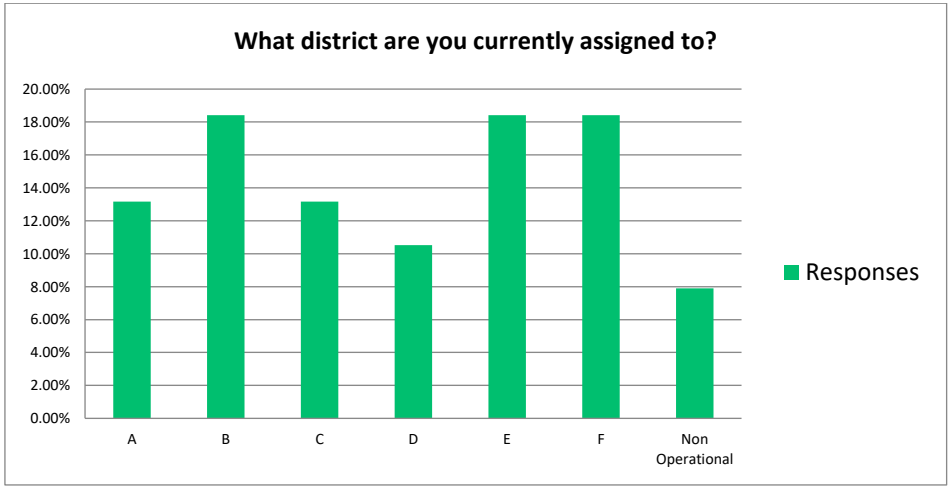


Survey 2		
What watch are you currently assigned to?		
Answer Choices	Responses	
A	29.73%	11
B	18.92%	7
C	18.92%	7
D	24.32%	9
Training Centre	8.11%	3
	Answered	**37**
	Skipped	**3**

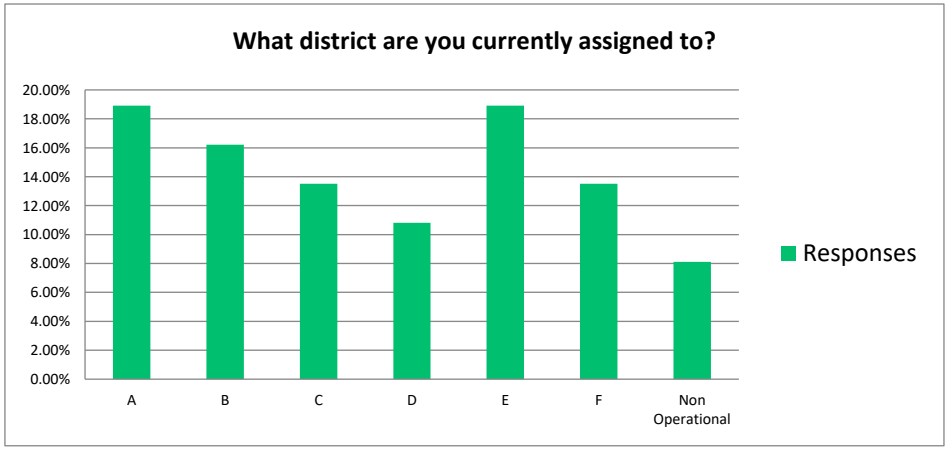


Question 9

Survey 1		
What district are you currently assigned to?		
Answer Choices	Responses	
A	13.16%	5
B	18.42%	7
C	13.16%	5
D	10.53%	4
E	18.42%	7
F	18.42%	7
Non Operational	7.89%	3
	Answered	**38**
	Skipped	**3**

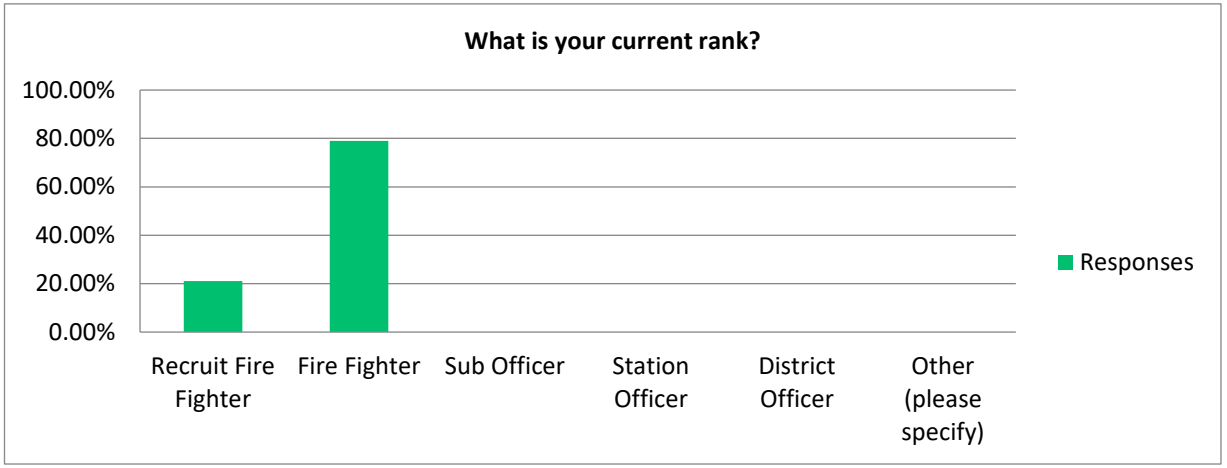


Survey 2		
What district are you currently assigned to?		
Answer Choices	Responses	
A	18.92%	7
B	16.22%	6
C	13.51%	5
D	10.81%	4
E	18.92%	7
F	13.51%	5
Non Operational	8.11%	3
	Answered	**37**
	Skipped	**3**

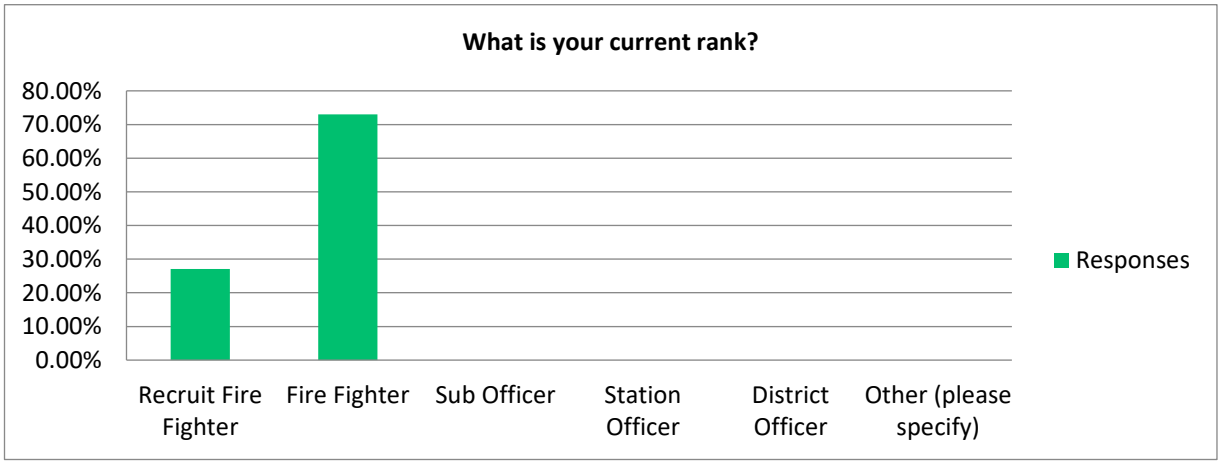


Question 10

Survey 1		
What is your current rank?		
Answer Choices	Responses	
Recruit Fire Fighter	21.05%	8
Fire Fighter	78.95%	30
Sub Officer	0.00%	0
Station Officer	0.00%	0
District Officer	0.00%	0
Other (please specify)	0.00%	0
	Answered	**38**
	Skipped	**3**

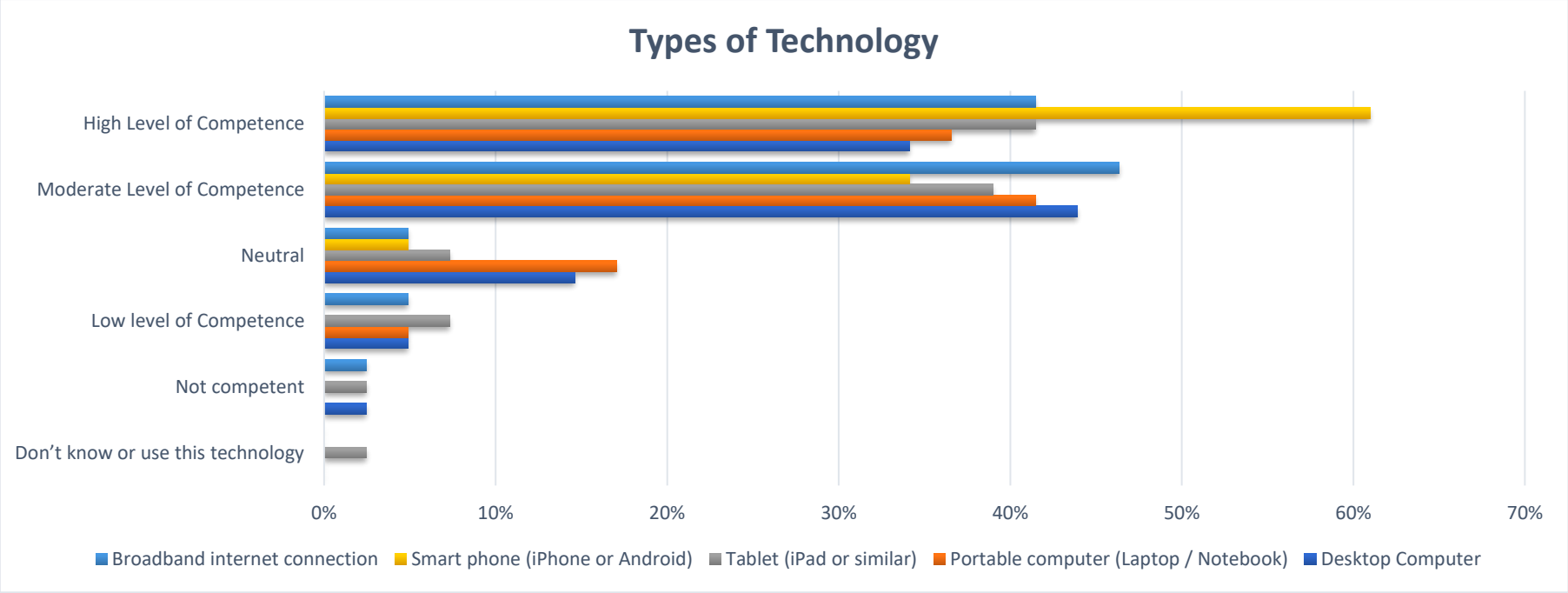


Survey 2		
What is your current rank?		
Answer Choices	Responses	
Recruit Fire Fighter	27.03%	10
Fire Fighter	72.97%	27
Sub Officer	0.00%	0
Station Officer	0.00%	0
District Officer	0.00%	0
Other (please specify)	0.00%	0
	Answered	**37**
	Skipped	**3**



Question 11 [Survey 1]

Survey 1						
Types of Technology	Don't know or use this technology	Not competent	Low level of Competence	Neutral	Moderate Level of Competence	High Level of Competence
Desktop Computer	0.00%	2.44%	4.88%	14.63%	43.90%	34.15%
Portable computer (Laptop / Notebook)	0.00%	0.00%	4.88%	17.07%	41.46%	36.59%
Tablet (iPad or similar)	2.44%	2.44%	7.32%	7.32%	39.02%	41.46%
Smart phone (iPhone or Android)	0.00%	0.00%	0.00%	4.88%	34.15%	60.98%
Broadband internet connection	0.00%	2.44%	4.88%	4.88%	46.34%	41.46%

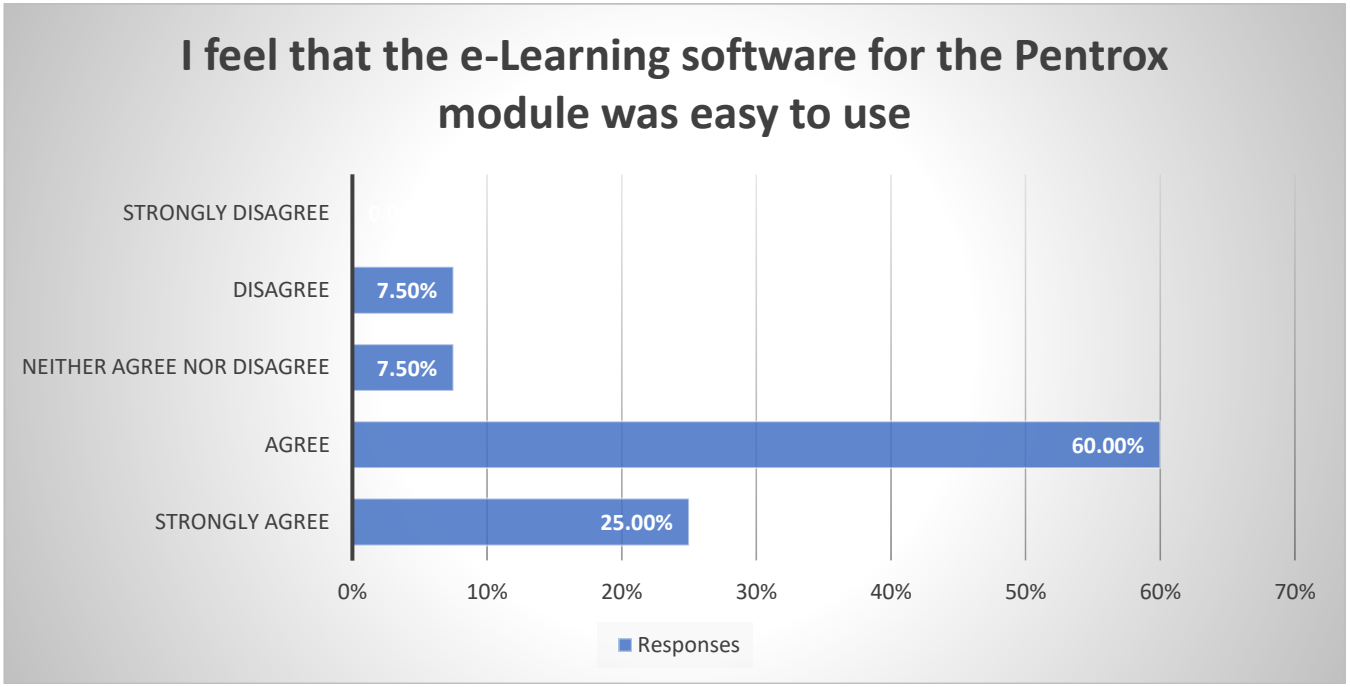


Question 11 [Survey 2]

Survey 2

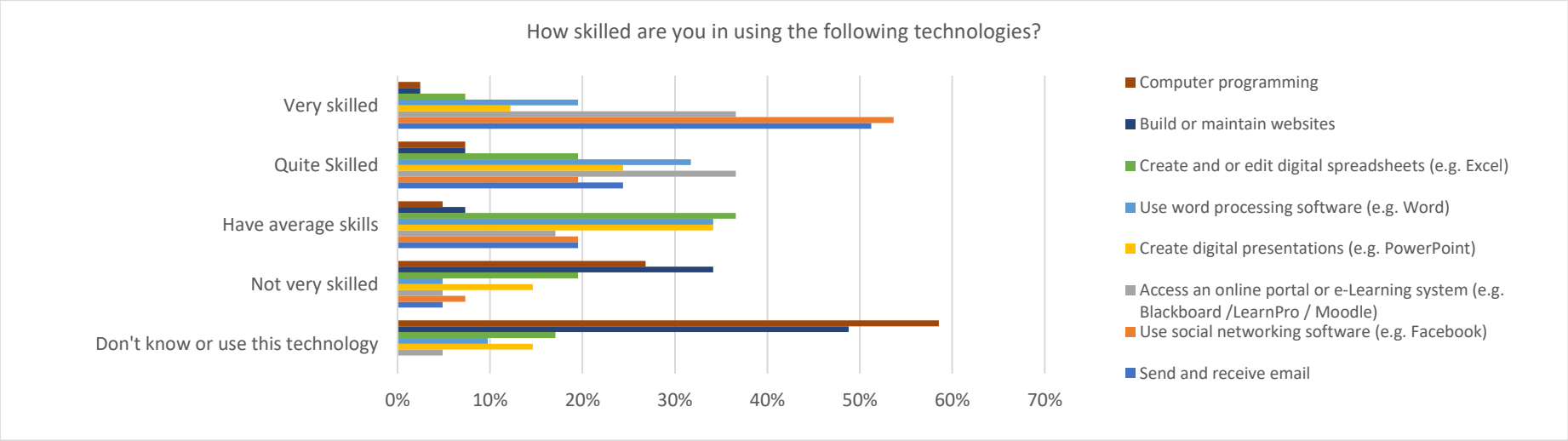
I feel that the e-Learning software for the Pentrox module was easy to use

Answer Choices	Responses
Strongly agree	25.00%
Agree	60.00%
Neither agree nor disagree	7.50%
Disagree	7.50%
Strongly disagree	0.00%



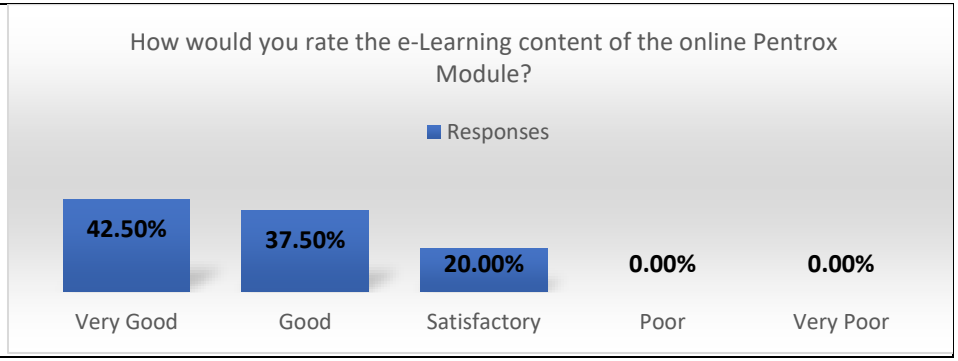
Question 12 [Survey 1]

Survey 1					
How skilled are you in using the following technologies?	Don't know or use this technology	Not very skilled	Have average skills	Quite Skilled	Very skilled
Send and receive email	0.00%	4.88%	19.51%	24.39%	51.22%
Use social networking software (e.g. Facebook)	0.00%	7.32%	19.51%	19.51%	53.66%
Access an online portal or e-Learning system (e.g. Blackboard /LearnPro / Moodle)	4.88%	4.88%	17.07%	36.59%	36.59%
Create digital presentations (e.g. PowerPoint)	14.63%	14.63%	34.15%	24.39%	12.20%
Use word processing software (e.g. Word)	9.76%	4.88%	34.15%	31.71%	19.51%
Create and or edit digital spreadsheets (e.g. Excel)	17.07%	19.51%	36.59%	19.51%	7.32%
Build or maintain websites	48.78%	34.15%	7.32%	7.32%	2.44%
Computer programming	58.54%	26.83%	4.88%	7.32%	2.44%



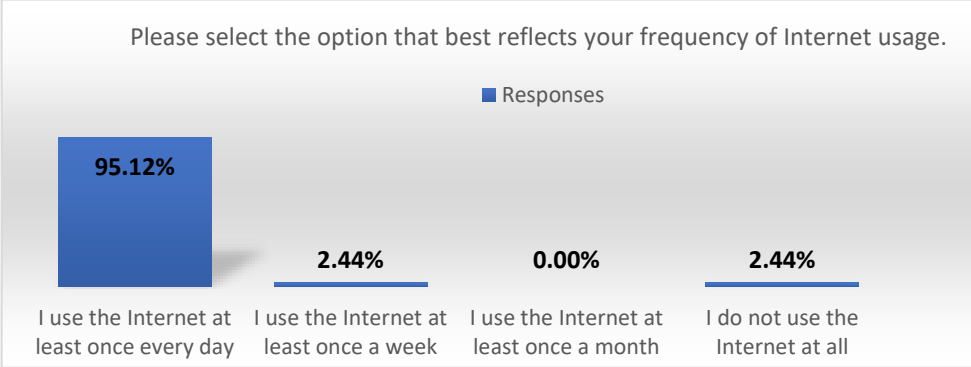
Question 12 [Survey 2]

Survey 2	
How would you rate the e-Learning content of the online Pentrox Module?	
Answer Choices	Responses
Very Good	42.50%
Good	37.50%
Satisfactory	20.00%
Poor	0.00%
Very Poor	0.00%



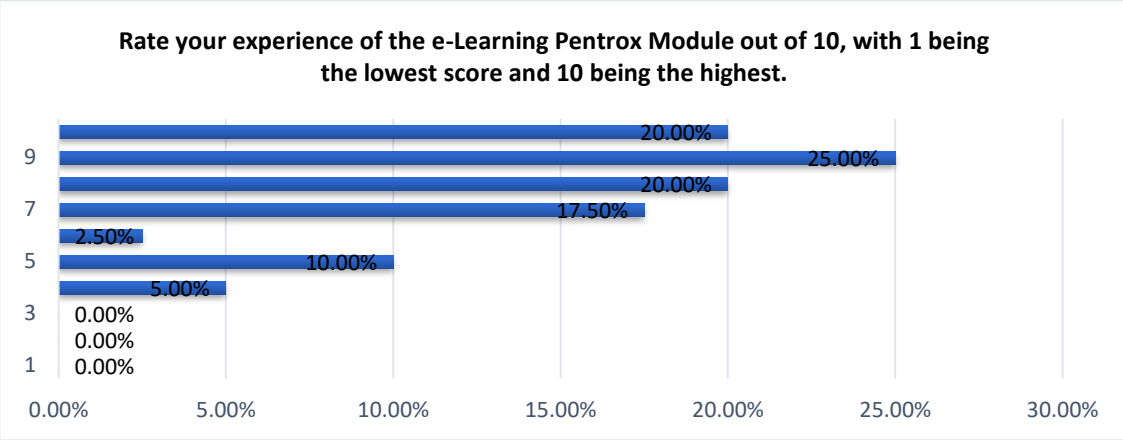
Question 13 [Survey 1]

Survey 1		
Please select the option that best reflects your frequency of Internet usage.		
Answer Choices	Responses	
I use the Internet at least once every day	95.12%	39
I use the Internet at least once a week	2.44%	1
I use the Internet at least once a month	0.00%	0
I do not use the Internet at all	2.44%	1



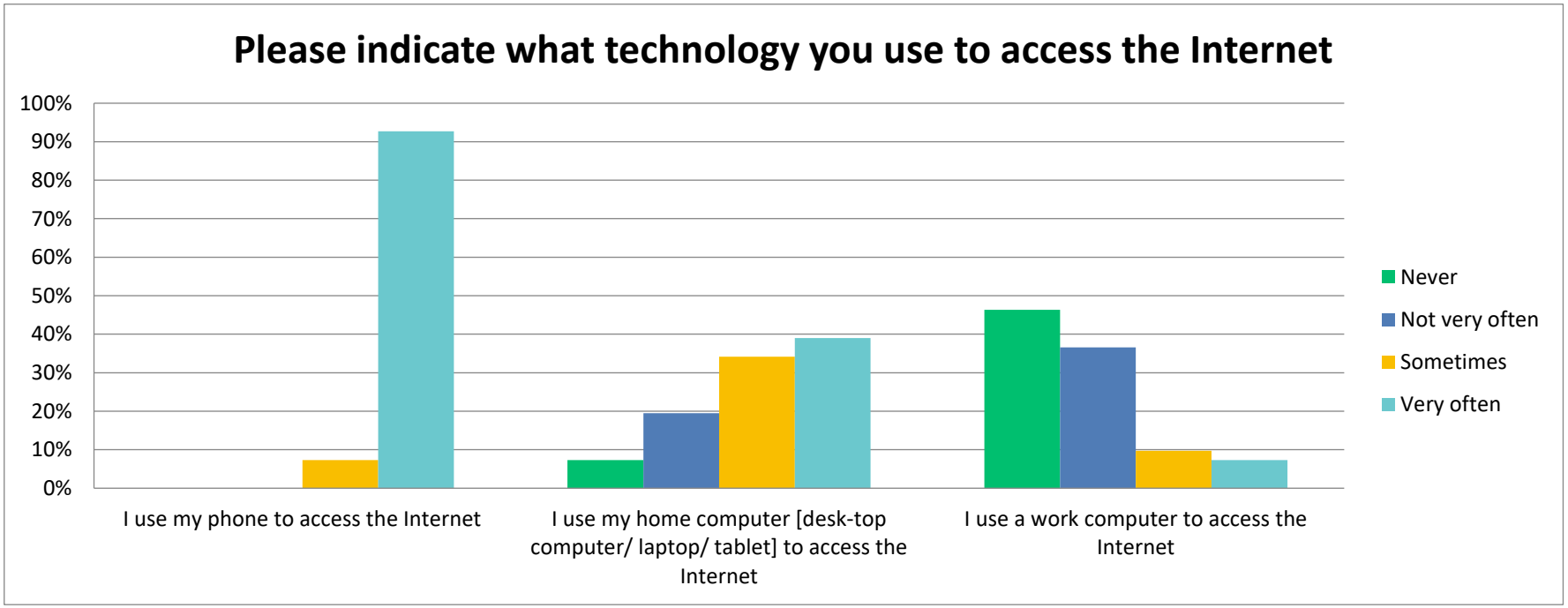
Question 13 [Survey 2]

Survey 2		
Rate your experience of the e-Learning Pentrox Module out of 10, with 1 being the lowest score and 10 being the highest.		
Answer Choices	Responses	
1	0.00%	0
2	0.00%	0
3	0.00%	0
4	5.00%	2
5	10.00%	4
6	2.50%	1
7	17.50%	7
8	20.00%	8
9	25.00%	10
10	20.00%	8



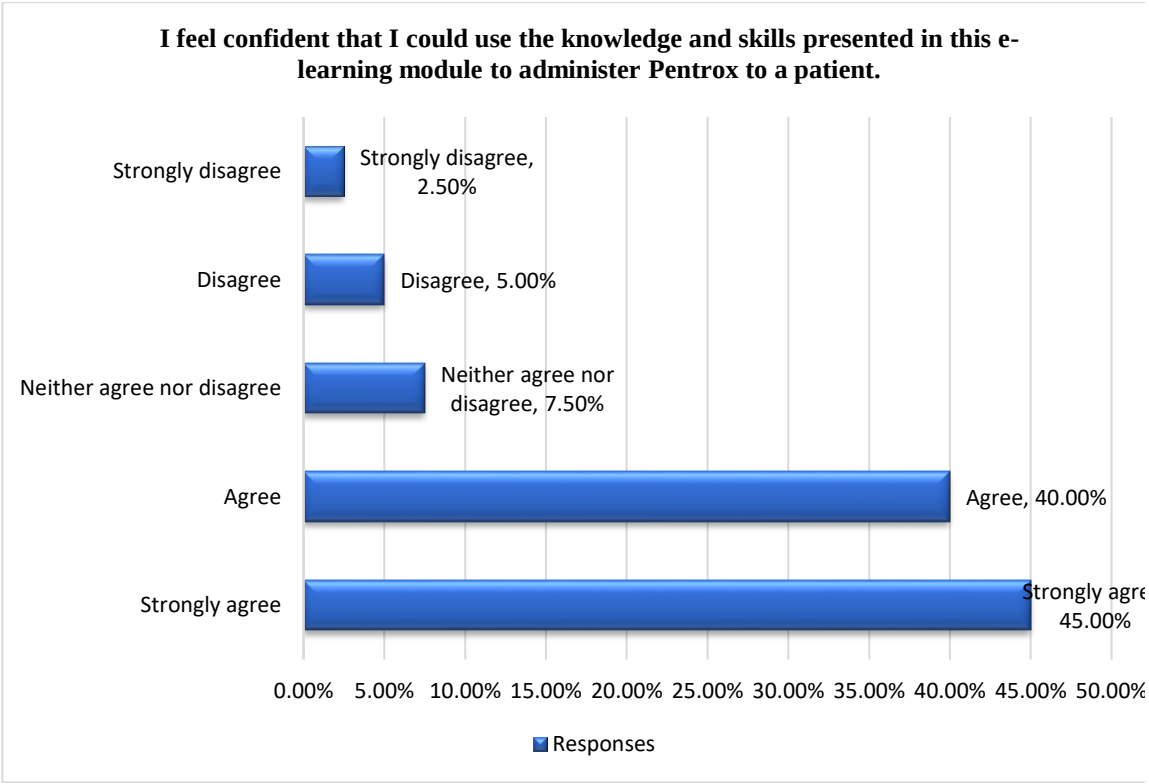
Question 14 [Survey 1]

Survey 1				
Please indicate what technology you use to access the Internet				
	Never	Not very often	Sometimes	Very often
I use my phone to access the Internet	0.00%	0.00%	7.32%	92.68%
I use my home computer [desk-top computer/ laptop/ tablet] to access the Internet	7.32%	19.51%	34.15%	39.02%
I use a work computer to access the Internet	46.34%	36.59%	9.76%	7.32%



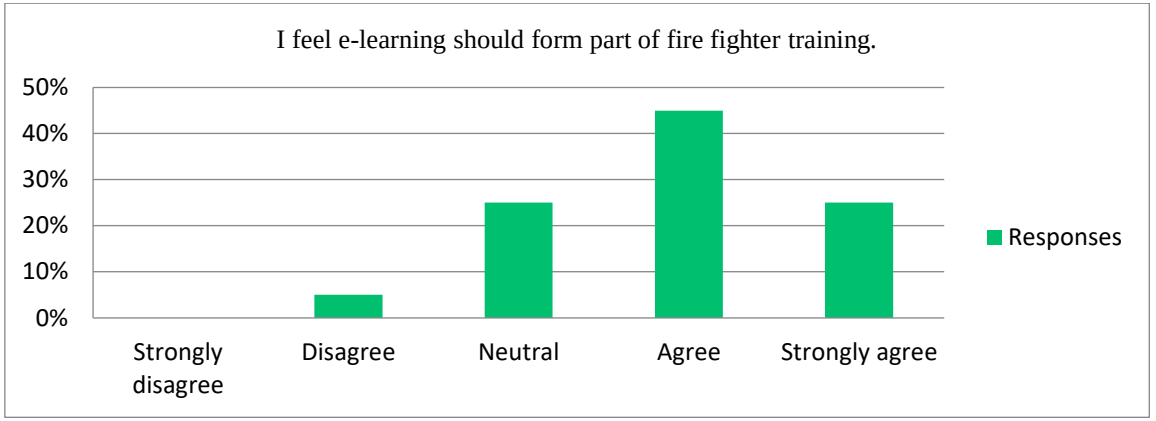
Question 14 [Survey 2]

Survey 2	
I feel confident that I could use the knowledge and skills presented in this e-learning module to administer Pentrox to a patient.	
Answer Choices	Responses
Strongly agree	45.00%
Agree	40.00%
Neither agree nor disagree	7.50%
Disagree	5.00%
Strongly disagree	2.50%

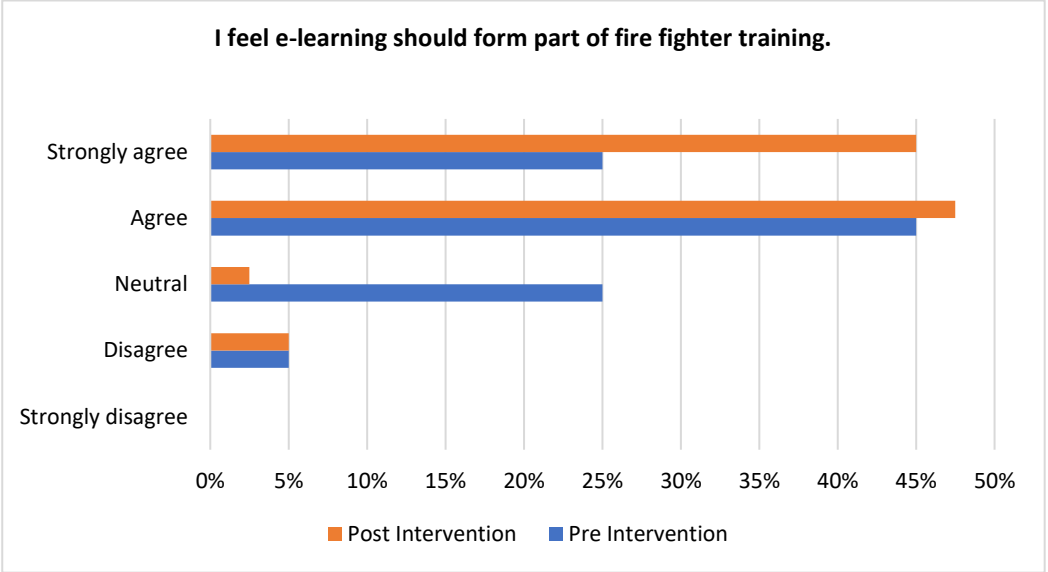


Question 15

Survey 1		
I feel e-learning should form part of fire fighter training.		
Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	5.00%	2
Neutral	25.00%	10
Agree	45.00%	18
Strongly agree	25.00%	10



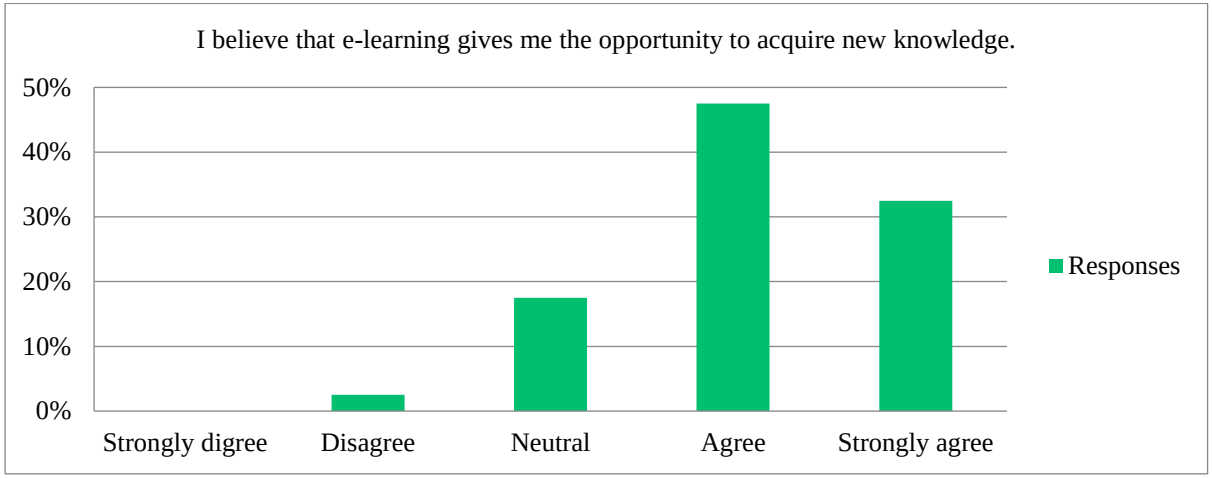
Survey 2			
I feel e-learning should form part of fire fighter training.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	0.00%	0.00%	0.00%
Disagree	5.00%	5.00%	0.00%
Neutral	25.00%	2.50%	22.50%
Agree	45.00%	47.50%	-2.50%
Strongly agree	25.00%	45.00%	-20.00%



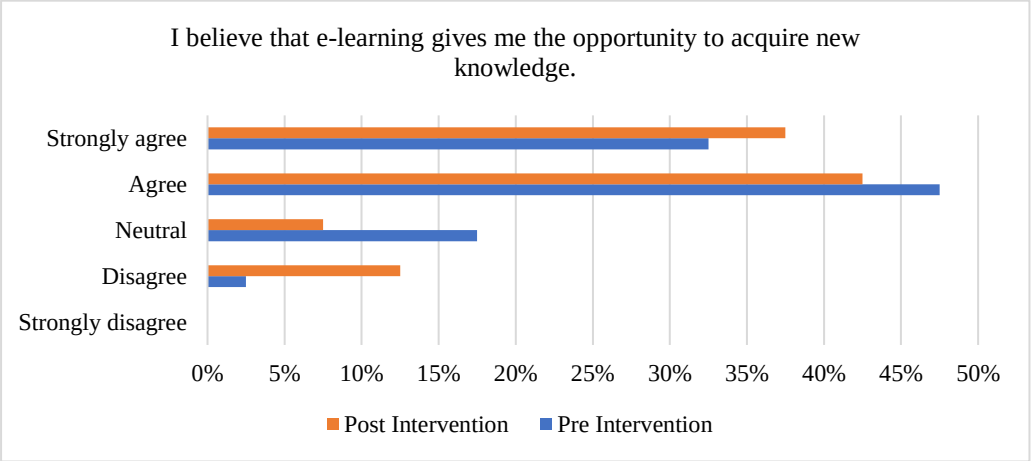
Question 16

Survey 1

I believe that e-learning gives me the opportunity to acquire new knowledge.		
Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	2.50%	1
Neutral	17.50%	7
Agree	47.50%	19
Strongly agree	32.50%	13

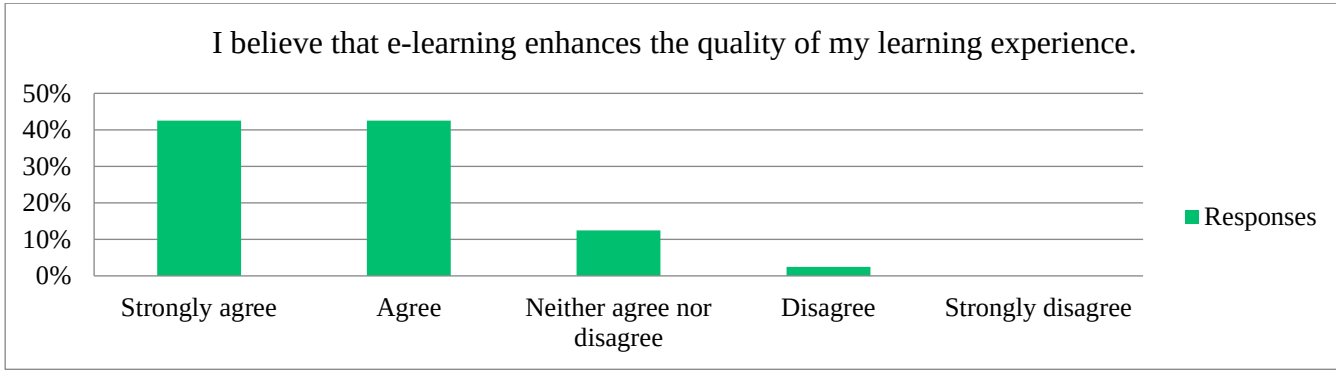


Survey 2			
I believe that e-learning gives me the opportunity to acquire new knowledge.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	0.00%	0.00%	0.00%
Disagree	2.50%	12.50%	-10.00%
Neutral	17.50%	7.50%	10.00%
Agree	47.50%	42.50%	5.00%
Strongly agree	32.50%	37.50%	-5.00%

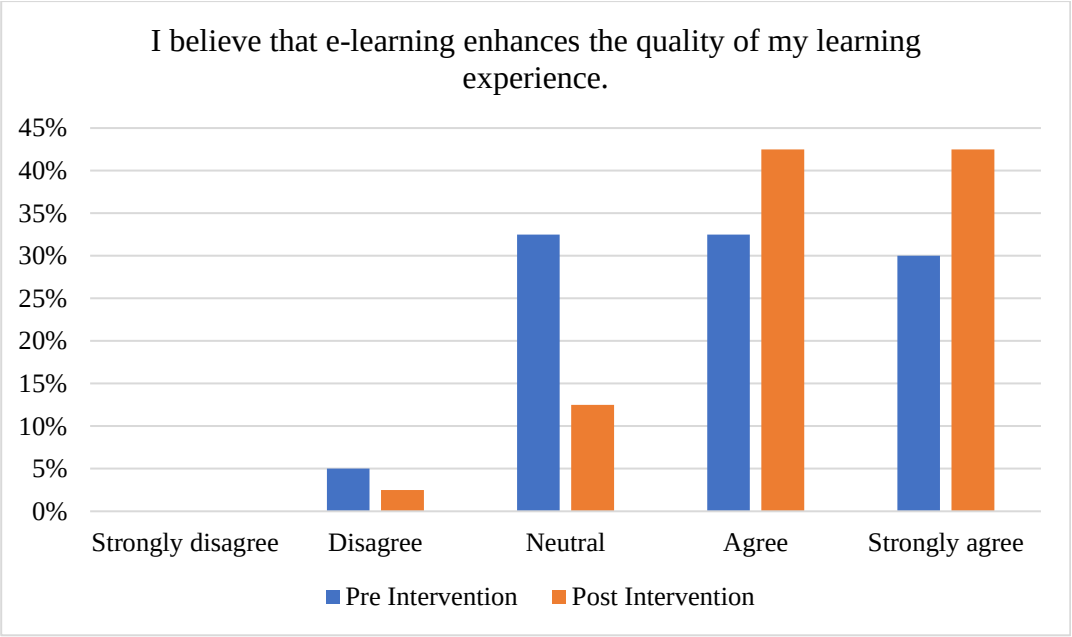


Question 17

Survey 1		
I believe that e-learning enhances the quality of my learning experience.		
Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	5.00%	2
Neutral	32.50%	13
Agree	32.50%	13
Strongly agree	30.00%	12



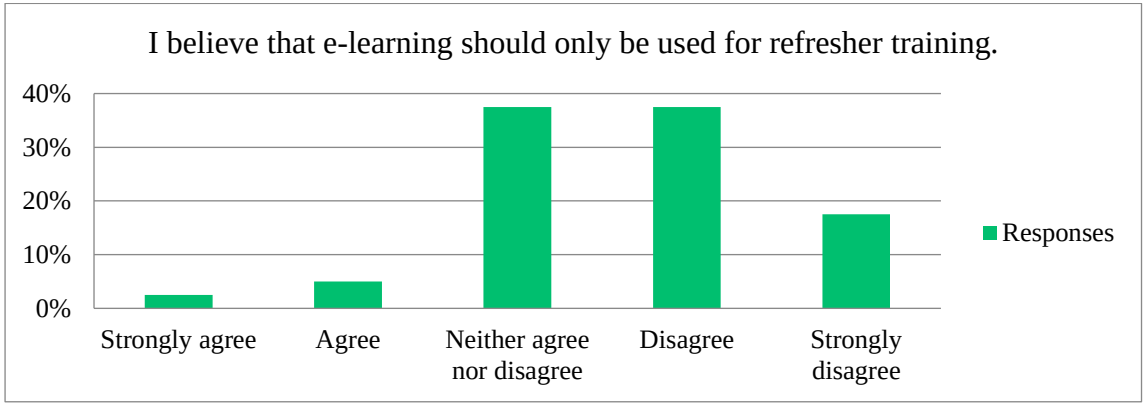
Survey 2			
I believe that e-learning enhances the quality of my learning experience.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	0.00%	0.00%	0.00%
Disagree	5.00%	2.50%	2.50%
Neutral	32.50%	12.50%	20.00%
Agree	32.50%	42.50%	-10.00%
Strongly agree	30.00%	42.50%	-12.50%



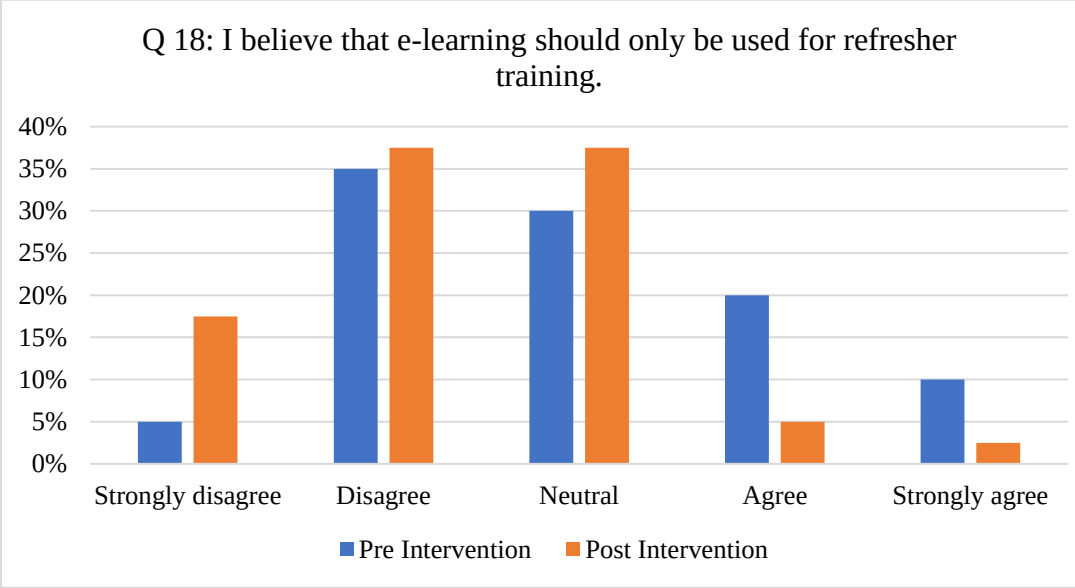
Question 18

Survey 1

I believe that e-learning should only be used for refresher training.		
Answer Choices	Responses	
Strongly disagree	5.00%	2
Disagree	35.00%	14
Neutral	30.00%	12
Agree	20.00%	8
Strongly agree	10.00%	4



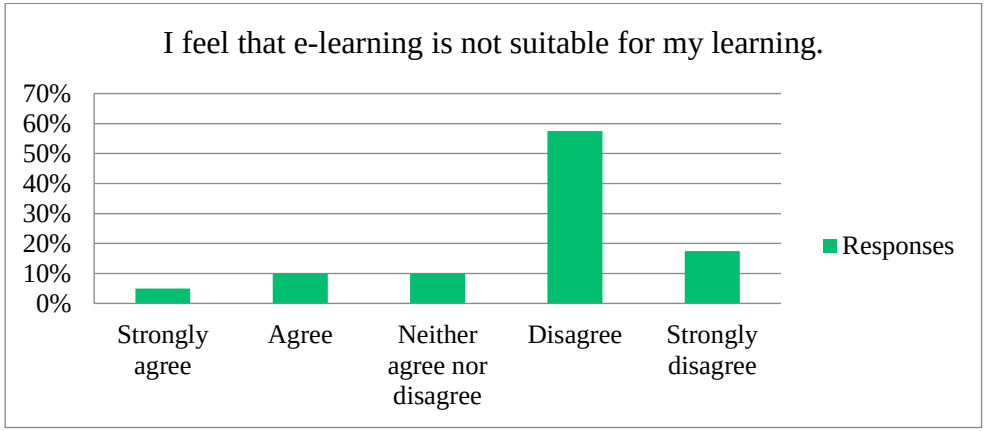
Survey 2			
I believe that e-learning should only be used for refresher training.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	5.00%	17.50%	-12.50%
Disagree	35.00%	37.50%	-2.50%
Neutral	30.00%	37.50%	-7.50%
Agree	20.00%	5.00%	15.00%
Strongly agree	10.00%	2.50%	7.50%



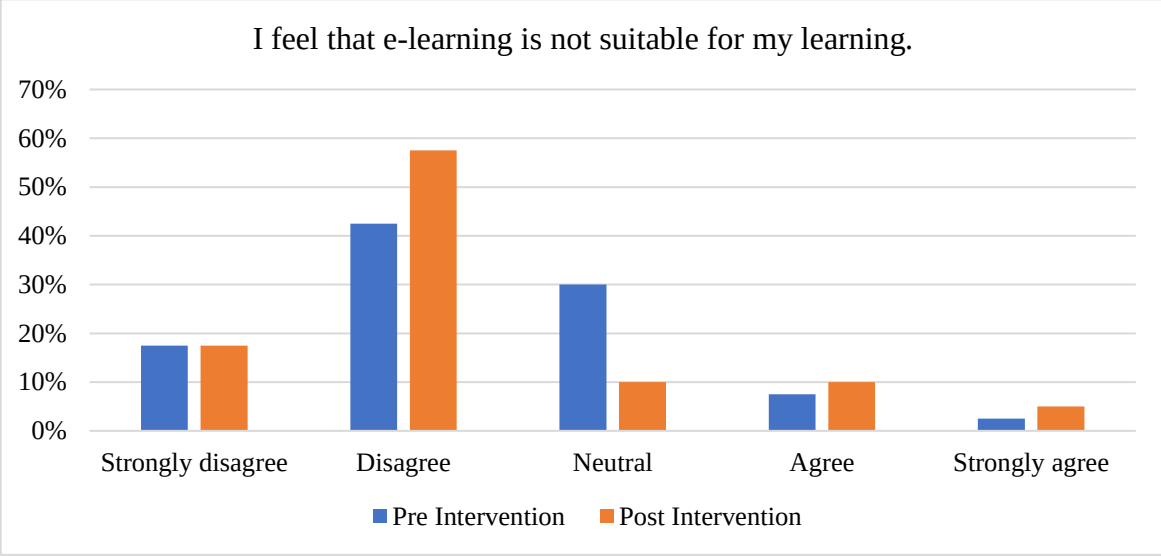
Question 19

Survey 1
I feel that e-learning is not a suitable platform for my own learning.

Answer Choices	Responses	
Strongly disagree	17.50%	7
Disagree	42.50%	17
Neutral	30.00%	12
Agree	7.50%	3
Strongly agree	2.50%	1



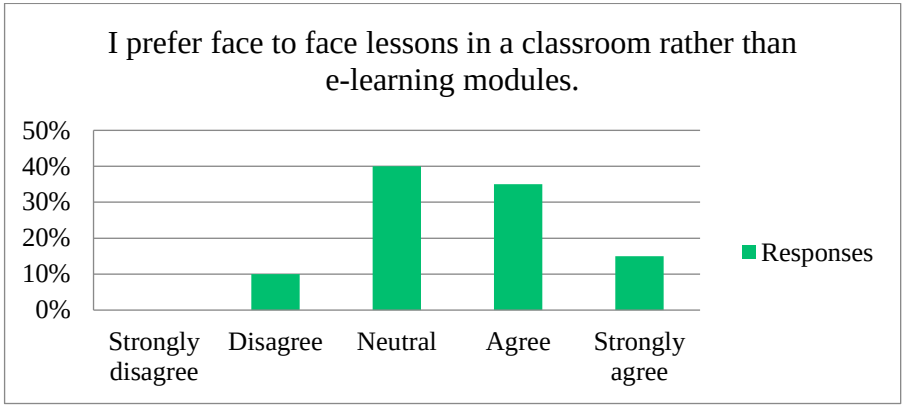
Survey 2			
I feel that e-learning is not a suitable platform for my own learning.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	17.50%	17.50%	0.00%
Disagree	42.50%	57.50%	-15.00%
Neutral	30.00%	10.00%	20.00%
Agree	7.50%	10.00%	-2.50%
Strongly agree	2.50%	5.00%	-2.50%



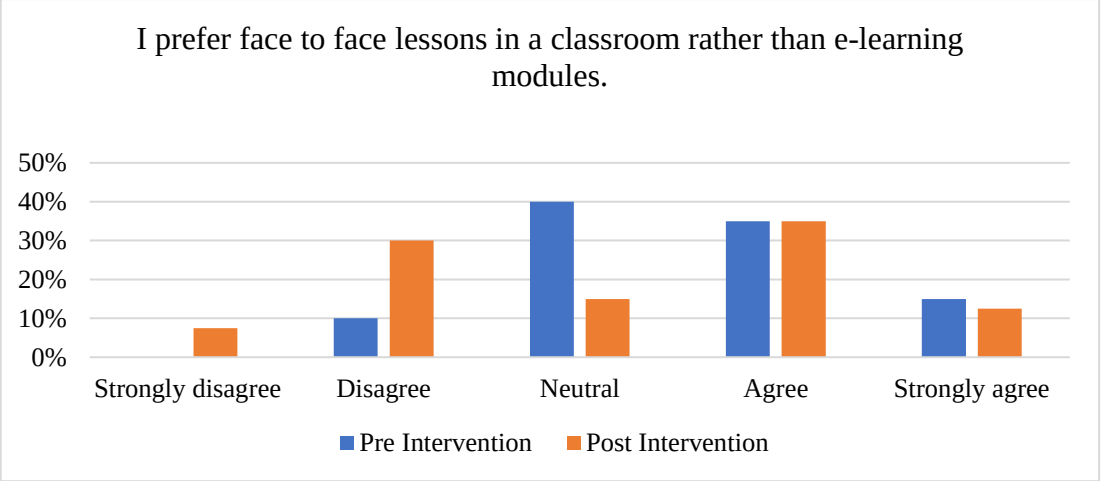
Question 20

Survey 1

I prefer face to face lessons in a classroom rather than e-learning modules.		
Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	10.00%	4
Neutral	40.00%	16
Agree	35.00%	14
Strongly agree	15.00%	6



Survey 2			
I prefer face to face lessons in a classroom rather than e-learning modules.			
Answer Choices	Pre Intervention	Post Intervention	Difference
Strongly disagree	0.00%	7.50%	-7.50%
Disagree	10.00%	30.00%	-20.00%
Neutral	40.00%	15.00%	25.00%
Agree	35.00%	35.00%	0.00%
Strongly agree	15.00%	12.50%	2.50%



Appendix H EMS Pilot LMS system