

**An Evaluation of the Effectiveness of Face-to-Face  
versus e-Learning in the UAE Civil Defence Sector**



## Abstract

In the UAE, e-Learning has been adopted as a new learning mode to increase awareness and standards of building fire safety of its civil defence workforce. Training in this sector has been mainly based around traditional classroom approaches. This research specifically focuses on an online approach to delivering and sustaining the continuous professional development (CPD) of UAE fire fighters. The key aim of this study is to evaluate the effectiveness of learning and performance between face-to-face learning and e-Learning. The central research question is: does learning effectiveness differ between traditional learning and e-Learning? This study employs a quasi-experimental research design to evaluate the three different learning interventions: face-to-face learning, high media rich e-Learning and low media rich e-Learning. A survey method was selected to gather the data on learning effectiveness following the completion of the training programme from a sample of participants ( $n=412$ ) professionally engaged in the civil defence sector. A key finding was that across all measures of learning effectiveness: engagement, cognitive performance and behavioural performance, scores in the face-to-face mode were significantly better than in the e-Learning mode. Furthermore learning effectiveness was found to be significantly better in high media rich than low media rich e-Learning design. The findings indicate that learning styles impacted on learning effectiveness between the three modes of learning. There was significant interaction between learning styles and learning mode on learning effectiveness. There were statistically significant differences in learning effectiveness for all learning styles. In 7 out of the 8 learning styles (Active, Reflective, Verbal, Visual, Sequential, Global, Sensing, Intuitive) learning effectiveness was higher on average in the face-to-face learning mode than in both of the e-Learning modes. The differences in terms of effect sizes varied between these learning styles. Only reflective learning exhibited a higher learning effectiveness score for high media rich e-Learning than face-to-face. Spatial ability did not have any statistically significant effect on learning effectiveness in the two learning approaches of traditional and e-Learning. However when comparing the two types of e-Learning high spatial ability learners performed less well in the low multimedia mode than in the high multimedia mode. This research provides evidence to show that learning styles are significantly related to learning achievement in e-Learning and there are differential effects for different learning styles. The study also provides evidence that the use of rich multimedia is positively related to higher learning effectiveness. The findings contribute to empirical evidence for differences between face-to-face and e-learning and the role of media richness and learning styles. The findings have practical implications for learning strategies.

## **Acknowledgement**

Firstly, I would like to extend my deepest gratitude to my advisor Professor Lamine Mahdjoubi for his continuous support and guidance throughout this Ph.D research which has been of great value. I am thankful his for his commitment and dedication and knowledge to my research. In particular, I would also like to give my deepest thanks and appreciation to my family for their support and belief in me throughout my research. I also would like to thank my government of the UAE for extending its support and direction in conducting this research.

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# **Chapter 1 Introduction**

## **1.1 Background and Context**

The United Arab Emirates (UAE) has developed into a key regional economic actor and international hub with significant diversity in nationalities and languages. This study focuses on fire fighter training using e-Learning for tackling fires in domestic high rise living accommodation. Civil defence in the UAE is increasingly undertaking a more vital role following the rapid pace of economic and social modernisation and growth and the creation of globally leading infrastructures. The Civil Defence Department has the key responsibility of ensuring that fire fighters are appropriately trained to protect the public and installations. Government targets for response times of four minutes by 2021 are exceeded by current response times of seven minutes. Moreover there is insufficient awareness of building fire safety and an identified need for more effective civil defence workforce training to enhance the quality of services. This research specifically focuses on an online approach to delivering and sustaining the continuous professional development (CPD) of UAE fire fighters.

E-learning has increasingly become a critical element within the development strategies of the public sector and organisations generally. Supported by new technologies the growth of e-Learning globally and in all fields has been rapid, and within the education sector is the fastest growing segment. In terms of civil defence training e-Learning serves as both a new learning mode and method of delivery, providing the opportunity to remove boundaries and bring learning communities together (Garrison, 2011) as well as personalise and tailor learning experiences (Rennie and Morrison, 2013).

The critical importance of enhancing the development of civil defence sector workers has been emphasised. Major priorities and areas of development have been identified by UAE Civil Defence to include: human resources development; leadership excellence; cadre development; creation and maintenance of a safety culture; implementation of extensive standards for prevention and advancing preventive awareness within the community; an effective strategic partnership with the public and private sectors in terms of emergency response, and incorporation of global best practice both in the field and administration (Abu Dhabi Civil Defence General Directorate, 2014; Directorate General of Civil Defence, 2016).

Within the Middle East region the UAE is notable as a key early adopter of e-Learning. Despite this the majority of higher education institutions have lagged in e-Learning provision due to low public perceptions of the quality of online learning and the resulting qualifications (Mirza and Al-Abdulkareem, 2011). This underlines the importance of ensuring quality assurance within UAE e-Learning. Civil Defence encompasses all seven emirates and has one central command and seven general directorates. Its core mission is the protection of life and property. This means that it is responsible for making sure that buildings comply with fire safety regulations and standards. Thus effective training is critical for fire fighters for both fire safety awareness and effective response to incidents.

## **1.2 Study Rationale**

The rationale for this study is driven by multiple key challenges and priorities concerning training and CPD within UAE civil defence, as well as issues in relation to learning styles, training delivery, and resourcing. Following the loss of 36 lives and a total of 2,700 fires in 2015 the UAE government set the key goal to reduce response

times to four minutes by 2021. The diversity of the country and the low level of awareness of fire safety means that there is significant need to ensure that civil defence managers are effectively trained, and that a lack of fire safety training scenarios and processes for individuals and civil institutions is addressed to support greater community awareness (Alteneiji, 2015).

Choosing an effective training approach is a major concern with different forms of training delivery available for civil defence practitioners. The literature highlights that the most widely used training methods include face-to-face training, online courses, virtual reality and simulations. While there are acknowledged advantages with the first two methods, virtual reality and simulations have been shown to be more useful for workplace and vocational training (Boldrini, 2016; Miller and France, 2013). To prepare for fire simulation training, fire fighters can undertake programmes that involve blended or hybrid training combining online learning with face-to-face meetings. Such mixed training is shown to improve the fire fighter's ability to retain the learning and to expand learning capabilities (Bala et al., 2016). Evidence underlines that courses and simulation training need to target skills development in the key area of critical assessment and analysis of a crisis situation to ensure an effective crisis response (Camacho et al., 2016). Real-time crisis simulation training is indicated to expand the learner experience and their perception of the significance of decision-making processes and efficient communications in crisis situations (Boldrini, 2016; Miller and France, 2013).

It is important to implement an effective training strategy in the UAE given the significance of delivering continuous professional development (CPD) that until now has been mainly based around traditional classroom approaches. Evidence from Al Hmoudi and Aziz (2015) highlights issues in the comprehension of particular civil

defence processes and in UAE training processes. CPD is critical for fire fighters and emergency personnel (Knox et al., 2013), as well as any employee and professional seeking to develop their skills or to obtain a necessary qualification for gaining or retaining a job. CPD for emergency response may involve learning to use a new technology or piece of equipment. A study by Knox et al., (2013) indicated that nearly all Emergency Medical Technicians (EMTs) participants viewed practical scenario-based activities to be the most useful within CPD.

Nevertheless undertaking CPD faces a range of challenges related to family life, considerable workloads, and self-control (Xu et al., 2016). Within civil defence contexts there are issues such as variable work patterns which form barriers to CPD as long hours and rotating shift patterns can mean that stability and consistency are difficult (Joyner, 2012). Moreover shortages of frontline staff at civil defence stations can be caused by delivery of traditional classroom training. The development of Fire Departments is challenged by a lack of funding and inadequate resources affecting the ability to send frontline staff on training courses, workshops and conferences located away from the workplace. Therefore fire departments are increasingly focusing attention on other effective, reliable and cost-effective approaches to promote practitioner training. Empirical evidence emphasises scenario-based training as a highly effective means to sustain competence and skills (Knox et al., 2013; Simpson et al., 2012).

Training delivery and differences in learning style are key issues to consider given that the average age of civil defence employees is below 30. Firefighter personnel are generally recruited in their early 20s and possess a distinct set of learning needs in comparison with more senior personnel (Bala et al., 2016). Current younger generations of fire fighters show a preference for electronic, visual and interactive training delivery



and are less receptive to the conventional forms of delivery evident in the public sector (Sarihan et al., 2016). Studies have shown that learning can be enhanced through personalisation and discovering knowledge independently (Leszczyński, 2015).

Civil defence training and learning is traditionally implemented in a face-to-face mode. As a result training that is delivered only in an online environment may be confronted by a number of issues. In particular the training content is highly technical, which suggests that learning can be maximised when learners are able to engage in practical exercises and problem-solving and when certain practices and techniques are taught interactively. The difficulty of recreating such face-to-face learning experiences in online environments has been acknowledged (Wang, 2013). Early models of online training mainly emphasise the delivery of information rather than online learning (Laurillard, 1993) however the nature of technical training underlines the ineffectiveness of making available information online or delivering static learning materials. This points to the critical issue of optimising and maximising effective civil defence learning experiences to ensure learners can develop knowledge in the online context.

Recent evidence underlines the importance of student learning style to learning and instruction. Both researchers and instructional designers argue that to ensure high quality and the effectiveness of instruction, design and pedagogical approaches including online courses should be adapted to students' learning styles (Valenta et al., 2001). There is a need for enhancing the viability and attractiveness of the e-Learning option for different types of learners. Further research is needed to explore any learning style similarities and differences between traditional and online learners and to what extent e-Learning influences any changes in student learning styles. Further it is

important to understand the extent to which learning effectiveness differs between learning approaches and factors. A comparative analysis will identify such differences and have implications for the design and development of civil defence training programmes.

E-learning represents a viable option for civil defence training and can complement traditional methods of delivery. The adoption of e-Learning is based on a number of perceived benefits including the ability to participate in real-life simulations that may not be reproducible in any other way, and control over participant interactions with realistic situations (Walker et al., 2011). In particular, online courses are able to be accessed conveniently and frequently (Batista, 2014) and are associated with higher retention and reaction abilities (Bala et al., 2016). It can foster the use of effective, new and user friendly products and technologies (DECIDE, 2015) while improvements in technology have ensured consistency and flexible, timely access (Batista, 2014).

However while the benefits of e-Learning as a training strategy are acknowledged there is some research to show mixed outcomes with the use of e-Learning. Limited empirical research has been conducted that investigates adult learner satisfaction with e-Learning instruction in an industry context. As a result there is limited guidance available for practitioners and industry leaders aiming to utilise e-Learning for training (Hairston, 2007). Moreover, while the literature has focused on models of information systems success there has been minimal research to evaluate the effectiveness or success of e-Learning systems within organisational settings (Wang et al., 2007). Further there are key issues in terms of resourcing and the effective design of courses (Leszczyński, 2015), and in particular delivering courses which are highly engaging. In addition there needs to be a focus on media-rich e-Learning solutions that fulfil the learning needs of

the field. The low level of online interaction within training courses underlines the need to include applied activities and real-life scenarios (Knox et al., 2013; Simpson et al., 2012). Such learning approaches may also support the development of spatial abilities which are critical in the area of civil defence enabling the visualisation of complex spatial problems and tasks. Spatial ability is identified as the capacity to comprehend, reason and remember the spatial relations among objects. Distinguishable from other types of abilities such as verbal or reasoning skills spatial abilities are crucial for navigation, understanding equipment, or estimating distance and measurement, and are key to success in diverse scientific fields (Gilbert, 2005). In order to link theory and practice, e-Learning courses and scenarios and virtual reality training has developed. One example during an Ebola emergency involved the virtual reproduction of an Ebola Treatment Centre to generate a realistic and safe environment in which emergency workers could obtain the needed skills. Despite certain limitations, the e-Learning environment was shown to be a cost-effective choice in comparison with traditional training methods (Camacho et al., 2016).

Nevertheless substantial investment is needed in resources, technologies, and expertise for e-Learning, which are limited by current financial constraints in public sector financing. Thus there is critical importance in ensuring effective quality assurance in the design and implementation of e-Learning to meet civil defence learning needs and maximise investment. These needs are reflected in the functions of Civil Defence as outlined by the UAE government with major priorities emphasised as:

- Predict disasters and crisis in order to prepare required plans to manage, and create and outfit emergency management centres.
- Prepare risks and disasters protection program, setting general alarm system for residents during emergency situations.

- Form teams needed to carry out response and relief operations and participate in restoration of life back to normal in affected areas.
- Prepare joint evacuation training program for both civilian and volunteers
- Conduct preventive awareness programmes for community members
- Coordinate assistance and support efforts to cater to regional departments (DGCD, 2017).

This study focuses on the necessity to evaluate the efficacy of different modes of learning: traditional learning and e-Learning within different design formats. This research is focused on the evaluation of different learning interventions in implementing course modules in three key areas of: Equipment Maintenance; Building Fire Safety; and Operational Procedures

The growing adoption of e-Learning as a major solution for the civil defence sector allows improved flexibility in terms of access for learners from different locations, and with different schedules and channels for accessing course resources. However, a key risk is a failure to align learner needs and preferences with current provision of e-Learning by institutions and to achieve effective learning outcomes (Bischel, 2013). Comparing the effectiveness of learning between interventions as the basis for quality assurance is therefore a core issue resulting in the development of multiple national and international efforts to develop appropriate quality assurance frameworks (Jung et al., 2011). However a significant number of institutions are argued to be inadequate in terms of quality evaluation and assessment of learning outcomes in e-Learning or dual learning contexts (Bischel, 2013).

### **1.3 Aims and Research Questions**

As a result of the dynamic context of civil defence and the integration of e-Learning into the civil defence training strategy there is an imperative to evaluate the effectiveness

of e-Learning relative to traditional modes of delivery to ensure quality of training for fire safety in sleeping accommodation and high rise buildings, with a particular focus on UAE Civil Defence. Given this context the aim of this research is to evaluate the effectiveness of learning and performance between two learning approaches: traditional versus e-Learning; and between two types of e-Learning design: low media rich and high media rich. The research is based on a central research question that is sub-divided into multiple questions. The intention is to further understanding on the effectiveness of civil defence training across two forms of learning. The central research question is: does learning effectiveness differ between traditional learning and e-Learning? A number of specific research questions fall under this main question:

RQ1: Does learning effectiveness differ between traditional learning and e-Learning?

RQ2: Do learning styles impact on learning effectiveness between different e-Learning designs?

RQ3: Does spatial ability impact on learning effectiveness between different e-Learning designs?

#### **1.4 Research Objectives**

To address this research goal and questions the following objectives have been formulated:

- To conduct experiments testing learning effectiveness between three modes of learning: tradition learning, e-Learning (design 1), e-Learning (design 2).
- To test and validate the effectiveness of the e-Learning modules in comparison to a traditional face-to-face mode of training delivery.
- To investigate learners' perceptions and performance between traditional learning and e-Learning course modules.
- To evaluate the interaction between learning styles and learning effectiveness within traditional and e-Learning.
- Recommend the implications of the findings for Civil Defence policy, practice, and future research.

## **1.5 Significance and Contribution to Knowledge**

This research is important to the field of e-Learning evaluation and quality assurance and helps in extending existing knowledge. The study makes a key contribution by providing an understanding of the stakeholders, processes and contextual factors which are critical to the development of quality assurance in the e-Learning modules. This research addresses the evolving nature of e-Learning in UAE public sector organisations and provides a theoretical understanding of issues which may potentially benefit practitioners and policy makers in developing an effective dynamic framework of fire safety tutorials.

## **1.6 Structure of Thesis**

The structure of thesis is presented in Figure 1-1. The first chapter of this thesis has introduced the subject of the research and the context detailing the background, the rationale for this research, and aims and significance. Chapter 2 presents an overview of civil defence and training in the UAE providing a strong contextual perspective forming the basis for this study. Chapter 3 reviews the current literature and discusses the key themes and debates in e-Learning that contribute to the theoretical framework and underpins the research process.

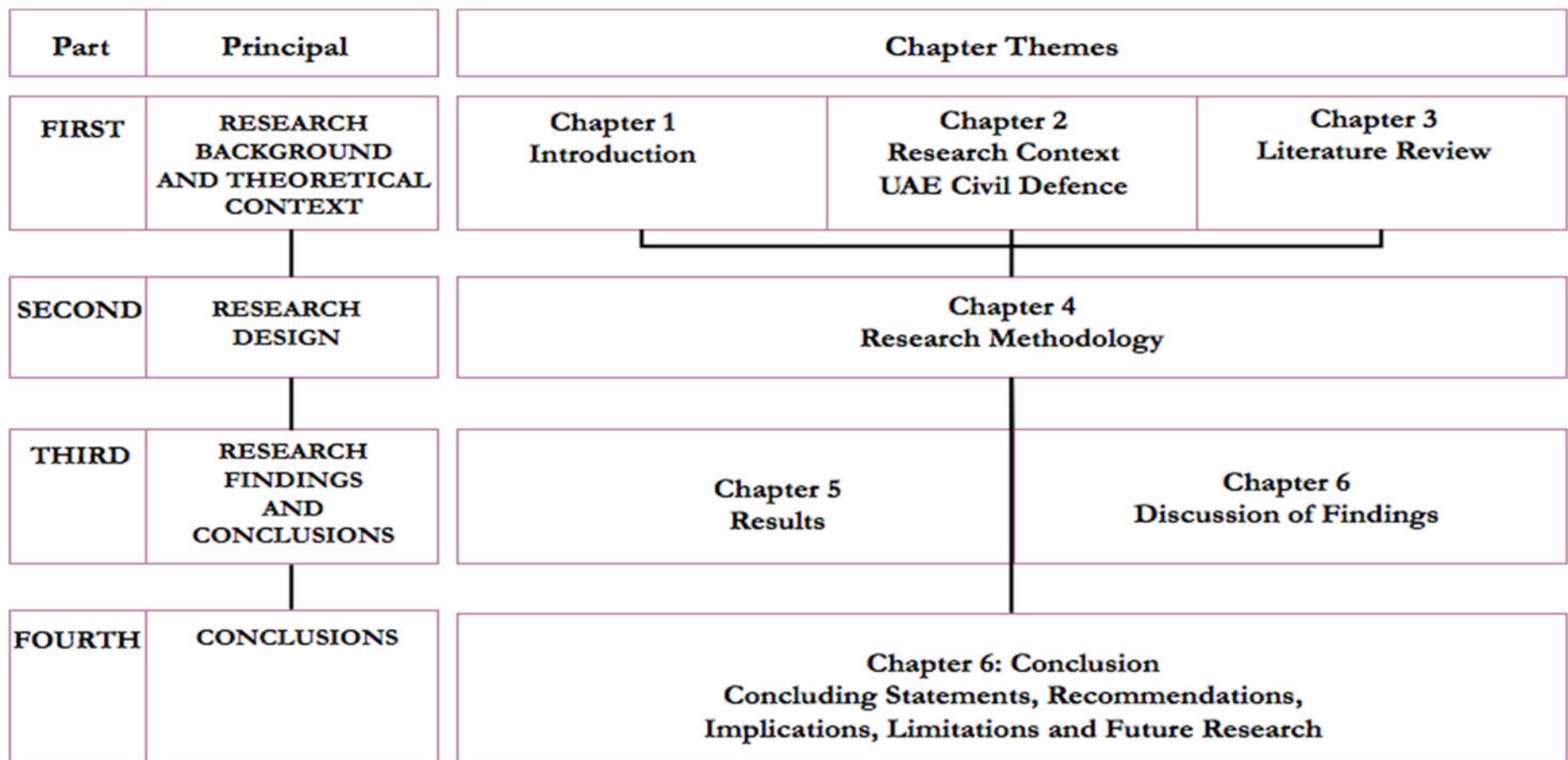


Figure 1-1 Thesis Structure

This forms the basis for the research design outlined in Chapter 4 that details and justifies the methodological approach and procedures selected to address the research goals. Chapter 5 presents the results of the data gathered from the experiment and survey while Chapter 6 analyses and discusses the key findings and implications from the results. The concluding chapter summarises the thesis and the key conclusions that can be drawn from the research process and discusses the main contribution, recommendations, limitations and the opportunities for future research.



## **Chapter 2      Research Context**

### **2.1 Introduction**

Civil Defence departments encompass a system of measures aimed at providing both protection and emergency relief to civilians that are subject to emergencies, natural disasters or hostile attacks (Merriam-Webster, 2004). It involves the preparation and delivery of help and support to individuals, communities and groups that require immediate assistance as a consequence of either man-made or natural events (CDA, 2013). The General Directorate for Civil Defence was founded in 1976 under federal law by the Federation Supreme Council. Civil Defence is the primary responsibility of the Ministry of the Interior (MoI), which creates and shapes the national strategy, vision and mission for civil defence, defined as making the UAE “one of the most secure and safest countries in the world.” The law identifies the role of civil defence to “protect citizens, public and private properties, rescue affected people, ensure safety of transportation, ensure work flows properly in public facilities, and finally protect sources of national wealth during emergency and public disasters” (Dhanhani, 2010, p.70).

Key civil defence structures include the Civil Defence Council, and the General Directorate of Civil Defence while each emirate has a civil defence regional committee and civil defence centre headed by Abu Dhabi (UAEInteract, 2015). These structures contain a range of different departments and subsections which include planning and development, operations, technical, civil protection and security, and information technology and multimedia among others (Epicos, 2013). Strategy implementation is the responsibility of individual emirates. Civil defence in Abu Dhabi, Dubai and Sharjah is managed by a General Directorate while Ajman is managed by a General

Administration, and the remaining three emirates have Departments (Epicos, 2013). The coordination of civil defence across these structures at regional and Emirati level involves emergency and rescue services including fire, and ambulance, police force civil defence units, air and maritime rescue, and civilian volunteers (Epicos, 2013).

Emirate civil defence organisations are key actors in civil defence operational activities. As well as commercial and industrial safety and security, these organisations support disaster response and rescue missions and train and coordinate emergency units and teams of volunteers to provide assistance to civil defence workers during crises (DubaiGov, 2015; ADCD, 2014). Civil defence organisations are further involved in raising public awareness, road safety, supporting preventive safety in buildings, collecting and organising risk information and statistics, ensuring that civil defence workers and managers are trained, establishing rapid response teams and updating equipment and promoting its use (EPICOS, 2013). Key objectives are the protection of life and property and safeguarding the availability and safety of transportation, utilities, communication and the overall environment (DubaiGov, 2015; ADCD, 2014). Building fires can have significant implications in terms of loss of life, business and property damage. In the United States, fires in 2012 led to 3,005 civilian fire fatalities, 17,500 civilian fire injuries and approximately \$11.6bn in property losses (National Fire Protection Association, 2012). London has recently witnessed one of the worst building fires in recent history in Grenfell Flats which led to significant loss of life (BBC, 2017). In 2015 the UAE suffered 2,700 building fires with the loss of 36 lives.

Building fire safety is critical for a range of reasons. It supports the prevention of accidents and damage or destruction to buildings while knowledge of fire safety can

ensure the safe evacuation of buildings. Fire safety can be enabled through training based on best practices in fire safety codes.

Over time development of the UAE Civil defence has experienced a number of challenges. Due to its geographical position the UAE can be subject to natural disasters including floods, landslides and earthquakes. The level of preparedness and response to these crises including the 2002 Fujairah earthquake has led to criticism in the past. This was viewed to have arisen from an absence of clarity within different government entities concerning their role and a lack of communication and integration (Dhanhani, 2010). Challenges also emerge from the comparatively different risks faced across different emirates such as the business and industry hubs of Dubai and Abu Dhabi (Dhanhani, 2010).

To address these challenges the aim of UAE civil defence is to ensure the continuous development of high standards and the fulfilment of strategic objectives to attain the highest level of safety possible (UAEInteract, 2015a). Evidence shows that this has been accompanied by an increased focus on the training and development of workers, and the introduction of new technologies and practices which entail training needs. Dubai for example has put into place legal mandates to ensure that ambulance services are developed and enhanced to match international best practices. This has motivated continuous training and educational programmes to advance employee competencies (UAEInteract, 2015b). Three key types of training approaches are common in fire safety training. These are preparation for fire simulation training; face to face vocational training employing fire simulations, and CPD delivered mainly in the classroom (Jane Lamb et al., 2014).

The UAE is consistently introducing new civil defence technologies such as the deployment of drones in Dubai to view and fight fires (UAEInteract, 2014a) and the use of wireless remote aircraft in search and rescue missions (UAEInteract, 2013). A range of initiatives have also centred on personnel training and education in other countries. Recently study tours in Australia have been undertaken by UAE paramedics while search and rescue teams have been involved in cross-European training in operations (UAEInteract, 2014b; UAEInteract, 2010). Training to enhance the level of team preparedness is a further key strategic priority (ADCD, 2014). Aligning with stated objectives in the 2021 vision, the UAE is intending to establish a global civil defence training academy receiving 200,000 trainees annually and providing an advanced curriculum, premises and simulation systems. Training is proposed for cadres from the fields of fire, rescue and public safety (Khaleej Times, 2015).

A key element of the civil defence strategy is to raise public awareness. This has included for example undertaking evacuation drills in Ajman schools (ACDGov, 2015), and updating safety protocols and regulations to drive standards such as the 2011 introduction of a new Fire Safety Code of Practice in Dubai (Algassim and Daeid, 2014).

## **2.2 Civil Defence Training Academy**

Emirates Civil Defence Academy (ECDA) forms part of Dubai's Civil Defence and concentrates on fire-fighting sciences and fire safety. ECDA is a leading global training facility with a strong reputation both nationally and throughout the Middle East. A key offering is accredited training certificates from national and international authorities in association with highly credible training and service providers such as The International Fire Service Accreditation Congress and National Board on Fire Service Professional Qualifications, The Fire and Emergency Services Training Institute (Toronto, Canada),

and The Institution of Fire Engineers, Canada Branch, (Emirates Civil Defence Academy, 2017a).

The academy provides a variety of courses in Firefighting and Rescue including Fire Behaviour Training and English for Specific Purposes (Emirates Civil Defence Academy, 2017a), and courses have been developed to meet the requirements of the UAE Ministry of Interior such as First Aid Training and Special Courses (Emirates Civil Defence Academy, 2017b). A number of drivers are identified in relation to undertaking a new approach towards training in fire safety. These include:

- Accommodating firefighters who work in shifts or remote areas
- Impact on frontline staffing of traditional classroom forms of training
- The young average age of the workforce which is below 30
- Preference for electronic delivery among new firefighter generations
- Need to keep up to date with constantly changing legislation, particularly in respect of building fire safety
- Growing emphasis on cost effectiveness driving new approaches to minimise training costs

In relation to building fire safety critical issues are risk assessment in living/sleeping accommodation and operational procedures in high rise buildings. Module 1 of this study addresses building fire safety, while Module 2 addresses fire risk assessment in living/sleeping accommodation and Module 3 focuses on operational procedures in high rise buildings.

There are key fire safety risks for the occupants of sleeping accommodation due to increased vulnerability to fire as a result of lack of awareness during sleep. This is

heightened when staying in unfamiliar accommodation such as hotels. Consequently effective training is needed to attain a fire safe environment in sleeping accommodation. However this is challenged by the difficulties of fire safety within high-rise buildings. The UAE in particular possesses some the tallest buildings globally, and having more than one level means that in the event of a fire there are significant numbers of people that need to travel sometimes long vertical distances on staircases to evacuate the premises.

### **2.3 UAE Civil Defence Training Needs**

To achieve its civil defence goals the UAE government has recently advanced with Dubai Civil Defence Smart Services supported by a published list of requirements (Directorate General of Civil Defence, 2014b). Some of the key elements on the list focus on training courses and awareness services including:

- Firefighting training courses;
- Evacuation drills training courses;
- Awareness lectures;
- Awareness bus trips;
- Awareness lectures on how to use fire extinguishers;
- Approval for House of Expertise.

Certain tasks identified for Dubai Civil Defence have implications for training. These include:

- Preparing a risks and disasters protection programme, and setting a general alarm system for residents' situations.

- Forming teams to conduct response and relief operations and participate in restoring normal life in affected areas.
- Preparing a joint evacuation training programme for both civilians and volunteers
- Conducting preventive awareness programmes for community members
- Improving professional training methods, according to the international training curriculum applied in ECDA, through continuous training programmes as part of the strategy for Smart City Defence (Directorate General of Civil Defence, 2015).

In order to achieve the vision of Dubai's transformation into Smart Dubai a number of supporting factors have been identified. These include 1) analysis and categorisation of internal stakeholders 2) mapping of their needs and 3) the generation for each classification of specific training and capacity-building plans. These relate to technical training and adaptation to redesigned processes. Additionally continuous training and education is proposed with the aim of supporting the expansion of open data and peer-to-peer learning models that enable actors to share experiences, advice, and information (Smart Dubai, 2015).

Within the Risk Mitigation Plan for Smart Dubai a number of measures have been identified to address gaps in expertise and short term training (Smart Dubai, 2015). Improved training methods are a key element of Dubai's Smart City Defence training strategy as noted above (Directorate General of Civil Defence, 2015). This points to a potentially significant role for e-Learning. Many opportunities arising from the use of e-Learning in instruction can be applied to civil defence.

Dubai intends to meet the initial requirements for a smart safe environment by 2021 as envisioned, while between 2021-2028 ongoing upgrading of defence and e-security

policies will be prepared and implemented. In 2014 the Dubai Centre for E-Security was established to provide government bodies the logistical support and technical tools needed. Operational and tactical knowledge is therefore required for the potential development of a knowledge and research centre focused on protection and security methodologies (Efthymiopoulos, 2016). Training needs within civil defence have expanded and broadened in conjunction with other elements such as technology, equipment, facilities, human resources and organisations. This is recognised by the Directorate General of Civil Defence which emphasises that a science-based vision based on international professional standards is required to meet these needs (Directorate General of Civil Defence, 2014c).

## **2.4 Civil Defence Training Issues**

Research has identified a significant issue in the UAE in terms of understanding Early Warning System (EWS) and effective training processes to address this (Al Hmoudi and Aziz, 2015). A key factor is the lack of any single body responsible for both natural and manmade hazards. The main entity providing EWS is the National Centre of Meteorology and Seismology which concentrates only on warning of natural hazards. Further EWS in the UAE does not currently account for measures of preparedness, public education and awareness, the creation of mitigation strategies, and participation which supports preparation in both emergency response and the community (Al Hmoudi and Aziz, 2015; Alteneiji, 2015).

Conclusions from research highlight that to consolidate EWS the UAE should learn from international experience which has been identified as effective by the UN (Alteneiji, 2015). Currently EWS training and awareness for managers is inadequate, and this is similarly reflected in a lack of training processes and scenario training for



civil society institutions and individuals (Alteneiji, 2015). The role of the National Emergency Crisis and Disaster Management Authority (NCEMA) is to offer training courses oriented towards embedding a culture and standards of emergency management, particularly within the private sector. Nevertheless there is an identified lack of knowledge and expertise within this organisation for overall emergency planning (Alteneiji, 2015).

A lack of policies and outdated senior level attitudes are noted to have hindered the implementation of professional training in emergency preparedness. Further the private sector and NGOs lack awareness of training options and there is a shortfall in qualified trainers. Despite adoption of the emergency management standard policy for risk assessment created in the UK, employees at all levels of government have been found to lack adequate training in creating a risk register and how to properly assess risk (Alteneiji, 2015).

Information systems and the sharing of information are further key issues impacting on training. Within the UAE's emergency management standard the use of official information systems were not identified. Although systems have been introduced designed specifically to facilitate information sharing between emergency services and agencies and other stakeholders, their full implementation has been hindered by problems relating to lack of system competence among employees and the attitudes of managers towards information sharing with other agencies and departments (Alteneiji, 2015).

A significant need exists in the UAE for emergency medicine given the injury and disease profile of the country. However there is a shortfall in terms of consultants who have emergency medicine training and are board-certified with negative impacts on the

quality of this type of training. Perceptions further exist that training quality is better in the West and there is no clear career path for those doctors at consultant or attending level in the UAE. Although the Emirates Society of Emergency Medicine provides residency courses and has established fellowship programmes, compared to the United States emergency medicine remains underdeveloped (Fares et al., 2014).

Language is a further key challenge for CPD in the public emergency sector. Qualitative evidence on the perceptions of paramedic students towards video assisted learning as an instructional tool for enhancing emergency skills showed that the majority considered course language as a significant barrier impacting their professional development. A strong preference for use of the mother tongue in instruction was indicated (Bala et al., 2016).

The literature emphasises other challenges including an absence of online interaction during training programmes, such as applied exercises or real-life scenarios (Knox et al., 2013; Simpson et al., 2012), a lack of opportunity for asking questions while undertaking video training and generational differences in attitudes to learning (Bala et al., 2016).

## **2.5 Potential of E-Learning**

Many opportunities offered by the use of e-Learning in instruction and training can be used to advantage in civil defence. One important means for students to learn is through multimedia such as sound, videos, still images, and text. In the traditional classroom environment learners have personal interactions with instructors in a live context. In order to present the significant quantity of information required to teach building fire safety within the classroom in a rapid time period a number of characteristics are common. The presence of learners is required in the classroom and

they must follow the pace of the instructor. The learning experience is essentially reliant on the experience and skill of the instructor and learners are motivated and assessed by the instructor within the classroom. With e-Learning in contrast students are able to learn at their own pace allowing them to better understand the concepts, and a consistent learning experience is ensured. Adult learners can be more engaged, and by facilitating flexible on demand access e-Learning can more easily fit in with the requirements of busy adults. Nevertheless learners are required to be self-motivated and self-disciplined in order to benefit from e-Learning.

Evidence shows that e-Learning has a number of advantages for learning performance. Some findings indicate that e-Learning can lower learning times by approximately 40 to 60% when compared to traditional instruction (Zenger and Uehlein, 2001). In another study the majority of students using e-Learning perceived that it had saved them time (Forslin and Thulestedt, 1989). People are argued to remember only 15% of information transmitted by sound, 25% of information transmitted visually however to remember 60% of what they interact with (Wolfgram, 1994). E-learning is essentially interactive so that learning processes become active and users are able to do rather than simply watch (Scliwier and Misanchuk, 1993). Miller (1990) shows that learners showed a 25% improvement in retention following participation in interactive courses. Evidence points to a range of e-Learning features that positively impact on the motivational and cognitive aspects of e-Learning. These include being learner-centred (Holmes and Gardner, 2006), enhancing knowledge efficacy by facilitating access to significant quantities of information, and providing flexibility in the time and location of the delivery of information for learning (Wagner et al., 2008). Further e-Learning can overcome barriers to participation, facilitate communication and enhance the relationships that keep learning sustained (Wagner et al., 2008). By guiding and focusing

learner attention and providing sequential processes, e-Learning promotes further opportunities for interactivity (Park and Hopkins, 1993; Rieber, 1990).

A number of affective features of e-Learning have also been noted in the literature. Individual preferences are strongly emphasised (Codone, 2001), and learners are able to focus on only certain parts of the course if that is their desire (Urdan and Weggen, 2000). Individuals may pace themselves through the course (Smedley, 2010) and e-Learning has been found to reduce learner stress and increase satisfaction (Amer, 2007; Marc, 2002; Klein and Ware, 2003). According to Algahtani (2011) e-Learning can also play a vital role in compensating for shortfalls in teaching staff. Horton (2000) shows that the provision of e-Learning increased learner satisfaction by a third, knowledge retention by a quarter, significantly reduced costs by 80% and increased enrolment by three times.

## **2.6 Conclusion**

This chapter has presented the research context surrounding the adoption of e-Learning in the UAE civil defence sector. This has addressed the role of Civil Defence Training Academy, Civil Defence training needs, key challenges, and the role of e-Learning. Enhancing the capability of civil defence is revealed as a critical priority in the UAE that has motivated the adoption of efficient and effective modes of learning delivery. The challenges associated with a shortage in qualified trainers combined with the training priorities identified has emphasised the strategic role of e-Learning to achieve the civil defence goals of the UAE government. The Risk Mitigation Plan has identified gaps in expertise and short term training (Smart Dubai, 2015) and improved training methods are a key element of the training strategy (Directorate General of Civil Defence, 2015). While the implementation of e-Learning represents a contemporary

approach to improving professional training methods and promoting continuous training programmes the efficacy of e-Learning is a key issue. Therefore the research context emphasises the importance of a comparative evaluation of e-Learning to ensure its optimal integration and utilisation within the civil defence training strategy. This context therefore provides the basis for the literature review and the focus of the research process.

## **Chapter 3      Literature Review**

### **3.1 Introduction**

The aim of this chapter is to present the theoretical basis of this study through exploration of the key themes and debates in relation to e-Learning and examination of the key concepts of e-Learning that form the basis of this study. Theory and evidence are discussed in relation to e-Learning and its main principles, student learning styles and their role and relevance within e-Learning, e-Learning evaluation and comparison with traditional teaching approaches.

A review of the literature points to the significant potential of e-Learning within training contexts such as civil defence. The literature shows that multiple factors can impact the effectiveness of e-Learning in this context including teaching factors, design principles and learning styles. A critical evaluation is conducted that reveals the role of learning styles and how they relate to e-Learning with a focus on differentiating the main categories of learning style and the applicability of traditional models to e-Learning. Limited research has examined how individual learner characteristics influence their behaviour when undertaking e-Learning. The latter sections of the review focus on learning styles in the e-Learning environment and the role and use of multimedia in e-Learning and to support learner styles. The literature shows that no single learning style dominates among learners and considerable challenge exists for e-Learning instructors and designers to understand and address diverse learning needs. Finally the literature highlights differing perspectives on the effectiveness of e-Learning in comparison with traditional approaches. While the potential is underlined for the elimination of barriers while offering greater flexibility and personalised learning,

critics have highlighted the potential isolation and frustration of learners in e-Learning environments and possible reduction in learner interest and learning effectiveness.

### **3.2 E-Learning**

E-learning is a new modality in learning that challenges traditional learning modes. E-learning has been inclusively defined as an approach to learning and teaching, representing all or part of the educational model applied, and based on the utilisation of electronic devices and media as tools for enhancing access to training, interaction and communication promoting the adoption of new ways of understanding and developing learning (Sangra et al., 2012, p.152). E-learning, sometimes also identified as web-based learning or Open and Distance learning (ODL), refers to learning designed to be conducted at a distance and using electronic channels of communication. E-learning manifests in multiple forms of applications and processes: Web and computer-based learning, digital collaboration, and virtual classrooms and it comprises content delivery via Internet, LAN/WAN or intranet/extranet, audio-and videotape, satellite broadcast, CD-ROM and interactive TV (Kakkar, 2008). E-learning definitions have evolved to identify e-Learning as learning experiences or content which is facilitated and delivered by internet technology to improve the knowledge and performance of an individual (Pantazis, 2001). A more simple definition describes e-Learning as the utilisation of technology to support and improve learning practice (Mayes and De Freitas, 2006). The effectiveness of e-Learning in comparison with conventional face-to-face methods is reliant on how well techniques are applied that fulfil the teaching objectives and the effective coordination of student-teacher interactions (Hope and Guiton, 2006).

The introduction of novel technologies and social networking has offered significant opportunities that are dynamically shaping e-Learning. A key development is a major

shift in perspective on learning itself and the critical processes through which learning supports and integrates the acquisition of knowledge and experience. Technological advances are driving changes in how people learn, fostering real-time access to a wide range of learning and knowledge sources accessible on-demand. Thus learning has become a continuous, formal or informal process conducted within and beyond organisational boundaries.

Technological developments have resulted in implications for the design and evaluation of e-Learning. These include:

- Enhanced capability to track and analyse learning behaviour through the monitoring and arranging of information flows and interactions. This can help with understanding of learner needs to better provide more tailored support
- Unparalleled levels of learning and collaboration regardless of geographical location
- Extensive growth of available information and data able to be accessed across a range of repositories and providing important sources of intelligence.

The capacity of games to support educational aims such as increasing student motivation or presenting complex ideas in new engaging ways has been recognised (Dunwell, et al, 2011). When integrated within a mixed-learning approach increased effectiveness is noted, implying that games should be part of a varied teaching approach particularly when exploratory or experiential teaching methods are used (Dunwell, et al, 2011). In the context of civil defence education case study evidence shows the use of serious games for training in aspects such as building evacuation. The study findings underline the accuracy and variables that could be considered within effective game design. Numerous data points can be fixed on the players' individual or collective evacuation paths which can enhance the comprehensiveness of the data. The data



collected is used to generate a pool of information and employed to give player feedback (Dunwell, 2011). A key element of this type of training is that it necessitates changes in learner behaviour and not just the acquisition of new knowledge. The use of game-based training is therefore highly appropriate, as teaching and simulation aspects can be used together to reinforce the correct behaviours to be adopted during an evacuation.

Mobile learning or M-learning has been enabled by the proliferation of mobile devices allowing the possibility for learners to engage with the broader learning community anywhere and at any time (Engel and Green, 2011). For instructors, mobile technologies offer the potential to develop media-rich, interactive content which can enhance learner experiences through realistic learning activities (Tseng et al., 2016) that encourage learners to expand the learning experience beyond the classroom. Numerous scholars have underlined the potential for mobile technologies to foster the engagement and creativity of learners (Falloon and Khoo, 2014; Cochran et al., 2013; Morrone et al., 2012). Nevertheless some limitations have been noted in the current way this mode of learning is applied, including a lack of explicit teaching theory for m-Learning (Traxler and Kukulska-Hulme, 2005), a lack of effective integration within educational activities and evaluations (Laurillard, 2007) and an absence of a defined support framework for teachers and learners (Attewell, 2008).

Blended or hybrid learning is frequently used within fire services and combines online learning with face-to-face meetings. This type of training environment is acknowledged to improve learning capabilities and retention (Bala et al., 2016). Blended training is highly customisable and can be tailored to the operations, procedures and needs of each department (Batista, 2014; Leszczyński, 2015). In the development of blended courses for firefighters consideration should be given to factors such as

retention capabilities (Bala et al., 2016), computer skills (Leszczyński, 2015) and learning strategies based on age (Kong et al., 2013; Batista, 2014). Nevertheless the training product should remain accessible to all regardless of their technical skills or age (Leszczyński, 2015).

Simulation and virtual reality have become key teaching methods within the civil defence sector and are recognised as highly suitable for vocational or workplace training (Boldrini, 2016; Miller and France, 2003). Simulation training can support the development of critical skills for the rapid assessment and analysis of crisis situations to effectively respond to emergency needs (Camacho et al., 2016). It implies that the real-life situation is reproduced in a controlled way, so that in the context of firefighting training learners are exposed to actual fire and equipment to enhance their crisis management and response capacities. Research implementing simulation training using online and virtual reality technologies for emergency response scenarios and hazard assessment response has shown that this mode of learning enhanced learners' understanding and response capabilities in relation to crisis situations (Boldrini, 2016). The action or active learning involved is shown to allow practitioners to achieve improved understanding of the process and raise their confidence when participating in real-life emergency situations. Further it expands learners' experience and their perception of the importance of effective decision-making processes and risk communication (Boldrini, 2016; Miller and France, 2003).

The widespread use and capacities of social media can have substantial implications for student teacher interaction. Many different social media tools are available that can be used for learning and collaboration and despite differences in spatial distance are shown to support different educational activities including group working and

assessment (Kear et al., 2013). Social networking encompasses multiple communication activities conducted across online channels using applications such as social networking sites, blogs, forums, wikis and web conferencing (Kear et al., 2013). Forums are highlighted to be significant tools for stimulating debate and discussion while wikis facilitate collaborative writing. A key value is the provision of real-time tools such as instant messaging which provides the perception of real-world connection to teachers and other learners argued to be critical for effective e-Learning (Kear et al., 2013). Recent theories of social learning align well with the community building potential of the online environment (Palloff and Pratt, 2007). Kear (2010) provides evidence that student motivation and completion of courses are significantly advanced by interaction with online learning communities. Collaboration is facilitated by opportunities for peer assessment and feedback and through the experience of online team working, while community-building is encouraged through increased perceptions of engagement and belonging to a course community by means of social media interactions (Kear et al., 2013). However challenges are noted in the use of social media in education including managing student expectations in relation to teacher response, and balancing the need for support with the development of learner self-management. This entails that teachers adopt new skills and approaches to fulfil roles as learning facilitators rather than knowledge holders (Kear et al., 2013).

### **3.3 Traditional versus E-Learning**

The literature has presented evidence on the efficacy of e-Learning in relation to traditional approaches which is a key focus of debate. Numerous studies have underlined the educational benefits and the positive perceptions of students on e-Learning courses (Vargas and Tian, 2013; Hussin et al., 2009). In comparison with traditional teaching modes in which courses are taught in the classroom by teachers and the learning process

is centred on the instructor who has control over the course, the class and its configuration, e-Learning provides a strong emphasis on learning by students at their own pace (Hiltz and Turoff, 2002).

Current information technologies integrate opportunities provided by technological developments underpinned by theoretical advancements in e-Learning. As multimedia technology has progressed increased multimedia content is available within e-Learning systems. Such systems incorporate and present educational content in diverse media including image, audio and video as well as text. Nevertheless an absence of flexibility and interactivity have undermined the effectiveness of multimedia systems due to unstructured and passive ways of presenting learning content. Within these systems learners are provided minimal control in terms of the structure of knowledge and how it is acquired in relation to individual needs (Conkova, 2013; Maki et al., 2000). This emphasises the need on a technical level to aim for an efficient method that incorporates multimedia content and the theoretical in comprehending the effect of different factors on the effectiveness of e-Learning (Dongsong et al., 2004).

Some studies have indicated that e-Learning may be as effective if not more so than traditional classroom instruction (Batte et al., 2003; Blake et al., 2003) however in specific situations it is challenging to verify whether e-Learning can replace it. Advocates for e-Learning have noted its effectiveness over a traditional learning experience for the potential elimination of barriers while offering greater flexibility and convenience in addition to content currency, personalised learning, and feedback (Swan et al., 2000; Kiser, 1999; Matthews, 1999). However critics have highlighted the potential isolation and frustration of learners in e-Learning environments (Hara and Kling, 2000) and possible reduction in learner interest and learning effectiveness (Maki

et al., 2000). Learning is predominantly socio-cognitive and e-Learning may not suit all individuals as an appropriate learning style. One study shows that despite recognition by some trainees that the e-Learning system was effective and engaging they would still prefer, if given the choice, to receive traditional classroom instruction (Conkova, 2013). Weak motivation in course completion can manifest in online settings due to a lack of real-time human interaction (Morse, 2003). Thus effective e-Learning is acknowledged to require elements in addition to technologies such as appropriate course design, current relevant content, strategic and effective teaching plans, and support and service staff at all levels (Hussin et al., 2009). Research further points to greater logistical difficulties in e-Learning comparative to that in a traditional setting, such as the increased amount of time in lesson preparation needed by a teacher (Kakkar, 2008). The widespread provision of education and information through the internet due to its low costs and immediate delivery (Hiltz and Turoff, 2002) presents a further logistical challenge in terms of enhancing Internet security. In particular the high usage of multimedia materials in e-Learning can lead to easy unauthorised access to the content network (Kakkar, 2008).

This points to a significant need to focus on assessing the effectiveness of e-Learning in comparison with traditional classroom-based methods. Multiple research studies have focused on evaluation of effectiveness across both modes (Ho and Dzung, 2010; Suanpang et al., 2004; Lim, 2002; Schoenfeld-Tacher et al., 2001; Russell, 1999). Other common approaches increasingly adopted by organisations and researchers include metrics for learner satisfaction (Al-Furaydi, 2013), and measures which have included, or have considered, the factors impacting the effectiveness of and learner satisfaction with e-Learning courses (Wang and Chiu, 2011; Joo et al., 2011; Liao and Lu, 2008).

In comparisons of the effectiveness between online and offline learning environments the impact of the learning environment on learning outcomes has been consistently examined. There is considerable research which on the one hand points to the effectiveness of e-Learning to produce higher learning outcomes over traditional. Findings have shown that students' performance in terms of final grades was better than or as effective as in traditional courses (Soffer and Nachmias, 2018; Harmon and Lambrinos, 2006; Shachar and Neumann, 2003; Ladyshevsky 2004). Meta-analyses conducted by Shachar and Neumann (2003) and Soffer and Nachmias (2018) support the outperformance of distance education when accounting for the final course grades. A focus shift from questioning the general suitability of distance education for all students to questioning the suitability of face-to-face education was proposed (Shachar and Neumann, 2003). Means et al., (2009) meta-analysis considered more than 1,000 empirical studies from 1996 to 2008 and concluded that learning outcomes in the online environment are modestly better than those in a traditional format. The researchers argue that the key to understanding the results in the online mode is a combination of time spent, curriculum, and pedagogy. No support for stating that online learning is significantly better than the traditional was however found.

In a comparison of classroom and e-Learning outcomes for social work at masters level Harrington (1999) shows that students with previous academic success may do equally as well with distance learning approaches as with traditional classroom methods. Thirunarayanan and Perez-Prad (2001) provide evidence of slightly improved outcomes for online learners over those taught using classroom approaches as measured by class post-tests however differences were not statistically significant. Smith (2001) conducted a comparison of instructional delivery in an MBA marketing planning course and offered descriptions of the differences required in the two environments to attain the

same learning objectives. Meanwhile evidence from McLaren (2004) shows that the final learning outcome for students on an undergraduate business statistics programme was achieved irrespective of the instructional mode adopted.

Beyond final course grades, research also highlights improvement in student engagement and satisfaction in e-Learning contexts (Kemp and Grieve, 2014; Chen et al, 2010; Navarro and Shoemaker, 2000). Online environments succeeded better in engaging students with course structure, improved communication with the course staff, increased frequency of engagement with the material, and improved engagement and satisfaction, while those in the classroom courses expressed better contribution of the learning content (Soffer and Nachmias, 2018). Online learners are likely to have a more robust internal motivation for knowing, accomplishing and experiencing simulation (Rovai et al, 2007).

Some literature has proposed that interaction within an e-Learning environment encourages student-centric learning, participation among learners on a wider basis and provides more reasoned and in-depth discussion than in traditional classroom environments (Smith and Hardaker, 2000; Karayan and Crowe, 1997). Online environments are noted to encourage less daunting interactions between individuals and there are lower time pressures on learner interactions than within face-to-face contexts (Warschauer, 1997). Shyer and more reticent learners may feel less constraints to participating in online interactions (Citera, 1988). Nevertheless the potential advantages of online interactions could fail to be fulfilled if there is a lack of close connection among learners. Haythornthwaite et al., (2000) shows that learners who did not make connections with others in their group indicated greater feelings of stress and isolation.

McConnell (2000) offers an extensive comparison of the differences between face-to-face and e-Learning.

Nevertheless there is some evidence that traditional face to face delivery may produce higher learning effectiveness than e-Learning.

Comparisons of e-Learning with traditional approaches underline elements which are inherent to face to face approaches and that may not be easily replicable in the online environment. A key element of classroom learning is the social and communicative interactions between students with teachers and peers. The ability of learners to ask questions, share opinions and thoughts, or disagree with a particular perspective are essential learning activities (Ni, 2013). Frequently it is through discussion, debate, and conversation that new concepts can be made clearer, assumptions can be challenged, new ideas formed, skills are practiced and learning objectives can be attained. E-learning therefore necessitates significant adjustments on the part of instructors in addition to students for effective interactions to take place. A study by Johnson et al., (2000) examined learner satisfaction and learning outcomes in an online human development graduate course and in a traditional face-to-face programme. No difference was found in terms of multiple measures of learning outcomes between the two course formats however learners reported higher positive perceptions of the instructor and overall course quality on the on-campus course.

One key school of thought argues that it is individual differences and instructional methods, such as lectures, assignments, group discussions or reading textbooks which exert a greater influence on learning outcomes, compared to delivery media (Sitzmann et al, 2006; Tamim, 2011; Bernard et al 2004; Russell 1999; Clark 1983, 1994). Meta-analyses conducted by Means et al (2010) and Nguyen (2015) support these findings



and argue that student performance as measured by grade is independent of the mode of instruction. Sitzmann et al (2006) shows that learning results are determined rather by instructional methods than delivery media. Specifically, the meta-analysis indicates that declarative knowledge is more effective when taught in classroom rather than through web-based instruction, though equal declarative knowledge was achieved when the same instructional method was used and students expressed similar satisfaction for both delivery media. In order to enrich learning of declarative knowledge through the instructions via web, learners should be given control, feedback and practice (Sitzmann et al, 2006).

A recent literature review by Nortvig et al., (2018) based on 44 studies published between 2014 and 2017 provides significant support for the premise that contextual factors are more important for learning effectiveness than the mode of delivery. The study concluded that there were no inherent features in the two teaching modes of face-to-face and e-Learning which resulted in higher or lower learning outcomes for learners. Rather situational and context-dependent factors were identified as the principal reasons for differences in outcomes. Multiple diverse factors can potentially impact e-Learning effectiveness including the characteristics of individual learners, as well as the content, the nature of the media and technology. Factors such as course design (Gray and Diloreto, 2016; Lee, 2014), learning communities (Saghafi et al., 2014; Baxter and Haycock, 2014), and roles and relations of instructors (Moore, 2014; Swan and Shih, 2014) are shown to have key impact on cognitive outcomes and learner engagement and satisfaction. In terms of course design the value is underlined of including interaction and dialogue within e-Learning courses (Chigeza and Halbert, 2014; Rivers et al., 2014). In an online learning environment dialogue is shown to strengthen reflective practices and interactive discourse especially when utilising social networking tools (Rivers et al.,

2014). Multiple studies identify that opportunities for interaction among students and their instructors play a significant role (Chiero et al., 2015; Fedynich et al., 2015) in both learner outcomes and satisfaction.

Evidence points to the existence of and access to an online learning community within e-Learning course design as influential over the learning performance of learners, and students who benefitted from an online learning community performed significantly better than those to whom no online learning community was offered, although with differential effects across learners with different learning styles (Zhan et. al., 2011). The use of specific tools to create online learning communities such as PeerWise has been shown to increase student engagement and improve their learning outcomes, motivation and perception of the learning (Feeley and Parris, 2012; Denny et al., 2008).

A strong instructor presence within online programmes is highly beneficial for effectiveness and facilitation of online learner engagement and satisfaction (Moore, 2014; Swan and Shih, 2014). Establishing an online presence may be achieved in numerous ways such as regular communication with learners, ongoing feedback and critical discourse shaped and moderated by the instructor (Gray and DiLoreto, 2016). A need has been identified for learners to feel connected to the instructor as well as to peers and to the course content (Southard, et al., 2015; Martín-Rodríguez et al., 2015). Instructors can attain greater presence and connection in e-Learning through the strategic combination of pedagogical elements such as synchronous and asynchronous discussions, audio and video, practical activities and other tools (Gray and DiLoreto, 2016). Southard et al., (2015) show that the high impact videos featuring the instructor with or without course content highly effective in establishing a strong instructor presence and in developing learner interest in the learning topic, particularly in purely

e-Learning courses. The study shows that real backdrops of subject interest and accompanying interactive multimedia where for example static objects were brought to life and moved with the instructor's narration were effectively deployed to promote learner perceptions of connectedness to both instructor and content (Southard, et al., 2015).

### **3.4 Pedagogical Implications of E-Learning**

The differences between traditional classroom-based approaches and e-Learning point to significant implications for teaching methods and pedagogy. The key factor driving the widespread expansion of e-Learning is convenience and not learning, according to comprehensive studies (Sonwalkar, 2005). The first goal of education is to teach people how to constantly indicate the correct response. Studies based on cognitive theory show that motivation, reflection and memory are relevant factors to learning (Hubackova, 2014) hence learning is understood as an internal process, which depends on the learner's ability and effort to undertake this process and their existing conceptualisations. Teaching in a programmed environment implies the delivery of the information content and concepts according to the presumption that information is better integrated when delivered in small pieces. These understandings have also been employed in e-Learning concepts and teaching methods (Hubackova, 2014).

Constructivist theories on learning emphasise that persons assimilate information at different speeds (Hubackova, 2014) and actions such as observation, comparison and perception entail personal variations in the quality and pace of the actions. Students are inclined to choose their learning styles based on previous effectiveness shown in traditional teaching settings though, as practice demonstrates, it is difficult for them to choose in advance. A brief diagnostic test before the starting of the learning process is

acknowledged as a constructive strategy towards identifying learning style (Hubackova, 2014). Electronic facilities do not carry an advantage over textbooks as long as the textbooks are based on constructivist learning theories (Hubackova, 2014). Hubackova (2014) emphasises how constructivists support a number of assumptions, such as: the concept of learners' motivation is developed as key for understanding that the acquisition of information is perceived differently by each person; the importance of employing different perspectives on the same information; the relevance for students experiencing interaction and interchanging perspectives with the teacher and other students; an emphasis on the individual as the final goal of teaching processes.

According to constructivist theorists, a degree of autonomy, though not total independence, is of significance for each learner (Hubackova, 2014). The learner's interaction with the learning material content throughout the learning process is fundamental for constructivism, as the content allows learners to fully understand why and what they are doing while navigating through the materials. Another relevant factor supporting motivation, teamwork and competition is social environment, such as a classroom in a traditional setting. In an e-Learning environment, social medium is facilitated by a series of multimedia applications (Hubackova, 2014). Constructivist perspectives focus on embedding knowledge as a system, comparative to the perspective of nurturing skills to express incomplete pieces of knowledge (Hubackova, 2014).

Rogers (1983) emphasises that effective learning is the result of the attitudinal factors shared within each specific relationship between learner and teacher. Further, a new perspective is expressed when discussing the teachers' role in guiding and facilitating learning. The concept of learner within a constructivist approach of e-Learning is developed by Zlamalova (2010), who points to the learners' autonomy, interaction with

contents of the learning materials and adjusting time for contact teaching and e-Learning.

A further key implication in the e-Learning environment is the focus not only on delivering information but also on the machine capabilities of transfer, acquisition and even learning (Hubackova, 2014). There is a need for enhancement of teaching quality through flexibility, sophistication and content management, as the new teaching methods, otherwise positively perceived, are considered to be laborious, inflexible and technically under-managed (Sonwalkar, 2005).

### **3.4.1 Design Implications**

The shift from traditional to e-Learning presents new risks and issues in relation to usability and design with implications for the evaluation of e-Learning in comparison to traditional. A key framework for directing and assessing e-Learning design has been proposed by Mesquita (2011). It shares a multi-disciplinary approach as teaching approaches are frequently overlooked when considering only usability, and an e-Learning context needs to account for more than usability and design. Therefore, theory from three distinct disciplines of usability, instructional design and affective learning and motivation informs the multidisciplinary approach. Mesquita (2011) builds the framework on the pillars of instructional design and usability parameters. The first is drawn from seven parameters which support learning connections according to cognitive instructional design studies and which also allow e-Learning evaluation. Interactivity is a key factor for engaging learners (Lanzilotti et al., 2006; Rentroia et al., 2006; Hiltz and Turoff, 2002; Weston et al., 1999) and to keep learners actively involved (Reushle et al., 1999).

The quality of the existing content and information is relevant for content and resources (Mesquita, 2011) and it is valued for its appropriateness and as a factor for stimulating learning connections (Reeves et al., 2002). Content and resources are assessed in terms of currency, credibility, accuracy, objectivity and coverage (Lanzilotti et al., 2006). The use of multi-media may support the delivery of information and enrich explanations (Driscoll, 2002) when it is employed in an engaging and effective manner (Keeker, 1997). The objectives set for learning and performance concerns will drive the use of multimedia (Driscoll, 2002), though multimedia may well obstruct or distract from learning (Powell, 2000; Shiratuddin et al., 2003). Learning strategies design is relevant for applying key aspects of learning strategies within e-Learning interfaces (Cercone, 2008; Kiili, 2007; Martens et al., 2004). Squires and Preece (1999) propose the dimensions of contextual authenticity and learning, while Clark and Mayer (2003) suggest collaborative learning to be integrated into the design. A substantial improvement in performance is underpinned by the instructional feedback (Mesquita, 2011), especially when it displaces the learner misconceptions comparative to the right or wrong basic feedback (Horton, 2000). Feedback relates to instructional assessment, evaluated based on the degree to which the goals set by the learners were accomplished, considering the challenges which have been identified and the clear learner outcomes (Weston et al., 1999). Learner guidance and support refers to the necessity of offering prompts to learners in order to adapt to e-Learning methods (Mesquita, 2011).

Affective motivation and learning connections are part of the instructional design pillar (Mesquita, 2011). The model of motivation proposed by Keller (1983) suggests that instructional design strategies are important in the context of: drawing attention and supporting curiosity and interest; learners' motivation, needs and interest; trust in the

positive anticipation of reaching the desired outcomes; and contentment of external and internal gratification for strengthening the effort.

The second pillar of the proposed framework relies on five parameters drawn from e-Learning usability theory and contemplation of the different aspects of functional design. The first parameter refers to the navigation features, which organise the overall structure and content in order to appear clearly to the learner (Mesquita, 2011). Learnability, the second parameter, refers to how easily or well the learning curve is conveyed (Rentroia et al., 2006). System accessibility assesses the accessibility of the system for learners with disabilities and the degree to which the uniformity of design, themes and layout offer predictability for rapid adaptation to the system. The final parameter of visual design considers four key aspects: scanability, choice of colour, readability and space provision (Granic and Cukusic, 2007). In the context of e-Learning, this facilitates content understanding (Kayler and Weller, 2007; Mesquita, 2011).

### **3.4.2 Challenges for E-Learning**

The new learning environment represented by e-Learning produces unique challenges in adapting and innovating pedagogical methods to ensure e-Learning effectiveness. Among learners there is no single dominant learning style and therefore instructors are required to understand differences in order to address diverse learning needs (Mupinga et al., 2006). Within e-Learning there is thus significant challenge in embedding ways to address learning style differences to enhance learning outcomes. The growing prevalence of e-Learning within current educational delivery means that traditional ways of learning are frequently inadequate, emphasising the need to take account of learning style diversity in virtual programmes (Folley, 2010; Donahue and

Glodstein, 2013). Learner preferences towards a specific learning style may constrain their capacity to learn when the training is presented focused on a different style. The skill of the instructor in relation to e-Learning technologies is a further key challenge affecting learning outcomes (Zapalska and Brozik, 2006).

The culture of learners presents a further challenge for instructors and an unseen factor emphasised by the fact that students in e-Learning environments are frequently not seen by instructors. It is noted that cultural differences are often not considered in the design and delivery of teaching (Hannon and D'Netto, 2007), or differences in the use of technology and skill and linguistic differences linked to culture which can impact the ability to use e-Learning and responses to the manner in which the learning content is structured. This can result in reduced learning outcomes (Callaghan et al., 2008).

E-learning technologies therefore need to be based on pedagogical principles to facilitate the achievement of learning (Islam et al., 2015). For teaching to be effective instructors need to plan and deliver instructional content based on learner styles and preferences and be prepared to mentor learners to transfer knowledge and skills. E-learning requires that specific teaching approaches are adopted particularly in relation to individual and group interaction and online evaluations (Islam et al., 2015).

### **3.5 Learning Styles**

Learning styles have significant importance and influence in terms of learner performance. Evidence shows that individual abilities to attain a specific learning goal can be impacted by individual learning styles (Shauna and Marcia, 2005) as well as learner characteristics including culture, age and gender (de Jong, 1991) which is a significant consideration for fire safety training. A key issue is whether a particular learning style affects performance under different modes. Some learning styles may



have implications for the preferences between online and traditional approaches to learning (Conkova, 2013; Flores et al., 2012).

### **3.5.1 Definitions of Learning Style**

Individual competence in the learning domain is contended to be significantly influenced by learning style (Kolb, 1984). A learning style can be defined as the manner in which an individual arranges, combines and compares information that they have consciously acquired before it is recorded in the brain (Goldstein and Blackman, 1978). It is argued to reflect the learner's preference towards particular learning strategies in a particular learning situation (Gregorc, 1979; Entwistle, 1981). Learning styles are a combination of specific cognitive, affective and physiological dimensions that indicate a consistent tendency in the way in which individual learners experience, react to and involve themselves in the learning situation (Griggs, 1991; Kang, 1999). Learning style encompasses elements such as strategies for problem-solving, decision-making behaviour, and the barriers found in the learning situation and response to others' expectations (McDermott and Beitman, 1984).

While scholars do not always make a distinction between learning style and cognitive style, it has been argued that cognitive styles are more related to conceptual, academic study while learning styles are broader and have more practical application (Ghinter and Liu, 1999). Learning styles are argued to be influenced by five key types of factors including: physical factors containing intake and perception; emotional factors such as commitment and perseverance; psychological factors including reflective or impulse tendencies; sociological factors including the instructor and the learning group, and finally factors in the environment such as audibility (Kang, 1999). Butler (1987) notes

that a learning style represents the most effective and easiest approach for individual learners to realise the self and their relationship with their environment.

### **3.5.2 Role of Learning Styles**

Learning styles may be used as a means for assessing each learner and learning task and the most appropriate and effective teaching strategy or method (Cronbach and Snow, 1977). Identifying individual learning styles allows instructors to incorporate the different ways their learners discern and process information (Foroozesh-nia and Rajee, 2015) and may influence educators towards adopting new interfaces in their teaching practice (Borgman et al., 1995). There is a significant body of work focused on identifying different types of learning styles. A widely acknowledged learning style archetype identifies differences between visual learners who prefer graphical representation and verbal learners who are more textually oriented. Visual and verbal learning styles are viewed as situated at two ends of a continuum in which learners more or less favour either style.

Two key ways can be employed to identify the learning styles of students. Firstly standardised questionnaires can be employed to determine the learning style in terms of a specific learning style model (Huang et al., 2012; Shaw, 2012; Hauptman and Cohen, 2011). Questionnaires have noted advantages in that they provide numerical ratios or values of respondent learning modes nevertheless are time-consuming to complete. Moreover it is not always possible to identify a predominant learning style if two or more learning modes indicate simultaneously high values.

### **3.5.2.1 Perceptual Learning Styles**

A number of learning styles have been categorised by James and Blank (1993). These include perceptual learning styles in which information is selected from the environment by using the senses and individualised pathways. When information is introduced into the pathway it is initially stored in short-term memory however ongoing exposure and use of the information facilitates retention within the long term memory.

Seven key perceptual pathways or modes have been identified related to perceptual learning styles:

1. Aural pathways relate to listening;
2. Haptic implies a tactile pathway of touching or holding;
3. Interactive identifies verbalisation and discussing with others;
4. Kinaesthetic relates to body movement;
5. Olfactory means utilising the sense of smell;
6. Print is textual pathways of reading and writing;
7. Visual refers to viewing images, objects, and activities.

The theory identifies that any one of these senses could predominate in terms of processing information. The Visual, Auditory, and Kinaesthetic (VAK) learning style model is one of the most widely acknowledged models of learning style (James and Blank, 1993). This suggests that any fire safety learning programme should present information in a way that appeals to all three sensory modes to enhance the performance of all learners.

### **3.5.2.2 Affective styles**

Affective learning styles are identified with human emotions and their changeability and the emotional response to challenges and incentives (Davidson, 1992). A key concept within affective development is that of emotional regulation (Thompson, 1994) which relates to a wide collection of processes used to maintain, increase or reduce the strength of emotional

response (Derryberry and Reed, 1996). Emotional regulation can at the same time be both automatic and controlled, resulting from voluntary and controlled practices which have become progressively more automatic. Thus affective learning styles are linked to emotional characteristics which include persistence, motivation, attention, structure and responsibility (Davidson, 1992). These factors have been shown to be significant in learning (Gruender, 1996). Therefore design and evaluation of e-Learning should take account of the influence of e-Learning characteristics on learners' affective learning styles.

### **3.5.2.3 Cognitive Styles**

Multiple definitions of cognitive styles have been proposed. It is traditionally identified as a dimension of personality affecting values, attitudes and social interaction. According to Tennant (2006, p.81) cognitive styles are 'an individual's characteristic and consistent approach to organising and processing information'. They can be viewed as the mental behaviour individuals usually apply to problem-solving and the manner in which they acquire, arrange and utilise information (Riding and Cheema, 1991). Thus a cognitive style reflects how knowledge is acquired (cognition) and how it is processed (conceptualisation).

It has been noted that the design of fire safety training programmes has mainly reflected the stereotypical views of designers rather than embedding individual differences in cognitive learning styles (Tweed, 2001). Limited research has examined how individual learner characteristics influence their behaviour when conducting digital learning tasks (Tweed, 2001). Pektas (2007) proposes testing the cognitive styles of learners in fire safety training which could enhance learning.

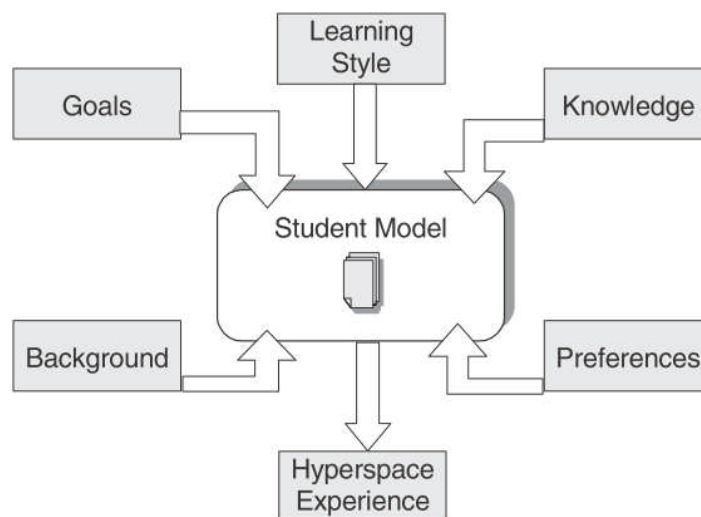
### **3.5.3 Differences in Learning Styles**

Modern educational theories assume there exist different ways of learning relative to individuals. This assumption aligns with the cognitivist and the constructivist perspectives which argue that learning and teaching depend on variations between individuals (Foroozesh-nia and Rajee, 2012). Learning styles describe the distinctive behaviours of a psychological, cognitive and affective nature which can reliably indicate how learners interact with, react to and understand a learning context (Keefe, 1979). Learning styles have been correlated to a wide array of aspects and variations between individual learners. These links are underpinned by observed variations in learners' levels of ease depending on the learning mode – active as opposed to contemplative learning, or visual as opposed to verbal mode – or on the learning focus – concrete and factual as opposed to abstract and theoretical. It is noted that learning styles are considered distinct from each other rather than inferior or superior to each other as each style has different strengths and limitations (Felder and Brent, 2005).

Scholars agree that learners vary in their attitudes and incentives towards teaching and learning, and that they respond differently to specific educational environments and methods. As a result it is argued that teachers' improved understanding of these variations between learners potentially enables better responses to the different individuals' needs (Felder and Brent, 2005). The variations in learning styles are categorised into three groupings with regard to a learner's intellectual circumstances such as their perspectives on the gaining and assessing of knowledge, their way to approach learning which can be strategic, superficial or in-depth, and their style in processing and acquiring knowledge. These groupings all have important effects on teaching and learning (Felder and Brent, 2005).

The variety of learning styles and the importance of the variations between them highlight the significance of understanding which are the most appropriate learning environments for these styles. Scholars have examined several variables of learning to assess their impact on e-Learning. Research on context dependent learning outcomes has focused on both particular and general factors such as psycho-social, personality, learning style and environmental variables, and demographic and teaching ones (Foroozesh-nia and Rajee, 2015).

Variations in learning styles, needs and preferences need to be acknowledged as they have a significant impact on the effectiveness of teaching and its improvement. An additional variable which must be taken into account is the learner’s attraction to diverse modes in order to respond to their specific knowledge deficits. The basic learners’ model depicted in Figure 3-1 indicates the role and importance of these individual variables and distinguishing features.



**Figure 3-1 Basic Learner Model Encompassing Individual Differences**

Source: Magoulas et al., (2003, p. 6). “Used with permission of the author”

Researchers have proposed a number of models to visualise learning styles. However, it is noted that due to these models' conceptual overlaps they can be categorised into five primary groups (Coffield, 2004). These five main model categories underline variations in terms of learning approaches and strategies, stable personality typologies, cognitive structures, flexibly stable learning preferences, and inherent learning preferences and styles. The main differences between learners concern learning strategies, learning styles, cognitive styles, and affective variables (Ehrman et al., 2003).

The models focusing on constitutionally-based, or inherent, learning preferences and styles argue that cognitive and learning styles are genetically determined and as a result unchanging and difficult to modify. According to these models, the brain's hemispheres at the base of sensory and perceptual modes impact individual learning styles, which are in turn considered to be composed of and affected by psychological, physiological, emotional, environmental, sociological and VAKT (visual, auditory, kinaesthetic, and tactile) stimuli (Dunn, 2003).

Models based on cognitive structures view learning styles as determined by general habitual behaviours on which unvarying, regular practices are founded (Coffield, 2004). As a result, these theories view learning styles as unreceptive to change. Some of the main models based on this viewpoint are the Wholist – Analytic and Verbalizer – Imager (Riding and Cheema, 1991), and the field-dependent and field-independent model (Witkin et al., 1977).

Learning style models focusing on stable personality types are exemplified by the Myers-Briggs Type Indicator (MBTI). This measuring tool assesses types of personalities on the basis of how people interact with and become involved in the world around them (Briggs and Briggs-Myers, 2017). The MBTI consists of four binary

personality tendencies: Judging/Perceiving, Sensing/Intuition, Thinking/Feeling, and Extroversion/Introversion; and analysed on the basis of a combination of people's preferences within each pair results in sixteen types of personality (Doulik et al., 2017).

Models focusing on flexibly stable learning preferences consider learning styles to be individual inclinations modifiable with the context rather than fixed aspects of a person. This approach forms the basis of a number of commonly utilised models such as the Learning Style Inventory (LSI) (Kolb, 1984), the Felder-Silverman model (Felder and Silverman, 1998), and the Learning Style Questionnaire (Honey-Mumford, 1986). The LSI views individual learning styles as composed of two learning preferences within a wider learning process that converts experience into knowledge through four steps: concrete experience, abstract conceptualisation, active experimentation and reflective observation (Kolb, 1984).

The concept of individualised learning is founded on the proposition that specific teaching strategies are not appropriate in all cases; hence the achievement of learning objectives depends on adapting instructional methods to the learner's specific style (Federico, 2000). Kemp et al. (1998) showed that success in language learning is significantly impacted by instructional modifications. They therefore emphasise the pedagogical importance of taking into account learners' characteristics, capacities, skills and experiences as a groups or as individuals when planning learning environments (Kemp et al., 1998).

Learners are characterised by different learning styles. These variations in learners' preferences can be seen in their responses to visual information as opposed to verbal data, their preference for independent rather than interactive learning, or their degree of absorption of spoken and written information (Felder, 1996). In order to adapt

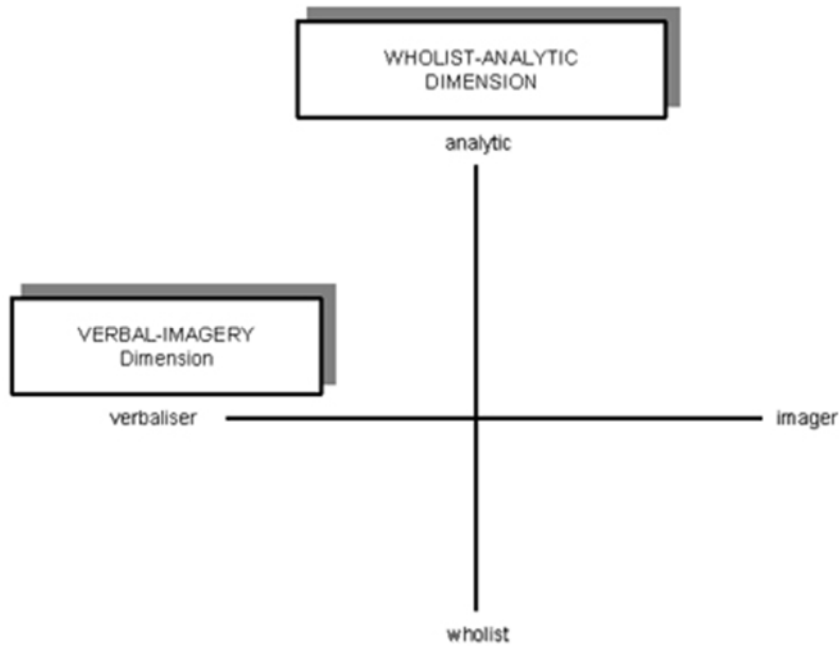


pedagogical methods to these observed variations between learners, instructors have utilised a range of theories and models based on psychological, perceptual and cognitive concepts.

The following sub-sections examine five models commonly utilised to assess students' learning styles: Cognitive Styles Analysis (CSA), Visual-Auditory-Kinesthetic (VAK), Kolb's Learning Style Inventory (KLSI), Honey and Mumford's Learning Styles Model, the Myers-Briggs Type Indicator (MBTI) and the Felder-Silverman Learning Styles model.

### **3.5.3.1 Cognitive Styles Analysis (CSA)**

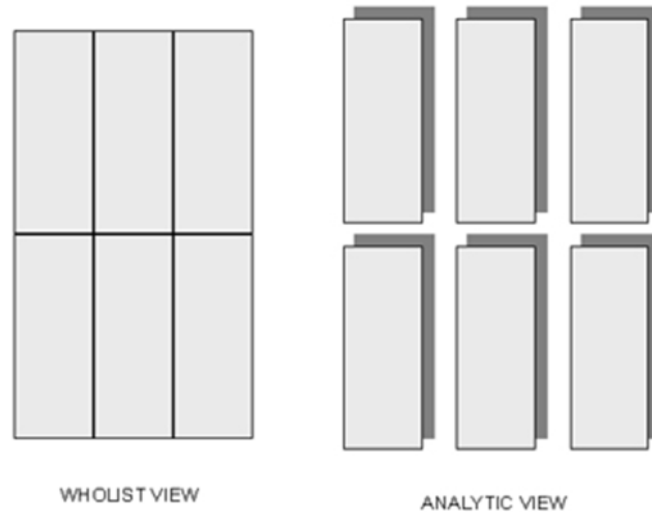
Cognitive theory views learning styles as a manifestation of the distinct ways individuals have of interpreting the information they are given. Developed by Riding and Cheema in 1991, Cognitive Styles Analysis (CSA) assesses learners on two dimensions: one axis measures the Wholist-Analytic spectrum, while the other axis assesses the Verbal-Imagery aspect of learning. Although both dimensions impact a learner's style, each aspect is independent of the other in this measurement. Figure 3-2 shows a visualisation of the cognitive dimensions of learning styles according to Riding (1996):



**Figure 3-2 Riding’s Learning Style Diagnostics**

Source: Riding (1996, p.30).

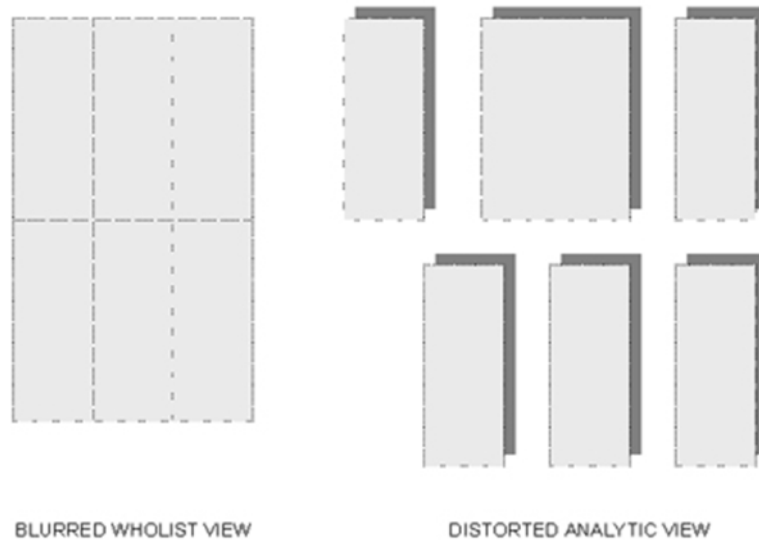
The vertical axis measures the Wholist-Analytic dimension, i.e. a learner’s ability to understand information in its constituent parts or in its totality. Analytic learners view a situation as a gathering of parts rather than as a whole, while Wholists see situations as an ensemble and do not necessarily differentiate between the parts. The Wholist-Analytic aspect of learning influences how people understand the structure and sequence of the information they receive. Figure 3-3 shows a possible visualisation of perception on the Wholist-Analytic axis (Riding, 1996).



**Figure 3-3 Riding's Wholist-Analytic View**

Source: Riding (1996, p.36).

On the other hand, the Verbal-Imagery dimension of learning influences how people assimilate the mode in which the information is presented, such as images and texts (Riding, 1996). This aspect of learning affects individuals' extroversion and introversion, as well as their verbal expression and internal picturing. The Verbal-Imagery dimension determines the manner of an individual's representation of information and their internal or external focal point of attention. Hence, it also affects a person's relationships, performance and behaviour. Figure 3-4 gives a representation of the Verbal-Imagery aspect of information perception (Riding and Cheema, 1991).



**Figure 3-4 Riding's Verbal-Imagery View**

Source: Riding (1996, p.37).

Later research indicates that the CSA assessment method for learning styles is not reliable as a predictor of performance in complex learning tasks. In particular, a study by John and Boucouvalas (2002) found that the Verbal-Imagery dimension was inadequate for predicting learners' performance in auditory-visual combination tasks. Thus, as e-Learning utilises a variety of complex instructional tasks, the CSA model cannot be reliably used in these contexts to predict the performance of learners.

### **3.5.3.2 VAK model**

The VAK (Visual, Auditory, and Kinaesthetic) model of learning styles originated in the 1920s and has since been adjusted to a variety of contexts including learning, evaluations and behavioural. The VAK model is founded on the utilisation of the three sense receptors of vision, hearing and kinaesthesia to establish how information is received and thus the learning style. It posits that although individuals might employ different styles or combinations of styles according to the learning task, they generally have a dominant

information receiving style. The VAK model additionally considers information filtering to be the pre-eminent way to acquire new knowledge (Fleming and Mills, 1992). As a dominant learning style is not necessarily appropriate to a given learning situation, and as a learner's preferred style is not always their strongest, it is important for instructors to present information in more than one instructional mode so as not to overburden the working memory of learners (Cotton, 1998).

The VAK styles are described thus:

- Visual learners have a preference for illustrations and other visual images, and absorb knowledge better when they can see what they are being taught.
- Auditory learners have a preference for listening and talking. They acquire knowledge better when they are being taught verbally and through listening and discussions.
- Kinaesthetic or tactile learners have a preference for learning through doing. They have a hands-on, active approach to learning, moving, touching and physically exploring their surroundings.

The VAK learning styles model provides an uncomplicated explanation to understand ways of learning. While the complexity of other models renders their practical implementation difficult, the VAK's simplicity has ensured its continuing popularity (Driscoll and Garcia, 2000). However, while applying the VAK model to learners' performance in the context of e-Learning appears to be appropriate, there has been to date little research on the links between VAK learning styles, the specific characteristics of e-tutorials and learner performance.

### 3.5.3.3 Kolb's Learning Style Model

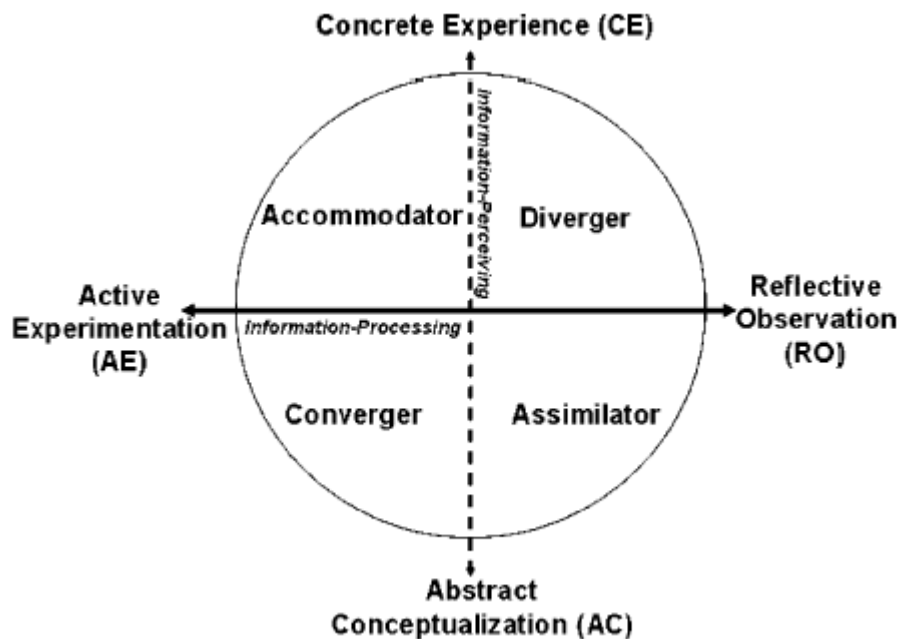
The Learning Style Inventory (KLSI) developed by Kolb (1984) has been widely employed since its inception. The KLSI centres on the perception and processing of new knowledge by people. It posits that learning takes place in the tension between the opposing poles of two dimensions. The first axis opposes abstract conceptualisation to concrete experience, i.e. thinking and experiencing, while the second axis contrasts reflective observation to active experimentation – watching and doing.

Experiential Learning Theory (ELT) provides the basis for Kolb's (1984) model. ELT views learning as a continually repeating cycle of learning processes in succession. In the 1970s Kolb introduced a distinction between the perception and the processing of information undertaken by learners within the cycle that constitutes the learning process, and consequently subdivided this process into four modes: Concrete Experience (CE) involves hearing, seeing, touching and feeling; Abstract Conceptualisation (AC) describes the logical examination of the new knowledge; Active Experimentation (AE) is the application of the information; and Reflective Observation (RO) describes the thinking about the novel knowledge (Kolb, 1984)

As can be seen in Figure 3-5, using the KLSI learners are assessed on each of the four learning modes, and characterised on the basis of their scores into four learning style types: Accomodators, Divergers, Convergors and Assimilators.

Accommodators utilise a practical approach to learning on the basis of their feelings. Divergers prefer concisely and logically presented although wide-ranging information. Convergors learn by putting in practice theories and ideas. Assimilators aim to put wide-ranging information into a logical and concise form. Effective learners do not exclusively

rely on their dominant style, but rather employ all styles opting for the most effective in accordance with the circumstances (Kolb, 1984).



**Figure 3-5 Kolb's Learning Styles and Learning Modes "Used with permission of the author"**

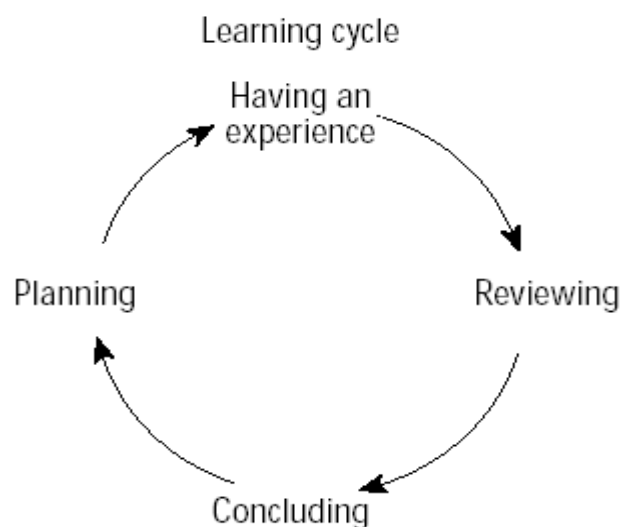
Source: Wang et al., (2006, p. 1306)

While the validity of the KLSI is not at issue, its application to e-Learning contexts might be problematic. Indeed, this model does not take into account a number of new skills specific to e-Learning environments and technology. In particular, the 'navigation' skills necessary to interact within the Internet, and the ability to locate information that is delivered in a number of different formats, including audio, video, text, animation and image, and to then utilise this information to complete a complex task. Thus the KLSI might not be sufficiently reliable to identify e-learners' differences in style and plan an e-tutorial on that basis.

### 3.5.3.4 The Honey and Mumford Learning Styles Model

The learning styles model developed by Honey and Mumford (1992) views learning as a cycle (Figure 3.7) and combines the stages of this learning process with different learning styles. The learning cycle is viewed as comprising several distinct types of learning stages, such as practical or theoretical, or taking place individually or in groups, and each learning style is linked to a stage in the model. Thus for instance the stage termed 'having an experience' is associated with field training, while the generation of concepts and conclusions is linked to lectures.

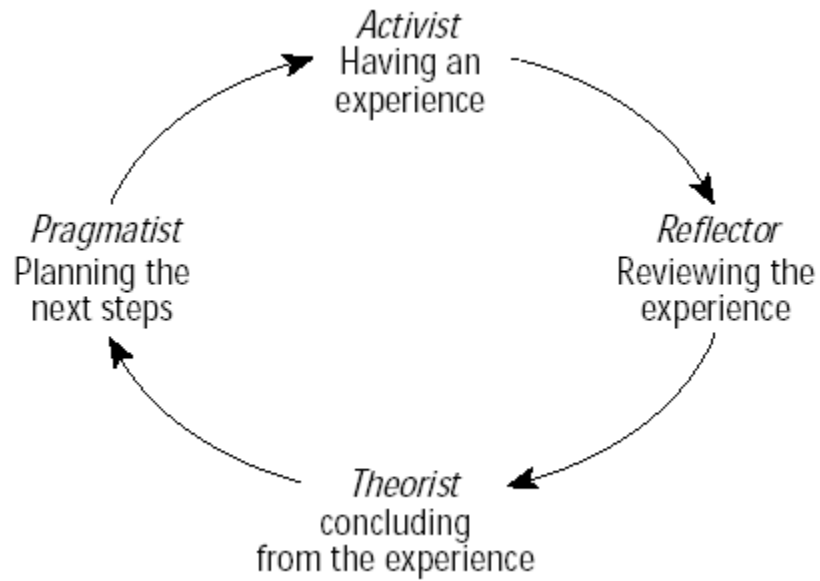
Individuals, be they learners or instructors, show an inclination to use a specific learning style over others resulting in a preference for a particular learning stage. These preferences are a detriment to learning (Mumford, 1995). Although the Honey and Mumford model is based on Kolb's model, it integrates Kolb's oppositional learning axes into a learning cycle and argues that learners' responses to a learning experience are tied to their preferences for a particular stage of the learning process.



**Figure 3-6 The Learning Cycle**

Source: Mumford (1995, p.46).





**Figure 3-7 Learning Styles and the Learning Cycle**

Source: Mumford (1995, p.49).

While Figure 3-6 presents Honey and Mumford's learning cycle, Figure 3-7 presents the different learning styles within their associated learning cycle stages. The different learning styles can be described as follows: Activists are intuitive individuals who learn from their senses and through active experimentation; Reflectors are inventive learners who gain information in concrete ways and then analyse and generalise it in their own specific manner often scorning instructions; Theorists are abstract thinkers who gather knowledge by analysing concepts and developing theories; Pragmatists are individuals who both think and do, developing knowledge theoretically and then testing and processing it practically.

Kolb's Learning Styles Inventory is commonly used in the US, while Honey and Mumford's model is more popular in the UK. However, they can both be said to have limitations and benefits.

### 3.5.3.5 The Myers-Briggs Type Indicator

The Myers-Briggs Type Indicator (MBTI) was originally developed as a personality assessment and applied to generate pedagogical methods for the teaching of engineering (Harold and Paul, 2003). Based on the theory of personality types proposed by Jung (1875-1961), the MBTI assesses and characterises students' personalities according to their tendencies. Students can thus be:

- **Introverts** whose attention is centred on their inner abstract world and who tend to think things through, or **Extroverts** who concentrate on the world around them and tend to experiment.
- **Intuitors** who focus on concepts, possibilities and meanings using their imagination, or **Sensors** who concentrate on facts, details and procedures being practical.
- **Feelers** who are sympathetic and base their decisions on humane, personal factors, or **Thinkers** whose decisions are founded on rules and logic and tend to be sceptical.
- **Perceivers** who are adaptable and seek more information rather than closure, or **Judges** who plan and follow programmes and who seek closure regardless of the information's completeness.

These personality tendencies can be linked and combined to compose 16 different types of learning styles.

The different models of learning styles presented in this section all have limitations as regards their adaptation to the modern e-Learning applications offered to learners. The

competences necessary to interact with new technologies are distinct from the traditional skills learners used to rely upon and apply to learning and working. As a result, the models described above have limited applicability for e-Learning training designers and instructors to identify the learning styles appropriate to instruction through digital media.

#### **3.5.3.6 Felder-Silverman Learning Styles**

Based on Kolb's (1984) learning theories Felder and Silverman's (1988) learning style model (FSLSM) adopts a four dimensional approach to define learning styles in detail relating to processing information, perceiving information, receiving information and understanding information (Felder and Silverman, 1988). The dimensions each contain two bipolar categories, to which learners are assigned one in each dimension according to their behavioural tendencies. These are: active/reflective; sensing/intuitive; verbal/visual and sequential/global.

Information can be processed either actively by engaging in physical activities, or reflectively through an introspective process involving thinking and reflection on the subject (Felder, 2002). Active learners learn best when they are able to experiment and actively apply the information and when they can ask questions. They prefer to work cooperatively with others in groups and make contributions to the learning process (Kaliska, 2012). Active learners respond well to teaching strategies involving role playing, games and simulations, problem solving, debates and discussion and brainstorming and online rely on tools involving collaboration, communication and search for learning (Santo et al., 2015). In contrast reflective learners prefer thinking and abstracting the information before doing, and periodically stop and review what has been learned and think about possible questions and applications (Santo et al., 2015). Reflective learners tend towards theoretical concepts and identifying interrelations. Preferring to work alone, watch and listen, reflective learners are

more oriented towards teaching methods involving presentation, case study, question and answer methods and use electronic media such as digital journals and articles and internet research (Cheng et al., 2016).

Learners can be either sensing or intuitive in how they prefer to perceive or take in information (Felder, 2002). Sensing learners focus on physical sensations and sights and sounds, tend to prefer concrete data and facts and are able to reproduce them easily, are procedure oriented and careful with details and show facility for practical, applied approaches including laboratory and experimental work and problem solving (Kaliska, 2012). Intuitive learners rely on intuition, imagination and divergent thinking to perceive information, tend towards theory, meaning and abstract conceptualisations and enjoy discovering possibilities and relationships and making connections while disliking repetition or factual learning requiring significant commitment to memory (Cheng et al., 2016; Santo et al., 2015). Such learners respond to teaching strategies involving discussions, role playing, games and simulations and may predominantly use search and tutoring electronic media (Santo et al., 2015).

Receiving information identifies how learners prefer information to be presented, categorised on the poles as either visual or verbal. Visual learners understand and remember better from learning material presented either through graphical or video representation, such as pictures, diagrams, charts, films or demonstrations. Games and simulations and information presentation in visual form are considered to be appropriate strategies for this style of learner (Santo et al., 2015). In contrast verbal learners depend more on information delivered through words either written or spoken (Felder, 2002). Text and sound are key characteristics of the media that appeals most to verbal learners while presentation,

discussion, question and answer, and brainstorming can be effective teaching strategies (Santo et al., 2015).

In terms of how they organise and advance towards understanding information, learners can be either sequential or global. Sequential learners show a preference towards linear learning presented in small, incremental and logical steps (Felder, 2002). Such learners are oriented towards convergent thinking utilising elementary thinking processes such as analysis and synthesis to uncover wider interrelations (Kaliska, 2012). Teaching strategies such as guidance, presentation and question and answer are appropriate when framed within content shown within a predefined learning path. Global learners tend towards a more holistic or systems thinking process first needing to view the problem as an element within a whole context before understanding can be developed and applied (Cheng et al., 2016). Information is absorbed and connections are made without deliberate contemplation, but more intuitively and accidentally using divergent thinking to build a complete picture (Kaliska, 2012). Global learners often learn in large, almost random leaps and while able to solve complex problems rapidly and innovatively may have difficulty in explaining how they reached this resolution (Santo et al., 2015). This type of learner reacts well to role playing, brainstorming, case study teaching methods and will likely emphasise collaboration, communication and search within their use of electronic media (Santo et al., 2015).

### **3.5.4 E-Learning Styles**

Evidence shows that particular learning styles may be more adaptable to e-Learning than others. As acclimatising to e-Learning is recognised as particularly arduous for a multitude of learners, cognitive theorists as well as software developers emphasise that learners have to develop new conceptual models enabling them to make sense of and understand how to work within this novel learning context (Discenza et al., 2001). Synchronous and

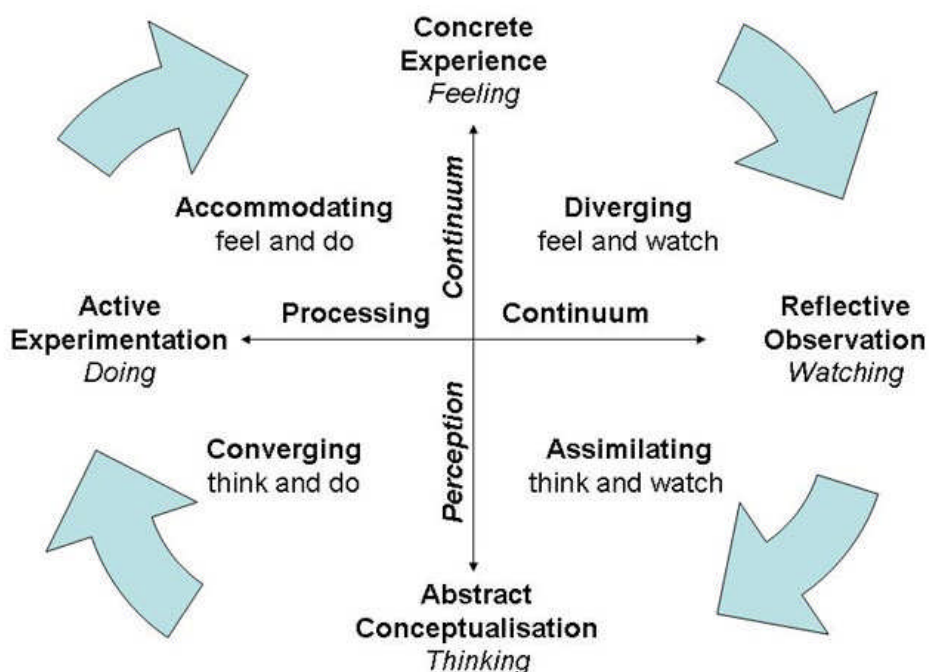
asynchronous models of e-Learning exist. The first aligns more with traditional settings and the course is led by the lectures held online (Midkiff and DaSilva, 2000 in Kakkar, 2008). The second mode relies on independent learning of the participants with slight or no interaction with the instructor (Omwenga and Rodrigues, 2006). Asynchronous online learning may occur regardless of place and time and it can embrace a self-paced learning, email exchanges with the course lecturer, and message exchanges within a discussion group (Kakkar, 2008). Studies refer to synchronous distance education as the harmonisation of the classroom instruction, which depends on time and place, to a remote education classroom through video and/or audio-conferencing media (Bernard et al., 2004). Communication and interaction between participants and information access occur immediately in e-Learning courses in asynchronous mode. Synchronous e-Learning features refer to audio conferencing, satellite broadcasting, chat rooms and video teleconferencing. (Kakkar, 2008).

It has been proposed that once the learning style of a student has been determined then e-Learning instruction can be adapted to suit the preferences of that individual (Alomyan, 2004). Researchers view the differences between individual learners as significant. These differences include the skills, opinions and perspectives of learners, and are seen as affecting the individual's general usage and acceptance of new technologies, as well as their particular viewpoints on computer and internet enabled learning (Liaw, 2008; Åkerlind and Trevitt, 1999). It has also been shown that some learning styles as well as some specific learner traits such as high levels of field independence, self-regulation, self-efficacy and motivation are comparatively more receptive to e-Learning (Flores et al., 2012).

Different standpoints have been adopted to research learning styles. While some researchers view learning styles as specific patterns of distinct behaviours that delineate the way individuals approach the experience of learning (Campbell et al., 1996), other scholars

emphasise the flexibility of learning styles and that learners utilise different styles depending on the learning subject and environment (Alharbi et al., 2011).

Figure 3-8 shows learning styles combined with the learning cycle. According to Kolb (1984), learning styles include individual choice about how to perceive and process information entailing mental and sensory factors.



**Figure 3-8 Learning Styles within the Learning Cycle**

Source: Kolb (1984, p.107) "Used with permission of the author"

Several scholars underline that while learning styles are flexible and variable, the process of change is often protracted. As a consequence of this difficulty for learners to adjust their learning style to particular instructional methods, it is easier and more efficient to adapt the teaching materials, components and methodologies to the students' learning styles (Yilmaz-Soylu and Akkoyunlu, 2002).

Learning styles are deemed to be efficient measures distinguishing the favoured learning behaviours of individual learners (Bostrom et al., 1993). Hence ascertaining learners' styles allows teachers to understand how each individual receives and processes information. On the basis of this awareness of the way learners perceive information, progress in their learning, and gain and retain new abilities, learning materials can be tailored and provided for the range of learning styles. Evidence indicates that adjusting instructional methods to learning styles improves learning outcomes and increases learners' satisfaction (Lindsay, 1999). However, it has also been shown that instructors often utilise pedagogical styles that conform to their own preferences and learning style (Ebeling, 2000). As a result, learning experiences frequently concentrate on a particular stage of the learning cycle and are therefore unable to achieve their purpose. According to Cowley et al. (2002), a learner's awareness of their learning style enables them to modify how they gain knowledge. The alignment of instructional materials with the learners' styles is thus seen by Bartomeus (2003) as a key element in the steady improvement of learning materials and their quality.

It is recognised that instructors working in an e-Learning context are afforded a smaller range of possibilities to directly affect the process of learning; this consequently highlights the necessity to design e-Learning instructions that integrate learning style differences (Bartomeus, 2003). This integration would enable instructors to mediate learning by creating a learning environment that enhances learning. Additionally, e-Learning environments that comprise diverse multimedia components have been argued to allow learners the possibility to self-evaluate their learning through a wider range of means. Moreover, learners' awareness of their learning preferences and style enables



them to take advantage of the availability of diverse instructional materials and media associated with their learning style (Bartomeus, 2003).

The reasoning at the base of e-Learning is that learning materials offered through technological media allow learning to take place in diverse circumstances and on the basis of each learner's needs (Laurillard, 1993). E-learning's main benefit is that it allows non-sequential interactions to take place (Chen and Paul, 2003), which is compatible with the significant role of instructional flexibility afforded by e-Learning that enables diverse learning styles to be provided for (Taylor, 1998).

The effectiveness of e-Learning courses hinges on the combination of diverse pedagogical options enabling learners to apply their preferred learning style. Thus different types of learning materials can be offered to learners with different learning styles: textual material for learners who prefer text-based learning or multimedia material for learners who are more comfortable with visual and audible learning (Shank and Sitze, 2004).

Research on the use of computer-assisted language learning (CALL) in relation to learning styles shows the importance of learner preferences on outcomes and satisfaction (Snyder, 2000). Further evidence indicates that the alignment of online instructional methods with learning styles is positively related to learning outcomes (Martini, 1986). The relationship between learning styles and a preference for particular pedagogical methods has also been shown: while computer-based teaching is appealing to Convergers, classroom-based teaching is more preferred by assimilators (Buch and Bartley, 2002). A study on the utilisation of a hypermedia teaching system that varied on the basis of the learners' characteristics as well as their cognition and levels of

understanding indicated that learning outcomes significantly improved with the sophistication and adaptability of the system (Triantafillou et al., 2003).

### **3.6 Multi-Media Learning Theories**

The term multimedia describes tools that offer information in more than one format such as video, audio, text and graphics. It is also used to describe media containing data that can be processed, accumulated and disseminated digitally. E-learning tools transmit information through a variety of media including text, still images, audio, video and animations (Greenlaw and Hepp, 1999).

Multimedia content incorporates two or more media (Mayer, 1997). Instructional materials are no longer limited to static forms such as text given the growing diversification of curriculum presentation. Further multimedia materials rather than paper-based content is being used to engage learner interest and attention. Multimedia learning materials comprised of visual elements such as static graphics, video, or animation and words in the form of narration or onscreen text provide a potentially effective tool for enhancing learner understanding within online learning environments (Chen and Sun, 2012). Consideration should be given to designing multimedia messages that foster meaningful learning as it is noted that effectiveness varies across different multimedia messages (Mayer and Moreno, 2002). The widely acknowledged dual coding theory (DCT) (Paivio, 1990) applies cognitive concepts to multimedia learning and models various processes of information retrieval and processes within individual cognitive behaviour. The theory stresses that both visual and verbal systems play key roles within learning activities. The verbal channel transforms input from audio senses into verbal representations while the visual channel takes input derived from the eyes and transforms it into pictorial or graphical representations (Mayer and Moreno, 2002). Evidence from Large et al., (1994) based on dual coding theory shows that

the retention of learning is improved by the use of pictures that in two key ways encourage the activation of dual coding. Mousavi et al., (1995) on the other hand found that the inclusion of multimedia materials consisting of both visual and auditory text narration resulted in less efficient learning as a result of divided attention. This effect was observed when the same mode of media, for example visual and visual, was used for different types of information. To extract learning from these materials it is necessary for learners to divide their attention between the materials to understand and use them.

### **3.6.1 Choice of Media**

The choice of media may potentially have significant influence on learning outcomes. The cognitive theory of multimedia learning supports the existence of this relationship (Mayer, 2001). Principles underpinning the theory assert that learners process information using both auditory and visual channels which are then integrated by the learner however there is restricted capacity to process information from each channel (Sahasrabudhe and Kanungo, 2014). Within e-Learning content is generally presented using either or both channels. For example the utilisation of text and graphics points to the use of the visual channel while the addition of sound such as a voice annotation indicates the utilisation of both channels to convey learning content. Overloading visual and auditory channels with extensive cues and symbols is noted nevertheless to potentially negatively influence learning effectiveness. Thus, while it is expected that media choice can impact learning effectiveness, it is suggested linear increases in effectiveness do not necessarily result when media choice is progressively adjusted to include more multimedia elements from text to graphics to audio to talking heads to full-motion video or animation. Further it is assumed that the relationship between media choice and learning effectiveness is moderated by the learners' learning styles (Sahasrabudhe and Kanungo, 2014).

E-learning is based on the cognitive theory of multimedia learning proposed by Mayer (1994) which offers the fundamentals to design e-Learning pedagogical tools (Mayer and Moreno, 1998; Moreno and Mayer, 1999; Mayer 2001, 2005). This cognitive theory of e-Learning views learners as active participants who build knowledge in a purposeful learning process which requires them to deliberately choose information from the offered variety, coherently arrange its representations, and incorporate the new with the old knowledge (Mayer, 2001).

The dual coding theory proposes that information is processed through two channels: the auditory/verbal channel and the visual/pictorial one, which respectively process narrations and animations (Paivio, 1971, 1991; Clark and Paivio, 1991). However, research indicates that the recollection of images is easier than that of words, even in the case of repeatedly presented visual or verbal information (Paivio, 1975), and that this image superiority effect (Nelson et al., 1976; Paivio et al., 1968) has been related to a faster and more thorough retrieving of the information contained in images than in words (Smith and Magee, 1980; Nelson, 1979). Reinforcing these results, a study on engineers' learning styles found they had a preference for visual information such as charts, diagrams, and videos, both as regards training and in their daily work context (James-Gordon and Bal, 2001).

Evidence shows that the effectiveness of learning through multimedia depends on four basic elements, namely learning outcome, content type, instructional method and delivery media (Clark, 2008). Rusli et al, (2014) further underline the importance of considering learning style. The type of media visualised also influences learning effectiveness. Two key categories of static or animation (interactive) multimedia visualisation are identified. Findings suggest that the use of interactive multimedia to present learning content is more effective than static, especially in terms of learning outcomes. Rusli et al. (2014) found that

multimedia technologies enhance content visualisation, collaborative network technologies and improve the student's ability in applying visual concepts such as object-oriented modelling. Evidence further shows that interactive in comparison with static multimedia presentations may enhance the post-test performance (Marsh et al., 2008, Mayer, 2001, Rolfe and Gray, 2011) and animations can improve student performance over static graphics (O'Day, 2006; O'Day, 2007, Rolfe and Gray, 2011).

Similar results have been found by Rusli (2015) and Rusli and Negara (2017). Rusli (2015) investigated the impact of multimedia learning with high and low interactivity on the learning result by controlling the student's prior knowledge. Findings indicate that dynamic multimedia presentations are more effective than static presentations to learning results. Rusli and Negara (2017) analysed the advantages of using static/interactive multimedia by assessing the capacity of students in applying concepts, procedures, and principals of Java programing using 138 students in 4 classes. The findings reveal that multimedia learning with animated visualisation is more effective than presentation with static visualisation in enhancing students' learning outcomes.

Interactive or dynamic multimedia have proved to be more efficient is learning more complex materials (Holzinger et al., 2008). Hence as the complexity of learning material increases so does the importance of appropriate representations which may in turn attract a learner's attention and interest (Holzinger et al., 2008, Mayer, 2001). Mešić (2015) compare the impact of simulations, sequences of printed simulation frames and conventional static diagrams on the understanding of one-dimensional kinematics among 63 students. The results shows that students who learned from dynamic multimedia stimulations significantly outperformed their peers who learned using static diagrams. The findings also confirm that there are significant gender differences in terms of dynamic multimedia effectiveness on

learning outcomes. Learning from sequences of printed simulation frames seems to be particularly effective for female participants.

Some negative aspects have been noted in relation to interactive multimedia implications on learner outcomes. These comprise of problems arising from self-guidance (relating to the lack of clear objectives and self-directed learning which may lead to an unwillingness to learn), and diminished media richness in that face to face communication reduces when communication becomes electronic (Rusli et al., 2014).

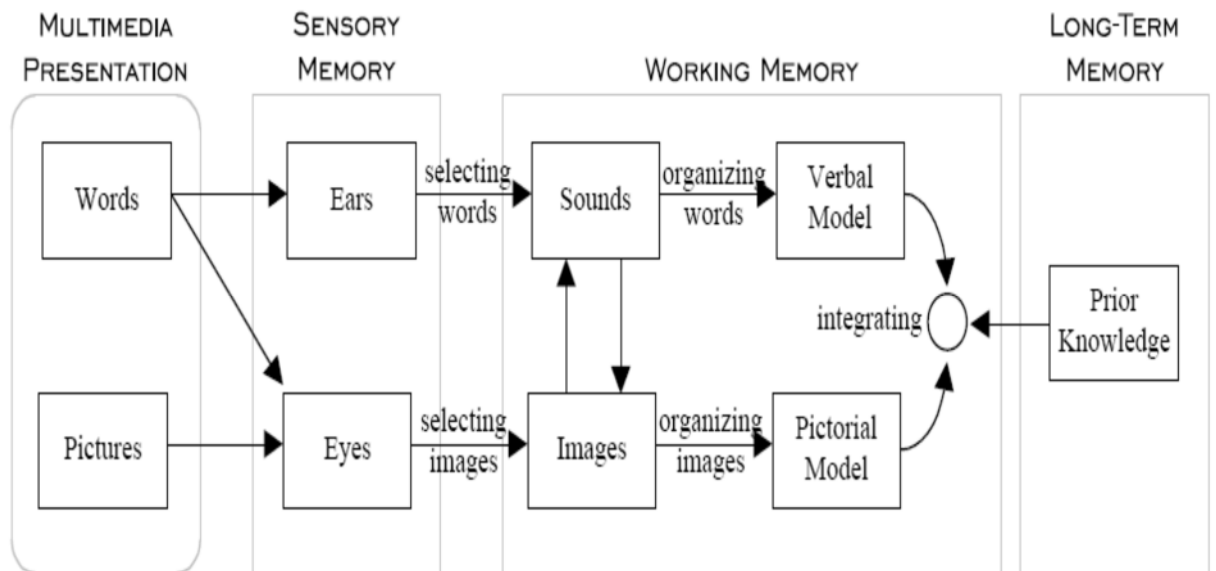
### **3.6.2 Multimedia Cognitive Learning Processes**

According to Mayer's and Moreno's (1998) cognitive theory of e-Learning, animated information is processed through the learner's visual processing system, while narrated information is managed by the auditory processing system. However, learners do not simply receive information, they apply three crucial processes of cognition: they select the new information in their preferred verbal or visual form; organise it by developing a coherent representation of the information, creating a mental verbal and pictorial model; and finally integrate these mental representations with each other and with their pre-existing knowledge (Mayer and Moreno, 1998).

Within a multimedia learning environment, information is presented as an external representation which can involve animation as well as narration, and from which learners select for processing the elements that are most beneficial to them. While narrations are processed through the auditory channel into sounds and verbal mental representations, animations are similarly processed through the visual channel (Mayer, 2003).

It has been highlighted that text-based learning material can include both images and printed words, and that both of these are processed through the visual channel. However,

printed words although perceived visually can be transformed by the learner into verbal representations thus processed through the auditory channel rather than the perceiving visual one (Mayer, 2003).



**Figure 3-9 Cognitive Theory of e-Learning**

Source: Doolittle (2002, p.13).

Figure 3-9 describes the parallel processing taking place in the learners according to Mayer’s cognitive theory of e-Learning. Learners perceive the multimedia presentation through their eyes and ears, i.e. their sensory memory; they then select the words and pictures to be processed in the auditory and visual processing channels of their working memory. The selected words and images are next organised within the working memory into verbal and pictorial models which are then combined and incorporated with their prior knowledge stored in their long-term memory (Mayer, 2001).

Mayer (2003) underlines that these selective, organisational and integrational processes take place iteratively. The result of this active learning is to build learning outcomes which

are recorded in the learner's long-term memory and indexed so they can be recalled and utilised (Mayer, 2003).

As these three cognitive processes are jointly fundamental for purposeful learning, it is necessary to design pedagogical material in ways that enable their maximal utilisation (Mayer and Moreno, 2002).

### **3.6.3 Cognitive Load Theory**

Cognitive load theory is another widely known theory according to which the visual and auditory channels that process information have limited capacity (Mayer, 2001; Sweller, 1999). This theory aims to enhance the storage and representational capacity of the learner's memory by decreasing the load on the working memory (Baddeley, 1992; Sweller, 1988).

The sensory memory has a maximum capacity load, termed the channel capacity, which refers to the greatest extent of information it is able to hold at any one time (Miller, 1956). Pedagogical presentations should thus take the channel capacity into account and be designed to utilise the learner's cognitive processes and channels without overwhelming them (Moreno and Mayer, 1999). Pedagogical presentations comprise both words and images which in an e-Learning context can be subdivided in spoken or written words and static or dynamic images (Mayer, 2003). Moreno and Mayer (1999) showed that utilising audio instead of visual text reduces the load of the working memory and enhances learning.

Cognitive loads are described as extraneous, intrinsic, or germane. The extraneous cognitive load is determined by the presentation of the information and its manner in relation to the intrinsic load. The intrinsic cognitive load is regulated by the number of



elements that interact within a memory area and cannot be modified by instructors. The germane cognitive load is related to the processing of information and the development of mental representations that enable successful learning (Chandler, 2004; Sweller, 1994). While effective learning can take place with a high extraneous cognitive load (Carlson et al., 2003), efficient learning outcomes require the germane cognitive load to be maximally enhanced as the extraneous load is minimised (Höffler and Leutner, 2007).

### **3.7 Spatial Ability**

E-learning may support the development of spatial ability which has been identified as the capacity to create, retain, recover and transform visual images in a well-structured way (Lohman, 1996). Spatial ability refers to the capacity for accurately visualising a three-dimensional object in two-dimensional space and is comprised of two key components of spatial relations and spatial visualisation. This is the ability to mentally manipulate visual objects to rotate, twist or invert them (Towle and Kinsey, 2005; Sorby, 1999). Spatial ability is viewed as a type of intelligence which can be trained and improved in order to foster higher learning outcomes with focused spatial training (Lee, 2006; Olkun, 2003). Skills in spatial visualisation may be enhanced to provide better spatial design in fire safety training programmes. Learners may also benefit from such skills in order to mentally visualise and process the learning content and to visually express and record this learning in accordance with the content (Olkun, 2003).

Spatial visualisation abilities are held to affect the level of academic achievement in engineering disciplines such as structural design and are important in domains such as teaching and learning in these areas (Alias et al., 2003). Evidence shows this ability is key for learner success in terms of engineering design, drawing, graphics, computer-aided design,

3D animation (Olkun, 2003; Jerz, 2002; McCuiston, 1990) and real models (Miller, 1992) as well as traditional workbook sketches (Alias et al., 2002). Therefore in the 3D graphics environment spatial visualisation abilities strongly impact learner performance and are critical for solving 3D-related problems. However the presentation of 3D spatial information in a two-dimensional manner is considered to be a key limitation of conventional teaching methods due to the challenge in understanding the 2D graphical representation of 3D objects (Mackenzie and Jansen, 1998). Evidence from Nokwe (1993) highlights that problems may lie rather with the instructional means employed to present information than with learner incapacity to visualise spatial relationships. Spatial visualisation skills have been categorised into four key areas of: mental representation of two dimensional elements in a 3D environment; visualisation of the 3D environment from a two-dimensional drawing; mentally manipulating and rotating objects to another plane, and finally the visualisation of objects to scale (Zavotka, 1986).

Scholars have classified spatial abilities into four key categories of spatial orientation, spatial visualisation, spatial perception and spatial relations. In order to test learners mental abilities in these areas standardised tests have been developed. These include the Mental Rotation Test (MRT) and the Mental Cutting Test (MCT), widely used to test spatial skills at all levels and assess spatial visualisation skills (Hartman et al. (2006). Spatial relations tests measure learners' skills in mentally rotating objects in two dimensions. These include spatial relations tests developed by Thurstone (1958), rotation of images tests (Duerman and Salde, 1971), left or right hand identification and the cards rotation test developed by Ekstrom et al. (1976). Spatial orientation tests evaluate the individual's ability to maintain clarity when visual stimuli are changed necessitating a mental rotation of a configuration (Ekstrom et al., 1976). Two key tests have been developed to measure this ability of: the Guilford-Zimmerman Spatial Orientation Test (Guilford and Zimmerman, 1948) in which two pictures

of the same object in different spatial orientations are presented to participants after which they are requested to identify the direction in which the object has moved; the Perspective-Taking Test, in which participants are requested to visualise a transformation from an ego-centric perspective.

Multiple tests have been developed to evaluate diverse levels of ability in spatial visualisation. These include the Mental Rotations Test, the Purdue Spatial Visualization Test – Visualization of Rotations, the 3-Dimensional Cube Test, the Group Embedded Figures Test, the Differential Aptitude Test and the Revised Minnesota Paper Form Board Test (Branoff, 2000; Sorby, 1999). Piaget and Inhelder (1971) note the importance of cognitive development in the achievement of an individual's potential. Therefore such cognitive tests could be useful for assessing spatial visualisation ability including tasks related to mental rotation and cognitive tests such as the Paper Folding, Form Board and Surface Development tests.

### **3.8 Evaluation of Learning**

The literature indicates differences between e-Learning and traditional classroom-based approaches relating to pedagogical principles, design, learning styles and issues which underline the need to evaluate e-Learning in comparison with traditional. Evaluation theory is a key element in the study of this subject. Evaluation represents an important instrument in attaining higher quality in e-Learning as seeking understanding and reflection of components and processes is necessary in implementing quality assurance strategies (Conole, 2004).

The evaluation process supports primary quality assessment, and risk management. E-learning framework encompasses five types of evaluation (Oliver, 2000). Formative evaluation incorporates the necessary information which allows system improvement

and adjusting, in order to achieve the development of the team. The key emphasis of summative or experimental evaluation relates mainly to learning and course results assessments towards an established point of reference and less on improvement. Assessment objectivity is provided through the use of external evaluators.

Illuminative evaluation aims to establish and analyse distinctive factors which from the participants' perspective assures the course success (Oliver, 2000). This involves pragmatic techniques such as explanation, observation, and inquiry. Integrative evaluation includes components from both summative and illuminative evaluation, but the obtained results are not subject to generalisation. Quality assurance or auditive evaluation can help to determine good practice and compliance. These types of activities are carried out by external evaluators within statutory agencies (Oliver, 2000).

Evaluation can also be perceived in terms of the purposes for assessment. Evidence shows three main aims which are integral to e-Learning evaluations (Harland, 1996). First, evaluation represents an important means of achieving the necessary information needed in the decision-making process. Control or understanding can be added as complementary elements for supporting the first purpose (Franklin et al., 2004). Control evaluations help assess the effectiveness of compliance, monitoring or surveillance. Awareness and intellectual understanding are increased once e-Learning systems goals are comprehended by the evaluator (Harland, 1996). Such practices generate higher reflections and practice progress which over time may produce higher quality achievements (Franklin et al., 2004). Further evidence shows that e-Learning evaluation represents a complex systematic process, intrinsically linked to e-Learning development as well as its implementation (Raspopovic et al., 2014).

### **3.8.1 Kirkpatrick's Model of Evaluation**

Training effectiveness can be assessed in terms of any particular outcomes viewed as relevant to the organisation, however biased conclusions can result if based on a single set of criteria (Ruhe and Zumbo, 2008). Kirkpatrick (1987) introduced a widely established model for the evaluation of training in order to reduce the occurrence of bias based on four key levels. These are identified as: reaction, relating to learner satisfaction with the programme; learning, defining the content such as facts, principles or techniques learnt; behaviour, in terms of changes in work-related behaviour as a result of the training and finally quantifiable outcomes such as improvements in quality or quantity and cost reductions (Kirkpatrick and Kirkpatrick, 2009).

A key assumption in the Kirkpatrick model is the definitiveness of evaluations, perceived as the basis for wider replication and generalisation to larger groups. However this view is challenged by the consideration that many diverse factors can impact the effectiveness of training within organisations and which are impossible to be captured by any single model (Bennett and Arthur, 1997). The central focus solely on training outcomes as a measure of effectiveness provides a further limitation, as evaluation of effectiveness should include multiple variables related to the individual, organisation and training that can influence outcomes such as the knowledge and preparation of the evaluator for the training subject matter (Aldrich, 2002).

The model nevertheless provides significant flexibility despite its acknowledged limitations in the specific encouragement of instructors to adopt and adapt techniques, methods and approaches from others and to comprehend the distinction between evidence and proof of training outcomes (Kirkpatrick and Kirkpatrick, 2009).

Level One: The first level of evaluation is that of the reaction of the training participants. Concrete measurement outcomes at this level are frequently provided through the utilisation of a participant questionnaire at the close of a training session. This form of reactive evaluation allows participants the opportunity to appraise multiple different aspects of the training including the content (Kirkpatrick and Kirkpatrick, 2009). However there are specific limitations noted with reactive evaluations which means that they cannot be solely depended upon to provide a definitive measure of training effectiveness (Ruhe and Zumbo, 2008). Moreover such forms of evaluation do not provide any objective measure of how well the participants have learned and internalised the training content (Kirkpatrick and Kirkpatrick, 2009). Consequently their value has therefore been questioned, based on the highly subjective nature of these evaluations (Davis et al., 1998) which according to Aldrich (2002) makes any evaluation based solely on Level One data irrelevant. As a result the remaining three evaluation levels within Kirkpatrick's model are considered to be more capable of creating a more accurate and holistic training evaluation.

Level Two: The second level of learning is used by trainers to identify if there has been any advance in knowledge or skills as a result of the training (Kirkpatrick and Kirkpatrick, 2009). A range of techniques are utilised to evaluate learning. These can include asking participants their learning expectations for the training and whether these were fulfilled. However again this is acknowledged to be based on significant subjectivity and may not reflect the genuine views of participants (Ruhe and Zumbo, 2008). Another method is to test learners in relation to the instructional content, nevertheless learning evaluations at this level are acknowledged to be unable to demonstrate whether knowledge or skills have been meaningfully transferred (Ruhe and Zumbo, 2008). Level Two data therefore relies substantially on self-assessment data

from instructors and participants which is potentially ineffective in identifying behaviour change within an individual (Kirkpatrick and Kirkpatrick, 2009).

Level Three: The third level of behaviour relates to a critical aspect of training evaluation in establishing the usefulness of the training investment in terms of the transfer of work-related skills, knowledge or capabilities. This involves evaluation of behaviour and how the training session is incorporated within staff knowledge and capabilities thus measuring the progression from learning to practice (Kirkpatrick and Kirkpatrick, 2009). It is acknowledged that evaluations at this level do not need to be undertaken in person or even at a specific location with networked technologies facilitating assessment of diverse aspects and elements of work performance (Kirkpatrick and Kirkpatrick, 2009). Given the availability of such technologies this level of assessment is contended to have even greater relevance in contemporary workplaces for evaluating modern forms of training including e-Learning. Computer-based testing of performance is argued to offer a precise and effective assessment of learning and comprehension. This demonstrates certain metrics that comprise a computer-based part of evaluation.

Level Four: Level four pertaining to results is viewed as frequently the most significant level of evaluation for management as it provides evidence that can be related to tangible performance features such as cost reduction, greater productivity or sales, or enhanced quality. Such concrete data produces justifiable evidence for continued investment and enhancement of training and development initiatives. Assessment of value is viewed as the most important at this level as training is evaluated from the perspective of business outcomes and in terms to which management is most receptive. However this data from an organisational and business perspective is complex and

challenging to obtain (Winfrey, 1999). For training delivered in any mode or medium, information on participants' learning is critical for evaluating both training effectiveness and cost-benefits to the sponsoring organisation (Kirkpatrick and Kirkpatrick, 2009). This level of evaluation could be considered particularly relevant for e-Learning given some scepticism in terms of its efficacy for producing learning or behavioural changes as a result of its relatively recent introduction (Martinez, 2003). In the final evaluation of training programme effectiveness an acknowledgement of barriers to the transfer of knowledge and skills is argued to be critical within any model of training evaluation (Kirkpatrick and Kirkpatrick, 2009).

### **3.8.2 Evaluation Approaches**

Freire et al (2012) identify several important evaluation methods which serve as a guide and help explain the adoption of e-Learning evaluation platforms. First, methods should be written-up as a complete record and allow for rapid assessment. Within the evaluation platforms both methods and stakeholders views should be included. A multidisciplinary approach which includes components such as motivation and engagement, in conjunction with functional aspects which help augment the user voice within the e-Learning framework. Initiating an early stage evaluation of the e-Learning process can avoid costly reworking (Freire et al., 2012). Further early evaluation allows for decisive action to be undertaken in response to early conclusions (Franklin, et al., 2004).

Few studies have suggested the use of total quality management within evaluation models. An application of Chen's (2009) performance-evaluation model for e-Learning was performed by Martinez-Caro et al., (2015). The empirical model focuses on minimising the resources wastage in terms of selecting the most urgent improvements



and measures for raising student satisfaction. Several dimensions are taken into account, namely: student-student interaction; teacher-student interaction; content, and system flexibility and convenience. Earlier aspects of the Importance-Satisfaction (I-S) matrix (Yang, 2003) are replaced, to support a better understanding of consumer requirements and the level of satisfaction, thereby helping to provide the means to minimise resource wastage.

As a result of model inefficiency in selecting the most urgent improvement, an adapted matrix has evolved which splits performance into three zones. The first is Zone A, or the insufficient resource allocation zone. The second is Zone B or investment reduction to prevent waste while the third is Zone APCZ, or the appropriate performance control zone. The investment of resources in the quality attributes which fall into APCZ zone are well-balanced and need to be preserved.

Furthermore, performance control within APCZ are defined using upper and lower control lines. Those items that are located outside the perimeter control should seek to be improved. The model was applied to a live e-Learning system for university students and proved to be useful for selecting the most urgent attributes requiring improvement based on user perceptions and level of satisfaction (Martinez-Caro et al., 2015).

ISO 9126 could be seen as a useful tool for evaluating e-Learning systems, especially when there is no consensus on a standard framework for evaluating system quality (Chua and Dyson, 2004). The ISO 9126 quality model identifies six main characteristics, namely: functionality, reliability, usability, efficiency, maintainability (which refers to easy modification and error diagnosis) and portability (software ability to be transferred from one system to another). Particular attention is directed towards both function and technical aspects, while a limited awareness is directed to human-

computer interaction (HCI) factors in assessing usability factors such as learning ability, understanding and attractiveness (Chua and Dyson, 2004, Lindgaard, 1994).

Empirical validation of the evaluation model is provided in the context of university student's e-Learning system Blackboard, which showed the system performance capabilities in detecting general and critical errors. However, the results do not provide detailed analysis of features such as usability. For instance, results such as appearance attribute are considered too general and requiring refinement through reference to the determined HCI usability principles (Chua and Dyson, 2004). Although there is no common criteria for usability, some degree of specificity has been found in the literature, in terms of observable equivalence in usability measures. Nevertheless, no pedagogical evaluation arrangements for e-Learning systems have been provided such as quality context assessment, identifying the strategies that better fit the user patterns or learner motivation. Multidisciplinary e-Learning assessment is crucial for a complete evaluation framework.

An evaluation framework shown in Table 3-1 has been provided by Mohammadi and Homayoun (2013) based on a review and incorporation of several evaluation factors found within eight studies (Chiou et al., 2010; Shee and Wang, 2006; Ozkan and Koseler, 2009; Andreu and Jáuregui, 2005; Chin and Kon, 2003; Chao and Chen, 2009; Tzeng et al., 2006; Wang et al., 2007). The general framework provides a powerful and thorough set of evaluation criteria based on four distinct dimensions which permits e-learning managers to be more flexible in assigning the relevance of various factors based on the system set goals and objectives. The model encompasses all stages of learner interaction from the initial stage to post-course assessment. The proposed model of multi-criterial methodology is based on a previous study made by Shee and Wang

(2006), who also use many of the established criteria such as content, interface, social aspects and personalisation of the learning process. Table 3-1 shows the evaluation dimensions.

Bhuasiri et al. (2012) showed that successful implementation of e-Learning programmes is dependent on changes in student behaviour, motivation and technological awareness. A model of information systems proposed by Delone and McLean (2003) manages to incorporate several fundamental elements from the perspective of e-Learning users, six of which gain widespread acceptance: system quality, information quality, service quality, use, user satisfaction, and net benefits (Petter et al., 2008).

**Table 3-1 Evaluation Dimensions**

<b>Content</b>
Learning Models, Course Design, Up-to-date content , Sufficient content, Useful content , E-Learning Material, Self Learning, Course Quality, Instruction Materials, Interactive course, Up to date course information, Offline/online resources , Language support, Intellectual property rights, Qualified e-learning course designer, Course materials prepared in advanced , Library facilities/support, Availability, Content Personalization
<b>Social</b>
Learner Cognitive Process, Environment facilities, Ease of discussion with other learners, Ease of discussion with teachers, Ease of accessing shared data , Ease of exchanging, learning with the others, Learning Community, Personalization, Student commitment, IT support, Protection of students' details and privacy, Intellectual property rights
<b>Interface</b>
Ease of use, User-friendliness, Ease of understanding, Operational stability , Quality of Website Platform, Personalization, Webpage Connection, Multimedia, tools/technologies, Download Speed
<b>Learning</b>
Capability of controlling learning progress , Capability of recording learning performance, Learning Models, Synchronous Learning Asynchronous Learning, Learning Record, Self Learning, Participant Motivation and System Interaction, Interactive course Learn from past performance, Consideration for disabled students

Source: Mohammadi and Homayoun (2013, p.14) - "Used with permission of the author/copyright holder"

System quality evaluation is conducted through the first three components, relating to the evaluation of user platform performance, reliability, stability and security, including user response capability. Using metrics such as clarity, relevancy, organisation, presentation, and currency, the quality of information can be assessed, while the evaluation of the instructor-student interaction is used for determining the quality of service, using availability, timeliness utility, delivery organisation and other criteria (Delone and McLean, 2003).

Student satisfaction regarding the course and learning experience, together with the efficiency of the use of learning material, is evaluated by user satisfaction, intended use and net benefits. The latter may be positive or negative, which can be measured by the final evaluation of academic achievement, general improvement of learning and the retained knowledge. Technology dependence and social isolation are part of the overall preoccupations in relation to the negative aspects of the e-Learning experience (Delone and McLean, 2006).

The success of an e-Learning system is generally evaluated throughout three methods: Technology Acceptance Model, the User Satisfaction Model and e-Learning Quality model (Raspopovic et al., 2014). Based on Delone and McLean's (2006) methodology, other scholars such as Raspopovic et al., (2014) evaluate e-Learning systems using six components. To measure system efficiency, metrics have been used to evaluate flexibility, responsiveness, reliability, ease of use, stability and security. Using clarity, currency, presentation and organisation, the quality of the information and implicitly the content of the course is evaluated. In order to evaluate the student -teacher interaction, metrics are used not only for the clarity and organisation of pedagogical

teaching, but also for the availability and helpfulness to students. The metrics needed to measure use are based on the frequency of use of learning materials. The ability to recommend, the experience and the overall satisfaction comprise the results for user satisfaction. Net benefits were measured in terms of enhancing learning perceptions, knowledge and academic outcomes. Raspopovic et al. (2014) highlights that some quantitative values relate to students' perceptions and prejudices, which makes it more difficult to be quantified. Nevertheless Raspopovic et al. (2014) reports the use of robust methodology and thus can be used to improve student outcomes by identifying system gaps.

### 3.8.3 Evaluation Frameworks

Multiple criteria used for e-Learning assessment are summarised in the table below. Weight criteria assessments are accompanied by numbers indicating their relevance. Statistical data regarding either weights or influence have been provided in Table 3-2.

**Table 3-2 Criteria and Evaluation Methods for e-Learning Quality**

Source	E-learning Quality Criteria	Evaluation Method
Matsatsinis <i>et al.</i> 2003, Delias <i>et al.</i> 2007	(1) Interface (I) (style, ease of use, customization, multimedia quality, communication), (2) Functionality (F) (response time, security, reliability, interoperability), (3) Content (C) (organization, up-to-datedness, assessment, sufficiency, format)	MUSA
Blass and Davis 2003	Appropriateness (B), Design (I), Interaction (I, F), Evaluation (B)	
Ehlers 2004	Tutor Support (F), Cooperation and Communication (F), Technology (T), Costs-Expectations-Benefits (B), Information Transparency of Provider/Course (F), Course structure (C), Didactics (P)	
Hwang <i>et al.</i> 2004	User interface design (I, F, C, T) (Quality of web-page design, Suitableness of web-link design, Usability, Response time of the user interface, Quality of media presentation, Maintainability and extendibility, Quality of security mechanism, Quality of learning guidance and operational support), Quality of instructional contents (C, P, T) (Correctness, Structure, Completeness, Readability, Difficulty, Target fitting, Assistive content, Price, Portability, Digitization quality)	Fuzzy logic, AHP

Lanzilotti <i>et al.</i> 2006	Technology (T), Interaction (I,F), Content (C), Services (F)	eLSE (Abstract Tasks inspection)
Gilbert <i>et al.</i> 2007	Synergy between theory and practice (P), specific subject criteria (C), discussion forums (F), interaction (I, F), learning support (F), robustness (F), usability (I), access to resources (F), currency of study Materials (C), student work scheduling (F)	
Tzeng <i>et al.</i> 2007	Personal Characteristics and System Instruction (F), Participant Motivation and System Interaction, Range of Instruction Materials and Accuracy (C), Webpage Design and Display of Instruction Materials (I), E-Learning Environment (F), Webpage Connection (F), Course Quality and Work Influence (F), Learning Records (F), Instruction Materials (C)	MCDM
Marques <i>et al.</i> , 2008	Content (C), LMS Communication (F), Management Processes (B), Results (learners' performance, credibility, ROI, learners' satisfaction) (B, F)	Mean
Shee and Wang 2008	Interface (I), Learning Community (F), Content (C), Personalization (F)	MCDM
Sun <i>et al.</i> , 2009	Instruction presentation (I), student learning management (B)	
Büyüközkan <i>et al.</i> , 2010	(1) Complete Content (C), (2) Right and Understandable Content (C, P), (2) User Interface (I), (3) Security (T, B), (4) Personalization (F), (4) Interactivity (F), (5) Navigation (T)	Fuzzy AHP
Ertl <i>et al.</i> , 2010	Cognition (prerequisites, strategies) (P), Epistemology (content quality, content presentation, content acceptance) (C), Society (facilitation/tutoring, sociability) (B, F), Technology (usability, support) (T, I, F)	
Hogo 2010	Learners' profile	
Huang and Huang 2010	Usage data (viewing time, page view frequency, navigational path length) (F), Questionnaire	Fuzzy clustering
Lin 2010	(1) Information quality (Accuracy, Currency, Completeness, Format) (C), (2) System quality (Accessibility, Navigability, Response time, Learnability) (F, P), (3) Service quality (Reliability, Responsiveness, Trust, Empathy) (F, B), (4) Attractiveness (Multimedia capability, Webpage design, Course design) (I)	Fuzzy AHP
Lee 2010	Perceived service quality (feedback, support) (F), Perceived ease of use (clear, understandable, easy to use, goals' fitting) (I, P), Perceived usefulness (learning speed, improvisation of accomplishment, productivity and effectiveness) (F), Online learning acceptance and satisfaction	
Alptekin <i>et al.</i> 2011	Customer needs (Completeness, Easy to understand, Credibility, Price, Ease of use, Visual attractiveness, Personalization) (I, C, B, F), Product Characteristics (Links and references, Evaluation, Content organization, Attractive multimedia, Payment methods, Instructors' qualification, Personalized advisory, Credibility, Communication) (C, B, I, F)	Distance metric
Jung 2011	(1) Staff Support (B), (2) Institutional Quality Assurance Mechanism (B), (2) Learning Tasks (C, P), Interaction (I), Institutional Credibility (B), Learner Support (F), Information and Publicity (C, B),	
Kay 2011	Learning (P), Design (I), Engagement (I,F, B)	
Liu <i>et al.</i> , 2011	web usability (I), learning materials (C), assisting functionality (F), technology integration (T), learner preferences (F)	

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Jeong and Yeo 2014	Multimedia content: (1) Learnability (P, F), (2) User Friendliness (C, I), (3) Enjoyment (P, F), Media loss rates, Frame rates, Download time (Access time), File size, User control, Up-to-date.
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### **3.9 Theoretical Framework and Hypotheses**

A review of the literature and relevant themes in relation to the evaluation of traditional and e-Learning modes of delivery emphasise key research questions and gaps which inform this study. The literature emphasises a need to develop understanding of the interaction and influence of different factors under different learning environments as the basis for course and programme development. The differences between traditional and e-Learning modes of delivery have been shown to impact on learning outcomes in various ways. Many studies have examined the influence of different modes of delivery and learning environment on learning outcomes. Notably, differences in the face-to-face and e-Learning settings have diverse implications for learning outcomes impacting both positively and negatively on the learning experience. The research context and a review of the literature leads to several key research questions and hypotheses. Figure 3-10 shows the theoretical framework and focal dimensions of this research to evaluate learning effectiveness of the fire safety programme for civil defence learners. Learning mode, learner characteristics, and multimedia richness provide the inputs to evaluate learning effectiveness at three levels: affective, cognitive and behavioural. A central question is how does learning effectiveness differ between traditional learning and e-Learning? The differences in learning environment in terms of unique engagement, instructional support, content delivery, feedback and pedagogical practices will impact on learning outcomes in different ways. Thus the first hypothesis comes from the significant need to understand if the differences between face-to-face and e-learning modes of training delivery affect learning effectiveness which will provide a basis for

identifying and designing the most efficient and effective learning experience. Investigation of this issue will provide greater insight into the optimal structure for e-learning programmes. Therefore it is hypothesised *(H1) Learning effectiveness is significantly better in traditional face-to-face learning than e-learning across different measures.*



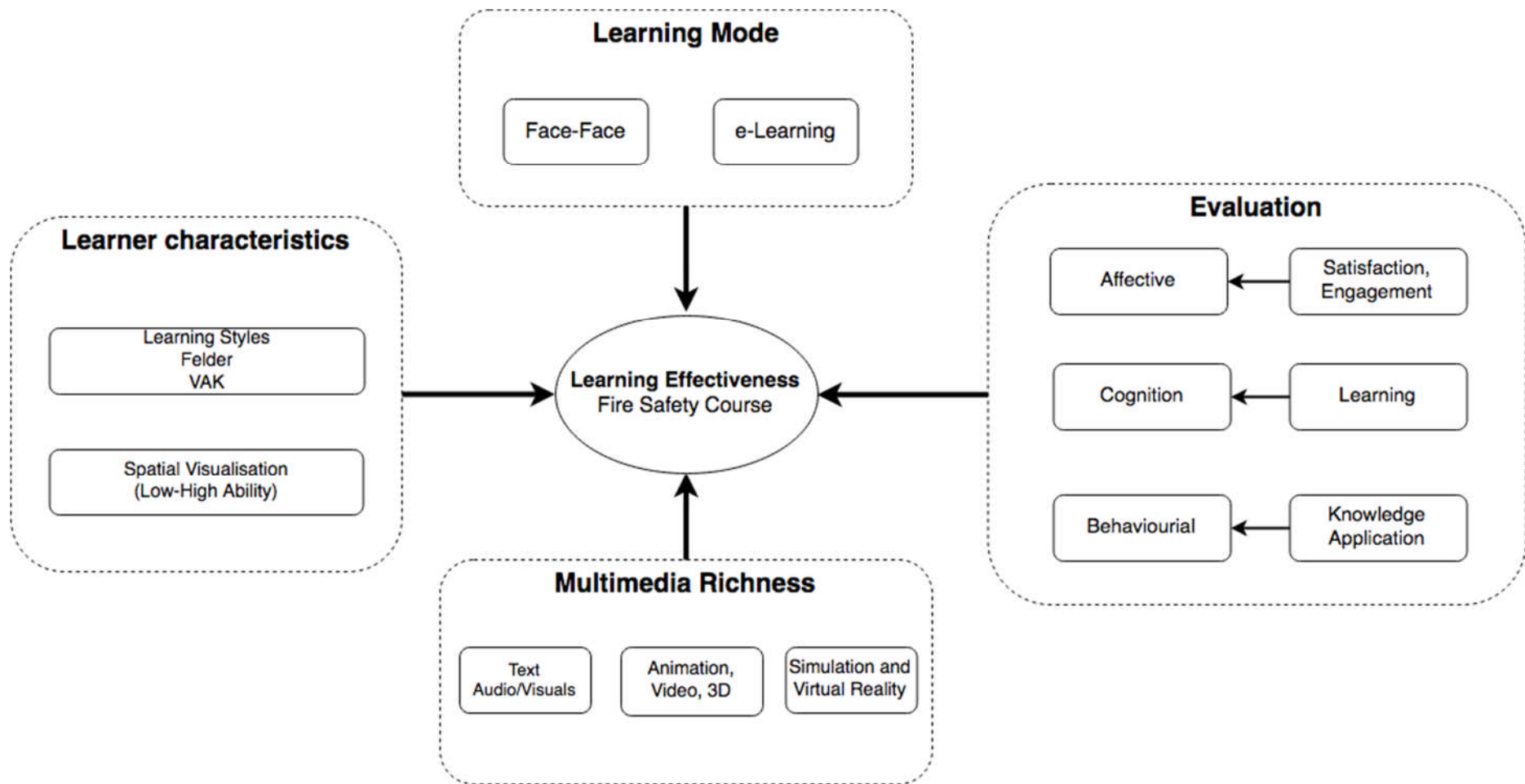


Figure 3-10 Conceptual Framework Evaluating Learning Effectiveness

The evaluation of different modes of learning can also be examined from a multimedia perspective. A key question is in what ways multimedia use impacts on learning effectiveness. Research shows that the choice of media may potentially have significant influence on learning outcomes. This has implications for exploring the relationship between media richness, learning styles and learning outcomes. Thus the second hypothesis states that *(H2) In e-Learning design approaches, learning effectiveness is significantly better in high media rich (text, audio-visual, animation, 3D) than low media rich (text, audio, visual)*. The motivation for this hypothesis comes from the need to understand whether and to what extent the level of media employed impacts on learners so that technology can be adapted and tailored to optimise learning.

Furthermore, learning effectiveness can be defined and measured in many ways in terms of learner reactions, behavioural learning, satisfaction, self-efficacy and overall performance outcomes. The extent to which the learning approach addresses the needs of learners is a further measure of learning effectiveness. A key question arising from this review is how individual learners' approaches, preferences or interactions with learning situation relate to their learning outcomes. Specifically do learning styles impact on learning effectiveness between different e-Learning designs? Theory on learning styles provides a perspective on learner preferences and how they may relate to different modes of learning. Given that the literature shows that learner needs are susceptible to the learning context it is hypothesised that *(H3) Learning styles have higher significant effects on learning effectiveness using e-Learning than traditional learning*. This hypothesis is motivated by the need to understand if there is a need to adopt and adapt learning approaches to address different learning styles. This is important not only for maximising learning effectiveness in e-Learning design but also

for the contribution greater understanding can make to promoting learner engagement and satisfaction. The fourth hypothesis combines theory on spatial abilities in relation to e-Learning and multimedia theory as a basis for exploring whether spatial abilities relates to learning effectiveness in the two modes of learning. Therefore it is also hypothesised that *(H4) Spatial ability has a higher significant effect on learning effectiveness using e-Learning than traditional learning.* The motivation for this hypothesis emerges from the need to comprehend if learner's spatial ability has any effect on learning effectiveness and if so whether there is necessity to adapt e-Learning design to account for different levels of spatial ability. The knowledge contributed on spatial ability can be used to optimally structure the e-Learning programme with a better use of resources to promote learning in learners with different levels of spatial ability.

### **3.10 Conclusion**

This chapter has presented the theoretical basis for this study through the exploration of the key themes and debates in relation to e-Learning and examination of the key concepts of e-Learning that form the basis of this study. Specifically a review has been presented of the relevant literature in relation to e-Learning and the evaluation of e-Learning programmes. The definition of traditional and e-Learning, design implications, learning styles, multimedia theory and learning evaluation are presented to inform the research focus.

The distinctions revealed between traditional forms of learning and e-Learning provide insights into pedagogical implications and challenges that provide a focus for analysis and evaluation of e-Learning strategies. The role of learner characteristics contributed a perspective into the role of learning styles and the impact on learner performance. Different models of learning styles emphasise the differences and

complexity of how individuals learn and disparity in evidence support of their application to the design of e-Learning. Furthermore, e-Learning styles represents a contemporary research dimension and knowledge gap in terms of understanding the effects of learning styles on learning performance in an e-Learning environment. Multimedia theory emerges as a significant relevant dimension that has been addressed in this review as multimedia assumes a critical role in gaining the attention and engagement of learners. Multimedia choice and the cognitive learning implications can potentially impact learning effectiveness. In terms of learner characteristics it has been shown that spatial ability is a learner characteristic that interacts with learning mode and multimedia choices. Finally, the analytical framework for this study is situated within learning evaluation theory that delineates approaches and frameworks in evaluating the impact of learning interventions.

This review has revealed a gap in understanding of the relative impact of traditional versus e-Learning modes of learning. While independently the literature presents frameworks for the design and implementation of the respective modes of learning, further research is required in the area of comparative evaluations. This is related to the central research question: how does learning effectiveness differ between traditional learning and e-Learning across different measures? A review of the literature points to the significant potential of e-Learning within training contexts such as civil defence. Multiple factors can impact the effectiveness of e-Learning in this context including teaching factors, design principles and learning styles. Finally, this review culminated in the identification of an area of significant and novel research that has the potential to enhance understanding into the relative impacts of different modes

of learning on learning effectiveness while accounting for learning styles and multimedia configurations. The resulting framework in

Figure 3-10 identifies the analytical dimensions that will address the research questions and address the research context and problem for civil defence in the UAE in furthering understanding of the effectiveness and role of e-Learning.

## **Chapter 4      Methodology**

### **4.1 Introduction**

The aim of this chapter is to present and discuss the rationale for the research approach underpinning this study and which guides the research design, and the strategies and methods adopted to address the research goal. Key elements of the research processes are presented including the underlying philosophy, the research strategies and methods utilised, the collection and analysis of the data and ethical considerations. This research adopts the positivist paradigm employed within multiple similar studies on e-Learning (Moore et al., 2011; Cho et al., 2009; Selim, 2007; Liaw, 2008).

### **4.2 Research Philosophy**

All research is underpinned by a philosophical view which guides the research design and consists of core assumptions in relation to the nature of reality, termed ontology, and the validity of knowledge and how we know it, epistemology (Cresswell, 2003). Two key schools of thought reflect fundamentally divergent perspectives on these issues. Reality is viewed either as external to human consciousness and thus objective and singular, or as multiple, socially defined by individual and group interpretation, and therefore highly subjective as its existence depends on the observer's perspective (Eriksson and Kovalainen, 2008). Epistemological perspectives reflect a similar distinction, in which knowledge is asserted to be objective and observable or able to be subjectively interpreted (Saunders et al., 2009).

Arising from this basic divergence are two key research perspectives of positivism and interpretivism. Positivism asserts that research is value free, knowledge is only

legitimate when derived from experience and the accounts and facts research produces are directly correlated to a reality independent of the observer, positing a universal truth or causal laws that can be applied across contexts (Eriksson and Kovalainen, 2008). Based on the empiricism of the natural sciences and predominantly associated with quantitative methods, positivism provides a basis for observing and measuring variables previously identified as attributes of the subject of interest and able to change, and which can be subsequently analysed to reveal patterns and relationships (Saunders et al., 2009). Thus a key advantage of adopting this perspective is the ability to determine causal factors and make predictions (Bryman and Bell, 2007). Moreover the utilisation of quantitative data and generally large sample sizes provides opportunities for greater generalisation of the findings. Nevertheless certain limitations are acknowledged in relation to positivist research, based in particular on the key argument that it is inflexible and artificial and while emphasising objective observation is restricted and superficial in providing an understanding of individual and subjective perspectives in relation to traditional and e-Learning approaches to instruction (Saunders et al., 2009).

In direct contrast interpretivism views reality as essentially subjective and shaped by the perceptions of individuals. Interpretivist researchers thus accept that the same phenomenon can be understood and interpreted in multiple different ways (Collis and Hussey, 2013) and the distinction between social reality and natural reality requires different methods of inquiry (Crotty, 2005). Associated mainly with qualitative research, the perspective provides the foundation for inductive processes leading to the development of theory (Collis and Hussey, 2013). Therefore the emphasis is not on generalisation but to obtain a deep understanding of the structure of a phenomenon (Saunders et al., 2009) by exploring the practices and processes, interactions and sense-making of social actors in relation to a given situation or context (Crotty, 2005). An

interpretivist perspective can therefore sustain the provision of a more holistic and in-depth account of the experience of e-Learning compared to traditional learning through enabling the exploration of multiple perspectives (Creswell and Clark, 2007). However interpretivist-based research is acknowledged to be vulnerable to increased researcher bias as a result of the subjectivity inherent in the conducting this type of research. Further the primary data generated in these studies is more difficult to generalise given the generally smaller sample sizes and potential lack of representativeness (Saunders et al., 2009).

In this study a positivist perspective is assumed enabling objective observation and measurement of the study variables.

### **4.3 Research Strategy**

Research methodologies in the area of information technology are relatively new and mainly comprise a range of approaches and methods which have been modified from various disciplines including the natural sciences, social sciences and business and management research. Creswell (2003) identifies three main approaches in research of quantitative, qualitative, and mixed methods. A quantitative approach is adopted in this study based on a positivist research perspective.

This study employs a quasi-experimental research design in order to evaluate the different learning interventions. Suchman (1967) emphasises a scientific approach to evaluation, placing the principles of experimental design more widely within the broader context of policy evaluation and underlining the significance of considering the related social context. By adopting a scientific method, it was argued that evaluation findings would be more objective and able to be verified in terms of validity and reliability. Borusch (2003) highlights the application of experimental designs for the



evaluation of programmes in multiple diverse service areas such as criminal justice and employment in addition to secondary education and distance education.

Experimental and quasi-experimental designs for the evaluation of programmes aim at generating unbiased results in terms of programme effectiveness. Conventionally programme evaluations based on experimental designs involve the randomised selection of individuals or groups to one or more conditions (Stufflebeam and Coryn, 2014). Evaluation research underpinned by experimental designs share a similar characteristic with applied research in permitting predictions of evaluation outcomes. Suchman (1967) identifies recommendations within evaluation reports as an example of prediction. Differing from traditional laboratory research however an experimentally-based evaluation study incorporates a range of different variables over which there is minimal if any control by the evaluator. It is emphasised that within evaluation research measurable and observable variables are the key subject of interest based on the aim of the programme to change the values of these variables (Suchman, 1967).

In the frequent case where it is impossible to conduct research based on a true experimental design those conducting evaluations often have to depend on quasi-experimental designs. This is because they do not rely on the randomised assignment of participants thus enhancing their feasibility. However these designs do require that the treatment is well-defined and applied and that any control group is kept apart from the experimental group. Quasi-experimental research designs are similar to experimental designs in that they test causal hypotheses. In quasi-experimental designs the programme is tested for the extent to which objectives are achieved as defined by a pre-specified collection of indicators (White and Sabarwal, 2014).

Quasi-experimental designs define a comparison group with baseline characteristics that are as similar as possible to the treatment group. The role of the comparison group is to show what may have been the outcomes if the programme had not been applied (White and Sabarwal, 2014). Quasi-experimental methods involving the generation of a comparison group are mainly adopted in cases where it is not possible to have randomly selected individuals or groups composing treatment and control groups. This is noted to always be necessary for ex-post impact evaluations. Such designs may also be required for ex-ante impact evaluations in cases where constraints exist in terms of logistics, political factors or ethical, such as the requirement for a phased rollout (White and Sabarwal, 2014). Due to the training context in the UAE civil defence programme there are limitations in conducting random tests. Sampling for the experiments was based on existing cohorts enlisted in the civil defence programme.

#### **4.4 Experiment Design**

This study employed a non-equivalent control group design comprising one control group and two experimental groups. The control group consisted of learners undertaking the course programme delivered through traditional classroom-based methods.

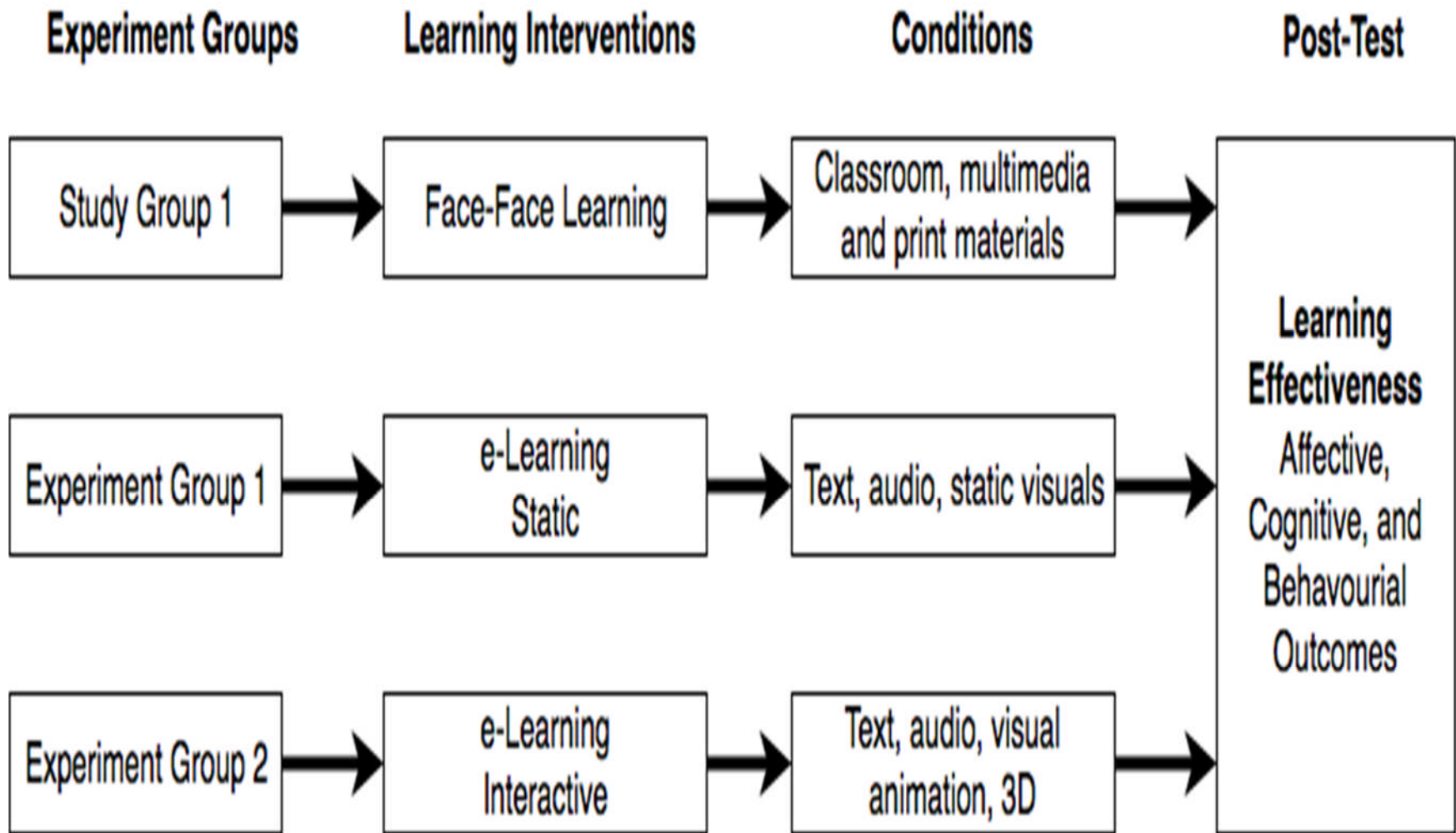


Figure 4-1 Experiment Design

The remaining two experimental groups consisted firstly of learners delivered the course programme via low media-rich e-Learning and secondly learners delivered the course programme via high media-rich e-Learning, as shown in Figure 4-1. The differences between the experimental groups relate to the level of audio-visual material and the interaction afforded by means of features such as animation and 3D. There were two key similarities between the three groups in the study. Firstly the groups were all taught the course programme simultaneously and secondly, to ensure equivalency the instructional content and course objectives were identical across the groups.

Nevertheless there were major differences between the control and two experimental groups in terms of instructional media, instructional methods, scheduling, accessibility to the instructor, and class location. Learners in the experimental groups were able to receive tutor support daily while learners in the control group met with instructors in the traditional classroom once per week to receive support. In the control group the instructor utilised PowerPoint as a teaching aid within classroom instruction while the online environment was used to post supplementary material and notes. Further, the e-Learning delivery modes for the two experimental groups were designed to two levels of media richness. According to media richness theory different communication mediums have different levels of media richness (Lengel, 1986). Phone calls for example are less media rich than video-conferencing as they cannot reproduce the social visual cue that video conferencing can. In the online environment, rich media elements can be defined as content that interacts with the user in some way, such as streaming video in response to the user's mouse hovering over it. Experimental group 1 incorporated a lower media rich format of text and audiovisual. The second experimental group incorporated a richer media design integrating animation and 3D in

the delivery format. Students were sampled during the training delivered between Jan 2018 – March 2018. The key phases in research process is outlined in Figure 4-2.

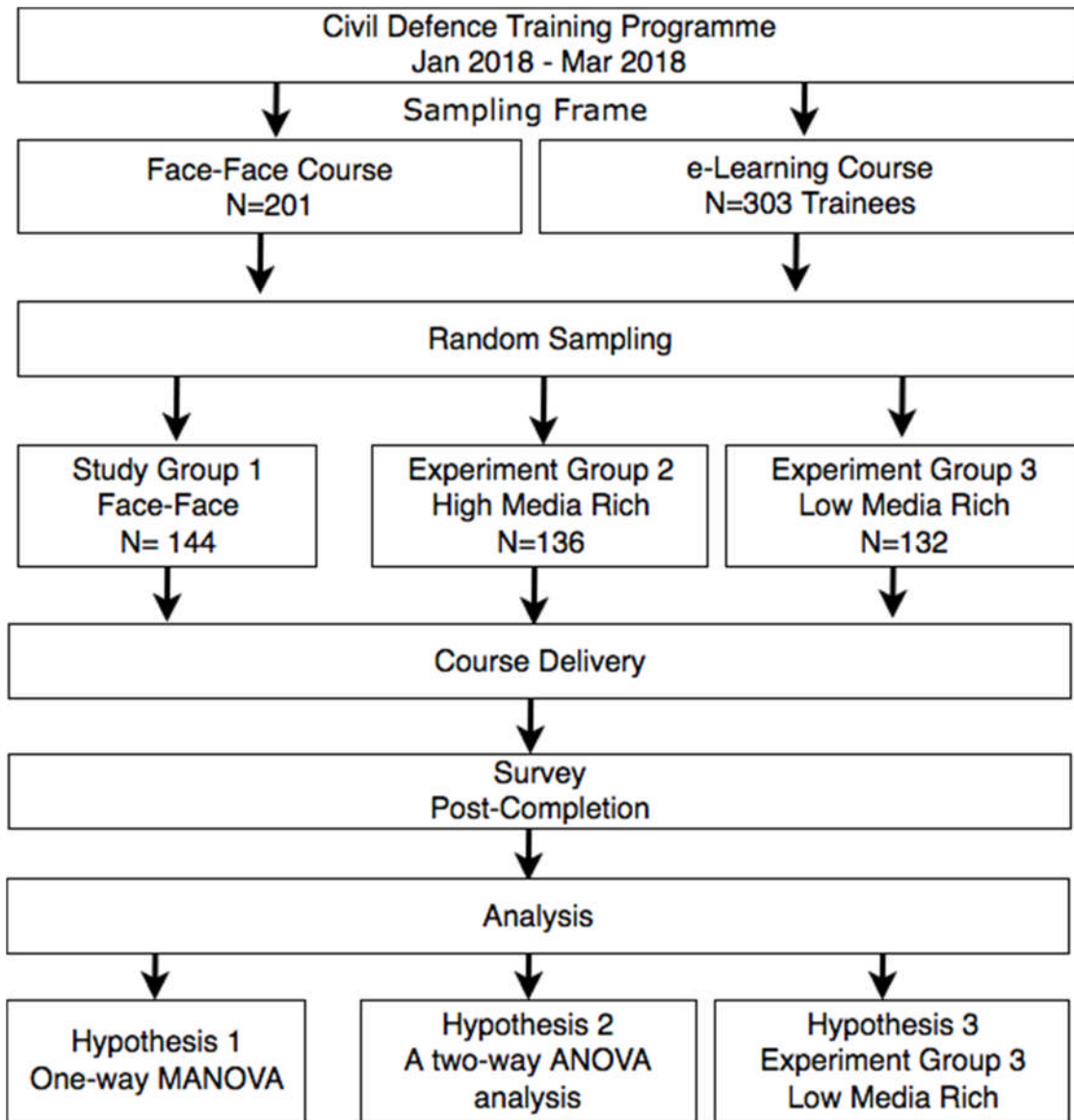


Figure 4-2 Key Phases in the Research Process

#### 4.5 Research Method

A survey method was selected to gather the data on aspects such as the learning effectiveness and behaviour of learners following the completion of the training programme. A survey is a cross-sectional method in which respondents answer specific

questions in relation to their perceptions, beliefs, emotions, behaviour or attitudes, using a survey instrument such as a questionnaire (Salkind, 2010). Adopting this method allowed for the collection of a large quantity of data over several different time points in a rapid, convenient and economical manner (Somekh and Lewin, 2011). The collection of consistent and standardised data, supporting easier statistical analysis and comparison (Saunders et al., 2009) and their effectiveness in terms of allowing comparison within or between population subgroups (Bhattacharjee, 2012) were considered key advantages for this study focused on comparison between two separate groups of learners. Data from questionnaires can be highly valid and representative with the potential for generalisation to the wider population of learners within civil defence (Somekh and Lewin, 2011). The survey method is widely used in social sciences research forming around 70% of all studies (Lodico et al, 2006). In educational research, surveys have been utilised across a wide range of themes to collect information for example on test scores to determine patterns of low achievement, or to discover trends in student interests. Within research on e-Learning, surveys have been consistently used to measure aspects such as student perceptions, satisfaction, success factors and the effectiveness of e-Learning (Moore et al., 2011; Cho et al., 2009; Selim, 2007; Liaw, 2008).

## 4.6 Instrument Measures

To evaluate the learning effectiveness between traditional and e-Learning mode of delivery a survey instrument will be used to collect data on the key variables in this study indicated in Table 4-1.

**Table 4-1 Key Variables**

Hypothesis	Independent Variable	Dependent Variables
RQ1: Does learning effectiveness differ between traditional learning and e-Learning?	Learning Mode	Learning Effectiveness
RQ2: Do learning styles impact on learning effectiveness between different e-Learning designs?	Learning styles, Learning mode	Learning Effectiveness
RQ3: Does spatial ability impact on learning effectiveness between different e-Learning designs?	Spatial Ability, Learning mode	Learning Effectiveness

Participants in all three groups will at the end of the course complete a survey consisting of the variables in Table 4-2.

For learner characteristics data on gender and age and education level was collected (Appendix 1). The main characteristics surveyed related to learner styles. To evaluate the learning styles of students on the course programme this study adopted the Index of Learning Styles (ILS) (Felder and Silverman, 1988; Felder and Soloman, 1991, 1994) (Appendix 4). Based on the Kolb model the ILS categorise learner styles into four dimensions: active/reflective, sensing/intuitive, visual/verbal, and sequential/global (Felder, 1993). Research shows that the ILS can be considered a valid and reliable instrument for assessment of learning styles (Hou et al., 2010; Felder and Spurlin, 2005). The ILS assesses the strength for each preference within the four domains using a total of 44 question items. A score of 1 or 3 for any of these preferences indicates a weak

preference, while scores of 5 or 7 point to a moderate preference, and 9 or above indicates a strong preference.

**Table 4-2 Survey Measures**

Dimension	Measure	No	Description	Source
<b>Learner Characteristics</b>				
<b>Demographics</b>	Personal characteristics	4	- Age, Gender, Computer literacy	Author own
<b>Learning Styles</b>	Index of Learning Styles (ILS)	44	Items 1-7 assess active/reflective learning style; Items 8-23 sensing/intuitive; Items 24-31 visual/verbal; Items 32-44 sequential/global; binary yes/no scale	Felder and Silverman (1988)
	Style of Processing (SOP) Questionnaire based on Verbalizer-Visualizer Questionnaire (VVQ)	20	10 items related to a visual style; 10 items related to a verbal style; 4-part Likert type scale	Childers et al., (1985)
<b>Learning Effectiveness</b>				
<b>Affective</b>	Learner Satisfaction	6	Items 5-8, 10-11 assess learner satisfaction using 6-part Likert-type scale	Kirkpatrick (2012)
	Learner Engagement	4	Items 1-4 assess learner engagement and interest using 6-part Likert-type scale	Kirkpatrick (2012)
<b>Cognitive</b>	Cognitive Learning	7	Items 12, 14, and 16-20 assess cognitive outcomes using 6-part Likert-type scale	Adapted from: Steinke and Fitch (2007); Stephan et al (2007); Kirkpatrick (2012)
<b>Behavioural</b>	Application of Knowledge	4	Items 9, 11, 13 and 15 assess application of knowledge to job role using 6-part Likert-type scale	Kirkpatrick (2012)
<b>Spatial Ability</b>				
Spatial Ability	Spatial Visualisation	30	30 items designed to assess the visualisation of the rotation of 3D objects. Multiple choice answers.	Guay (1980)



In order to identify the learner style of processing this study adopted the Verbalizer–Visualizer Questionnaire (VVQ) (Jonassen and Grabowski, 1993). This is principally utilised to determine verbal and visual cognitive styles. A modified version of this scale, the Style of Processing (SOP), was proposed by Childers et al., (1985) comprising two subscales each containing 11 question items. A four-part Likert scale is used for participant responses, ranging from 1 for “always false” to 4 for “always true”. Childers et al., (1985) further created a revised SOP scale comprising 20 questions within two subscales of verbal and visual to generate two categories of those who verbalise and those who visualise. These scales have been previously tested showing Cronbach’s alpha reliability of 0.81 and 0.86 in identifying the cognitive visual and verbal styles of learners respectively. The reliability of the scale overall is 0.88. This suggests that there is sufficient reliability for use of the revised scale to identify visual and verbal styles. Childers et al., (1985) use this scale as a single scale nevertheless they highlight the potential for further research of using the scale in its two parts. Gould (1990) separated two SOP subscales at the median and by combining them generated four categories to consider of: Low Processors oriented towards low verbal/low visual; High Verbals, showing a preference for high verbal/low visual; High Visuals, oriented towards low verbal/high visual, and High Processors who prefer high verbal/high visual. To understand how cognitive style affects learning performance and emotion while utilising diverse multimedia learning materials this study adopts the SOP as a single scale to categorise all learners as either verbalisers or visualisers by comparing participants’ SOP scores in relation to mean SOP scores.

To measure the spatial visualisation ability of learners an online version of the Revised Purdue Spatial Visualization Tests: Visualization of Rotations was used (Appendix 5). This test incorporates 30 questions aimed at assessing how well

individuals can visualise three-dimensional object rotations. Over the past three decades the PSVT-R test has been applied to thousands of higher education learners to measure their abilities in relation to spatial visualisation.

#### **4.6.1 Learning Effectiveness**

Learning effectiveness is the dependent variable surveyed for this study. As “a function of effective pedagogical practices” (Joy and Garcia, 2000 p.33) learning effectiveness is considered complex to measure. A frequent focus is on the learning outcomes of students (Mashaw 2012; Moody and Sindre 2003; Sahasrabudhe and Kanungo 2008). Effective learning processes have been characterised in terms of active learning and knowledge construction. Learning is effected through processes of problem solving that are cooperative and team-focused involving other learners. Effectiveness is also highly connected to success (Petter et al. 2012; Alsabawy et al. 2011; Baker and Papp 2004). Some studies have focused on a more specialised form of effectiveness including teaching or educational effectiveness. For example Looney and Akbulut (2007) adopt the term teaching effectiveness to examine in-depth student evaluation of the instructional design presented and the effect on students’ expectations, goals, beliefs and emotions.

To measure the learning effectiveness construct this study draws on Kirkpatrick’s (1994) training evaluation model that comprises four key levels: reaction; learning, behaviour, results. For this study learning effectiveness is evaluated at the first three levels based on self-reported evaluation and performance test (Appendix 3). The first level of evaluation gathers data on learner perspectives of how the programme was delivered rather than the content of the programme, Learner’s reaction is measured in terms of satisfaction and engagement. The learning level is evaluated in terms of

cognitive learning based on knowledge acquisition and understanding of course content. The behavioural level is measured in terms of learners' perceived value of the course in relation to knowledge application in work behaviour. The Cognitive Learning Scale (CLS) was used in this study to measure the cognitive and behavioural outcomes of the programme. This scale is designed to measure cognitive outcomes of experiential or service learning in regard to aspects such as transfer, problem-solving and metacognition, processes which support critical thinking and intellectual development, and also student perceptions of the learning (Fitch and Steinke, 2013). The revised version of the CLS contains a total of nine items with the same set of statements designed to be delivered both pre-course and post-course to enable evaluation of learner responses before and following completion of service-Learning programmes. Responses are recorded using a Likert-type rating scale. Testing of the CLS indicates an Alpha coefficient for the nine items of .86 (Steinke and Fitch, 2007b), suggesting that the items have relatively high internal consistency (Salkind, 2010).

#### **4.7 Pilot Testing**

In order to maximise the response rate and the reliability and validity of data collection prior to implementation of the survey the instrument was first pilot tested (Saunders et al., 2009) among a small group of five learners. The aim of pilot testing is to refine the questionnaire to ensure that the questions are clear and comprehensible, and possess face validity. Face validity concerns the extent to which a questionnaire is representative and suitable for addressing the concept it aims to measure (Saunders et al., 2009). Completed questionnaires were checked to ensure that the respondents did not encounter any problems in comprehending or answering questions, and feedback was elicited on the clarity of the instructions and questions, and if there were any questions which caused some mental discomfort. Following this procedure some

amendments were made to the instrument including adjustments to the wording of certain questions.

#### **4.7.1 Sampling Strategy**

This study adopts a purposive random sampling strategy to collect quantitative data from a sample of participants professionally engaged in the civil defence sector. A purposeful approach is adopted to select three groups of learners specifically from this sector engaged on the same course programme but delivered in three different modes of face to face, high media e-Learning programme and low media e-Learning. The aim was to purposefully select participants with a balance of learning styles in all groups. Purposive sampling is widely utilised in qualitative and quantitative research as a technique to identify and select information-rich cases for in-depth study (Patton, 1990). These cases are those which have information on issues of key significance to the purpose of the research (Palinkas et al., 2015). Given the limited numbers of individuals who can serve as sources of primary data due to the nature of the research context, design and goals, adopting a purposive approach is considered a highly effective strategy for this study (Saunders et al., 2009).

To address the research questions there was a need to sample an equivalent number of each of the eight learning styles in each of the three learning modes. To achieve this participants were randomly sampled over a three month time period from a total of 504 learners who undertook the week long course programme delivered in one of the three different modes. These learners were categorised into their respective learning styles in order to obtain an equivalent number of people for each learner style. Of these 412 learners were selected to participate who collectively represented a balance of learning

styles across the three modes. This resulted in a roughly equivalent number of learning styles for each mode of learning ranging between 13 to 21 for each learning style.

The sample adequacy was determined by calculating Using G\*Power to determine the necessary sample size for one Way Manova, two-way Anova. Based on the standard alpha level 0.05, standard Power assumption of .80 and effect size of .06. The total sample size for this study exceeded significantly the minimum necessary sample of 156.

#### **4.8 Data Collection Procedures**

This study utilised a self-administered survey method to collect data from both the control group undertaking learning delivered through traditional classroom-based methods and the experimental groups experiencing the same course programme delivered via e-Learning. For the cognitive outcomes data was collected from participants post-test immediately following course completion. For the behavioural measure data was collected two months after the completion of the course. In all groups the dependent variables pre and post-tested were learning performance and learning styles, while the independent variable was the instructional environment applied on two levels of traditional and e-Learning. The data was used to evaluate learning styles, learning effectiveness, cognitive styles, learning performance and impact on work behaviour or practice. The first stage involved the completion of a questionnaire designed to gather data on demographic details and self-efficacy. The demographic data collected basic information including age, years of experience in their civil defence role and qualification level. Data was also recorded on date of programme completion, work location and a contact e-mail which permitted tracking and communication at the different times of data collection. The choice was made to collect data four weeks following programme completion as this allowed sufficient time for participants to

evaluate their learning and post-course practice, while accounting for the gradual decrease in knowledge levels post-training which are acknowledged to occur particularly in the first six to twelve months (Tippett, 2004; Yang et al., 2012).

The survey was delivered through an online medium to maximise convenience for participants and response rates (Saunders et al., 2009). Participants were provided with a link to the survey hosted on SurveyMonkey, an online survey tool widely adopted for academic research where they could complete the survey. Once the survey was completed participants were sent an automatic email thanking them for their participation and reminding them of the date of the next stage of data collection.

#### **4.9 Data Analysis**

To analyse the quantitative data statistical analysis techniques were applied including statistical comparison and inferential analysis to identify any differences between the three groups. In particular analysis of variance, or ANOVA techniques were used to compare the means and assess the variances across the three groups. ANOVA is a statistical method for analysing measurements dependent on multiple kinds of effects operating at the same time, and further for supporting recognition of which kinds of effects are important and to estimate the effects (Scheffe, 1959, p.3). ANOVA is considered the most broadly adopted statistical technique for assessing the significance of treatment effects (Salkind, 2010).

Statistical analysis was performed to analyse the differences between groups and conditions within this research and to address the four key hypotheses. Multiple statistical tests were conducted to address each hypothesis. A One-way Multivariate analysis of variance (MANOVA) was performed to compare learning effectiveness between the three modes of learning. A two-way ANOVA analysis was conducted to

investigate whether there are any significant differences between the learning modes, learning style and learning performance. The independent variables were learning mode and learning style and three dependent variables were used: engagement, cognitive performance and behavioural performance. A two-way ANOVA was performed to examine the effects of learning mode and levels of spatial ability on learning effectiveness.

#### **4.10 Ethics**

The design and conduct of this study has been based on consideration for the ethical issues involved at each and every stage of the research. For any research study involving human participants respect for the individual, the minimisation of harm and the maximisation of the benefits of the research are widely acknowledged as overarching ethical principles (CIOMS, 1991). This study is focused on a potentially sensitive area for the participants relating to their professional life and their performance and experiences in the acquisition of new professional skills.

In particular the primary research hinges on the monitoring and evaluation of the learning performance of two separate groups of learners. This is acknowledged to have potential ethical implications, in terms of affecting the mental state of participants who may feel they are being appraised and judged while undergoing the training programme and possibly causing increased performance anxiety or stress, or further, feelings of inadequacy if learning goals are not met.

Thus significant measures were applied to ensure that individual rights of autonomy and confidentiality were fully respected and any risks mitigated (Saunders et al., 2009). The study purposes, participant rights of autonomy and confidentiality and the implications of participation were fully explained to participants with opportunities

provided for clarification so that the decision to participate was based on informed consent (Bryman and Bell, 2007). Participants were also made fully aware of the voluntary nature of their participation and their right to withdraw from the research at any stage. Confidentiality was preserved by ensuring that all data was anonymised and stored securely with access available only to authorised personnel (Saunders et al., 2009).

Moreover the nature of this research means that there are ethical implications at an organisational level and there is a recognition of the need to be sensitive to the professional reputation of the instructors and organisations involved in the delivery of the training. To ensure that in the context of the UAE Civil Defence sector ethical requirements are fulfilled this study was explicitly conducted in accordance with the ethical guidelines provide by the University of West England (UWE) code of good conduct for research. A duty is acknowledged to ensure that the research design is credible and the findings produced are valid and reliable. To ensure this was achieved the research was designed to appropriately meet the objectives of the research study, relevant standards within the discipline were adhered to and the research design was fully explained and justified within the thesis (Bryman and Bell, 2007).

#### **4.11 Conclusion**

This chapter presented the research design employed for this study, and discusses the rationale for the research perspective and approach underpinning the research. A quasi-experimental research design was described that incorporated a scientific based method to contribute evaluation findings that were objective and capable to be verified in terms of validity and reliability. Sampling for the experiments was based on existing cohorts enlisted in the civil defence programme. The rational towards quasi-experimental



method was influenced by the practical constraints due to the training context in the UAE civil defence programme and the limitations in conducting random testing. ANOVA and MANOVA statistical analysis techniques were adopted to enable comparison to identify any differences between the two groups. The ethical considerations were outlined to ensure the protection and rights of participants and the organisation in this study. In summary, the research design and procedures in this chapter describe a systematic, valid and reliable research design to generate data and results to address the research goals for this thesis.

# Chapter 5      Results

## 5.1 Introduction

This chapter presents the results of the quasi-experimental research design in order to evaluate the different learning interventions. This aim of this study was to evaluate the effectiveness of learning and performance between two learning approaches: traditional versus e-Learning; and between two types of e-Learning design modes: high media-rich versus low media-rich. The central research question is: does learning effectiveness differ between traditional learning and e-Learning? The intention is to further understanding on the effectiveness of civil defence training across two forms of learning. This question is divided into three specific research questions:

RQ1: Does learning effectiveness differ between traditional learning and e-Learning?

RQ2: Do learning styles impact on learning effectiveness between different e-Learning designs?

RQ3: Does spatial ability impact on learning effectiveness between different e-Learning designs?

These questions have been investigated empirically with the formulation and testing of four hypotheses:

H1: Learning effectiveness is significantly better in traditional face-to-face learning than e-learning across different measures.

H2: In e-Learning design approaches, learning effectiveness is significantly better in high media rich (text, audio-visual, animation, 3D) than low media rich (text, audio, visual).

H3: Learning styles have higher significant effects on learning effectiveness using e-Learning than traditional learning.

H4: Spatial ability has a higher significant effect on learning effectiveness using e-Learning than traditional learning.

For the cognitive outcomes data was collected from participants immediately following course completion. For the behavioural measure data was collected two months after the completion of the course. Statistical analysis was performed to analyse the differences between groups and conditions within this research and to address the four key hypotheses. Different statistical tests were conducted to address each hypothesis. A one-way Multivariate Analysis of Variance (MANOVA) was performed to address H1 and H2, and two-way Analysis of Variance (ANOVA) was performed for H3 and H4. MANOVA was performed to compare learning effectiveness between the three modes of learning, while ANOVA analysis was conducted to investigate whether there are any significant differences between the learning modes, learning style and learning performance. MANOVA is an extension of ANOVA techniques. In an ANOVA, statistical differences are analysed on one continuous dependent variable by an independent grouping variable. MANOVA extends this by considering multiple continuous dependent variables, bundling them into a weighted linear variable or composite variable. Thus this technique essentially tests whether the independent grouping variable explains a statistically significant amount of variance in the composite dependent variable. The remainder of this chapter outlines the statistical analysis conducted and the key results for each test performed.

## 5.2 Descriptive Results

Descriptive analysis shows that the sample of 412 participants was predominantly male (82%) compared to female (18%) as shown in Table 5-1.

Table 5-2 shows that while 92% of participants were aged under 50, 64% were between the ages of 18 and 29 representing a relatively young demographic overall.

The frequencies of learners were balanced among the three modes of learning at 35% for face to face, 33% for the high media e-Learning programme and 32% for the low media programme as shown in Table 5-3.

Table 5-4 indicates firstly the average mean learning effectiveness scores for each learning style in each different mode. In the face to face mode the Active learning style had the highest score at 5.07 while the lowest score was 4.23 for the Reflective style. In the high media mode the Reflective style scored the highest at 4.65 while Verbal styles obtained the lowest score of 2.88. For the low media mode Reflective styles attracted the highest score of 3.81 while Intuitive styles at 3.11 recorded the lowest score. The table also details the frequencies for the eight learning styles which were relatively evenly reflected across the total sample: active (57); reflective (48); verbal (57); visual (47); sequential (56); global (46); sensing (62); intuitive (39). Within each mode of face

to face, high media e-Learning and low media e-Learning there is a balance of learning styles ranging from 9 for the lowest frequency to the highest at 27.

**Table 5-1 Participant Gender Profile**

		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	Female	74	18.0	18.0	18.0
	Male	338	82.0	82.0	100.0
	Total	412	100.0	100.0	

**Table 5-2 Participant Age Profile**

		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	18-29	262	63.6	63.6	63.6
	30-49	117	28.4	28.4	92.0
	50-64	33	8.0	8.0	100.0
	Total	412	100.0	100.0	

**Table 5-3 Learner Frequencies**

		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	Face-to-face	144	35.0	35.0	35.0
	eLearnHM	136	33.0	33.0	68.0
	eLearnLM	132	32.0	32.0	100.0
	Total	412	100.0	100.0	

**Table 5-4 Descriptives of Learning Styles**

<b>Group</b>	<b>Learning Style</b>	<b>Average Mean Learning Effectiveness</b>	<b>Std. Deviation</b>	<b>N</b>
Face-to-face	Active	5.07	.672	20
	Reflective	4.23	.617	16
	Verbal	5.00	.738	21
	Visual	4.29	.589	15
	Sequential	4.95	.772	19
	Global	4.41	.672	17
	Sensing	4.68	.829	27
	Intuitive	4.74	.572	9
	Total	4.70	.756	144
eLearn High Media	Active	3.87	.582	16
	Reflective	4.65	.370	18
	Verbal	2.88	.455	17
	Visual	4.09	.531	19
	Sequential	3.68	.577	18
	Global	3.98	.725	16
	Sensing	3.88	.716	17
	Intuitive	3.67	.690	15
	Total	3.85	.740	136
eLearn Low Media	Active	3.30	.547	21
	Reflective	3.81	.312	14
	Verbal	3.74	.634	19
	Visual	3.56	.583	13
	Sequential	3.42	.531	19
	Global	3.28	.448	13
	Sensing	3.22	.695	18
	Intuitive	3.11	.514	15

	Total	3.43	.586	132
Total	Active	4.08	.968	57
	Reflective	4.26	.563	48
	Verbal	3.95	1.08	57
	Visual	4.00	.623	47
	Sequential	4.02	.921	56
	Global	3.94	.774	46
	Sensing	4.04	.973	62
	Intuitive	3.70	.858	39
	Total	4.00	.878	412

### 5.3 Validation of Data

Before the analysis was conducted, initial assumptions testing was performed to test for normality, linearity, univariate and multivariate outliers, homogeneity of variances and multicollinearity. The data was tested to ensure that it meets seven assumptions for MANOVA: sample size, normality, outliers, linearity, multicollinearity and singularity and homogeneity of variance-co-variance matrices (Pallant, 2010). For the sample size, Table 5-5 shows that the number of cases in each group exceed the minimum number of two cases per dependent variable in each group (Pallant, 2010). There was homogeneity of variance-covariance matrices as confirmed with the Box's Test of Equality of Co-Variances. Box's M is statistically significant as

Table 5-6 shows with the Sig. value larger than .001 ( $p=0.011$ ).

**Table 5-5 Descriptive Statistics for Dependent Variables**

	Group	Mean	Std. Deviation	N
EN	Face-to-face	4.90	.898	144
	eLearn High Media	4.12	1.06	136
	eLearn Low Media	3.55	.832	132
	Total	4.21	1.09	412
CG	Face-to-face	4.56	1.02	144
	eLearn High Media	3.77	.966	136
	eLearn Low Media	3.44	.803	132
	Total	3.94	1.05	412

BH	Face-to-face	4.64	.921	144
	eLearn High Media	3.65	.881	136
	eLearn Low Media	3.30	.769	132
	Total	3.88	1.03	412

**Table 5-6 Box's Test of Equality of Covariance Matrices**

Box's M	F	df1	df2	Sig.
26.21	2.16	12	801497.19	.011

**Table 5-7 Levene's Test of Equality of Error Variances**

	F	df1	df2	Sig.
Engagement	3.18	2	409	.042
Cognitive	4.71	2	409	.010
Behavioural	4.16	2	409	.016

#### **5.4 Analysis of Learning Modes and Learning Effectiveness**

This analysis examined whether learning effectiveness varied under different modes of learning implemented. One-way MANOVA was performed to compare learning effectiveness between the three modes of learning. The categorical independent variable was learning mode with three levels (face-to-face to e-Learning, High Media e-Learning, and Low Media e-Learning); and the dependent variables were the measures of learning effectiveness: engagement, cognitive performance and behavioural performance. This technique allows analysis of multiple dependent variables (engagement, cognitive performance, and behavioural performance) while controlling for Type I error.



**The one-way MANOVA has the assumption that there are equal variances between the groups of the independent variable, learning mode, for each dependent variable. Equal variances can be assumed for cognitive and behavioural variables with Sig. value greater than 0.05 as indicated in**

Table 5-7. However the dependent variable for engagement performance is statistically significant ( $p = 0.04$ ) and violates assumptions for equality of error variance. As a result, and in line with Tabachnick and Fidell's (2007) suggestion a stricter alpha level of 0.025 or 0.01 will be applied for the F test.

To test for normality, Statistical Package for the Social Science (SPSS) was used to calculate the Mahalanobis distance. The data was normality distributed. Mahalanobis distance was used to test for multivariate outliers and any abnormal patterns in the dependent variables. The value for Mahalanobis distance (MD) of 10.024 was compared to the critical value which is 13.42 based on 2 dependent variables. As the MD is lower than the critical value this means there are no issues with multivariate outliers.

A scatter plot was conducted which did not reveal any signs of non-linearity and therefore meets the assumption of linearity. Testing for multicollinearity was performed to ensure the dependent variables were not highly correlated. The correlation matrix in Table 5-8 reveals that the three dependent variables were moderately correlated. This meets the condition for MANOVA for the dependent variables to be moderately correlated.

After testing for assumptions the MANOVA analysis was conducted to test for any significant differences between the learning modes and learning performance. The analysis of the independent variable of learning mode and three dependent variables of engagement, cognitive performance and behavioural performance confirmed that here

was a statistically significant difference between the learning modes on the combined dependent variables,  $F(6, 814) = 36.3, p < .0005$ ; Wilks'  $\Lambda = .622$ ; partial  $\eta^2 = .211$ .

**Table 5-8 Correlation Matrix of Dependent Variables**

		<b>EN</b>	<b>CG</b>	<b>BH</b>
EN	Pearson Correlation	1	.563**	.553**
	Sig. (2-tailed)		.000	.000
	N	412	412	412
CG	Pearson Correlation	.563**	1	.500**
	Sig. (2-tailed)	.000		.000
	N	412	412	412
BH	Pearson Correlation	.553**	.500**	1
	Sig. (2-tailed)	.000	.000	
	N	412	412	412

\*\* . Correlation is significant at the 0.01 level (2-tailed) EN = Engagement CG = Cognitive BH = Behavioural

**Table 5-9 MANOVA -Test of Between-Subjects Effects**

<b>Dependent Variable</b>	<b>Type III Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>	<b>Partial Eta Squared</b>
Engagement	123.08	2	61.54	69.80	.000	.254
Cognitive	77.34	2	38.67	44.89	.000	.180
Behavioural	134.95	2	67.47	90.94	.000	.308

**Table 5-10 Estimated Marginal Means**

<b>Dependent Variable</b>	<b>Group</b>	<b>Mean</b>	<b>Std. Error</b>	<b>95% Confidence Interval</b>	
				<b>Lower Bound</b>	<b>Upper Bound</b>
Engagement	Face-to-face	4.87	.078	4.72	5.03
	eLearn High Media	4.12	.081	3.96	4.28

	eLearn Low Media	3.54	.082	3.38	3.71
Cognitive	Face-to-face	4.47	.077	4.32	4.62
	eLearn High Media	3.77	.080	3.62	3.93
	eLearn Low Media	3.44	.081	3.28	3.60
Behavioural	Face-to-face	4.64	.072	4.50	4.78
	eLearn High Media	3.65	.074	3.51	3.80
	eLearn Low Media	3.29	.075	3.15	3.44

One-way ANOVA follow-up results were used to determine which dependent variable would appear to be contributing to the statistically significant MANOVA. These results are contained within Table 5-9. The results for each dependent variable separately indicated that all three dependent variables were statistically significant using Bonferroni adjusted alpha level of 0.17. The level of statistical significance has been adjusted for multiple comparisons. There was a statistically significant difference in engagement scores between learners from different learning modes,  $F(2, 409) = 69.8, p < .0005$ ; partial  $\eta^2 = .254$ ; cognitive performance  $F(2, 409) = 44.88, p < .0005$ ; partial  $\eta^2 = .18$ ; and behavioural performance  $F(2, 409) = 90.944, p < .0005$ ; partial  $\eta^2 = .308$ .

Inspection of the means in Table 5-10 for these three variables showed that the face to face group report higher levels of engagement. Data is presented as mean  $\pm$  standard deviation. Engagement scores decreased from face-to-face learning mode ( $4.9 \pm 0.9$ ) to e-Learning High Media ( $4.1 \pm 1$ ) to e-Learning Low Media mode ( $3.5 \pm 0.8$ ). In terms of cognitive performance, the score decreased from face to face learning mode ( $4.5 \pm 0.9$ ) to e-Learning High Media ( $3.7 \pm 0.9$ ) to e-Learning Low Media mode ( $3.4 \pm 0.8$ ). For behavioural performance the score decreased from face to face ( $4.6 \pm 0.9$ ) to e-Learning High Media ( $3.7 \pm 0.9$ ) to e-Learning Low Media mode ( $3.3 \pm 0.8$ ).

**Table 5-11 Multiple Comparisons – Tukey HSD**

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
EN	Face-to-face	eLearn HM	.76*	.112	.000	.49	1.02
		eLearn LM	1.33*	.113	.000	1.06	1.60
	eLearn HM	Face-to-face	-.76*	.112	.000	-1.02	-.49
		eLearn LM	.57*	.115	.000	.30	.84
	eLearn LM	Face-to-face	-1.33*	.113	.000	-1.60	-1.06
		eLearn HM	-.57*	.115	.000	-.84	-.30
CG	Face-to-face	eLearn HM	.70*	.111	.000	.44	.96
		eLearn LM	1.03*	.112	.000	.77	1.30
	eLearn HM	Face-to-face	-.70*	.111	.000	-.96	-.44
		eLearn LM	.33*	.113	.010	.07	.60
	eLearn LM	Face-to-face	-1.03*	.112	.000	-1.30	-.77
		eLearn HM	-.33*	.113	.010	-.60	-.07
BH	Face-to-face	eLearn HM	.98*	.103	.000	.74	1.23
		eLearn LM	1.34*	.104	.000	1.10	1.59
	eLearn HM	Face-to-face	-.98*	.103	.000	-1.23	-.74
		eLearn LM	.36*	.105	.002	.11	.61
	eLearn LM	Face-to-face	-1.34*	.104	.000	-1.59	-1.10
		eLearn HM	-.36*	.105	.002	-.61	-.11

EN=Engagement CG=Cognitive BH=Behavioural LM=Low Media HM=High Media

Tukey post hoc analysis revealed that for engagement the decrease from face to face to e-Learning high media (-0.76, 95% CI (-.49 to -1.02) was statistically significant ( $p < 0.005$ ), as well as the decrease from face to face to e-Learning Low Media mode (-1.33, 95% CI (-1.60 to -1.06). As shown in Table 5-11 for cognitive performance the analysis revealed the decrease from face to face to e-Learning high media (-0.70, 95% CI (-.96 to -.44) was statistically significant ( $p < 0.005$ ), as well as the decrease from face to face to e-Learning Low Media mode (-1.03, 95% CI (-1.3 to -.77). For the third dependent variable, Tukey post hoc analysis revealed that for behavioural scores the decrease from face to face to e-Learning high media (-0.98, 95% CI (-.1.23 to -.74) was statistically significant ( $p < 0.005$ ), as well as the decrease from face-to-face to e-Learning Low Media mode (-1.34, 95% CI (-1.59 to -1.10).

## **5.5 Analysis of Learning Styles, Learning Modes and Learning Effectiveness**

This analysis employed a two-way ANOVA to investigate whether there are any significant differences between the learning styles, learning modes and learning performance. The independent variable was learning mode and three dependent variables were used: engagement, cognitive performance and behavioural performance. Initial assumptions testing was performed to test for normality, linearity, univariate and multivariate outliers, homogeneity of variances and multicollinearity. Homogeneity of variances was confirmed, as assessed by Levene's test for equality of variances,  $p = .010$ . Table 5-12 shows the mean scores for learning effectiveness across the three modes of learning.

**As indicated in**

Table 5-13 there was a statistically significant interaction between group and learning styles for learning effectiveness score,  $F(14, 388) = 8.987, p < .0005$ , partial  $\eta^2 = .245$ . Given that there was a significant interaction effect a follow-up analysis was conducted to explore the relationship between learning mode and learning styles.

**Table 5-12 Means and SD of Learning Styles**

<b>Group</b>	<b>LS</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>N</b>
Face-to-face	Active	4.97	.716	20
	Reflective	4.08	.590	16
	Verbal	4.98	.734	21
	Visual	4.29	.575	15
	Sequential	4.89	.746	19
	Global	4.41	.672	17
	Sensing	4.64	.789	15
	Intuitive	4.70	.588	18
	<b>Total</b>	<b>4.65</b>	<b>.749</b>	<b>144</b>
eLearn High Media	Active	3.87	.582	16
	Reflective	4.72	.383	18
	Verbal	2.88	.455	17
	Visual	4.09	.531	19
	Sequential	3.68	.577	18
	Global	3.98	.725	16
	Sensing	3.88	.716	17
	Intuitive	3.67	.690	15
	<b>Total</b>	<b>3.86</b>	<b>.752</b>	<b>136</b>
eLearn Low Media	Active	3.30	.547	21
	Reflective	3.90	.356	14
	Verbal	3.77	.588	19

Visual	3.56	.583	13
Sequential	3.42	.531	19
Global	3.28	.448	13
Sensing	3.22	.695	18
Intuitive	3.11	.514	15
<b>Total</b>	<b>3.44</b>	<b>.592</b>	<b>132</b>

**Table 5-13 Two-Way Anova -Test of Between Subject Effects**

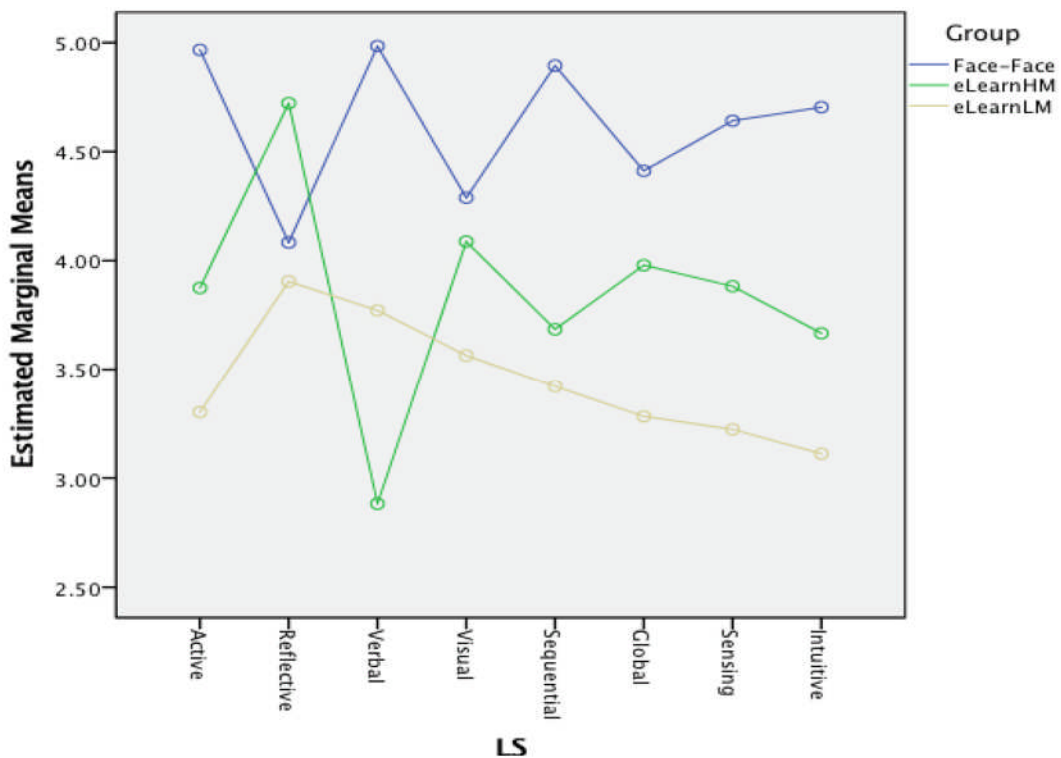
<b>Source</b>	<b>Type III Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>	<b>Partial Eta Squared</b>
Corrected Model	158.42 <sup>a</sup>	23	6.89	18.01	.000	.516
Intercept	6225.89	1	6225.89	16282.53	.000	.977
Group	92.87	2	46.43	121.44	.000	.385
LS	5.44	7	.777	2.03	.050	.035
Group * LS	48.10	14	3.44	8.99	.000	.245
Error	148.36	388	.382			
Total	6901.44	412				
Corrected Total	306.78	411				

Dependent variable: Learning Effectiveness (LE) a. R Squared = .516 (Adjusted R Squared = .488)

**Table 5-14 Simple Effects for Learning Styles**

LS		Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Active	Contrast	29.06	2	14.53	37.69	.000	.163
	Error	149.56	388	.385			
Reflective	Contrast	5.59	2	2.80	7.26	.001	.036
	Error	149.56	388	.385			
Verbal	Contrast	42.69	2	21.35	55.38	.000	.222
	Error	149.56	388	.385			
Visual	Contrast	3.87	2	1.93	5.01	.007	.025
	Error	149.56	388	.385			
Sequential	Contrast	23.36	2	11.68	30.30	.000	.135
	Error	149.56	388	.385			
Global	Contrast	9.44	2	4.72	12.24	.000	.059
	Error	149.56	388	.385			
Sensing	Contrast	22.22	2	11.11	28.83	.000	.129
	Error	149.56	388	.385			
Intuitive	Contrast	14.28	2	7.14	18.53	.000	.087
	Error	149.56	388	.385			

Dependent variable: Learning Effectiveness (LE)



**Figure 5-1 Estimated Marginal Means for Learning Effectiveness**



In terms of the Simple Main effects there was a statistically significant difference in mean learning effectiveness score between the three modes of learning across all learning styles. Table 5-14 indicates Active, Verbal, Sequential and Sensing showed large effect sizes. For the Active learning style there was a statistically significant difference in mean learning effectiveness,  $F(2, 388) = 37.69$ ,  $p < .005$ , partial  $\eta^2 = .163$ ; Verbal  $F(2, 388) = 55.381$ ,  $p < .005$ , partial  $\eta^2 = .222$ ; Sequential,  $F(2, 388) = 30.302$ ,  $p < .005$ , partial  $\eta^2 = .135$ ; Sensing,  $F(2, 388) = 28.826$ ,  $p < .005$ , partial  $\eta^2 = .129$ . Reflective and Visual learning styles exhibited the smallest effect: Reflective,  $F(2, 388) = 7.258$ ,  $p = .001$ , partial  $\eta^2 = .036$ ; Visual,  $F(2, 388) = 5.014$ ,  $p = .007$ , partial  $\eta^2 = .025$ . The interaction effect between learning styles and learning mode in terms of learning effectiveness is visually plotted in Figure 5-1.

Pairwise Comparisons analysis revealed that for the Active Learning Style the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (1.092, 95% CI, .59 to 1.59) was statistically significant ( $p = 0.000$ ), as well as the increase from face-to-face learning and e-Learning Low media (1.665, 95% CI, 1.2 to 2.1), and the increase from e-Learning High Media and e-Learning Low media (.573, 95% CI, .08 to 1.06).

For the Reflective Learning Style the results showed that the decrease from face-to-face learning to e-Learning High Media in learning effectiveness score (-.639, 95% CI, -1.1 to -.128) was statistically significant ( $p = 0.008$ ), as was the increase from e-Learning High Media and e-Learning Low Media (.817, 95% CI, .228 to 1.347).

For the Verbal Learning Style the results showed that the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (2.102, 95% CI, 1.6 to 2.5) was statistically significant ( $p = 0.00$ ), as well as the increase from face-to-face

learning and e-Learning Low Media (1.212, 95% CI, .74 to 1.6), and the decrease from e-Learning High Media and e-Learning Low Media (-.890, 95% CI, -1.3 to -.39).

For the Visual Learning Style the results showed that the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (.201, 95% CI, -.31 to .71) was not statistically significant, however the increase from face-to-face learning and e-Learning Low Media (.725, 95% CI, .16 to 1.2) was statistically significant ( $p = 0.006$ ), as was the increase from e-Learning High Media and e-Learning Low Media (.524 to , 95% CI, -0.12 to 1.05).

For the Sequential Learning Style the results showed that the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (1.210, 95% CI, .72 to 1.6) was statistically significant ( $p = 0.00$ ), as well as the increase from face-to-face learning and e-Learning Low Media (1.474, 95% CI, .99 to 1.9).

For the Global Learning Style the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (.433, 95% CI, (-.08 to .95) was statistically significant ( $p = 0.136$ ), as well as the increase from face-to-face learning and e-Learning Low Media (1.130, 95% CI, .58 to 1.6), and the increase from e-Learning High Media and e-Learning Low Media (.697, 95% CI, .14 to 1.2).

For the Sensing Learning Style the increase from face-to-face learning to e-Learning High Media in learning effectiveness score (.760, 95% CI, .29 to 1.2) was statistically significant ( $p = 0.000$ ), as well as the increase from face-to-face learning and e-Learning Low Media (1.420, 95% CI, .96 to 1.8), and the increase from e-Learning High Media and e-Learning Low Media (.660, 95% CI, .15 to 1.1).

For the Intuitive Learning Style the increase from face-to-face learning to e-Learning

High Media in learning effectiveness score (1.037, 95% CI, .41 to 1.6) was statistically significant ( $p = 0.000$ ), as was the increase from face-to-face learning and e-Learning Low Media (1.593, 95% CI, .96 to 2.2), and the increase from e-Learning High Media and e-Learning Low Media (.556, 95% CI, .01 to 1.09).

## **5.6 Analysis of Spatial Ability and Learning Effectiveness**

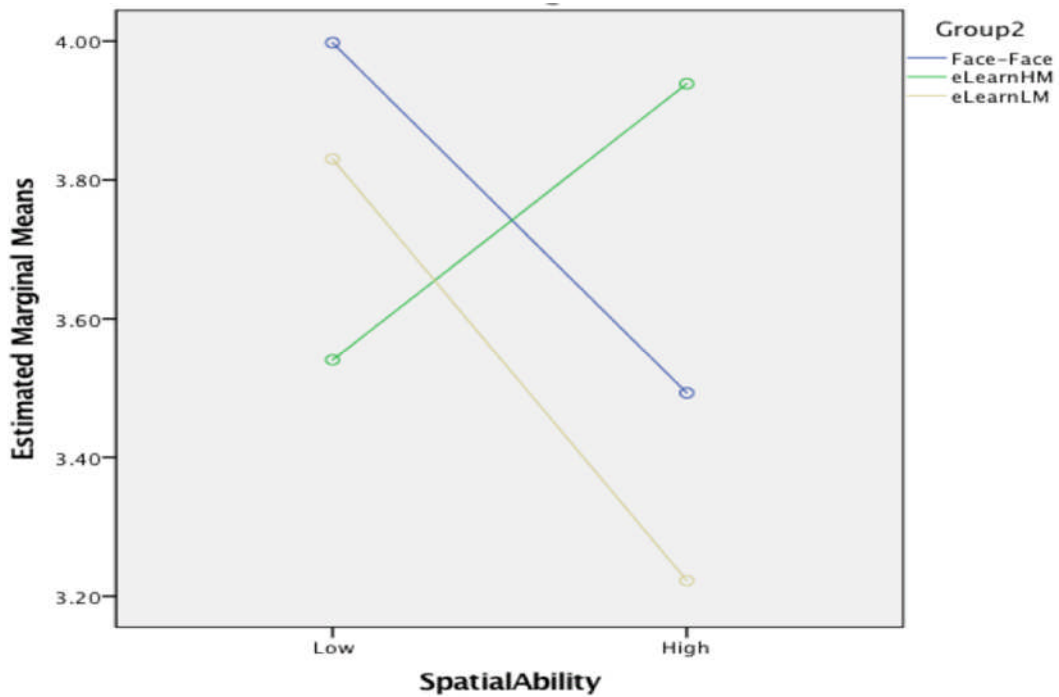
This analysis addressed the third research question to examine the relationship between spatial ability and learning effectiveness across the three modes of learning. A two-way ANOVA was performed to examine the effects of learning mode and levels of spatial ability on learning effectiveness. Residual analysis was performed to verify assumptions of the two-way ANOVA. Boxplots were inspected to identify outliers, and normality was assessed using Shapiro-Wilk's normality test for each cell of the design while homogeneity of variances was assessed by Levene's test. A small number of outliers (5) were removed, while residuals were normally distributed ( $p > .05$ ). Homogeneity of variances is confirmed as measured by Levene's test for equality of variances,  $p = .963$ .

Initial descriptive statistics of the mean scores for learning effectiveness for learners with low and high spatial ability across the three modes of learning are presented in Table 5-15. This indicates differences in scores between low and high spatial ability learners. The pattern of results is plotted in Figure 5-2. For face to face learning, learners with low spatial ability scored better on average compared to learners with high spatial ability. For high media e-Learning mode the result is reversed with learners with high spatial ability scoring better in terms of overall learning effectiveness. In contrast for the low media e-Learning mode learners with high spatial ability scored lower in terms of overall learning effectiveness than low spatial ability learners.

There was a statistically significant interaction between learning mode and spatial ability for learning effectiveness score,  $F(2, 253) = 3.49$ ,  $p = .032$ , partial  $\eta^2 = .027$ . Based on this, an analysis of simple main effects for education level was conducted with statistical significance using the Bonferroni adjustment and being accepted at the  $p < .025$  level.

**Table 5-15 Descriptive Statistics Learning Mode and Spatial Ability**

<b>Learning Mode</b>	<b>Spatial Ability</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>N</b>
Face-to-face	Low	3.99	1.38	44
	High	3.49	1.43	42
	Total	3.75	1.42	86
e-Learning (High Media)	Low	3.54	1.36	42
	High	3.94	1.35	44
	Total	3.74	1.36	86
e-Learning (Low Media)	Low	3.83	1.42	43
	High	3.22	1.31	44
	Total	3.52	1.39	87
Total	Low	3.79	1.39	129
	High	3.55	1.39	130
	Total	3.67	1.39	259



**Figure 5-2 Estimated Marginal Means Plot Spatial Ability \* Learning Mode**

The simple main effect of learning mode on mean learning effectiveness score for those face to face learners was not statistically significant,  $F(1, 253) = 2.88, p = .09$ , partial  $\eta^2 = .011$ . The simple main effect of learning mode on mean learning effectiveness scores for e-Learning High Media learners was not statistically significant,  $F(1, 253) = 1.796, p = .181$ , partial  $\eta^2 = .007$ . There was no statistical difference in mean scores between low or high spatial ability learners in those modes of learning. However, for e-Learning there was a statistically significant difference in mean learning effectiveness score between low and high spatial ability learners on the low media e-Learning mode  $F(1, 253) = 4.323, p = .041$ , partial  $\eta^2 = .016$ .

All pairwise comparisons were run for each simple main effect with reported 95% confidence intervals and p-values Bonferroni-adjusted within each simple main effect (Table 5-16). The mean  $\pm$  standard deviation for the learning effectiveness score in terms

of low and high spatial ability on the low media e-Learning course was  $3.83 \pm 1.03$  for learners with low spatial ability and  $3.29 \pm 1.08$  for learners with high spatial ability, a statistically significant mean difference of 0.608 (95% CI, 0.26 to 1.189).

**Table 5-16 Pairwise Comparisons**

Learning Mode	(I) Spatial Ability	(J) Spatial Ability	Mean Difference (I-J)	Std. Error	Sig.b	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Face-to-face	Low	High	.505	.297	.090	-.080	1.09
	High	Low	-.505	.297	.090	-1.09	.080
eLearn High Media	Low	High	-.398	.297	.181	-.983	.187
	High	Low	.398	.297	.181	-.187	.983
eLearn Low Media	Low	High	.608*	.295	.041	.026	1.19
	High	Low	-.608*	.295	.041	-1.19	-.026

Based on estimated marginal means

\*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

## 5.7 Conclusion

This chapter presented the results generated from the quasi-experimental research

conducted. The results were structured into four sections. The first section (5.2) provides the descriptive results for the three study groups and their means for research variables. The subsequent sections are presented in line with the research hypotheses.

Section 5.3 presents the results for One-Way MANOVA analysis comparing learning effectiveness of three dependent variables and mode of learning. The results presented address the differences in learning effectiveness between face-to-face and e-Learning (H1) and between low media e-Learning and High media e-Learning (H2). The results indicated that face-to-face learning was more effective than both modes of e-Learning. The result also revealed significant difference in learning effectiveness between low and high media rich e-Learning in favour of high media. Section 5.4 presented the results from a Two-way ANOVA analysis to investigate whether significant differences existed between the learning modes, learning style and learning performance (H3). The results provided support for significant differences in learning effectiveness for learning styles across the three modes of learning. Finally, section 5.5 presented the results from a two-way ANOVA that examined the effects of learning mode and levels of spatial ability on learning effectiveness (H4). There was partial interaction between spatial ability and learning mode in influencing learning effectiveness. The significance and implications of these major findings are stated and discussed in the next chapter.

## **Chapter 6      Discussion of Findings**

### **6.1 Introduction**

While e-Learning has been emphasised as a contemporary approach to learning that promises to contribute to improve standards of learning, its effectiveness has yet to be verified. This research was conducted to evaluate the effectiveness of face-to-face versus e-Learning in the UAE civil defence sector. The notion that e-Learning can be a transformative approach to address the goals of the civil defence sector has yet to be fully realised as corroborated by the results of this study. The evaluation conducted points to an e-Learning environment which is not comparable to face-to-face learning in terms of learning effectiveness. This chapter reflects on the main findings of the quasi-experimental research and discusses the findings in light of the research questions, hypotheses and literature review. The discussion is structured in accordance with the four research hypotheses.

### **6.2 Reflection on the Validity of the Research Design**

This study employs a quasi-experimental research design in order to evaluate the different learning interventions using a survey method to collect the data. Review of the literature suggests that this is a valid approach for investigating the learning interventions. Many studies in this area have employed experimental (Surjono, 2015; Suanpang and Petocz, 2006; Katz and Yablon, 2003; McLaren, 2004; Schutte, 1998;) or quasi-experimental designs (Driscoll et al., 2012; Abdelaziz et al., 2011) to evaluate highly similar topics such as the effects of face-to-face versus e-Learning or the influence of media preferences and learning styles on learning outcomes. In the absence of experimental or quasi-experimental designs studies have also investigated the outcomes of different learning interventions using survey methods to collect the data



(Rusli and Negara, 2017; Rusli et al., 2014; Ni, 2013; Monika, 2013; Blackmore et al., 2008) or secondary data derived from learners' test or exam results (Ni, 2013; Gulacar et al., 2013; Wilson and Allen, 2008). Multiple studies further use ANOVA statistical techniques to analyse the comparative data (Rusli and Negara, 2017; Rusli et al., 2014; Gulacar et al., 2013; Wilson and Allen, 2008).

### **6.3 Learning Effectiveness between Traditional vs E-learning**

This research proposed the hypothesis that *Learning effectiveness is significantly better in traditional face-to-face learning than e-learning across different measures* (H1). Learning effectiveness is measured as cognitive outcomes, learner engagement and learner behaviour. The one way MANOVA analysis confirmed support for this hypothesis with results revealing that across all three measures the face to face learning mode experienced significantly better learning effectiveness than the two e-Learning modes tested. The size of effect was large for all measures. This finding lends supports to the body of literature that points to higher overall learning effectiveness for the traditional mode of face to face delivery than e-Learning (Abdel Aziz, 2011; Reime et al., 2008; Shen et al., 2007).

Based on this finding it is apparent that learning effectiveness is better under face to face learning than in e-Learning. Furthermore, these results are consistent across all three measures of learning effectiveness. Face to face learners performed better attitudinally in terms of perceived engagement, cognitive performance in terms of knowledge absorbed and behaviourally, in terms of perceived benefits in the workplace.

There is much credence attached to face to face due to the high level of tutor interaction and group interaction which may be a significant factor in explaining this difference. A core element of classroom learning is a high level of learner engagement

made possible by the social and communicative interactions between students with teachers and peers (Ni, 2013). Compared to e-Learning modes of learning, in face to face learning there is greater opportunity to immediately and spontaneously ask questions, share opinions and thoughts, discuss, debate, and converse to clarify concepts, challenge assumptions, form new ideas, practice skills and achieve learning objectives. This can occur naturally and spontaneously and is free from the technical requirements in e-Learning which make it more challenging to achieve the same level of access and continuity in interaction as face to face learning. Critics have highlighted the potential isolation and frustration of learners in e-Learning environments (Hara and Kling, 2000). Moreover a lack of real-time human interaction has been found to weaken motivation in completing online courses (Morse, 2003).

The complexity of the curriculum may necessitate effective interaction between tutor and learners that face to face learning offers. It may be that in the context of civil defence, e-Learning programmes need to build in more opportunities for student to peer and teacher interaction, discussion and clarification that can support learning of complex and highly experiential aspects of fire safety. Some literature points to the ability of e-Learning to facilitate student-centric learning, wider learner participation and more reasoned and in-depth discussion than in traditional classroom environments (Smith and Hardaker, 2000; Karayan and Crowe, 1997). Lower time pressures on learner interactions and online rather than face to face interactions may encourage increased interaction (Warschauer, 1997) and shy and more reticent learners may feel less constrained to participate (Citera, 1988). Therefore the degree of interaction enabled between learners and tutors may account for the lower scores for learning effectiveness.

The face to face learning mode also provides greater opportunity for peer to peer interaction. In the face to face learning mode the opportunity for peer to peer interaction is available, while in the e-Learning mode both tutor interactions and group and peer to peer interactions need to be designed effectively. Therefore the difference in scores may be associated with the design of the e-Learning programme which may be limited in terms of creating the close connection among learners that is needed to facilitate greater learning interactions and quality of discussion. This aspect has been found to be critical to learning effectiveness. Haythornthwaite et al., (2000) shows that learners who did not make connections with others in their group indicated greater feelings of stress and isolation.

The findings showed that traditional learners experienced higher cognitive outcomes in the form of better test results than learners within e-Learning. The result aligns with broad evidence indicating higher learning outcomes in the traditional modality (Abdel Aziz 2011; Means et al, 2009; Shen et al., 2007). One meta-analysis concludes that overall there is no support for the proposition that online learning is significantly better than traditional (Means et al, 2009). A possible explanation for the finding in this study is that civil defence training can involve significant amounts of factual or descriptive (declarative) knowledge which needs to be stored in the memory. Sitzmann et al (2006) indicate that declarative knowledge is more effectively acquired in the classroom in comparison with web-based instruction, though equal declarative knowledge was achieved when the same instructional method was used and students expressed similar satisfaction for both delivery media. In order to enrich learning of factual knowledge through e-Learning, it was concluded that learners should be given greater control, feedback and practice (Sitzmann et al, 2006). This suggests that there may be elements in the e-Learning programme that need to be enhanced in terms of providing more

learner control and greater mechanisms for feedback to enable learners to effectively acquire large amounts of factual data and procedural knowledge. Mechanisms may need to be provided that enable learners to practice the knowledge they have acquired to ensure that it is committed to memory.

Once again this emphasises the potential for design factors to influence learning effectiveness in comparison with face to face. It could be that there is insufficient support to guide e-learners on the programme in undertaking self-directed learning. Some evidence highlights negative implications related to interactive multimedia for learner outcomes emerging from issues centred on self-guidance in particular: a lack of clear objectives and self-directed learning which may result in an unwillingness to learn, and diminished media richness in which face to face communication reduces when communications are primarily electronic (Rusli et al., 2014).

However this result conflicts with much literature which underlines positive cognitive outcomes for e-Learning when comparing learning across both modes (Soffer and Nachmias, 2018; Harmon and Lambrinos, 2006; Shachar and Neumann, 2003; Ladyshevsky 2004). Meta-analyses show that learning outcomes of students in the online environment are modestly better than those under a traditional format (Soffer and Nachmias, 2018; Means et al., 2009; Shachar and Neumann, 2003). Critical success factors focus on a combination of time spent, curriculum, and pedagogy (Means et al., 2009). As the curriculum was the same in this study in both modes, this suggests that there may be areas in relation to pedagogy to which the e-Learning programme is not optimised. Effective e-Learning is acknowledged to require elements in addition to technologies such as appropriate course design, current relevant content, strategic and effective teaching plans, and support and service staff at all levels (Hussin et al., 2009).

Furthermore it is possible that variables outside the scope of this study have influenced the findings. One key possibility relates to the digital skills of the participants which could partly explain why cognitive outcomes were higher in the traditional mode of learning. To be able to function in the e-Learning environment both the instructor and learner must be familiar with using the Internet, online chatting and messaging, become proficient with the learning management system (LMS) applications and have the capacity to collaborate with others (Salmon, 2003). Chaffin and Maddix (2004) highlight the need for a good level of computer and communication skills for e-Learning as when instructors and learners are not having face to face encounters there is potential for misinterpretation of meaning. There is further evidence to show that individual differences in instructional methods, such as lectures, assignments, group discussions or reading textbooks exert a greater influence on learning outcomes than different delivery modes (Sitzmann et al, 2006; Tamim, 2011; Clark 1983, 1994; Bernard et al 2004; Russell 1999). Meta-analyses conducted by Sitzmann et al (2006), Means et al (2010) and Nguyen (2015) support the findings and argue that student performance as measured by grade is independent of the mode of instruction (Ni, 2013).

The higher learner engagement evident in this study in the face to face mode than e-Learning is inconsistent with much of the findings in earlier literature. Research has pointed to higher levels of student engagement and satisfaction with e-Learning over traditional (Soffer and Nachmias, 2018; Kemp and Grieve, 2014; Chen et al, 2010; Kuh and Hu 2001; Navarro and Shoemaker, 2000). The difference in engagement between face to face and e-Learning may point to numerous factors that may explain higher levels of engagement in the face to face learning mode compared to e-Learning design. One explanation for this result could relate to specific design elements in the online programme that are failing to maximise the unique features of e-Learning that lead to

greater engagement and higher positive attitudes. The lower performance for e-Learning may be due to limited design features in e-Learning to effectively compensate for the lack of human interaction that is achieved with face to face learning mode. In spite of the significant advantage in terms of face to face learning, asynchronous technology of e-Learning nevertheless provides students more opportunities for engagement with the course through enabling the conduct of learning activities at their own convenience. Online environments have been evidenced to succeed better in engaging students with course structure, as well as enhancing communication with course staff, and increasing the frequency of reviewing course material, all elements found to improve overall engagement and satisfaction (Soffer and Nachmias, 2018). This suggests that civil defence learners may be lacking the support necessary to fully maximise the asynchronous and engaging dimensions of e-Learning. Increased focus may need to be placed on ensuring that tools and processes are in place that optimise communication with instructors and encourage learners to take advantage of asynchronous possibilities to engage with the course content at their own pace.

#### **6.4 Learning Effectiveness between High and Low Multimedia**

This research examined the differences between different types of media, specifically high media rich e-Learning mode of delivery and low media rich e-Learning mode. The study hypothesised that *In e-Learning design approaches, learning effectiveness is significantly better in high media rich (text, audio-visual, animation, 3D) than low media rich (text, audio, visual) (H2).*

Results showed that this hypothesis was fully supported with a high media rich design evidencing increased learning effectiveness in comparison with low media rich. Large differences in effect size were identified. This finding is consistent with the overall trend

in the literature. Evidence shows that interactive in comparison with static multimedia presentations may enhance post-test performances (Rusli and Negara; 2017; Rusli et al. 2014; Rolfe and Gray, 2011) and animations have improved student performance over static graphics (Rolfe and Gray, 2011; O'Day, 2007; O'Day, 2006). Rusli (2015) investigated the impact of multimedia learning with high and low interactivity on the learning result by controlling the student's prior knowledge. The authors' findings confirm that dynamic visualisation presentations are more effective than the static visualisation presentations to learning result.

The higher level of learner engagement and interest noted to be generated by multimedia use is a key explanation for this result. The complex course content in the context of civil defence fire safety training may also influence the higher outcomes found in comparison with low multimedia. Evidence has shown that increased use of interactive or dynamic multimedia has proved to be more efficient in learning of more complex materials and in applying concepts, procedures, and principals (Rusli and Negara, 2017; Holzinger et al., 2008). Studies point to the conclusion that as the complexity of learning material increases so does the importance of appropriate representations which may in turn attract a learner's attention and interest (Holzinger et al., 2008, Mayer, 2001). Mešić (2015) compared the impact of simulations, sequences of printed simulation frames and conventional static diagrams on the understanding of one-dimensional kinematics. Students who learned from dynamic multimedia stimulations significantly outperformed their peers who learned using static diagrams.

Another reason could relate to the efficacy of the design of the e-Learning module in relation to integration of a media rich environment. Incorporation of good design principles in relation to interactive multimedia may have enhanced the learning

effectiveness of the programme. Rusli and Negara (2017) conclude that by following specific principles to guide the presentation of interactive multimedia formats including contiguity and the principle of segmentation (Clark and Mayer, 2008) the cognitive load of learners during the learning process can be effectively managed (Rusli and Negara, 2017). This is key in e-Learning design as according to cognitive load theory the visual and auditory channels that process information have limited capacity (Mayer, 2001; Sweller, 1999). This means that to enhance the storage and representational capacity of the learner's memory multimedia design should decrease the load on the working memory (Baddeley, 1992; Sweller, 1988). Results in this study suggest that the pedagogical presentation of high multimedia is taking channel capacity into account and is designed to utilise the learner's cognitive processes and channels without overwhelming them (Moreno and Mayer, 1999).

## **6.5 Learning Effectiveness across Different Learning Styles**

Learning styles have significant importance and influence in terms of learner performance. This aspect of learning was incorporated into the research design to investigate if differences in performance could be identified for learning styles across the different modes of learning. To test the interaction effect between learning and learning style it is hypothesised that *Learning styles have higher significant effects on learning effectiveness using e-Learning than traditional learning (H3)*.

The study hypothesised that learning styles will impact learning effectiveness between traditional learning and e-Learning. Data analysis also investigated the impacts of learning styles on learning effectiveness in high and low media-rich e-Learning designs. Eight learning styles of active/reflective, sensing/intuitive, visual/verbal and sequential/global were evaluated. Overall the findings from this research indicate that



learning styles do indeed impact on learning performance between difference modes of learning; both between face learning and e-Learning as well as significant differences in learning effectiveness between the low media e-Learning format and high media e-Learning format.

Learning style therefore has an impact on learning outcomes when compared between face to face and e-Learning and between high and low multimedia. While this research lends support to the role of learning styles, it contrasts with other research that has indicated that students learn equally well in either modality, regardless of learning style (Aragon et al., 2002; Anzalone, 2008). There is consistency with findings pointing to differences in outcomes for different learning styles. A key outcome of Manochechr (2006) comparing the effects of learning style on learning outcomes in e-Learning versus a traditional approach is that learning style in traditional learning was not important while in e-Learning it was highly significant. More recent evidence suggests that incorporating learner preferences within the design of e-Learning programmes enhances learner performance (Abdullah et al., 2015).

On balance, the findings from this research provide support for the importance of learning styles and the interaction with modes of learning and learning effectiveness. Therefore learner characteristics impact on their learning performance depending on the mode of learning. The implications of this can be discussed in terms of each learning style tested in this research.

### **6.5.1 Active Learning Style**

The results from this study showed that active learners experienced a high difference in learning effectiveness between the traditional modality and e-Learning. This supports previous literature which shows that more active styles perform better in traditional face

to face settings when compared with e-Learning (Lu et al., 2007; Manochechr, 2006). The finding points to the necessity of explicit consideration of the needs of active learners within the design of e-Learning programmes to ensure that active learners are able to fully maximise the opportunities provided by this modality. The difference in scores of learners with active learning style suggests that the specific needs of such learners may not be sufficiently addressed with e-Learning. Active learners retain and understand information better when they are able to experiment actively with the material and apply the learning. Active participation, discussions, asking questions and explaining to others are key aspects which enhance learning effectiveness for these learners. They prefer to work cooperatively with others in groups and make contributions of new, creative, or challenging ideas to the learning process (Kaliska, 2012). Therefore the lower performance of learners of this style in the e-Learning mode may suggest that for this sample of learners these elements have not been effectively designed into the e-Learning mode.

The finding from this research adds to existing evidence from the literature which emphasises differences in performance of active learners, and contrasts with Saeed and Yang (2008) who find no support for differences in learning outcomes between active and reflective styles in the e-Learning mode. Battalio (2009) showed that active learners performed less well in terms of cognitive outcomes than reflective learners in the e-Learning mode. It was also found that by incorporating collaborative elements this increased the performance of active learners. Active learners performed significantly better in collaborative versions of an e-Learning course than on a self-directed version (Battalio, 2009).

Thus the degree to which collaborative elements are effectively designed into e-Learning environments can enhance the experience of active learners. Such learners may respond well to instructional strategies which involve strong elements of interaction and activity such as role playing, games and simulations, problem solving, debates, discussion and brainstorming and online rely on tools involving collaboration, communication and search for learning (Santo et al., 2015). These are all pedagogical strategies which may lend themselves more to a classroom-based approach (Lu et al., 2007).

The findings have implications for the design of civil defence training programmes. In particular a need is suggested for ensuring balanced learning opportunities that encourage and promote greater reflectivity and digestion of course materials while ensuring that there are ample opportunities for the more interactive, interpersonal and discursive elements that will satisfy active learners. The use of e-Learning does not preclude active learners from achieving equivalent outcomes as face to face. The use of technology has been shown to impact on higher order thinking as it supports the development of synthesis and analysis, judgment, and knowledge application (Robinson and Hullinger, 2008). By ensuring that there are opportunities for engaging students in collaboration, problem solving and stimulation, higher order skills can be effectively developed (Duderstad et al, 2002). Collaborative work has become part of most of online course designs (Thurmond and Wambach, 2004), emphasising that increasing focus on designing opportunities for greater collaboration in conjunction with other elements will support active learners to achieve higher outcomes in e-Learning.

Moreover the finding underlines a potential need to incorporate a more blended learning approach within civil defence training programmes which ensures that active

learners are accommodated through opportunities for classroom instruction. Traditional classroom is preferred for carrying out class discussions, where immediate feedback, engagement in discussing course content and contribution to the learning content is appreciated by active learners (Kemp and Grieve, 2014). At the same time active learners need to be encouraged to engage in the reflective behaviour important for success in an e-Learning mode. Evidence in the literature has highlighted the potential benefits of a blended learning approach for learning outcomes. Thai et al (2015) investigated students' performance in face-to-face, e-Learning, and blended learning modes finding that the design of blended learning led to better achievements when compared to e-Learning. Al-Qahtani and Higgins (2012) also show a significant difference in favour of blended learning while no significant difference is manifested between students in the e-Learning and traditional groups.

A comparison between different e-Learning formats tested in this research indicates that learning styles play a role in learner performance. A comparison between high and low media e-Learning formats also revealed differences in learning effectiveness. The findings showed that learning effectiveness was higher for active learners in the high multimedia mode compared to the low. This result is not unexpected given the preference of active learners for more interactive forms of learning. Active learners may become bored with presentations involving static visual and textual material that does not engage them in performing activities and interacting with the content. Enhancing the learning effectiveness of e-Learning for this group of learners therefore involves adoption of high multimedia elements.

### 6.5.2 Reflective Learning Style

Analysis of learning effectiveness of reflective learners between different modes of learning also indicated differences. Reflective learners achieved higher learning effectiveness in the high multimedia e-Learning mode than in the face to face mode. Although the differences were small, reflective learners appeared to respond well to use of interactive multimedia. Findings also indicated a small increase in learning effectiveness over the low multimedia mode. It is possible that e-Learning compared to face to face learning provides greater opportunity for reflective learning. Reflective learners prefer to quietly reflect on the learning content to think and abstract the information before doing, and periodically stop and review what has been learned and think about possible questions and applications (Santo et al., 2015). They tend towards theoretical concepts and identifying interrelations (Cheng et al., 2016) and prefer to work alone, watch and listen (Mendes de Silva et al., 2015). Graf and Kinshuk (2006) show that reflective learners spend more time on examples and greater engagement with outline learning material than other learning styles.

The e-Learning environment addresses such needs for learners to reflect and work at their own pace. This result is consistent with the literature which points to the importance of reflective styles for learning outcomes in the e-Learning environment (Lu et al., 2007; Manochehr, 2006; Allert, 2004; Thomas et al., 2002). Mendes da Silva et al., (2015) found that the Active/Reflective learning style dimension was the only style that impacted learning performance in both online and face to face settings. The reflective learners were found to have higher performance in both modes compared to active learners. Manochehr (2006) found that Convergers and Assimilators, two of Kolb's (1984) learning styles which share highly similar elements with the Reflective

style denoted by Felder and Silverman (1988), achieved higher learning outcomes in the e-Learning mode when compared to traditional instructor-based programme delivery. Manochehr and Young (2006) similarly show the success of Convergents and Assimilators in an e-Learning, rather than instructor-based, course. Lu et al., (2007) find that in a purely e-Learning context Assimilator and Converger learning styles experienced higher mean learning outcomes than the other learning styles.

The findings in this study suggest that there are elements within reflective learning styles that are highly suited to e-Learning. Numerous studies have evidenced higher performance of reflective learners in e-Learning (Battalio, 2009). Reflective learners are the most adaptive and successful learners in the e-Learning context in comparison with other learning styles (Battalio, 2009; Palloff and Pratt, 2007). In this study reflective styles achieved lower scores compared to active learners in the face to face mode. Ke and Carr-Chellman (2006) provides a possible explanation in that unlike active learners dependence on peer effort and commitment made reflective learners uncomfortable. However, in an online interactive environment Mehlenbacher et al., (2000) found that reflective learners performed more successfully than active learners.

Literature points to a range of behaviours associated with the reflective learning style that may explain higher learning outcomes. Online students have been found to be more reflective when compared to face to face learners, reporting a greater preference for abstract conceptualisation and learning by thinking (Esichaikul and Bechter, 2010; Aragon et al., 2002). Reflective learners engage more significantly in a key online behaviour related to e-Learning outcomes of preparing and producing content based on reflection (Cheng et al., 2016). Lu et al., (2007) find that Convergents and Assimilators spent more time on reading the learning materials and digesting them than Divergers

and Accommodators (associated with active and concrete elements, aligning with the Active style) who spent more time on online interaction and discussion. Higher learning outcomes were indicated for the Convergents and Assimilators. Total reading time was found to have a greater influence on learning outcomes than total discussion time (Lu et al., 2007).

However the findings indicated that for reflective learners greater outcomes were achieved in the high media e-Learning mode than when static multimedia was employed. This suggests that there are aspects in the high multimedia programme that encourage and support reflective learners to engage their reflexivity and their preferences towards thinking and abstracting the information before doing, as well as their ability to periodically stop and review what has been learned and think about possible questions and applications (Santo et al., 2015).

### **6.5.3 Sensing Learning Style**

The findings showed that the sensing style performed better in the face to face mode than e-Learning and sensing learners achieved higher outcomes with high multimedia than low. The differences in outcome were high for sensing learners. To some extent this result conflicts with the literature in which considerable evidence suggests that elements of a sensory learning style are highly adaptable to the e-Learning environment supporting higher outcomes (Mendes de Silva et al., 2015; Cheng et al., 2016; Huang et al., 2012). When comparing the performance of learners in e-Learning and traditional modes Mendes de Silva et al., (2015) shows that learners with a sensory style obtained higher learning outcomes in the online setting than in a face to face environment. The sensory style is viewed as highly compatible with the e-Learning environment as it

provides factual data and practical problem-solving using well-established methods, and content in concrete steps (Huang et al., 2012).

One explanation for this result could be that the e-Learning programme is not integrating the pedagogical and learning elements that literature emphasises are important for sensing learners to achieve higher outcomes in e-Learning. Evidence shows that online participation can enhance e-Learning performance outcomes (Huang et al., 2012; Zhang et al., 2006; Davies and Graff, 2005). Sensing learners in particular have been shown to be more participatory in online activities that enhance e-Learning than other types of learners (Cheng et al., 2016). Huang et al., (2012) found that the sensory style indirectly predicted learning performance through the mediation of online participation while other styles did not. Cheng et al., (2016) also demonstrate that participation is greater among sensing learners, who participate in three of four online learning activities critical to e-Learning outcomes including accessing and reading information, interactive learning and networked learning (Cheng et al., 2016). Their orientation towards a practical, hands-on approach led to significant engagement with interactive aspects such as online quizzes, simulations and games and the careful attitude of sensing learners towards details resulted in detail sharing behaviour with peers across media such as forums and wikis (Cheng et al., 2016). This links with the greater learning effectiveness experienced by sensing learners in this study in relation to high multimedia use which points to the need for integrating increased opportunities for these types of learning activities and greater overall interactivity and participation within the design of civil defence e-Learning to enhance outcomes for sensing learners.

A further explanation is related to sensing learners' focus on physical sensations and sights and sounds, the tendency to prefer concrete data and facts and ability to memorise



them easily. Such learners show preferences towards solving problems by means of well-established procedures and are patient with details. While showing facility for practical, applied approaches including laboratory and experimental work and problem solving (Kaliska, 2012), sensing learners do not like courses that have no linkage to the real world (Mendes de Silva et al., 2015). This suggests that the degree to which such learners are effectively engaged depends critically on a deeper understanding of what aspects of the e-Learning environment can be developed that addresses such needs.

#### **6.5.4 Intuitive Learning Style**

The intuitive style similarly indicated increased outcomes in traditional and high multimedia contexts. However the size of the effects was more moderate for intuitive learners. The finding for the intuitive style is to some extent consistent with evidence that suggests that intuitive learners may lack certain attributes which can promote success in the e-Learning environment. Intuitive learners have a generally low level of online participation compared with other learning styles (Huang et al., 2012). In terms of learner attitudes it may be that consideration of these styles within the design of programmes is important for learner satisfaction and motivation. Some evidence points to the prevalence of a sensing learning tendency among the majority of learners on both face to face and distance learning courses (Santo et al., 2015) which suggests that for learner satisfaction, programmes which take into account the balance of styles may be perceived more positively.

In these experiments the sample of intuitive learners may not be adjusted well to the e-Learning environment and may need increased support particularly in terms of promoting greater participation. Intuitive learners participate less frequently and for lower periods of time than sensory students leading to lower e-Learning performance

(Huang et al., 2012). Intuitive learners rely on intuition, imagination and divergent thinking to perceive information. Tending towards theory, meaning and abstract conceptualisations and discovering possibilities, relationships and making connections intuitive learners are quick and creative and dislike repetition or subjects requiring significant memorisation (Cheng et al., 2016; Santo et al., 2015). A key characteristic of e-Learning is the need for self-discipline and self-motivation to undertake and complete course programmes (Bencheva, 2010). However this could impact lower outcomes for intuitive learners who could find this aspect of e-Learning challenging as they have a tendency to become easily bored with more factual, repetitive learning.

The result also suggests potential failure to take into account different learning style orientations towards different learning and communication tools. Sensing and intuitive learners approach e-Learning differently in terms of the learning and communication tools used. Saeed and Yang (2008) show that sensing learners had strong preferences towards using traditional communication tools such as email, associated with their careful approach to detail, while intuitive learners, oriented towards discovering new possibilities and relationships, preferred to use relatively new tools such as IM or blogs (Saeed and Yang, 2008). Awareness of and integration of these different approaches could be important for ensuring high learner engagement and satisfaction within civil defence training programmes among sensing and intuitive learners.

### **6.5.5 Visual Learning Style**

The visual style of learning was revealed to achieve moderately higher learning effectiveness in the face to face mode than in e-Learning. Performance outcomes were also moderately better in the high multimedia context than the lower. This contrasts with Battalio (2009) who found no effects of a visual style on learning success in e-Learning.

One explanation for this result could be that visual learners are more stimulated and engaged in face to face contexts by the directly visual and interpersonal contact with instructors and peers that online modes may find challenging to substitute. Johnson and Johnson (2006) show that visual learners showed distinct preferences for real rather than virtual study groups. It is possible that the visual cues, body language and real presence of tutors and peers appeal to and engage visual learners more than the anonymous context online where this visual meta-information is not available.

However, the difference in performance may well be related to the quality of visual content in both e-Learning modes. Visual learners understand and remember better from learning material presented either through graphical or video representation, such as pictures, diagrams, charts, films or demonstrations. Such learners tend to replace words with symbols and reconstruct images in different ways (Mendes de Silva et al., 2017). Games and simulations and information presentation in visual form are considered to be appropriate strategies for this style of learner (Santo et al., 2015). This may place more focus on design quality and choice of visual content in the e-Learning course. There is significant scope for designers to incorporate means of communication that allow for more visual channels such as video conferencing however the elements of face to face contact that support visual learners may be difficult to replicate to their satisfaction. This points to the potential efficacy of a blended learning approach for this type of learner.

E-learning lends itself well to such needs, and therefore it is surprising visual learners in face to face score better for learning effectiveness. The finding for high multimedia is inconsistent with findings by Beckmann et al., (2015) on performance differences between visual styles in e-Learning. These showed firstly that whether the material presented was a good or bad fit for visual styles did not influence the amount of study time or learning

outcomes. Prior evidence further indicates no correlation between a visual learning style and learning outcomes in either matched or mismatched programmes (Kolloffel, 2012; Brown, 2006). The conflicting findings in this study suggest that further exploration of visual styles in different multimedia contexts is needed to understand what, if any, are the specific elements that influence effectiveness. It could be that only the use of high or interactive multimedia is able to stimulate higher learning outcomes in visual learners while the use of static multimedia may not have significantly more positive influence than a more verbally focused or mismatched presentation of learning content. Findings have shown that learners who are strongly visually oriented face significant challenges in expressing themselves in low media rich or textually-based e-Learning environments (Gomes et al., 2007).

There is also the potential for mismatch in learning materials to influence emotional factors such as motivation and satisfaction, important in the self-regulated learning context of e-Learning. High intrinsic motivation encourages more in-depth and conceptual learning and can influence learning success (Schiefele and Schreyer, 1994) and course completion (Levy, 2007). Beckmann et al., (2015) shows there was a significant influence of good or bad fit on the intrinsic motivation and satisfaction of learners. Visual learners were not satisfied or motivated by learning with text only. This has clear implications for the design of the civil defence programme in incorporating the needs of visual learners. A balanced approach may need to be considered as not all visual learners show strong preferences and orientations and verbal learners may be disadvantaged by an overly visual approach. Beckmann et al., (2015) indicates that attitudinal effects were most significant for learners with a strongly expressed visual style, with more balanced visual styles exhibiting lower effects.

### 6.5.6 Verbal Learning Style

A verbal style of learning was revealed as having significantly higher learning effectiveness in the face to face modality than in e-Learning. The high effect size for the verbal learners was much greater than the moderate effect size for visual learners. This points to the need to pay increased attention to the elements in e-Learning that are presenting barriers for verbal learners in particular. Verbal learners depend on information delivered through words either written or spoken to promote learning (Felder, 2002). Text and sound are key characteristics of the media that appeals most to verbal learners who like to take notes and change diagrams into words. Printed support materials often have value for verbal learners while presentation, discussion, question and answer, and brainstorming can be effective teaching strategies (Santo et al., 2015).

The result is to an extent unexpected given that e-Learning programmes by their nature are reading intensive and reading is an integral element of online programmes. The findings are inconsistent with prior studies indicating no overall difference in learning outcomes for verbal learners between face to face and e-Learning modes (Battalio, 2009; Beckmann et al., 2015). Similarly, recent evidence from Mendes de Silva et al., (2015) related to online and face to face assessment activities does not identify any statistically significant link between a verbal style and learner performance when comparing online and face to face modes.

However as with visual learners mismatched presentation of content can lead to the demotivation and dissatisfaction of verbal learners. It is possible therefore that the e-Learning programme may be oriented too strongly towards a visual learning style and visual display of content. Verbal learners depend more on information delivered through words either text or sound (Felder, 2002) while presentation, discussion, question and answer can be effective teaching strategies (Santo et al., 2015).

Results also indicated that verbal learners are the only one of the learning styles to have performed better in a low media e-Learning environment compared to a higher. There was also less of a performance gap between low multimedia and face to face mode than between high multimedia and traditional. The finding is not unexpected given the primary focus of verbal learners on text and words in learning. This is consistent with Gomes et al., (2007) who found that verbal learners in e-Learning responded better to text based solutions.

The result supports literature that underlines that increased use of multimedia may be less effective for verbal learners than with other styles (Rusli and Negara, 2017; Santos et al., 2015; Alias and Siraj, 2012). Alias and Siraj (2012) show that while customised tools and media were valuable for other learning styles the strategies proved less effective for verbal learners. This suggests that decreased use of multimedia could help support the effectiveness of verbal learners in the e-Learning environment and mitigate the potential cognitive overload that significant use of visual and interactive information could provoke (Moreno and Mayer, 2002). Moreno and Mayer (2002) highlight that learning outcomes in terms of retention and transfer are improved in e-Learning when words are presented both in auditory and visual modes but not when other concurrent visual material was present, underlining the importance of avoiding strong emphasis on visual presentation. Santos et al., (2015) suggests that pedagogical strategies adapt to the learning requirements of visual/verbal learners by mixing multimedia resources with written or verbal explanations to stimulate both channels.

### **6.5.7 Sequential Learning Style**

In terms of the sequential style results pointed to a higher level of learning effectiveness in face to face than e-Learning and greater effectiveness in high over low multimedia. The strength of difference was high in the case of sequential. It could be argued that tutors provide support to guide and order learning in a sequential manner. Online learners may be exposed

to greater freedom to explore content in a more random manner or could be exposed to design and layout of content that is more globally organised and less structured. In other words the design of e-Learning content can disadvantage sequential learners. Sequential learners show a preference towards linear learning presented in small, and incremental steps with each step emerging from the previous (Felder, 2002). Such learners tend to follow gradual and logical ways to solve problems and are oriented towards convergent thinking utilising elementary thinking processes such as analysis and synthesis to uncover wider interrelations (Kaliska, 2012).

Some evidence suggests that sequential learners significantly outperform global learners in the e-Learning mode of delivery highlighting that sequential learners can perform successfully in this context (Battalio, 2009). However, the largest body of evidence finds no significant variation in learning outcome in terms of a sequential learning style in the e-Learning context alone (Rusli et al., 2014; Kozub, 2010; McCann, 2006; Yilmaz-Soylu and Akkoyunlu, 2002). Although limited research has compared face to face and e-Learning for this style sequential learners have been found to predominate in both modes of face to face and distance learning (Santo et al., 2015). This emphasises the implication of not optimising e-Learning delivery to support sequential styles. A key reason for this finding may be that the sequential learners on the e-Learning programme are finding it more difficult to cope with the asynchronous features and the diverse array of media in which the content is being presented and to identify a defined learning path for themselves. Teaching strategies such as guidance, presentation and question and answer are appropriate for sequential learners when framed within content shown within a predefined learning path (Kaliska, 2012). These methods however may lend themselves more to a classroom environment which could partly explain the result. In traditional teaching modes courses are taught in the classroom by teachers and the learning process is centred on the instructor who has control over the course,

the class and its configuration (Hiltz and Turoff, 2002). In contrast e-Learning provides a strong emphasis on learning by students at their own pace (Hiltz and Turoff, 2002), thus learners are required to identify their own learning paths to some extent, which could make sequential learners uncomfortable. This suggests the need for measures to ensure clearly defined learning paths and learning milestones to mark progress towards clear goals to support the needs of sequential learners. To adapt to learning styles diverse media and technologies should be considered in e-Learning design however the provision of too many choices in either is argued to run the risk of cognitive overload and decreasing the effectiveness of e-Learning (Clark and Mayer, 2012; Hrastinski et al., 2010; Reiser, 2012; Schaer et al., 2006).

In spite of the lack of evidence on the impact of this style on learning performance across different modes, some research provides some insights. Bruhl (2008) for instance shows sequential learners were more likely than global to use “pull” resources such as video AI (Bruhl, 2008). This could be as a result of the ability to replay sequences and establish understanding before progressing to the following content. Other evidence also shows that sequential learners benefit from multimedia features such as podcasts, which enable them to repeatedly run the sequence of lectures to achieve improved understanding of the course content (Saeed and Yang, 2008).

#### **6.5.8 Global Learning Style**

Findings showed a similar pattern of results for global learning styles however the strength of difference was more moderate. When comparing face to face with high media e-Learning no statistically significant difference was identified. However, there was a difference in favour of face to face over low media e-Learning. This suggests that while face to face learning and high media e-Learning were comparable low media e-Learning in this



experiment somehow disadvantaged global learners. In face to face and high media environment there is greater scope to address the needs of global learners that may not be achieved in static low media e-Learning formats. Global learners learn fast by absorbing learning material virtually randomly without identifying connections or deliberate contemplation and then will suddenly and intuitively build a complete picture (Kaliska, 2012). They are also oriented towards a more holistic or systems thinking process first needing to view the problem as an element within a whole context before understanding can be developed and applied (Cheng et al., 2016). Global learners often learn in large, almost random leaps and while able to solve complex problems rapidly and innovatively may have difficulty in explaining how they reached this resolution (Santo et al., 2015). This type of learner reacts well to role playing, brainstorming, case study teaching methods and will likely emphasise collaboration, communication and search within their use of electronic media (Santo et al., 2015). All these elements may be undermined in a low media format. Global learners experienced higher learning outcomes with interactive multimedia.

There are different findings in the literature on the effects of this style on learning effectiveness. At a cognitive level Battalio (2009) shows that global learners do not perform nearly as well as sequential learners in the e-Learning context, while Mehlenbacher et al., (2000) shows that global learners are more successful than sequential learners online. According to Gomes et al. (2007) learning in the ordered and sequential manner that often characterises e-Learning course design can be difficult for global learners especially if the wider context, or goal of the subject or problem is not explained before entering into details.

The effect of this learning is not however consistent with all of the literature. Other literature has shown that the global style has no influence on learning effectiveness of e-Learning (Rusli et al., 2014; Kozub, 2010; McCann, 2006; Yilmaz-Soylu and Akkoyunlu,

2002). One potential reason for the results in this study could be a potential mismatch between the learning styles of instructor and students on the e-Learning courses. Felder (1993) highlights that frequently there can be misalignment between student learning styles and the teaching styles of instructors with implications for instructional design which can often be a reflection of teacher learning style preferences. Evidence by Willems (2011) shows that a preference for sequential or global learning styles could differ between e-learners and instructors, with undergraduates exhibiting a sequential style in contrast to the global style preferred by educators.

## **6.6 Learning Effectiveness and Spatial Abilities**

The study hypothesised that (*H4*) *Spatial ability has a higher significant effect on learning effectiveness using e-Learning than traditional learning.* Findings showed there was no statistically significant difference in learning effectiveness between high and low spatial ability learners in the two modes of face to face and e-Learning with high media. However, when comparing the two modes of e-Learning there was a statistically significant difference in learning effectiveness between high and low spatial ability learners in respect to high and low multimedia e-Learning. The average score for learning effectiveness of learners with high spatial ability scores was lower with low multimedia than low spatial ability learners. High spatial ability learners performed less well and were less engaged than those with less spatial ability. The implication appears to be that low media e-Learning disadvantages learners with high spatial ability in some way.

The result conflicts to some extent with evidence in the literature. Kline (2012) shows that high spatial ability learners outperformed low spatial ability learners in constructing mental models or representations when static multimedia were used. This prompts the possibility that there may not be a cognitive issue for high spatial ability learners in low multimedia

contexts. Rather barriers could centre on the attitudes of high spatial ability learners when presented with low use of multimedia. High spatial ability learners have greater positive attitudes towards the use of high quality 3D while low spatial ability learners prefer simple graphical representation (Huk et al., 2003). Low multimedia could disengage higher spatial ability learners who have greater capacity for mental representation and who may find static multimedia unchallenging and unstimulating. Huk et al., (2003) found evidence that low spatial ability learners tended to undervalue and neglect the features within high multimedia which led to improved learning outcomes, and it is possible that high spatial ability learners in this study may be doing something similar in the case of low multimedia use.

The result in this study implies the need to consider the most appropriate methods for incorporation of rich multimedia to accommodate learners with high spatial abilities. The integration of key design elements could enhance outcomes for high spatial ability learners. For example a study by Chen (2006) shows that VR-based learning was able to enhance outcomes for both types of learners when additional navigational aids were provided. Drawing on the evidence there is also a case for keeping 3D design elements simple (Lee et al., 2009; Huk et al., 2003; Garg et al., 2002).

This study did not find any statistically significant evidence that low spatial ability learners performed better in either type of e-Learning. This result is unexpected given that theory and evidence emphasises that learners with low spatial abilities may not benefit to the same extent as those with high spatial abilities when exposed to high multimedia learning elements (Greenhalgh, 2011; Huk, 2006; Chen, 2006; Moreno and Mayer, 1999). Research by Huk (2006) shows that only those biology learners with high spatial ability benefited from an interactive 3-D multimedia environment. A key reason for this result could be that the design of the high media-rich e-Learning programme in this study is effective for low spatial

ability learners and is succeeding in ameliorating the disadvantages such learners may experience in high multimedia contexts. Cognitive multimedia learning theory emphasises that learners with higher spatial ability are more able to effectively construct mental representations when viewing high multimedia elements such as 3D as they have enough cognitive capability in reserve (Huk, 2006; Moreno and Mayer, 1999; Mayer and Sims, 1994). In contrast low spatial ability learners may find construction of mental representations challenging in this context as they have limited cognitive capability left and may experience cognitive overload (Garg et al., 2002). In this study it appears that the use of media rich elements such as animation and 3-D have not placed undue cognitive overload on low spatial ability learners. Further research may be needed to determine which media rich elements, and the ways in which these are delivered, have a particularly impact on these learners.

This result also conflicts with some theory and evidence which intuitively points to the potential benefits of computer-based spatial learning tools such as 3-D graphics, animation and virtual reality for learners with either high or low spatial abilities (Huk, 2006; Durlach et al., 2000). Presentation of 3D spatial information in a two-dimensional manner is believed to challenge understanding of 3D objects (Mackenzie and Jansen, 1998) and in the case of low spatial ability learners therefore could be viewed as a key limitation of conventional teaching methods. Evidence from Pedrosa et al., (2014) further show that web-based learning tools allowing 3D manipulation were more efficient for low spatial ability learners.

A blended learning approach incorporating face to face elements within course programmes could be of significant benefit to both high and low spatial ability learners. Evidence from Greenhalgh (2011) directly compared high and low spatial ability learners on a traditional and synchronous distance learning engineering course and found that learners with low beginning spatial abilities indicated greater spatial ability improvement in face to

face courses than those on the distance learning course. Nokwe (1993) highlights that problems may lie rather with the instructional means employed to present information than with learner incapacity to visualise spatial relationships. In this context evidence suggests that certain computer-based instructional tools may be highly suited to producing enhanced spatial learning outcomes, in particular virtual reality (Mohler, 1999; McLellan, 1998).

## **6.7 Conclusion**

This chapter discussed the findings from the quasi-experimental tests conducted across three independent groups of learners from the Civil Defence sector. The three modes of learning were analysed for differences in learning effectiveness at the end of each of the programmes. The findings revealed significant differences in learning effectiveness and the four proposed hypotheses were confirmed. Firstly, across three measures of learning effectiveness (attitudinal, cognitive, behavioural) face-to-face learners achieved higher mean scores than the two different modes of e-Learning. The implication of this finding is that under online design formats the value of face-to-face learning has not been effectively transmitted to online learning. These findings were contrasted with the mixed results in the literature. To one extent these findings evidence the importance of face-to-face learning over e-Learning formats, while they go against part of the literature that evidences the enhanced learning outcomes for e-Learning compared to face-to-face. This has implications for the hybrid approach to learning or evaluation of technical and pedagogical aspects of e-Learning to optimise student's performance online. A shift to E-learning for the civil defence will reduce the effectiveness of learning and impact negatively on improvement of training standards and goals. The difference in effectiveness calls in to question design factors associated with e-Learning. The second major finding indicates that the choice of multimedia formats significantly impacts learning effectiveness. The third key finding revealed that the relationship between

modes of learning and learning effectiveness was influenced by learning styles. There was a statistically significant difference in learner scores for different learning styles across the three different modes of learning. This indicates that specific learning styles were more or less suited to face-to-face and e-Learning and between high and low media rich e-Learning formats. The results also confirmed the hypothesis, which proposed that learning effectiveness was significantly different between the two modes of learning as a result of spatial ability. On balance these findings indicate that e-Learning has not been optimised for the existing sample of learners in the civil defence. This places emphasis on learner characteristics and alignment to learning mode in addition to continuous measurement and analysis of learner performance outcomes. Further, the findings highlight the importance of consideration of hybrid strategies that focus on the strengths of each mode and maximising personalisation of learning modes to learner styles.

## Chapter 7 Conclusion

### 7.1 Introduction

E-learning has increasingly become a critical element within the development strategies of the public sector and organisations generally. This research specifically focused on an online approach to delivering and sustaining the continuous professional development (CPD) of UAE fire fighters, using e-Learning for training in tackling fires in domestic high rise living accommodation. The critical importance of enhancing the development of UAE civil defence sector workers has been emphasised in the context of high national diversity and low level of community fire safety awareness. As a result of the dynamic context of civil defence and the integration of e-Learning into the civil defence training strategy there is an imperative to evaluate the effectiveness of e-Learning relative to traditional modes of delivery to ensure quality of training.

Given this context the aim of this research was to evaluate the effectiveness of learning and performance between two learning approaches: traditional versus e-Learning; and between two types of e-Learning design: high media-rich versus low media-rich. The central research question is: does learning effectiveness differ between traditional learning and e-Learning? A number of specific research questions fall under this main question:

RQ1: Does learning effectiveness differ between traditional learning and e-Learning?

RQ2: Do learning styles impact on learning effectiveness between different e-Learning designs?

RQ3: Does spatial ability impact on learning effectiveness between different e-Learning designs?

## 7.2 Summary of Key Findings

The findings of this study establish empirical evidence in relation to learning effectiveness between the three modes of learning under different conditions. This evidence is summarised in relation to the four key hypotheses of this study.

*H1: Learning effectiveness is significantly better in traditional face-to-face learning than e-learning across different measures*

The results fully support H1 and show that across all measures of learning effectiveness: engagement, cognitive performance and behavioural performance, the face to face mode indicated significantly better outcomes than the e-Learning mode. The size of effect was large across all three measures.

*H2: In e-Learning design approaches, learning effectiveness is significantly better in high media rich (text, audio-visual, animation, 3D) than low media rich (text, audio, visual).*

The results for learning effectiveness between high media rich and low media rich e-Learning design fully support H2 with a large difference in effect size.

*H3: Learning styles have higher significant effects on learning effectiveness using e-Learning than traditional learning.*

The findings indicate that learning styles impacted on learning effectiveness between the three modes of learning. There was significant interaction between learning styles and learning mode on learning effectiveness. There were statistically significant differences in learning effectiveness for all learning styles. There were further statistically significant differences in mean learning effectiveness score between the three modes of learning across all learning styles. In 7 out of the 8 learning styles in



face-to-face mode learning effectiveness was higher on average than both of the e-Learning modes. Only reflective learning exhibited a higher learning effectiveness score for high media rich e-Learning than face-to-face. For Active learning style there was statistical difference in learning effectiveness scores. Active learning style performed better in face-to-face learning than both e-learning modes. Active learning style scored better in high media rich e-Learning than low media rich e-Learning. Verbal learning style performed significantly better in face-to-face learning than in either high or low media rich e-Learning. For visual learning style there was no statistically significance difference between face-to-face or high media e-Learning. However, there was a difference between face-to-face and low media e-Learning, where learning effectiveness was lower in low media rich e-Learning. For sequential learning style face-to-face was significantly better in learning effectiveness than both modes of e-learning. However, there was no statistical difference in scores between the two e-Learning modes. For global learning style, there was no difference in learning effectiveness between face-to-face or e-Learning. However, high media rich e-Learning performed higher than low media rich e-Learning. This pattern of result was similar for sensing learning style and intuitive learning style, with the latter score indicating a higher mean score than the sensing learning style.

*H4: Spatial ability has a higher significant effect on learning effectiveness using e-Learning than traditional learning.*

The findings show that H4 is not supported. However when comparing the two modes of e-Learning there was support for the higher effect of spatial ability on learning effectiveness. There was no statistically significant difference in learning effectiveness between high and low spatial ability learners in the two modes of face to face and e-

Learning. Nevertheless, a statistically significant difference in learning effectiveness was found between high and low spatial ability learners in respect to e-Learning design. High spatial ability learners performed worse in the low multimedia mode than in the high multimedia mode.

### **7.3 Recommendations**

The findings of this study prompt a number of recommendations for improving the training of civil defence in relation to e-Learning.

The significant variance identified between e-Learning and face to face outcomes emphasises the need to consider training policies which balance online and offline components within courses and that take account of learning preferences. Both face to face and e-Learning education can complement each other and deliver results that either method alone may not be able to achieve. Potentially the most effective approach is one that combines both e-Learning and face to face modes. Training strategies could adopt hybrid or blended models of learning combining face to face with online learning and which provide a level of access and continuity in interaction characteristic of face to face modes. Strategic requirements for e-Learning could be accommodated by means of a transitional period which allows for incremental implementation of this mode of learning.

In the case that the limitations in the e-Learning mode are considered too difficult to overcome in the short to medium term and a blended learning approach is viewed as most effective a balance needs to be considered in terms of which elements and concepts are more suitable for online and offline delivery in the design of the curriculum for technical disciplines such as civil defence fire safety.

Moreover the disparity in learning effectiveness identified between e-Learning and face to face underlines the critical need to understand the differences between the two modes to address the limitations of e-Learning in this context and maximise its potential effectiveness. Greater survey and measurement of a range of different outcomes should be undertaken including evaluation of learner outcomes, satisfaction and experiences to identify future barriers and strategies which can inform understanding of how to enhance the design of the e-Learning programme for greater learner effectiveness.

Given that the media richness of the e-Learning programme has significant influence over learning effectiveness the differential impacts of high and low use of multimedia and other design factors could be examined to gain increased understanding of how positive features can be maximised in e-Learning design. Good design principles in relation to integration and presentation of a media rich environment should be examined and incorporated to ensure that the cognitive load of learners can be effectively managed during the learning process. This can include incorporating facilities for learner control which are appropriate in building interactive multimedia learning enabling effective self-learning by learners.

The influence of learning styles on learning outcomes in the e-Learning mode is evident. This suggests that more data is needed to comprehend how e-Learning can be optimised to address the needs of different styles. Data on learning styles should be systematically collected to support the development of strategies that allow different types of learners to fully benefit from the advantages of e-Learning. Pedagogical strategies and electronic media that match a certain learning style implies the evaluation of students' learning styles to provide insight into the learners' abilities to capture the instructor's messages. Considered scaffolding of tasks within e-Learning design is

important to assist learners to develop skills in tasks and activities that are different to their own learning style preferences.

- For active learners, e-Learning design should incorporate increased opportunities to experiment with the learning material and design elements which emphasise and facilitate active participation such as discussions, group work and explanations to others. Branching scenario techniques could be employed to provide learning through experiences that would suit active learners.
- For reflective learners design should emphasise opportunities for reflection and review of learning material both before activities are initiated and periodically during the programme. Features such as online communities may be highly effective for reflective learners.
- For verbal learners particular attention needs to be paid to ensuring that their needs are incorporated within e-Learning design as they are negatively impacted by increased multimedia. A key design feature is the delivery of learning material in a choice of media modes including printed support materials to accommodate preferences towards spoken and written text. Robust support for the use of visual communication should be provided not only in how activities and content are proposed but also in the creation of solutions. The use of visual elements such as flowcharts, diagrams, and other visual representations should be facilitated.
- For visual learners high quality visual and multimedia content is important in addition to opportunities for face to face contact with tutors and peers in learning contexts to enable greater learning effectiveness in e-Learning.

- For global learners consideration should be given in e-Learning design to ensuring that subjects or topics are first outlined holistically and within the wider context before entering into subjects in depth. Interaction during activities should be designed to elicit more detailed answers for global learners who tend to skip details and provide answers which are too concise.
- For sequential learners e-Learning design needs to pay attention to how content can be structured and organised to incorporate a clear and sequential learning path.
- For sensing learners designing opportunities for online participation and interactive activities are important to address their needs in the e-Learning mode as well as the provision of opportunities for information sharing with peers which can lead to mutual benefits.
- For intuitive learners ensuring that there is sufficient support from tutors and design features to help them adjust to the e-Learning environment is key.

Based on the findings learners with particular learning styles could benefit from tutor guidance in choosing those online activities that can facilitate optimal learning. This guidance could involve interactions prior to the activity such as consultations or a simple brief online tutorial describing the characteristics and learning goals for each activity. In addition promoting learner knowledge of their own learning style could be considered as it is important for students to understand and develop new learning strategies towards the learning content presented in a non-preferential or mix of styles.

It is important for teachers and e-Learning designers to recognise that learning styles are not rigid as literature underlines the different intensities with which these styles can be present in individual learners. This places the onus of responsibility on the instructor

to prepare teaching plans which accommodate learners' preferred learning styles as well as supporting the development of non-preferred styles.

It is apparent that learner performance online is affected by specific characteristics such as learning style and spatial abilities. Greater investigation could be undertaken to enhance understanding of what other learner variables and characteristics need to be taken into account in e-Learning design to maximise learning effectiveness.

#### **7.4 Contribution**

The findings of this study point to the conclusion that learning styles are significant important variables and affect learning effectiveness between different modes of learning. Technology is a key factor and certain learning styles are more significant than others in terms of the impact of technology on learning outcomes. This research has significant value for pedagogy in terms of highlighting the importance of adapting teaching methods in the e-Learning environment to take account of different learning styles to optimise learning effectiveness.

This study contributes new knowledge on the learning effectiveness of the e-Learning mode in comparison with face to face, the impact of high and low media-rich environments in e-Learning and the effect of learning styles in these three modes. Prior empirical studies have produced mixed findings in these areas. This research provides evidence to show that learning styles are significantly related to learning achievement in e-Learning and there are differential effects for different learning styles. The study also provides evidence that the use of rich multimedia is positively related to higher learning effectiveness.

This research also makes a practical contribution for educational managers interested in implementing e-Learning in training in civil defence or other contexts. The knowledge contributed on learning styles can be used to optimally structure the e-Learning programme with a better use of resources to promote learning in learners across all learning styles.

A further contribution is made in terms of the design of e-Learning courses for promoting learner achievement and satisfaction. Specifically the findings suggest the efficacy of designing online activities that are adapted to different learning styles and enable active participation, collaboration and information-sharing and the development of self-reflection rather than just enabling access to information or conduct of simple interactive exercises.

The findings of this study highlight a number of implications for practice, policy, theory and pedagogy. For practice there are clear implications towards adapting e-Learning design to accommodate the needs of different learning styles to maximise learning effectiveness. In terms of policy a balance may need to be implemented in terms of integrating online and offline elements within a blended learning approach that takes account of individuals' learning preferences. Theoretical implications underline support for constructivist theories of learning and individual differences in the processing and assimilation of information and the importance of understanding and integrating learning style theories within e-Learning design. Given the variance in learning outcomes between face to face and e-Learning there are implications for pedagogy in relation to the need to ensure that there is access and continuity of interaction between teacher and learner which may include incorporation of face to face components within course design.

## **7.5 Limitations and Future Research**

A number of limitations are acknowledged in relation to this study. The wholly quantitative approach adopted is a key limitation in constraining in-depth insights and perspectives that could add further data to address the research questions and enhance the depth of the findings. The study limitation is affected by the positivist assumptions upon which quantitative approaches are based, in that they are unable to take into account how individuals form and sustain their reality and how they perceive and interpret their own actions and those of others (Saunders et al., 2009). The reliance on numerical description further limits the extent to which the e-Learning phenomena can be explored and explained (Somekh and Lewin, 2011).

The non-probability purposive strategy to select research participants provides a further limitation. The sample reflected the cohorts available at the time of research rather than a random selection of students. Potentially a non-probability approach can undermine the representativeness of the study findings and affect internal reliability (Saunders et al., 2009). Moreover there is greater potential for and difficulty in identifying researcher bias which can influence the objectivity of participant selection (Saunders et al., 2009).

This limitation also has implications for the quasi-experimental design adopted in this study. In such designs there is a lack of randomised assignment into test groups which could result in non-equivalence between groups thus limiting wider generalisability and reducing internal validity. The meaningfulness of the resulting statistical analyses may also be affected. There is further reduced control of variables in quasi-experimental research implying that prior factors and other influences are not accounted for and which can influence the findings (Thyer, 2012). A range of control



variables, for example digital literacy skills, may have influenced the findings of this study and which were not accounted for in the design of this research.

The findings of this study point to diverse areas for future research. Enlarging understanding of the differences between face to face and e-Learning in terms of learning styles and learning outcomes are key areas for future research, and in particular the specific components of each in terms of instructional approaches, teaching methods, learning materials, feedback, assessment and evaluation, course support, and peer support among others which may influence the effectiveness of learning outcomes in relation to different learning styles. While the results of this study can only be generalised to the participants within it, a long-term study incorporating demographic data may add to current findings and positively allay concerns in relation to the quality of e-Learning. Future research could also focus on exploring the different configurations of multimedia design and the specific multimedia elements and design factors in e-Learning which can enhance learner outcomes and satisfaction. There is a need for future research on the effectiveness of multimedia use not only focused on a broader range of teaching scenarios but also on a wider range of multimedia formats. Another useful area for future research is the planning and design of courses that accommodate different learning styles. Finally future research could explore the impact of a range of different control variables including demographic variables such as gender, age, education, as well as digital literacy skills, prior knowledge, and technological aspects that could influence the effectiveness of the e-Learning modality in comparison with traditional.

Further work is needed to investigate the long-term impacts of style-matched courses on performance-related factors, either directly or indirectly via emotional

factors. We thus suggest to conduct a long-term study and to employ a suitable test-retest procedure that would have to be developed. Moreover, there is a need to conduct such a study with a larger sample to verify the results obtained here particularly also for the verbal learners. Ideally such investigation could be conducted in a real learning setting, as extrinsic motivation, such as grades, also play an important, presumptively a negative, role (Lepper et al. 2005).

## References

- Abdullah, M., Daffa, W.H., Bashmail, R.M., Alzahrani, M. and Sadik, M. (2015) The Impact of Learning Styles on Learner's Performance in E-Learning Environment. *International Journal of Advanced Computer Science and Applications*. 6 (9), pp. 24-31.
- Abu Dhabi Civil Defense General Directorate (2014) *Higher Command Committee of Civil Defence Discusses the Development of Human Resources* [online]. Available from: <http://adcd.gov.ae/en/news/asdfghl.aspx> [Accessed 15 March 2017].
- Åkerlind, G.S. and Trevitt, A.C. (1999) Enhancing self-directed learning through educational technology: When students resist the change. *Innovations in Education and Training International*. 36 (2), pp. 96-105.
- Al Hmoudi, A. and Aziz, Z. (2015) Challenges for Integrated Early Warning and Disaster Management in the UAE. *WIT Transactions on the Built Environment*. 151, pp. 169-176.
- Alfonseca, E. Carro, R.M., Martin, E., Ortigosa, A. and Paredes, P (2006) The impact of learning styles on student grouping for collaborative learning: a case study". *User Modeling and User-Adapted Interaction*. 16 (3-4), pp. 377-401.
- Al-Furaydi, A. A. (2013) Measuring E-Learning Readiness among EFL Teachers in Intermediate Public Schools in Saudi Arabia. *English Language Teaching*. 6 (7), pp. 110-121.
- Algahtani, A. (2011) *Evaluating the Effectiveness of the E-Learning Experience in Some Universities in Saudi Arabia from Male Students' Perceptions*. Doctoral dissertation, Durham University.
- Alharbi, A., Paul, D., Henskens, F. and Hannaford, M. (2011) An investigation into the learning styles and self-regulated learning strategies for Computer Science students. In: Williams, G., Statham, P., Brown, N. and Cleland, B., (Eds.), *Changing Demands, Changing Directions*. Proceedings Ascilite Hobart, University of Tasmania, pp. 36-46.
- Alias, M., Black, T. R., and Gray, D. E. (2002) Attitudes towards Sketching and Drawing and the relationship with Spatial Visualisation Ability in Engineering Students. *International Education Journal*. 3 (3), pp. 165-175.
- Alias, M., Black, T. R., and Gray, D. E. (2002) Effect of Instructions on Spatial Visualisation Ability in Civil Engineering Students. *International Education Journal*. 3 (1), pp. 1-12.
- Alias, M., Black, T. R., and Gray, D. E. (2003) The relationship between spatial visualisation ability and problem solving in structural design. *World Transactions on Engineering and Technology Education*. 2 (2), pp. 273-276.
- Alias, N. and Siraj, S. (2012) Design and development of physics module based on learning style and appropriate technology by employing isman instructional design

- model. *TOJET: The Turkish Online Journal of Educational Technology*, 11 (4), pp. 84-93.
- Allert, J. (2004) Learning Style and Factors Contributing to Success in an Introductory CS Course. In: *Proceedings of the ICALT'04*. Joensuu, Finland.
- Alomyan, H. (2004) Individual differences: Implications for Web-based learning design. *International Education Journal*, 4 (4), pp. 188–196.
- Alptekin, S. E. and Karsak, E. E. (2011) An integrated decision framework for evaluating and selecting e-Learning products. *Applied Soft Computing*. 11 (3), pp. 2990-2998.
- Al-Qahtani, A.A. and Higgins, S.E. (2013) Effects of traditional, blended and e-learning on students' achievement in higher education. *Journal of Computer Assisted Learning*. 29 (3), pp. 220-234.
- Alsabawy, A. Y., Cater-Steel, A. and Soar, J. (2011) Measuring E-Learning System Success (Research In Progress). In: *PACIS 2011 Proceedings*. Paper 15.
- Alteneiji, H. R. (2015) A Strategic Approach to Emergency Preparedness in the UAE. University of Salford [online]. Available from: <http://usir.salford.ac.uk/36146/1/PhD%20Thesis%20-%20Hamdan%20Alteneiji.pdf>. PhD Thesis [Accessed 15 March 2017].
- Amer, T. (2007) E-learning and Education, Cairo: Dar Alshehab publication
- Andreu, R. and Jáuregui, K. (2005) Key factors of e-Learning: A case study at a Spanish bank. *Journal of Information Technology Education*, 4, pp. 1-31.
- Aragon, S.R., Johnson, S.D. and Shaik, N. (2002) The influence of learning style preferences on student success in online versus face-to-face environments. *The American Journal of Distance Education*. 16 (4), pp. 227-243.
- Attewell, J., Traxler, J., Riordan, B. and Dennett, C. (2008) Towards sustainable large scale implementation of mobile learning: The mobile learning network (MoLeNET). In: *The Bridge from Text to Context. Proceedings of the mLearn 2008 Conference*, pp. 28-35.
- Baddeley, A. (1992) Working memory. *American Association for the Advancement of Science*. 255 (5044), pp. 556-559.
- Baker, R. and Papp, R. (2004) Evaluating Critical Success Factors of Distributed Learning. In: *SAIS 2004 Proceedings*, Paper 42.
- Bartomeus, G. (2003) The role of cognitive styles in e-Learning: A discussion of literature. Höskolan i Borås.
- Batista Freddie Diaz (2014) E-Learning and the Fire Service. Fire Engineering [online]. Available from: <http://www.fireengineering.com/articles/2014/03/e-Learning-and-the-fire-service.html> [Accessed 15 March 2017].
- Battalio, J. (2009) Success in distance education: Do learning styles and multiple formats matter? *The American Journal of Distance Education*. 23 (2), pp. 71-87.

- Batte, M.T., Forster, D.L. and Larson, D.W. (2003) An assessment of student acceptance and performance in distance education with two-way interactive compressed video. *Review of Agricultural Economics*. 25 (2), pp. 524-539.
- Baxter, J. A. and Haycock, J. (2014) Roles and Student Identities in Online Large Course Forums: Implications for Practice. *The International Review of Research in Open and Distributed Learning*, 15(3).
- BBC (2017) *London fire: What happened at Grenfell Tower?* [online]. Available from: <http://www.bbc.com/news/uk-england-london-40272168> [Accessed 15 March 2017].
- Beckmann, J., Bertel, S. and Zander, S. (2015) Performance & Emotion--A Study on Adaptive E-Learning Based on Visual/Verbal Learning Styles. *International Association for Development of the Information Society*.
- Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L. and Huang, B. (2004) How does distance education compare with classroom instruction? A meta- analysis of the empirical literature. *Review of Educational Research*. 74 (3), pp. 379-439.
- Bhattacharjee, A. (2012) Social science research: Principles, methods, and practices. *Textbooks Collection*. 3 [online]. Available from: [http://scholarcommons.usf.edu/oa\\_textbooks/3](http://scholarcommons.usf.edu/oa_textbooks/3) [Accessed 15 March 2017].
- Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Rho J. J., and Ciganek, A. (2012) Critical success factors for e-Learning in developing countries: A comparative analysis between ICT experts and faculty. *Computers and Education*, 58 (2), pp. 843-855.
- Bischel, J. (2013) *The State of E-Learning in Higher Education: an Eye on Toward Growth and Increased Access Growth* [online]. Available from <<http://net.educause.edu/ir/library/pdf/ers1304/ERS1304.pdf>> [Accessed 28 April 2014].
- Blake, C., Jane Whitney, G. and Blackwell, C. W. (2003) Web-based training: What supervisors need to know. *SuperVision*. 64 (12), pp. 3-7.
- Blass, E. and Davis, A. (2003) Building on solid foundations: establishing criteria for e-Learning development. *Journal of Further and Higher Education*, 27 (3), pp. 227-245.
- Boldrini Fabrizio (2016) Civil Protection Massive Open Developed E-Learning for strategies of Resilience. In: *Final Conference Heraklion*, 13th October 2016.
- Borgman, C. L., Gallagher, A. L., Hirsch, S. G., and Walter, V. A. (1995) Children's searching behaviours on browsing and keyword online catalogues: The science library catalogue. *Journal of the American Society for Information Science*. 46 (9), pp. 663-684.
- Boruch, R.F. (2003) Randomized field trials in education. In: Kellaghan T. and Stufflebeam D.L. (Eds.). *International Handbook of Educational Evaluation*. Norwell, MA: Kluwer, pp. 107-124.

- Bostrom, R.P., Olfman, L., and Sein, M.K. (1993) Learning styles and end-user training: A first step. *MIS Quarterly*. 17 (3), pp. 118–120.
- Branoff, T.J. (2000) Spatial visualization measurement: A modification of the Purdue Spatial Visualization Test - Visualisation of Rotations. *The Engineering Design Graphics Journal*. 64 (2), pp. 14-22.
- Briggs, K. C. and Briggs-Myers, I. (2017) *MBTI Basics* [online]. Available from: <<http://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/>> [Accessed 15 February 2018].
- Brown, E. Brailsford, T., Fisher, T., Moore, A. and Ashman, H., (2006, May) Reappraising cognitive styles in adaptive web applications. In: WWW '06, *Proceedings of the 15th international conference on World Wide Web*. New York: ACM, pp. 327–335.
- Bryman, A. and Bell, E. (2007) *Business Research Methods*. 2nd ed. Oxford: Oxford University Press.
- Buch, K. and Bartley, S. (2002) Learning style and training delivery mode preference. *Journal of Workplace Learning*. 14 (1), pp. 5–10.
- Butler K. (1987) *Learning and Teaching style in Theory and Practice. The Learner's Dimension*. Columbia, CT.
- Büyüközkan, G., Arsenyan, J. and Ertek, G. (2010) Evaluation of e-Learning web sites using fuzzy axiomatic design based approach. *International Journal of Computational Intelligence Systems*. 3 (1), pp. 28-42.
- Callaghan, V., Gardner, M., Horan, B., Scott, J., Shen, L. and Wang, M. (2008) *A mixed reality teaching and learning environment. Hybrid Learning and Education*. Springer Berlin Heidelberg, pp. 54-65.
- Camacho, N. A., Hughes, A., Burkle Jr, F. M., Ingrassia, P. L., Ragazzoni, L., Redmond, A., Norton, I. and von Schreeb, J. (2016) Education and Training of Emergency Medical Teams: Recommendations for a Global Operational Learning Framework. *PLoS Currents*, 8.
- Campbell, L., Campbell, B. and Dickinson, D. (1996) *Teaching and Learning through Multiple Intelligence*. Needham Heights, MA: Allyn and Bacon.
- Carlson, R., Chandler, P. and Sweller, J. (2003) Learning and understanding science instructional material. *Journal of Educational Psychology*. 95 (3), pp. 629-640.
- Cercone, K. (2008) Characteristics of adult learners with implications for online learning design. *AACE Journal*. 16 (2), pp. 137-159.
- Chaffin, A. and Maddix, C. (2004) Internet teaching methods for use in baccalaureate nursing education. *Computers Informatics Nursing*. 22 (3), pp. 132–142.
- Chandler, P. (2004) The crucial role of cognitive processes in the design of dynamic visualizations. *Learning and Instruction*, 14 (3), pp. 353-357.

- Chao, R.-J. and Chen, Y.H. (2009) Evaluation of the criteria and effectiveness of distance e-Learning with consistent fuzzy preference relations. *Journal of Expert Systems with Applications*. 36 (7), pp. 10657-10662.
- Chen, C.J. (2006) Are spatial visualization abilities relevant to virtual reality? *e-Journal of Instructional Science and Technology*. 9, pp. 1-16 [online]. Available from: [http://www.usq.edu.au/electpub/e-jist/docs/vol9\\_no2/papers/full\\_papers/chen.pdf](http://www.usq.edu.au/electpub/e-jist/docs/vol9_no2/papers/full_papers/chen.pdf). [Accessed 15 March 2017].
- Chen, C.M. and Sun, Y.C. (2012) Assessing the effects of different multimedia materials on emotions and learning performance for visual and verbal style learners. *Computers & Education*. 59 (4), pp.1273-1285.
- Chen, P.S.D., Lambert, A.D. and Guidry, K.R. (2010) Engaging online learners: The impact of Web-based learning technology on college student engagement. *Computers & Education*. 54 (4), pp. 1222-1232.
- Chen, S. Y. and Paul, R. J. (2003) Individual differences in web-based instruction - an overview. *British Journal of Educational Technology*. 34 (4), pp. 385–392.
- Chen, S.H. (2009) Establishment of a performance-evaluation model for service quality in the banking industry. *The Services Industries Journal*, [e-journal] 29 (2). Available from: Taylor and Francis online, <http://www.tandfonline.com/doi/abs/10.1080/02642060802295034#.U2rA6fldWuI> [Accessed 28 April 2014].
- Cheng, G. and Chau, J. (2016) Exploring the relationships between learning styles, online participation, learning achievement and course satisfaction: An empirical study of a blended learning course. *British Journal of Educational Technology*. 47 (2), pp. 257-278.
- Chiero, R., Beare, P., Marshall, J. and Torgerson, C. (2015) Evaluating the effectiveness of e-Learning in teacher preparation. *Educational Media International*. 52 (3), pp. 188–200.
- Chigeza, P. and Halbert, K. (2014) Navigating E-Learning and Blended Learning for Pre-service Teachers: Redesigning for Engagement, Access and Efficiency. *Australian Journal of Teacher Education*. 39 (11), pp. 133–146.
- Childers, T.L., Houston, M.J. and Heckler, S.E. (1985) Measurement of individual differences in visual versus verbal information processing. *Journal of Consumer Research*. 12 (2), pp. 125–134.
- Chin, K.L. and Ng Kon, P. (2003) Key factors for a gully online e-Learning mode: A Delphi study. *20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE)*, pp. 589-592.
- Chiou, W.-C., Lin, C.-C. and Perng, C. (2010) A strategic framework for website evaluation based on a review of the literature from 1995–2006. *Journal of Information and Management*. 47 (5-6), pp. 282-290.

- Cho, V., Cheng, T.E. and Lai, W.J. (2009) The role of perceived user-interface design in continued usage intention of self-paced e-Learning tools. *Computers & Education*. 53 (2), pp. 216-227.
- Chua, B.B. and Dyson, L.E. (2004) Applying the ISO 9126 model to the evaluation of an e-Learning system. *ASCILITE 2004* [online]. Available from: <http://epress.lib.uts.edu.au/research/bitstream/handle/10453/3176/2004001452.pdf?sequence=1> [Accessed 28 April 2014].
- Citera, M. (1988) Distributed teamwork: The impact of communication media on influence and decision quality. *Journal of the American Society for Information Science*. 49 (9), pp. 792–800.
- Clark, J.M., and Paivio, A. (1991) Dual coding theory and education. *Educational Psychology Review*. 3 (3), pp. 149-210.
- Clark, R. C. (2008) *Developing Technical Training: A Structured Approach for Developing Classroom and Computer-Based Instructional Materials*. 3rd ed. San Francisco: John Wiley & Sons, Inc.
- Clark, R. C. and Mayer, R. E. (2003) *E-learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. San Francisco, CA: Jossey-Bass/Pfeiffer.
- Cochran, T., Narayan, V., and Oldfield, J. (2013) iPadagogy: Appropriating the iPad within pedagogical contexts. *International Journal of Mobile Learning and Organisation*. 7 (1), pp. 48-65.
- Codone, S. (2001) *An E-Learning Primer*. Pensacola, Florida.
- Coffield, F. (2004) Learning styles and pedagogy in post-16 learning. A systematic and critical review. *Newcastle University Report on Learning Styles* [online]. Available from: <<http://www.Isda.org.uk/files/PDF/1543.pdf>> [Accessed 12 February 2018].
- Collis, J., and Hussey, R. (2013) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*. Palgrave Macmillan.
- Conková, M. (2013) Analysis of perceptions of conventional and e-Learning education in corporate training. *Journal of Competitiveness*. 5 (4), pp. 73-97.
- Conole, G. (2004) E-learning: The hype and the reality. *Journal of Interactive Media in Education*, 12, pp. 1-18.
- Cotton, K. (1998) *Education for Lifelong Learning: Literature Synthesis*. Washington, DC: OERI.
- Council for International Organizations of Medical Sciences (CIOMS) (1991) *International Guidelines for Ethical Review of Epidemiological Studies*. Geneva: CIOMS.
- Cowley, J., Chanley, S., Downes, S., Holstrom, L., Ressel, D., Siemens, G., and Weisburgh, M. (2002) *Preparing Students for E-Learning* [online]. Available from: <[www.elearnspace.org/Articles/Preparingstudents.htm](http://www.elearnspace.org/Articles/Preparingstudents.htm)> [Accessed 11 February 2018].



- Creswell, J.W. and Clark, V.L.P. (2007) *Designing And Conducting Mixed Methods Research*. Sage Publications.
- Cronbach, L. and Snow, R. (1977) *Aptitudes and Instructional Methods: A Handbook for Research on Interactions*. New York: Irvington.
- Crotty, M. (2005) *The Foundations of Social Research: Meaning and Perspective in the Research Process*. 2-nd ed. London: Sage.
- Davidson, R.J. (1992) Emotion and affective style: Hemispheric substrates. *Psychological Science*, 3 (1), pp. 39- 43.
- Davies, J. and Graff, M. (2005) Performance in e-Learning: online participation and student grades. *British Journal of Educational Technology*. 36 (4), pp. 657–663.
- De Jong, T. (1991) Special Issue on Computer Simulations in an instructional context. *International Journal of Education and Computing*. 6, pp. 215-392.
- DECIDE (2015) Action 5.3.Deliverable 5.3.2.b *E-learning Platform Manual* [online]. Available from: <http://www.decide-project.eu/> [Accessed 11 March 2017].
- Delias, P., Matsatsinis, N. F. and Karagounakis, A. (2007) Towards a multi-criterion web-based tool for evaluation of an e-Learning system. In: *Innovations in E-learning, Instruction Technology, Assessment, and Engineering Education*. Springer, Dordrecht, pp. 289-293.
- DeLone, W. H., and McLean, E. R. (2003) The DeLone and McLean model of information system success: A ten-year update. *Journal of Management Information Systems*, 19(4), pp. 9–30.
- Denny, P., Hamer, J., Luxton-Reilly, A. and Purchase, H. (2008) September. PeerWise: students sharing their multiple choice questions. In: *Proceedings of The Fourth International Workshop on Computing Education Research ACM*, pp. 51-58.
- Derryberry, D. and Reed, M.A. (1996) Regulatory processes and the development of cognitive representations. *Development and Psychopathology*. 8 (1), pp. 215-234.
- Directorate general of Civil Defense (2014b) *Dubai Civil Defence Smart Services* [online]. Available from: <http://www.dcd.gov.ae/eng/2015080484/our-department/ssdcd/scsss.jsp> [Accessed 15 March 2017].
- Directorate General of Civil Defense (2014c) *Dubai Civil Defense Annual Report* [online]. Available from: <http://www.dcd.gov.ae/portal/yearlyreport/english/AnnualReport2014English.pdf> [Accessed 15 March 2017].
- Directorate General of Civil Defense (2015) *Dubai Civil Defense Annual Report* [online]. Available from: [http://www.dcd.gov.ae/portal/yearlyreport/2015/2015AnnualreportEnglish\(Full\).pdf](http://www.dcd.gov.ae/portal/yearlyreport/2015/2015AnnualreportEnglish(Full).pdf) [Accessed 15 March, 2015].
- Directorate General of Civil Defense (2016) Maj.Gen. Expert Almatrooshi Honors First Group of Address Hotel Knights and Other Civil Defence Distinguished

- Employees [online]. Available from: <http://www.dcd.gov.ae/eng/blog/Super-User/Page-3.jsp> [Accessed 15 March 2017].
- Directorate General of Civil Defense, (2017) *Civil Defence Tasks* [online]. Available from: <<https://www.dcd.gov.ae/portal/en/about-us/dcd-tasks.jsp>> [Accessed 15 March 2017].
- Discenza, R., Howard, C., and Schenk, K. (Eds.) (2001) *The Design and Management of Effective Distance Learning Programs*. Hershey, Pa: IGI Global.
- Donahue, N. and Glodstein, S. (2013) Mentoring the needs of nontraditional students. *Teaching and Learning in Nursing*. 8 (1), pp. 2-3.
- Donald L. Kirkpatrick and Kirkpatrick, J.D. (2009) *Evaluating Training Programs: The Four Levels* (Vol. 1). Berrett-Koehler Publishers.
- Dongsong, Z., Zhao, J.L., Lina, Z. and Nunamaker, J.J.F. (2004) Can e-Learning replace classroom learning? *Communications of the ACM*, 47 (5), pp. 75-79.
- Doolittle, P.E. (2002) Multimedia learning: empirical results and practical applications. Paper presented at the *Irish Educational Technology Users' Conference*, Carlow, Ireland.
- Doulik, P., Skoda, J. and Simonova, I. (2017) Learning Styles in the e-Learning Environment: The Approaches and Research on Longitudinal Changes. *International Journal of Distance Education Technologies*. 15 (2), pp. 45-61.
- Driscoll, M. (2002). *Web-Based Training: Creating E-Learning Experiences*. 2nd ed. San Francisco, CA: Jossey-Bass/Pfeiffer.
- Driscoll, S.A., and Garcia, C.E. (2000) Preferred Learning Styles For Engineering Students. In: ASEE Annual Conference, Session 1430 ASEE, St. Louis, MO. [Online]. Available at: <<http://www.asee.org/acPapers/20495.pdf>> [Accessed 6 August 2017].
- Dunn, R. (2003) *The Dunn and Dunn Learning Style Model and Research*. New York, USA: St John's University.
- Dunwell, I., Petridis, P., Arnab, S., Protopsaltis, A., Hendrix, M. and De Freitas, S. (2011) Blended game-based learning environments: extending a serious game into a learning content management system. In: *Intelligent Networking and Collaborative Systems (INCoS), 2011 Third International Conference. IEEE*. pp. 830-835.
- Durlach, N., Allen, G., Darken, R. Garnett, R.L., Loomis, L. Templeman, J. and Von Wiegand, T.E. (2000) Virtual environments and the enhancement of spatial behavior: Towards a comprehensive research agenda. *Presence: Teleoperators and Virtual Environments*. 9 (6), pp. 593-615.
- Ebeling, D. G. (2000) Adapting your teaching to any learning style. *Phi Delta Kappa*. 82 (3), pp. 247-248.
- Efthymiopoulos, M.-P. (2016) Cyber-Security in Smart Cities: The Case of Dubai. *Journal of Innovation and Entrepreneurship*. 5 (1) [online]. Available from: <https://doi.org/10.1186/s13731-016-0036-x> [Accessed 15 March 2017].

- Ehlers, U. D. (2004) Quality in e-Learning from a learner's perspective. *European Journal of Open, Distance and E-learning*, 7 (1).
- Ehrman, M., Leaver, B., and Oxford, R. (2003) A brief overview of individual differences in second language learning. *System*. 31 (3), pp.313–330.
- Ekstrom, R.B., French, J.W., and Harmon, H.H. (1976) *Kit of Factor Referenced Cognitive Tests*. Princeton, NJ: Educational Testing Service.
- Emirates Civil Defence Academy (2017a) *About the Academy* [online]. Available from: <http://eacds.ae/en/ecda/> [Accessed 15 March 2017].
- Emirates Civil Defence Academy (2017b) *Public Safety* [online]. Available from: <http://eacds.ae/en/fire-training-courses/public-safety/> [Accessed 15 March 2017].
- Emirates Civil Defense Academy (2017) *Fire and Rescue* [online]. Available at: <http://eacds.ae/en/fire-training-courses/fire-rescue/> [Accessed 15 March 2017].
- Engel, G., and Green, T. (2011) Cell phones in the classroom: Are we dialing up disaster? *Tech Trends*. 55 (2), pp. 39-45.
- Entwistle N. (1981) *Styles of Learning and Teaching: An Integrated Outline of Educational Psychology*. Wiley, Chichester.
- Eriksson, P. and Kovalainen, A. (2008) *Qualitative Methods in Business Research*. London: Sage.
- Ertl, B., Ebner, K. and Kikis-Papadakis, K. (2010, September) An infrastructure approach for the evaluation of e-Learning. In *World Summit on Knowledge Society*. Berlin, Heidelberg: Springer, pp. 98-104.
- Esichaikul, V. and Bechter, C. (2010) Catering for different learning styles in e-Learning. In: *Learning and Instruction in the Digital Age*. Springer US, pp. 361-374.
- Falloon, G., and Khoo, E. (2014) Exploring young students' talk in iPad-supported collaborative learning environments. *Computers and Education*, 77, pp. 13-28.
- Fares, S., Irfan, F. B., Corder, R. F., Al Marzouqi, M. A., Al Zaabi, A. H., Idrees, M. M. and Abbo, M. (2014) Emergency Medicine in the United Arab Emirates. *International Journal of Emergency Medicine*. 7 (1), p. 4.
- Federico, P.A. (2000) Learning styles and student attitudes toward various aspects of network-based instruction. *Computers in Human Behavior*, 16 (4), pp. 359-379.
- Fedynich, L., Bradley, K.S., and Bradley, J. (2015) Graduate students' perceptions of online learning. *Research in Higher Education Journal*, 27 (1), pp. 1–13.
- Feeley, M. and Parris, J. (2012) An Assessment of the PeerWise Student-Contributed Question System's Impact on Learning Outcomes: Evidence from a Large Enrollment Political Science Course [online]. Available from: <http://dx.doi.org/10.2139/ssrn.2144375> [Accessed 15 March 2017].

- Felder, R. M. and Soloman, B. A. (1991, 1994). Index of Learning Styles. Available from: <http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/ILS.pdf> [Accessed 15 March 2017].
- Felder, R. M. and Spurlin, J. E. (2005) A validation study of the Index of Learning Styles. Applications, reliability, and validity of the Index of Learning Styles. *International Journal of Engineering Education*. 21 (1), pp. 103-112.
- Felder, R.M. (1993) Reaching the second tier: Learning and teaching styles in college science education. *College Science Teaching*. 23 (5), pp. 286-290.
- Felder, R.M. (1996) Matters of style. *ASEE Prism*. 6 (4), pp. 18-23.
- Felder, R.M. and Brent, R. (2005) Understanding student differences. *Journal of engineering education*, 94 (1), pp. 57-72.
- Felder, R.M., Silverman, L.K. (2002) Learning and Teaching Styles in Engineering Education. *Engineering Education*. 78 (7), pp. 674-681.
- Fitch, P. and Steinke, P. (2013) Tools for assessing cognitive outcomes of experiential learning. In: *NCAHLC Annual Conference on Quality in Higher Education* [online]. Available from: <http://departments.central.edu/psychology/files/2011/07/HLC-2013-Paper-Fitch-Steinke.pdf>. [Accessed 15 March 2017].
- Fleming, N. D. and Mills, C. (1992) Not another inventory, rather a catalyst for reflection. *To Improve the Academy*. 11 (7), pp. 137-155.
- Flores, R., Ari, F., Inan, F.A., and Arslan-Ari, I. (2012) The impact of adapting content for students with individual differences. *Journal of Educational Technology & Society*. 15 (3), pp. 251–261.
- Folley, D. (2010) The lecture is dead long live the e-lecture. *Electronic Journal of e-Learning*. 8 (2), pp. 93-100.
- Foroozesh-nia, S., and Rajee (2015) Overview of the Significance of Different Learner Characteristics in Computer-Based Language Learning Environment. In: *Handbook of Research on Individual Differences in Computer-Assisted Language Learning*. IGI Global, pp. 1-23.
- Forslin, J., and Thulestedt, B. M. (1989) Computer aided design: A case strategy in implementing a new technology, *IEEE Trans. Eng. Manage.* 36 (3), pp. 191-201.
- Franklin, T., Armstrong, J., Oliver, M. and Petch, J. (2004) *Towards an Effective Framework for the Evaluation of E-Learning*. *E-Learning Research Centre* [online]. Available from: [http://franklin-consulting.co.uk/LinkedDocuments/framework\\_for\\_evaluation.doc](http://franklin-consulting.co.uk/LinkedDocuments/framework_for_evaluation.doc) [Accessed 28 April 2014].
- Freire, L.L., Arezes, P.M. and Campos, J.C. (2012) *A Literature Review about Usability Evaluation Methods for E-Learning Platforms* [online]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22316857> [Accessed 28 April 2014].

- Gaikwad, N. and Tankhiwale, S. (2014) Interactive E-learning module in pharmacology: a pilot project at a rural medical college in India. *Perspectives on Medical Education*, 3 (1), pp. 15-30.
- Garg, A.X., Geoffery, R.N., Eva, K.W., Spero, L. and Sharan, S. (2002) Is there any real virtue of virtual reality?: The minor role of multiple orientations in learning anatomy from computers. *Academic Medicine*. 77 (10), pp. 97-99.
- Garrison, D.R. (2011) *E-Learning in the 21st Century: A Framework for Research and Practice*. Oxford: Taylor and Francis.
- Ghinter, D. and Liu Y. (1999) Cognitive Styles and distance education. *The Journal of Distance Learning Administration*. 2 (3), pp. 1-19.
- Gilbert, J., Morton, S. and Rowley, J. (2007) e-Learning: The student experience. *British Journal of Educational Technology*. 38 (4), pp. 560-573.
- Gilbert, J. K. (Ed.). (2005). *Visualization in Science Education*. Dordrecht, The Netherlands: SpringerVerlag.
- Goldstein, K.M. and Blackman, S. (1978) *Cognitive Style: Five Approaches and Relevant Research*. John Wiley and Sons.
- Gould, S. J. (1990) Style of information processing difference in relation to products, shopping and self-consciousness. *Advances in Consumer Research*. 17, pp. 455-460.
- Granic, A. and Čukušić, M. (2007) *Universal design within the context of e-Learning. In: International Conference on Universal Access in Human-Computer Interaction*. Berlin, Heidelberg: Springer, pp. 617-626.
- Greenhalgh, S.D. (2011) *Measuring the Differences in Spatial Ability between a Face-To-Face and a Synchronous Distance Education Undergraduate Engineering Graphics Course*. Utah State University.
- Greenlaw, R., and Hepp, E. (1999) *In-line / On-line: Fundamentals of the Internet and the World Wide Web*. Boston: McGraw-Hill.
- Gregorc A. (1979) Learning/teaching styles: potent forces behind them. *Educational Leadership*. 36, pp. 234-236.
- Griggs, S. (1991) *Learning Styles Counseling*. ERIC Clearinghouse on Counseling and Personnel Services. Ann Arbor, MI.
- Gruender, C. D. (1996) Constructivism and learning: A philosophical appraisal. *Educational Technology*. 36 (3), pp. 21-29.
- Guay, R. B. (1980). *Spatial ability measurement: A critique and an alternative*. Paper presented at the Annual Meeting of the American Educational Research Association, Boston, MA. (ERIC Document Reproduction Service No. ED189166).
- Guilford, J.P. and Zimmerman, W.S. (1948) The Guilford-Zimmerman Aptitude Survey. *Journal of applied Psychology*. 32 (1), pp. 24-34.

- Hairston, N. R. (2007) *Employees' Attitude toward E-Learning: Implications for Policy In Industry Environments*. Dissertation, University of Arkansas, Ann Arbor.
- Hannon, J., D'Netto, B. (2007) Cultural diversity online: student engagement with learning Technologies. *International Journal of Educational Management*. 21 (5), pp. 418-432.
- Hara, N. and Kling, R. (2000) Students' distress with a web-based distance education course: An ethno-graphic study of participants' experiences. *Information, Communication and Society*. 3, pp. 557–579.
- Harland, J. (1996) Evaluation as realpolitik. In: D. Scott D and R. Usher, eds. 2002. *Understanding Educational Research*. London: Routledge.
- Harmon, O.R. and Lambrinos, J. (2006) Online format vs. live mode of instruction: Do human capital differences or differences in returns to human capital explain the differences in outcomes? *Economics Working Papers*. 200607.
- Harold, L.B, and Paul, I.H.L. (2003) Relationships between Student Learning Styles and Methods of Presentation for Engineering Technology Students. In: *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*.
- Harrington, D. (1999) Teaching statistics: A comparison of traditional classroom and programmed instruction/distance learning approaches. *Journal of Social Work Education*. 35 (3), p. 343-352.
- Hartman, N., Connolly, P., Gilger, J. and Bertoline, G. (2006) Developing a Virtual Reality Based Spatial Visualization Assessment Instrument. *ASEE Annual Conference and Exposition: Excellence in Education*. Chicago, IL; USA.
- Hauptman, H. and Cohen, A. (2011) The synergetic effect of learning styles on the interaction between virtual environments and the enhancement of spatial thinking. *Computers & Education*. 57 (3), pp. 2106–2117.
- Haythornthwaite, C., Kazmer, M., Robins, J. and Shoemaker, S. (2000) Community development among distance learners: Temporal and technological dimensions. *Journal of Computer Mediated Communication*. 6(1). Available from: the World Wide Web: <http://jcmc.indiana.edu/vol6/issue1/haythornthwaite.htm> [Accessed 15 March 2017].
- Hiltz, S.R. and Turoff, M. (2002) What makes learning networks effective? *Communications of the ACM*, 45 (4), pp. 56-59.
- Ho, C. L. and Dzung, R. J. (2010) Construction safety training via e-Learning: Learning effectiveness and user satisfaction. *Computers & Education*. 55 (2), pp. 858-867.
- Höffler, T. N., and Leutner, D. (2007) Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction*, 17 (6), pp. 722-738.
- Hogo, M. A. (2010). Evaluation of e-Learning systems based on fuzzy clustering models and statistical tools. *Expert Systems with Applications*, 37 (10), pp. 6891-6903.

- Holmes, B. and Gardner, J. (2006) *E-learning: Concepts and Practice*. Sage.
- Holzinger, A., Kickmeier-Rust, M. and Albert, D. (2008) Dynamic Media in Computer Science Education; Content Complexity and Learning Performance: Is Less More? *Educational Technology & Society*. 11 (1), pp. 279-290.
- Honey, P. and Mumford, A. (1992) *The Manual of Learning Styles*. 3rd ed. Honey, Maidenhead.
- Hope A. and Guiton P. (2006) *Strategies for Sustainable Open and Distance Learning*. London: Routledge Taylor and Francis Group.
- Horton, W.K. (2000) *Designing Web-Based Training: How to Teach Anyone Anything Anywhere Anytime*. London: John Wiley and Sons.
- Hou, M. H., Sobieraj, S., Pronovost, S., Roberts, S. and Banbury, S. (2010) *Suitable learning styles for intelligent tutoring technologies*. *Defense Research and Development Canada* [online]. Available from: [http://pubs.drdc.gc.ca/inbasket/mhou.100916\\_1316.Toronto\\_TR\\_2010\\_073\\_Revised.pdf](http://pubs.drdc.gc.ca/inbasket/mhou.100916_1316.Toronto_TR_2010_073_Revised.pdf) [Accessed 18 May 2011]
- Huang, E.Y., Lin, S.W. and Huang, T.K. (2012) What type of learning style leads to online participation in the mixed-mode e-Learning environment? A study of software usage instruction. *Computers & Education*. 58 (1), pp. 338–349.
- Huang, T. C. K. and Huang, C. H. (2010) An integrated decision model for evaluating educational web sites from the fuzzy subjective and objective perspectives. *Computers & Education*. 55 (2), pp. 616-629.
- Hubackova, S. (2014) Pedagogical Foundation of E-Learning. *Procedia-Social and Behavioral Sciences*. 131, pp. 24-28.
- Huk, T. (2006) Who benefits from learning with 3D models? The case of spatial ability. *Journal of Computer Assisted Learning*. 22 (6), pp. 392-404.
- Hussin, H., Bunyarit, F., & Hussein, R. (2009) Instructional design and e-Learning. *Campus - Wide Information Systems*. 26 (1), pp. 4-19.
- Hwang, G. J., Huang, T. C. and Tseng, J. C. (2004) A group-decision approach for evaluating educational web sites. *Computers & Education*. 42 (1), pp. 65-86.
- Islam, N., Beer, M. and Slack, F. (2015) E-learning challenges faced by academics in higher education. *Journal of Education and Training Studies*, 3 (5), pp. 102-112.
- James, W.B., and Blank, W. E. (1993) Review and critique of available learning-style instruments for adults. *New Directions for Adult and Continuing Education*. 59, pp. 47-57.
- James-Gordon, Y. and Bal, J. (2001) Learning style preferences of engineers in automotive design. *Journal of Workplace Learning*, 13 (6), pp. 239-245.

- Jane Lamb, K., Davies, J., Bowley, R. and Williams, J.P. (2014). Incident command training: the introspect model. *International Journal of Emergency Services*, 3(2), pp.131-143.
- Jeong, H. Y. and Yeo, S. S. (2014) The quality model for e-Learning system with multimedia contents: a pairwise comparison approach. *Multimedia Tools and Applications*. 73 (2), pp. 887-900.
- Jerz, R. (2002) Redesigning engineering graphics to include fire safety tutorials and sketching exercises. *Proceedings of the 2002 American Society For Engineering Education Annual Conference and Exposition*, pp. 1-8.
- John, D., and Boucouvalas, A.C. (2002) User Performance with Audio: The effect of subject's cognitive styles. *Educational Psychology*. 22 (2), pp. 133-147.
- Johnson, S.D., Aragon, S.R., Shaik, N. and Palma-Rivas, N. (2000) Comparative analysis of learner satisfaction and learning outcomes in online and face-to-face learning environments. *Journal of Interactive Learning research*. 11 (1), p. 29.
- Jonassen, D. H. and Grabowski, B. L. (1993). *Handbook of Individual Differences, Learning and Instruction*. Hillsdale, NJ: Erlbaum.
- Joo, Y.J., Lim, K.Y. and Park, S.Y. (2011) Investigating the structural relationships among organisational support, learning flow, learners' satisfaction and learning transfer in corporate e-Learning. *British Journal of Educational Technology*. 42 (6), pp. 973-984.
- Joy II, E.H. and Garcia, F.E. (2000) Measuring Learning Effectiveness: A New Look at No-Significant-Difference Findings. *Journal of Asynchronous Learning Networks*. 4 (1), pp. 33-39.
- Joyner Jeffrey (2012) What are the Working Conditions for a Firefighter [online]. Available from: <http://work.chron.com/working-conditions-firefighter-11401.html> [Accessed 15 March 2017].
- Jung, I, Wong, T.M., Chen, L., Baigaltugs, S., and Belawati, T. (2011) Quality assurance in Asian distance education: Diverse approaches and common culture. *International Review of Research in Open and Distance Learning* [online]. Available from: <http://www.irrodl.org/index.php/irrodl/article/view/991/1953> [Accessed 28 April 2014].
- Jung, I. (2011) The dimensions of e-Learning quality: from the learner's perspective. *Educational Technology Research and Development*. 59 (4), pp. 445-464.
- Kakkar, M. (2008) *A Synthesis of Good Design Practices for Standalone "Global E-Learning" for Global Organisations*. Dissertation, Concordia University (Canada), Ann Arbor.
- Kaliská, L. (2012) Felder's learning style concept and its index of learning style questionnaire in the Slovak conditions. *Grant Journal*. 1, pp. 52-56.



- Kang,S. (1999) Learning styles: Implications for ESL/EFL Instruction. *English Teaching Forum*. 37 (4), October - December 1999, p. 6.
- Karayan, S. and Crowe, J. (1997) Student perspectives of electronic discussion groups. *THE Journal: Technological Horizons in Education*. 24 (9), pp. 69–71.
- Kay, R. (2011) Evaluating learning, design, and engagement in web-based learning tools (WBLTs): The WBLT Evaluation Scale. *Computers in Human Behavior*. 27 (5). pp. 1849-1856.
- Kayler, M. and Weller, K. (2007). Pedagogy, Self-Assessment, and Online Discussion Groups. *Educational Technology & Society*. 10 (1), pp. 136–147.
- Kear K. (2010) *Online and Social Networking Communities: A Best Practice Guide for Educators*. Routledge.
- Kear, K., Rosewell J. and Williams K (2013) Quality Assurance For Excellence In E-Learning: The Role Of Social Networking. *2013 5th Conference on Information and Knowledge Technology (IKT)*.
- Keefe, J.W. (1979) Learning Style: An Overview. In: Keefe, J.W., ed., *Student Learning Styles: Diagnosing and Prescribing Programs*. Reston, VA: National Association of Secondary School Principals.
- Keeker, K. (1997) *Improving Web Site Usability and Appeal* [online]. Available from: <<http://msdn.microsoft.com/workshop/management/planning/improvingwebsiteusa.asp>>. [Accessed 10 April 2016].
- Keller, J. M. (1983) Motivational design of instruction. In: C.M. Reigeluth (ed.) *Instructional Design Theories and Models: An Overview of Their Current Status*. Hillsdale, NJ: Erlbaum.
- Kemp, J. E., Morrison, G. R., and Ross, S. M. (1998) *Designing Effective Instruction*. 2nd ed. Upper Saddle River, NJ: Prentice Hall.
- Kemp, N. and Grieve, R., (2014) Face-to-face or face-to-screen? Undergraduates' opinions and test performance in classroom vs. online learning. *Frontiers in Psychology*. 5, p. 1278.
- Khaleej Times, (2015) *UAE Civil Defence: Guiding best practices in the field* [online]. Available from: <https://www.khaleejtimes.com/article/20150302/ARTICLE/303029923/0> [Accessed 15 March 2017].
- Kiili, K. (2007) Foundation for Problem-Based Gaming. *British Journal of Educational Technology*. 38(3), pp. 394–404.
- Kirkpatrick, D.L. (1994) *Evaluating Training Programs. The Four Levels*. San Francisco: Berrett-Koehler.
- Kiser, K. (1999) 10 things we know so far about online training. *Training*, 36 (11), pp. 66–74.

- Kivunja, C. (2015) Innovative methodologies for 21st century learning, teaching and assessment: A convenience sampling investigation into the use of social media technologies in higher education. *International Journal of Higher Education*. 4 (2), p. 1.
- Klein, D. and Ware, M. (2003) E-learning: new opportunities in continuing professional development. *Learned Publishing*. 16 (1), pp. 34-46.
- Kline, K.A. (2012) *The Effects of Visualizations and Spatial Ability on Learning from Static Multimedia Instructions*. Georgia Institute of Technology.
- Knox S., Cullen W., Collins N., Dunne C. (2013) First evaluation of CPD advanced paramedic teaching methods in Ireland. *Journal of Paramedic Practice* 5 (1), pp. 29–35.
- Kolb, D.A. (1984) *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice-Hall.
- Kollöffel, B. (2012) Exploring the relation between visualizer–verbalizer cognitive styles and performance with visual or verbal learning material. *Computers & Education*. 58 (2), pp. 697–706.
- Kong, P. W., Suyama, J., and Hostler, D. (2013) A review of risk factors of accidental slips, trips, and falls among firefighters. *Safety Science*. 60, pp. 203-209.
- Kuh, G.D. and Hu, S. (2001) The relationships between computer and information technology use, selected learning and personal development outcomes, and other college experiences. *Journal of College Student Development*. 42 (3), pp. 217-232.
- Ladyshevsky, R.K. (2004) E-learning compared with face to face: differences in the academic achievement of postgraduate business students. *Australasian Journal of Educational Technology*. 20 (3). p. 316.
- Lanzilotti, R., Ardito, C., Costabile, M. F., and De Angeli, A. (2006) eLSE methodology: A systematic approach to the e-Learning systems evaluation. *Journal of Educational Technology and Society*. 9 (4), pp. 42–53.
- Large, A., Beheshti, J., Breuleux, A., & Renaud, A. (1994). Multimedia and comprehension: a cognitive study. *Journal of the American Society for Information Science*. 45 (7), pp. 515–528.
- Laurillard, D. (1993) *Rethinking University Teaching: A Framework for the Effective Use of Educational Technology*. London: Routledge.
- Laurillard, D. (2007) Pedagogical forms of mobile learning: Framing research questions. In: Pachler, N. (Ed.), *Mobile Learning: Towards a Research Agenda*. London, UK: WLE Centre, Institute of Education, pp. 153–177.
- Lee, J. (2014) An Exploratory Study of Effective Online Learning: Assessing Satisfaction Levels of Graduate Students of Mathematics Education Associated with Human and Design Factors of an Online Course. *The International Review of Research in Open and Distance Learning*. 15(1), pp.112-132.

- Lee, M.C. (2010) Explaining and predicting users' continuance intention toward e-Learning: An extension of the expectation–confirmation model. *Computers & Education*. 54 (2), pp. 506-516.
- Lee, S.H. (2006) *Improving Spatial Abilities in UWA Engineering Students*. University of Western Australia, Crawley: Faculty of Engineering, Computing and Mathematics.
- Levy, Y. (2007) Comparing dropouts and persistence in e-Learning courses. *Computers & Education*. 48 (2), pp. 185–204.
- Liao, H.L. and Lu, H.P. (2008) The role of experience and innovation characteristics in the adoption and continued use of e-Learning websites. *Computers & Education*. 51 (4), pp. 1405-1416.
- Liaw, S. S. (2008) Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-Learning: A case study of the Blackboard system. *Computers & Education*. 51 (2), pp. 864–873.
- Lim, D. H. (2002). Perceived differences between classroom and distance education: Seeking instructional strategies for learning applications. *International Journal of Educational Technology*. 3 (1), pp. 20-32.
- Lindgaard, G. (1994) *Usability Testing and System Evaluation*. London: Chapman and Hall.
- Lindsay, E. K. (1999) *An analysis of matches of teaching styles learning styles and the uses of educational technology* (Unpublished doctoral dissertation). North Carolina State University, Raleigh.
- Liu, G. Z., Liu, Z. H. and Hwang, G. J. (2011). Developing multi-dimensional evaluation criteria for English learning websites with university students and professors. *Computers & Education*. 56 (1), pp. 65-79.
- Lodico, M.G. and Spaulding, D.T., Voegtle (2006). *Methods in educational research: From theory to practice* (vol. 28). John Wiley & Sons.
- Lohman, D.F. (1996) Spatial ability and G. In: Dennis I. and Tapsfield P. (Eds.). *Human Abilities: Their Nature and Measurement*. Mahwah, NJ: Erlbaum, pp. 97-116.
- Looney, C.A. and Akbulut, A. Y. (2007) Combating the IS Enrollment Crisis: The Role of Effective Teachers in Introductory IS Courses, *Communications of the Association for Information Systems*. 19 (1), pp. 781-805.
- Lu, H., Jia, L., Gong, S.H. and Clark, B. (2007) The relationship of Kolb learning styles, online learning behaviors and learning outcomes. *Journal of Educational Technology & Society*. 10 (4), pp. 187-196.
- Mackenzie, D.S. and Jansen, D.G. (1998) Impact of e-Learning computer-based instruction on student comprehension of drafting principles. *Journal of Industrial Teacher Education*. 35 (4), pp. 61-82.

Magoulas, G., Papanikolaou, K. and Grigoriadou, M. (2003). Adaptive web-based learning: Accommodating individual differences through system's adaptation. *British Journal of Educational Technology*, 34 (4), pp. 1–19.

Magoulas, G.D., Chen, S.Y. and Papanikolaou, K.A. (2003 July) Integrating layered and heuristic evaluation for adaptive learning environments. In: *Proceedings of the Second Workshop on Empirical Evaluation of Adaptive Systems, held at the 9th International Conference on User Modeling UM2003, Pittsburgh*, pp. 5-14.

Maki, R.H., Maki, W.S., Patterson, M. and Whittaker, P.D. (2000) Evaluation of a Web-based introductory psychology course: I. Learning and satisfaction in on-line versus lecture courses. *Behavior Research Methods, Instruments, & Computers*, 32 (2), pp. 230-239.

Manochehr, N.N. (2006) The influence of learning styles on learners in e-Learning environments: An empirical study. *Computers in Higher Education Economics Review*. 18 (1), pp.10-14.

Marc, J. R. (2002) Book review: e-Learning strategies for delivering knowledge in the digital age. *Internet and Higher Education*. 5, pp. 185-188.

Marques, C. G., Noivo, J. and Veríssimo, M. (2008) e-QUAL: e-Learning with Quality. Proposal for an Evaluation Model on the Quality of e-Learning Courses. In: *Computers and Education*. Springer, London, pp. 83-90.

Marsh, K.R., Griffin, B.F. and Lowrie, Jr D.J. (2008) Medical student retention of embryonic development: impact of the dimensions added by multimedia tutorials. *Anatomical Sciences Education*. 1 (6), pp. 252–257.

Martens, R. L., Gulikers, J., and Bastiaens, T. (2004) The impact of intrinsic motivation on e-Learning in authentic computer tasks. *Journal of Computer Assisted Learning*. 20 (5), pp. 368–376.

Martínez-Caro, E., Cegarra-Navarro, J.G. and Cepeda-Carrión, G. (2015). An application of the performance-evaluation model for e-Learning quality in higher education. *Total Quality Management & Business Excellence*, 26 (5-6), pp. 632-647.

Martini, M. (1986). *An analysis of the relationships between and among computer assisted instruction, learning styles perceptual preferences attitudes, and the science achievement of seventh grade students in suburban New York School District* [Unpublished doctoral dissertation]. Dissertation Abstracts International. 47, 877A.

Martín-Rodríguez, Ó., Fernández-Molina, J. C., Montero-Alonso, M. Á., and González-Gómez, F. (2015) The main components of satisfaction with e-Learning. *Technology, Pedagogy and Education*. 24 (2), pp. 267–277.

Matsatsinis, N.F., Grigoroudis, E. and Delias, P. (2003). User satisfaction and e-Learning systems: Towards a multi-criteria evaluation methodology. *Operations Research*. 3 (3), pp. 249–259.

Matthews, D. (1999) The origins of distance education and its use in the United States. *The Journal (Technological Horizons in Education)*. 27 (2), pp. 54–66.

- Mayer R.E. and Sims, V.K. (1994) From whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. *Journal of Educational Psychology*. 86 (3), pp. 389-401.
- Mayer, R.E. (1994) Visual aids to knowledge construction: Building mental representations from pictures and words. In: Schnotz, W., and Khlhavy, W., eds. *Advances in Psychology*. 108, pp. 125-138.
- Mayer, R.E. (1997) Multimedia learning: are we asking the right questions? *Educational Psychologist*. 32 (1), pp. 1–19.
- Mayer, R.E. (2001) *Multimedia learning*. Cambridge, MA: University Press.
- Mayer, R.E. (2003) The promise of e-Learning learning: Using the same instructional design methods across different media. *Learning and Instruction*. 13, pp. 125-139.
- Mayer, R.E. (2005) Cognitive theory of e-Learning learning. In Mayer R. E., ed., *The Cambridge Handbook of E-Learning Learning*. Cambridge: Cambridge University Press, pp. 31-48.
- Mayer, R.E. and Moreno, R. (2002) Aids to computer-based e-Learning learning. *Learning and Instruction*. 12, pp. 107-119.
- Mayer, R.E., and Moreno, R. (1998) A Cognitive Theory of Multimedia Learning: Implications for Design Principles. Paper presented at the annual meeting of the *ACM SIGCHI Conference on Human Factors in Computing Systems*. Los Angeles, CA.
- Mayes, T. and De Freitas, S. (2006) Review of e-Learning theories, frameworks and models. JISC e-Learning Models Desk Study. Available from: [http://www.jisc.ac.uk/uploaded\\_documents/Stage%202%20Learning%20Models%20%28Version%201%29.pdf](http://www.jisc.ac.uk/uploaded_documents/Stage%202%20Learning%20Models%20%28Version%201%29.pdf) [Accessed 15 March 2017].
- McConnell, D. (2000) *Implementing Computer Supported Cooperative Learning*. London: Kogan Page Limited.
- McCouston, P. (1990) Static vs. dynamic visuals in computer assisted instruction. *ASEE Annual Conference Proceedings*. pp. 143-147.
- McDermott P. and Beitman B. (1984) Standardization of a scale for the study of children's learning styles: structure, stability, and criterion validity. *Psychology in the Schools*. 21 (1), pp. 5-14.
- McLaren, C. H. (2004) A comparison of student persistence and performance in online and classroom business statistics experiences. *Decision Sciences Journal of Innovative Education*. 2 (1), pp. 1–10.
- McLellan, H. (1998) Cognitives issues in virtual reality. *Journal of Visual Literacy*. 18 (2), pp. 175-199.
- Means, B., Toyama, Y., Murphy, R., Bakia, M. and Jones, K. (2009) Evaluation of Evidence-Based Practices. In: *Online Learning: A Meta-Analysis and Review of Online*

*Learning Studies*. U.S. Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service.

Mešić, V., Dervić, D., Gazibegović-Busuladžić, A., Salibašić, D. and Erceg, N. (2015). Comparing the Impact of Dynamic and Static Media on Students' Learning of One-Dimensional Kinematics. *Eurasia Journal of Mathematics, Science & Technology Education*. 11 (5), pp. 1119-1140.

Mesquita, A. (2011) *Sociological and Philosophical Aspects of Human Interaction with Technology: Advancing Concepts*. IGI Global.

Midkiff, S.F. and DaSilva, L.A. (2000). Leveraging the web for synchronous versus asynchronous distance learning. *International Conference on Engineering Education*, pp. 14-18.

Miller, C. (1992) The results of integrating real and computer generated models into a traditional sketching based engineering graphics course. *Engineering Design Graphics Journal*. 56 (2), pp. 27-47.

Miller, G. A. (1956) The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review*. 63 (2), pp. 81-97.

Miller, R. L. (1990) Learning Benefits of Interactive Technologies. *Multimedia and Videodisc Monitor*. 8 (2) pp. 14-15.

Miller, S., and France, D. (2013). A real-time emergency response scenario using Web 2.0 (Yammer) technology. *Planet*. 27 (2), pp. 21-29.

Mirza, A.A. and Al-Abdulkareem, M. (2011) Models of e-Learning adopted in the Middle East. *Applied Computing and Informatics*. 9 (2), pp.83-93.

Mohammadi, S. and Homayoun, S. (2013) Strategic evaluation of web-based e-Learning: A review on 8 articles. *ACSIJ Advances in Computer Science: an International Journal*. 2 (2), pp. 281-295.

Mohler, J.L. (1999) Utilizing desktop virtual reality to enhance visualization: Applied projects from the Department of Computer Graphics. In: *Proceedings of IEEE International Conference of Information Visualization*, pp. 363-369.

Moody, D.L. and Sindre, G. (2003) Evaluating the Effectiveness of Learning Interventions: An Information Systems Case Study. In: *ECIS 2003 Proceedings*, Paper 80.

Moore, J.L., Dickson-Deane, C. and Galyen, K. (2011) e-Learning, online learning, and distance learning environments: Are they the same? *The Internet and Higher Education*. 14 (2), pp.129-135.

Moore, R. (2014) Importance of developing community in distance education courses. *TechTrends*. 58 (2), pp. 20-25.

Moreno, R. and Mayer, R. E. (2002) Verbal redundancy in multimedia learning: When reading helps listening. *Journal of Educational Psychology*. 94 (1), pp. 156-163.

- Moreno, R., and Mayer, R. E. (1999) Cognitive principles of e-Learning design: the role of modality and contiguity. *Journal of Educational Psychology*. 91, pp. 358–368.
- Morrone, A. S., Gosney, J., and Engel, S. (2012, April). Empowering students and instructors: Reflections on the effectiveness of iPads for teaching and learning. *Educause Learning Initiative*, pp. 1-7.
- Morse, K. (2003) Does one size fit all? Exploring asynchronous learning in a multicultural environment. *Journal of Asynchronous Learning Networks*. 7 (1), pp. 37-55.
- Mousavi, S.Y., Low, R. and Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology*. 87 (2), pp. 319–334.
- Mumford, A. (1995). Putting learning styles to work: an integrated approach. *Industrial and Commercial Training*, 27 (8), pp. 28–35.
- Mupinga, D.M., Nora, R.T. and Yaw, D.C. (2006) The learning styles, expectations, and needs of online students. *College Teaching*, 54 (1), pp.185-189.
- Navarro, P. and Shoemaker, J. (2000) Performance and perceptions of distance learners in cyberspace. *American Journal of Distance Education*. 14 (2), pp. 15-35.
- Nelson, D.L. (1979) Remembering pictures and words: Appearance, significance, and name. In: Cermak, L.S., and Craik, F.I.M., eds., *Levels of Processing in Human Memory*. Hillsdale, NJ: Erlbaum, pp. 45-76.
- Nelson, D.L., Reed, V.S., and Walling, J. R. (1976). Pictorial superiority effect. *Journal of Experimental Psychology: Human Learning and Memory*. 2, pp. 523-528.
- NFPA (2012) *Fire Loss in The United States During 2012*. Available from: <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Overall-Fire-Statistics/FireLoss2013.ashx?la=en> [Accessed 15 March 2017].
- Nguyen, T. (2015). The effectiveness of online learning: Beyond no significant difference and future horizons. *MERLOT Journal of Online Learning and Teaching*. 11 (2), pp. 309-319.
- Ni, A.Y. (2013) Comparing the effectiveness of classroom and online learning: Teaching research methods. *Journal of Public Affairs Education*. 19 (2), pp. 199-215.
- Nortvig, A.M., Petersen, A.K. and Balle, S.H. (2018) A Literature Review of the Factors Influencing E-Learning and Blended Learning in Relation to Learning Outcome, Student Satisfaction and Engagement. *Electronic Journal of e-Learning*. 16(1), pp. 46-55.
- O'Day, D.H. (2006) Animated cell biology: a quick and easy method for making effective, high-quality teaching animations. *Life Science Education*. 5 (3), pp. 255–263.
- O'Day, D.H. (2007) The value of animations in biology teaching: a study of long-term memory retention. *Life Science Education*. 6 (3), pp. 217–223.

- Oliver, M. (2000) An introduction to the evaluation of learning technology. *Educational Technology and Society*. 3 (4), pp. 20-30.
- Olkun, S. (2003) Making connections: Improving spatial abilities with engineering drawing activities. *International Journal of Mathematics Teaching and Learning*. 3 (1), pp.1-10.
- Omwenga, E. and Rodrigues, A. (2006) Towards an education evaluation framework: synchronous and asynchronous e-Learning cases. *Journal of the Research Center for Educational Technology*, 2 (1), pp. 46-59.
- Ozkan, S. and Koseler, R. (2009) Multi-dimensional students' evaluation of e-Learning systems in the higher education context: An empirical investigation. *Journal of Computer and Education*. 53 (4), pp. 1285-1296.
- Paivio, A. (1971) *Imagery and Verbal Processes*. New York: Holt, Rinehart and Winston.
- Paivio, A. (1990) *Mental Representations: A Dual Coding Approach*. Oxford, England: Oxford University Press Book.
- Paivio, A. (1991) Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology*. 45, pp. 255-287.
- Paivio, A., (1975) Coding distinctions and repetition effects in memory. In: Bower, G.H., ed., *The Psychology of Learning and Motivation*, 9. New York: Academic Press, pp. 179-214.
- Paivio, A., Rogers, T. B., and Smythe, P. C. (1968) Why are pictures easier to recall than words? *Psychonomic Science*. 11 (4), pp. 137-138.
- Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N. and Hoagwood, K. (2015) Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*. 42 (5), pp. 533-544.
- Pallant, J. and Manual, S.S. (2010) *A Step by Step Guide to Data Analysis Using SPSS*. Berkshire UK: McGraw-Hill Education.
- Palloff, R.M. and Pratt, K. (2007) Online learning communities in perspective. In: *Online Learning Communities*, Luppicini, R. (ed.). Charlotte, North Carolina, pp. 3-15.
- Pantazis, C. (2001) *Executive summary: A vision of E-learning for America's workforce*. Report of the Commission on Technology and Adult Learning, ASTD.
- Park, O. C., and Hopkins, R. (1993) Instructional conditions for using dynamic visual displays e a review. *Instructional Science*. 21 (6), pp. 427-449.
- Patton, M. (1990) *Qualitative Evaluation and Research Methods*. Beverly Hills, CA: Sage, pp. 169-186.



- Pedrosa, C.M., Barbero, B.R. and Miguel, A.R. (2014) Spatial visualization learning in engineering: Traditional methods vs. a web-based tool. *Journal of Educational Technology & Society*. 17 (2), pp. 142-157.
- Pektas, S.T. (2007) *Effects of Cognitive Styles on Performance in CAAD Tasks*. *Human Computer Interaction and Cognition*, pp. 177-184.
- Petter, S., DeLone, W. and McLean, E. (2012) The Past, Present, and Future of “IS Success”. *Journal of the Association for Information Systems*. 13 (5), pp. 341-362.
- Petter, S., DeLone, W., and McLean, E. (2008) Measuring information systems success: Models, dimensions, measures, and interrelationships. *European Journal of Information Systems*. 17 (3), pp. 236–263.
- Piaget, J. and Inhelder, B. (1971) *Mental Imagery and the Child*. New York: Basic Books.
- Powell, T. A. (2000). *Web Design: the Complete Reference*. California: McGraw Hill.
- Pullen, D. (2013) Doctors online: learning using an internet based content management system. *International Journal of Education and Development using Information and Communication Technology*. 9 (1), p. 50.
- R. Moreno and R. E. Mayer (1999) Multimedia-supported metaphors for meaning making in mathematics. *Cognitive and Instruction*. 17 (3), pp. 215-248.
- Raspopovic, M., and Lucic, V. (2012) Analysis of e-Learning success factors. In: *Proceedings of the Third International Conference on e-Learning*. Belgrade Metropolitan University, Belgrade, Serbia, pp. 102- 107.
- Reeves, T. C., Benson, L., Elliott, D., Grant, M., Holschuh, D. and Kim, B., Kim, H., Lauber, E. and Loh, S (2002). Usability and instructional design heuristics for e learning evaluation. In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* [online]. Available from: <http://www.csloh.com/research/pdf/EdMedia2002.pdf> [Accessed 05 April 2014].
- Reime, M. H., Harris, A., Aksnes, J. and Mikkelsen, J. (2008) The most successful method in teaching nursing students infection control — E-learning or lecture? *Nursing Education Today*. 28 (7), pp. 798 – 806.
- Rennie, F. and Morrison, T. (2013) *E-Learning and Social Networking Handbook: Resources for Higher Education*. London: Routledge.
- Rentroia-Bonito, M. A., Jorge, J. A. and Ghaoui, C. (2006) Motivation to e-learn within organizational settings: An exploratory factor structure. *International Journal of Distance Education Technologies*. 4 (3), pp. 24-35.
- Reushle, S., Dorman, M., Evans, P., Kirkwood, J., McDonald, J. and Worden, J. (1999) Critical elements: Designing for online teaching. In: *Proceedings of ASCILITE99 Responding to Diversity: 16th Annual Conference*, pp. 5-8.
- Riding, R. (1996). *Personal Style Awareness and Personal Development*. Learning and Training Technology, Birmingham.

- Riding, R., and Cheema, I. (1991) Cognitive styles -- an overview and integration. *Educational Psychology*. 11 (3-4), pp. 193-215.
- Rieber, L. P. (1990) Animation in computer-based instruction. *Educational Technology Research and Development*. 38 (1), pp. 77–86.
- Rivers, B.A.A., Richardson, J.T.E., and Price, L. (2014) Promoting Reflection in synchronous Virtual Learning Spaces: Tertiary Distance Tutors' Conceptions. *The International Review of Research in Open and Distributed Learning*, 15(3).
- Rogers, E.M. (1983) *Diffusion of Innovations*. 3rd ed. New York, NY: Free Press.
- Rolfe, V. E. and Gray, D. (2011) Are multimedia resources effective in life science education? A meta-analysis. *Bioscience Education*. 18 (1), pp. 1-14.
- Rovai, A.P., Ponton, M.K., Wighting, M.J. and Baker, J.D. (2007). A comparative analysis of student motivation in traditional classroom and e-Learning courses. *International Journal on E-Learning*. 6 (3), pp. 413-432.
- Ruhe, V. and Zumbo, B.D. (2008) *Evaluation in Distance Education and E-Learning: The Unfolding Model*. Guilford Press.
- Rusli M., Negara, I. K. R. Y. (2017). The Effect of Animation in Multimedia Computer-Based Learning and Learning Style to the Learning Results. *Turkish Online Journal of Distance Education*, 18 (4), pp. 177-190.
- Rusli, M. (2015) The effect of presentation variety of interactive multimedia learning to the learning result. *International Journal of Computer Applications*. 122 (10), pp. 7-12.
- Rusli, M., Ardhana, I. W., Sudana, I. N. D. and Kamdi, W. (2014) The Effect of Presentation Strategy on Multimedia Learning-Animation vs Static Visualization-and Learning Style to Learning Result. *Academic Research International*. 5 (1), pp. 216-226.
- Russell, T. L. (1999) *The No Significant Difference Phenomenon*. Raleigh: NC, North Carolina State.
- RVPSVT (2017) Revised Purdue Spatial Visualization Tests: Visualization of Rotations [online] Available at: [https://ef.engr.utk.edu/ef105-2017-08/PSVT/instructions\\_2.php](https://ef.engr.utk.edu/ef105-2017-08/PSVT/instructions_2.php) [ Accessed 20 Feb 2018 ]
- Saeed, N. and Yang, Y. (2008, July) Using learning styles and preferences to incorporate emerging e-Learning tools in teaching. *Eighth IEEE International Conference on Advanced Learning Technologies, 2008. ICALT'08*, pp. 967-971.
- Saghafi, M. R., Franz, J. and Crowther, Ph. (2014) A Holistic Model for Blended Learning. *Journal of Interactive Learning Research*. 25 (4), pp. 531-549.
- Sahasrabudhe, V. and Kanungo, S. (2008) Relating E-Learning Effectiveness to Choice of Media for its Contents: A Quasi-Experimental Approach. *ICIS 2008 Proceedings*, Paper 108.

- Sahasrabudhe, V. and Kanungo, S. (2014) Appropriate media choice for e-Learning effectiveness: Role of learning domain and learning style. *Computers & Education*, 76, pp. 237-249.
- Salkind, N.J. (ed.) (2010) *Encyclopaedia of Research Design* (Vol. 1). Sage.
- Sangrà, A., Vlachopoulos, D. and Cabrera, N. (2012) Building an inclusive definition of e-Learning: An approach to the conceptual framework. *The International Review of Research in Open and Distributed Learning*. 13 (2), pp. 145-159.
- Santo, E.E., Soares, C.Q., da Silveira, E.C.F. and da Costa Oliveira, R.P., (2015) A learning styles comparative study from high level students of face-to-face and distance education. *Debate Universitario CAEE-UAI*. 4 (7), pp. 55-68.
- Sarihan, A., Oray, N. C., Güllüpnar, B., Yanturali, S., Atilla, R., and Musal, B. (2016) The comparison of the efficiency of traditional lectures to video-supported lectures within the training of the Emergency Medicine residents. *Turkish Journal of Emergency Medicine*. 16 (3), pp. 107-111.
- Saunders, M., Lewis, P. and Thornhill, A. (2009) *Research Methods for Business Students*. 5th ed. Harlow: Pearson Education.
- Schiefele, U. and Schreyer, I. (1994) Intrinsische Lernmotivation und Lernen: ein Überblick zu Ergebnissen der Forschung. *Zeitschrift für Pädagogische Psychologie*. 8 (1), pp. 1-13.
- Schoenfeld-Tacher, R., McConnell, S., & Graham, M. (2001) Do no harm - A comparison of the effects of on-line vs. traditional delivery media on a science course. *Journal of Science Education and Technology*. 10 (3), pp. 257-265.
- Schwier, R. and Misanchuk, E.R. (1993) *Interactive Multimedia Instruction*. Educational Technology.
- Selcuk, K., Nurses' perceptions of online continuing education [online]. Available from: <https://pdfs.semanticscholar.org/9283/71bb1518667a9abc4be3e6b041b466077fc1.pdf> [Accessed 15 March 2017].
- Selim, H.M. (2007) Critical success factors for e-Learning acceptance: Confirmatory factor models. *Computers & Education*. 49 (2), pp. 396-413.
- Shachar, M. and Neumann, Y. (2003) Differences between traditional and distance education academic performances: A meta-analytic approach. *The International Review of Research in Open and Distributed Learning*. 4 (2).
- Shank, P. and Sitze, A. (2004) *Making Sense of Online Learning: A Guide to Beginners and the Truly Skeptical*. San Francisco: Pfeiffer.
- Shauna A.S. and Marcia, A.A. (2005) Novice Drafters' Spatial Visualization Development: Influence of Instructional Methods and Individual Learning Styles. *Journal of Industrial Teacher Education*. 42 (2), pp. 38-60.

- Shaw, R. S. (2012) A study of the relationships among learning styles, participation types, and performance in programming language learning supported by online forums. *Computers & Education*. 58 (1), pp. 111–120.
- Shee, D. Y. and Wang, Y. S. (2008) Multi-criteria evaluation of the web-based e-Learning system: A methodology based on learner satisfaction and its applications. *Computers & Education*. 50 (3), pp. 894-905.
- Shiratuiddin, N., Hassan, S. and Landoni, M. (2003) A usability study for promoting econtent in higher education. *Educational Technology and Society*. 6 (4), pp. 112-124.
- Silva, D.M.D., Leal, E.A., Pereira, J.M. and Oliveira Neto, J.D.D. (2015) Learning styles and academic performance in Distance Education: a research in specialization courses. *Revista Brasileira De Gestão De Negócios*. 17 (57), pp. 1300-1316.
- Simpson PM, Bendall JC, Patterson J, Middleton PM (2012) Beliefs and expectations of paramedics towards evidence-based practice and research. *International Journal of Evidence Based Healthcare*, 10 (3), pp. 197–203.
- Sitzmann, T., Kraiger, K., Stewart, D. and Wisher, R. (2006) The comparative effectiveness of web-based and classroom instruction: A meta-analysis. *Personnel Psychology*. 59 (3), pp. 623-664.
- Smart Dubai (2015) *Change Management Framework* [online]. Available from: [http://dubaidata.ae/pdf/Change\\_Management\\_Framework\\_07022016.pdf](http://dubaidata.ae/pdf/Change_Management_Framework_07022016.pdf) [Accessed 15 March 2017].
- Smedley, J. (2010) Modelling the impact of knowledge management using technology. *OR Insight*. 23 (4), pp. 233-250.
- Smith, D. and Hardaker, G. (2000) e-Learning innovation through the implementation of an Internet supported learning environment. *Educational Technology and Society*. 3 (3), pp. 1–16.
- Smith, L. (2001) Content and delivery: A comparison and contrast of electronic and traditional MBA marketing planning courses. *Journal of Marketing Education*. 21 (1), pp. 35–44.
- Smith, M.C. and Magee, L.E. (1980) Tracing the time course of picture-word processing. *Journal of Experimental Psychology: General*. 109 (4), pp. 373-392.
- Snyder, R. F. (2000) The relationship between learning styles/Multiple Intelligences and academic achievement of high school students. *High School Journal*. 83 (2), pp. 11–21.
- Soffer, T. and Nachmias, R. (2018) Effectiveness of learning in online academic courses compared with face-to-face courses in higher education. *Journal of Computer Assisted Learning* [online]. Available from: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jcal.12258> [Accessed 15 March 2017].
- Somekh, B. and Lewin, C. (eds.) (2011) *Research Methods in the Social Sciences*. Sage.

- Sonwalkar, N. (2005) Adaptive learning technologies: From one-size-fits-all to individualization. *EDUCAUSE Research Bulletin*, Center for Applied Research.
- Sorby, S.A. (1999) Developing 3-D spatial visualization skills. *The Engineering Design Graphics Journal*. 63 (2), pp. 21-32.
- Sorby, S. A. (1999) *Spatial Abilities and Their Relationship to Computer Aided Design Instruction*. Cahrlotte, NC, United States, American Society for Engineering Education, Washington, DC 20036: United States.
- Southard, S., Meddaugh, J., and France-Harris, A. (2015) Can SPOC (self-paced online course) live long and prosper? A comparison study of a new species of online course delivery. *Online Journal of Distance Learning Administration*. 18(2) [online]. Available from: <https://www.learntechlib.org/p/158594/> [Accessed 15 March 2017].
- Squires, D. and Preece, J. (1999) Predicting quality in educational software: Evaluating for learning, usability and the synergy between them. *Interacting with Computers*. 11 (5), pp. 467-483.
- Steinke, P., and Fitch, P. (2007b) *Using Goal-Based Learning To Improve Cognitive Learning Outcomes: The Case Of Service-Learning*. Unpublished manuscript.
- Stufflebeam, D.L. and Coryn, C. (2014) *Evaluation Theory, Models and Applications*. Jossey-Bass.
- Suanpang, P., Petocz, P. and Kalceff, W. (2004) Student attitudes to learning business statistics: Comparison of online and traditional methods. *Educational Technology & Society*. 7 (3), pp. 9-20.
- Suchman, E. A. (1967). *Evaluative Research: Principles and Practice in Public Service and Social Action Programs*. New York, NY: Russell Sage Foundation.
- Sun, P.-C., Cheng, H.K., Finger, G (2009) Critical functionalities of a successful e-Learning system — an analysis from instructors' cognitive structure toward system usage. *Decision Support Systems*. 48 (1), pp. 293–302.
- Swan, K., and Shih, L. (2014) On the nature and development of social presence in online course discussions. *Journal of Asynchronous Learning Networks*. 9 (3), pp. 115-136.
- Swan, K., Shea, P., Frederickson, E., Pickett, A. Pelz, W. and Maher, G. (2000) Building knowledge-building communities: Consistency, contact, and communication in the virtual classroom. *Journal of Educational Computing Research*. 23 (4), pp. 389–413.
- Sweller, J. (1988) Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12 (2), pp. 257-285.
- Sweller, J. (1994) Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, 4, pp. 295-312.
- Sweller, J. (1999) *Instruction Design in Technical Areas*. Camberwell, Australia: ACER.

- Tamim, R.M., Bernard, R.M., Borokhovski, E., Abrami, P.C. and Schmid, R.F. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research*. 81 (1), pp. 4-28.
- Taylor, J. (1998) Learning styles: A practical tool for improved communications. *Super Vision*. 59 (7), pp. 18–19.
- Tennant, M. (2006) *Psychology and Adult Learning*. Routledge.
- Thai, T., De Wever, B. and Valcke, M. (2015). October. Impact of Different Blends of Learning on Students Performance in Higher Education. In: *European Conference on e-Learning. Academic Conferences International Limited*, p. 744.
- Thirunarayanan, M., & Perez-Prad, A. (2001). Comparing web-based and classroom-based learning: A quantitative study. *Journal of Research on Computing in Education*. 34 (2), pp. 131–137.
- Thomas, L., Ratcliffe, M., Woodbury, L., and Jarman, E. (2002) Learning Styles and Performance in Introductory Programming Sequence, In: *Proceedings of the SIGCSE'02, Feb.27-Mar.3, 2002*. Covington, USA.
- Thompson, R.A. (1994) Emotion regulation: A theme in search of definition. In: Fox, N.A. (Ed.) *The development of emotion regulation: Biological and behavioral aspects. Monographs of the Society for Research in Child Development*. 59, (Serial No. 240), pp. 25- 52.
- Thurmond, V. and Wambach, K. (2004) Understanding interactions in distance education: A review of the literature. *International Journal of Instructional Technology and Distance Learning*. 1 (1), pp. 9-27.
- Thurstone, T. G. (1958) *Manual for the SRA Primary Mental Abilities*. Chicago: Science.
- Thyer, B.A. (2012) *Quasi-Experimental Research Designs*. Oxford University Press.
- Tippett, J. (2004) Nurses' acquisition and retention of knowledge after trauma training. *Accident and Emergency Nursing*. 12 (1), pp. 39-46.
- Towle, E.J.M., and Kinsey, B. (2005) Work In Progress-Development of Tools to Improve the Spatial Ability of Engineering Students. In: *35th ASEE/IEEE Frontiers in Education Conference. October 19 - 22, 2005*. Indianapolis, IN.
- Traxler, J. and Kukulska-Hulme, A. (2005, October) Evaluating mobile learning: reflections on current practice. *Paper presented at the mLearn 2005, Mobile technology: The future of learning in your hands*, Cape Town, South Africa.
- Triantafyllou, E., Pomportsis, A., and Demetriadis, S. (2003). The design and the formative evaluation of an adaptive educational system based on cognitive styles. *Computers and Education*. 41 (1), pp. 87–103.

- Tseng, H. W., Tang, Y. Q., and Morris, B. (2016). Evaluation of iTunes University Courses through Instructional Design Strategies and m-Learning Framework. *Educational Technology and Society*. 19 (1), pp. 199–210.
- Tweed, C. (2001) The social context of CAAD in practice. *Automation in Construction*. 10 (5), pp. 617–629.
- Tzeng, G.H., Chiang, C.H., and Li, C.W. (2007) Evaluating intertwined effects in e-Learning programs: A novel hybrid MCDM model based on factor analysis and DE-MATEL. *Expert Systems with Applications*. 32 (4), pp. 1028-1044.
- Urdan, T.A. and Weggen, C.C. (2000) *Corporate E-Learning: Exploring a New Frontier*. W.R. Hambrecht & Co.
- Valenta, A., Therriault, D., Dieter, M. and Mrtek, R. (2001) Identifying student attitudes and learning styles in distance education. *Journal of Asynchronous Learning Networks*. 5 (2), pp. 111-127.
- Vargas, N., & Tian, X. (2013) E-Learning: Much More than a Matter of Technology. *International Journal of e-Education, e-Business, e-Management and e-Learning*. 3 (3), pp. 277-284.
- Wagner, N., Hassanein, K. and Head, M. (2008) Who is responsible for e-Learning success in higher education? A stakeholders' analysis. *Journal of Educational Technology & Society*. 11 (3), pp. 1-12.
- Walker, W. E., Giddings, J., and Armstrong, S. (2011) Training and learning for crisis management using a virtual simulation/gaming environment. *Cognition, Technology and Work*. 13 (3), pp. 163-173.
- Wang, H. C., & Chiu, Y. F. (2011) Assessing e-Learning 2.0 system success. *Computers & Education*. 57 (2), pp. 1790-1800.
- Wang, K.H., Wang, T.H., Wang, W. L and Huang, S. C. (2006) Learning styles and formative assessment strategy: enhancing student achievement in Web-based learning. *Journal of Computer Assisted Learning*. 22 (3), pp. 207-217.
- Wang, Y.-S., Wang, H.-Y. and Shee, D.Y. (2007) Measuring e-Learning systems success in an organizational context: Scale development and validation. *Computers in Human Behavior*. 23 (4), pp. 1792-1808.
- Wang, Z.J. (2013) A new perspective of instructional interaction research in distance education: Structuralism. *Morden Distance Education Research*. 5, pp. 28-33.
- Warschauer, M. (1997) Computer-mediated collaborative learning: theory and practice. *Modern Language Journal*. 8 (4), pp. 470–481.
- Weston, C., Gandell, T., McApline, L. and Filkenstein, A. (1999) Designing instruction for the context of online learning. *The Internet and Higher Education*. 2 (1), pp. 35-44.
- White, H. and Sabarwal, S. (2014) Quasi-experimental design and methods. *Methodological Briefs: Impact Evaluation*, 8. UNICEF.

- Willems, J. (2011) Using learning styles data to inform e-Learning design: A study comparing undergraduates, postgraduates and e-educators. *Australasian Journal of Educational Technology*, 27 (6), pp. 863-880.
- Witkin, H., Moore, C., Goodenough, D. and Cox, P. (1977) Field-dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research*. 47 (1), pp. 1-64.
- Wolfgram, D. (1994) *Creating Multimedia Presentations, with CD*. Que Corp.
- Xu, W., Jiang, Q., Qin, X., Fang, G., and Hu, Z. (2016). E-learning for grass-roots emergency public health personnel: Preliminary lessons from a national program in China. *Bioscience Trends*. 10 (3), pp. 235-239.
- Yang, C.C. (2003) Establishment and applications of the integrated model of service quality measurement. *Managing Service Quality* [e-journal]. 13 (4). Available from: Emerald [online] <http://www.emeraldinsight.com/journals.htm?articleid=842821> [Accessed 28 April 2017].
- Yang, C.W., Yen, Z.S., McGowan, J.E., Chen, H.C., Chiang, W.C., Mancini, M.E., Soar, J., Lai, M.S. and Ma, M.H.M. (2012) A systematic review of retention of adult advanced life support knowledge and skills in healthcare providers. *Resuscitation*, 83 (9), pp. 1055-1060.
- Yilmaz-Soylu, M., and Akkoyunlu, B. (2002) The effect of learning styles on achievement in different learning environment. *The Turkish Online Journal of Educational Technology*. 8 (4), pp. 42–50.
- Zavotka, S.L. (1986). Analysis of three dimensional computer graphics animation to teach spatial skills to interior design students. *Journal of Interior Design Education and Research*. 12 (1), pp. 45-52.
- Zenger, J., and Uehlein, C. (2001) Why Blended Will Win, *T+D (formerly Training and Development Magazine)*. 55 (8), pp. 54-62.
- Zhan, Z., Xu, F. and Ye, H. (2011) Effects of an online learning community on active and reflective learners' learning performance and attitudes in a face-to-face undergraduate course. *Computers & Education*. 56 (4), pp. 961-968.
- Zhang, D., Zhou, L., Briggs, R. O. and Nunamaker, J. F., Jr. (2006) Instructional video in e-Learning: assessing the impact of interactive video on learning effectiveness. *Information and Management*. 43 (1), pp. 15–27.
- Zlámálová, H. Principy distanční vzdělávací technologie a možnosti jejího využití v pedagogické praxi na technických vysokých školách (2002) [online]. Available from: <http://icosym.cvut.cz/telel/zlamalova.html>. [Accessed 15 March 2017].
- Zyński, P., Gotlib, J., Kopański, Z., Wejnarski, A., Świeżewski, S. and Gałązkowski, R. (2016) Analysis of Web-based learning methods in emergency medicine: randomized controlled trial. *Archives of Medical Science: AMS*. 14 (3), pp. 687-694.



## **Appendices**

Appendix 1 Part A – Participant Information

Appendix 2 Part B – Learner Demographics

Appendix 3 Part C – Learning Effectiveness Questions

Appendix 4 Part D – Learning Styles Questions

Appendix 5 Part E – Spatial Ability Test

## **Appendix 1 Part A – Participant Information**

# **Learning Survey**

## **Civil Defence Fire Safety Programme**

You have been invited to participate in providing feedback about the course that will be used to evaluate the effectiveness of the Civil Defence Academy training programmes and be used in PhD research study titled: **An Evaluation of the Effectiveness of Face-to-Face versus e-Learning in the UAE Civil Defence Sector.**

The information given below is intended to provide you with necessary data so that you can make an informed decision on whether or not you wish to participate. I would be grateful if you could read it carefully, and if you have any further questions please feel free to contact me. The purpose of this research is evaluate the effectiveness Civil Defence training programmes. The information you provided will be kept strictly confidential and used only to fulfil the objectives of the research. All data is gathered anonymity is assured as no identification of individuals will be made when presenting the research. You should note the following:

### **1. Why you have been invited to take part**

You have been invited to participate because you have attended one of the course being evaluated

### **2. What will happen if you agree to take part**

If you decide to take part in the study you will be asked to complete an online survey from a secure website which should take around 40 minutes to conclude. You can click on a website link which will provide access to the survey.

**3. Whether you can refuse to take part**

You are completely free to refuse as participation in this study is entirely voluntary.

**4. Whether you can withdraw at any time, and how**

At any point in the research you can choose to withdraw, simply by closing the screen where you are completing the survey.

**5. Whether there are any risks involved (e.g. side effects from taking part) and if so what will be done to ensure your wellbeing/safety**

Few risks to either wellbeing or safety are incurred by participation in this study, however you are of course free to withdraw at any time should this be of concern to you.

**6. What will happen to any information/data/samples that are collected from you**

Information from the questionnaire and consent forms will be kept separate at all times in order to maintain the anonymity of the results.

**7. Whether there are any benefits from taking part**

The data collected will be used to improve training standards and the design of course programs for your organization that benefit workers, the public and organization.

**8. How your participation in this study will be kept confidential**

Confidentiality will be assured through the storage of questionnaire results on secure computers which are located in locked offices. In addition you will be referred to by a code number and information that could be used to identify you or your business unit will not be recorded.

## Appendix 2 Part B – Learner Demographics

### 1. Age

18 -29

30-49

50-64

65 and older

### 2. Gender

Male

Female

## 2. Level of Computer Skills

**Expert**

**Experienced**

**Intermediate**

**Novice**

**Inexperienced**

## Appendix 3 Part C – Learning Effectiveness Questions

### Engagement

1. I was engaged with what was going on during the program.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

2. The class environment helped me to learn.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

3. My learning was enhanced by the facilitator.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

4. This program held my interest.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

### Satisfaction

5. Taking this program was worth my time.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

6. I will recommend this program to my co-workers.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

7. The training met my expectations

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

8. The course material were distributed and helpful

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

9. I understand how to apply what I learned on the job.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

10. I understand why this program was offered.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

11. The information in this program is relevant and applicable to my work.

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

**Cognitive**

As a result of participating in this course/program

12. I can list down all the important things covered in this course

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

13. I have gained knowledge in this course on how to solve certain problems at work

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

14. Helped me to make connections between the ideas and questions I have encountered  
in different classes and/or fields of study

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

15. Taught me how to apply things I learned in class to real problems.



**Strongly  
Disagree**

1

2

3

4

5

**Strongly  
Agree**

6

16. Greatly enhanced my learning beyond what I gained from reading course textbooks and attending this course

**Strongly  
Disagree**

1

2

3

4

5

**Strongly  
Agree**

6

17. Helped me to spontaneously generate my own examples of principles and concepts I learned

**Strongly  
Disagree**

1

2

3

4

5

**Strongly  
Agree**

6

18. Enhanced my understanding of the logic behind various perspectives about controversies in this field

**Strongly  
Disagree**

1

2

3

4

5

**Strongly  
Agree**

6

19. Allowed me to gain a much deeper appreciation of the importance of things I learned about in class

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

20. Provided me with a much deeper understanding of course material

<b>Strongly Disagree</b>						<b>Strongly Agree</b>
1	2	3	4	5	6	

## Appendix 4 Part D – Learning Styles Questions

Please choose only one answer for each question. If both “a” and “b” seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
  - a) try it out.
  - b) think it through.
  
2. I would rather be considered
  - a) realistic.
  - b) innovative.
  
3. When I think about what I did yesterday, I am most likely to get
  - a) a picture.
  - b) words.
  
4. I tend to
  - a) understand details of a subject but may be fuzzy about its overall structure.
  - b) understand the overall structure but may be fuzzy about details.
  
5. When I am learning something new, it helps me to
  - a) talk about it.
  - b) think about it.
  
6. If I were a teacher, I would rather teach a course
  - a) that deals with facts and real life situations.
  - b) that deals with ideas and theories.
  
7. I prefer to get new information in
  - a) pictures, diagrams, graphs, or maps.
  - b) written directions or verbal information.
  
8. Once I understand

**a)** all the parts, I understand the whole thing.

**b)** the whole thing, I see how the parts fit.

**9.** In a study group working on difficult material, I am more likely to

**a)** jump in and contribute ideas.

**b)** sit back and listen.

**10.** I find it easier

**a)** to learn facts.

**b)** to learn concepts.

**11.** In a book with lots of pictures and charts, I am likely to

**a)** look over the pictures and charts carefully.

**b)** focus on the written text.

**12.** When I solve math problems

**a)** I usually work my way to the solutions one step at a time.

**b)** I often just see the solutions but then have to struggle to figure out the steps to get to them.

**13.** In classes I have taken

**a)** I have usually gotten to know many of the students.

**b)** I have rarely gotten to know many of the students.

**14.** In reading nonfiction, I prefer

**a)** something that teaches me new facts or tells me how to do something.

**b)** something that gives me new ideas to think about.

**15.** I like teachers

**a)** who put a lot of diagrams on the board.

**b)** who spend a lot of time explaining.

**16.** When I'm analyzing a story or a novel

**a)** I think of the incidents and try to put them together to figure out the themes.

**b)** I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

**17.** When I start a homework problem, I am more likely to

**a)** start working on the solution immediately.

**b)** try to fully understand the problem first.

**18.** I prefer the idea of

**a)** certainty.

**b)** theory.

**19.** I remember best

**a)** what I see.

**b)** what I hear.

**20.** It is more important to me that an instructor

**a)** lay out the material in clear sequential steps.

**b)** give me an overall picture and relate the material to other subjects.

**21.** I prefer to study

**a)** in a study group.

**b)** alone.

**22.** I am more likely to be considered

**a)** careful about the details of my work.

**b)** creative about how to do my work.

**23.** When I get directions to a new place, I prefer

**a)** a map.

**b)** written instructions.

**24.** I learn

**a)** at a fairly regular pace. If I study hard, I'll "get it."

**b)** in fits and starts. I'll be totally confused and then suddenly it all "clicks."

**25.** I would rather first

**a)** try things out.

**b)** think about how I'm going to do it.

**26.** When I am reading for enjoyment, I like writers to

**a)** clearly say what they mean.

**b)** say things in creative, interesting ways.

**27.** When I see a diagram or sketch in class, I am most likely to remember

**a)** the picture.

**b)** what the instructor said about it.

**28.** When considering a body of information, I am more likely to

**a)** focus on details and miss the big picture.

**b)** try to understand the big picture before getting into the details.

**29.** I more easily remember

**a)** something I have done.

**b)** something I have thought a lot about.

**30.** When I have to perform a task, I prefer to

**a)** master one way of doing it.

**b)** come up with new ways of doing it.

**31.** When someone is showing me data, I prefer

**a)** charts or graphs.

**b)** text summarizing the results.

**32.** When writing a paper, I am more likely to

**a)** work on (think about or write) the beginning of the paper and progress forward.

**b)** work on (think about or write) different parts of the paper and then order them.

**33.** When I have to work on a group project, I first want to

**a)** have “group brainstorming” where everyone contributes ideas.

**b)** brainstorm individually and then come together as a group to compare ideas.

**34.** I consider it higher praise to call someone

**a)** sensible.

**b)** imaginative.

**35.** When I meet people at a party, I am more likely to remember

**a)** what they looked like.

**b)** what they said about themselves.

**36.** When I am learning a new subject, I prefer to

**a)** stay focused on that subject, learning as much about it as I can.

**b)** try to make connections between that subject and related subjects.

**37.** I am more likely to be considered

**a)** outgoing.

**b)** reserved.

**38.** I prefer courses that emphasize

**a)** concrete material (facts, data).

**b)** abstract material (concepts, theories).

**39.** For entertainment, I would rather

**a)** watch television.

**b)** read a book.

**40.** Some teachers start their lectures with an outline of what they will cover. Such outlines are

**a)** somewhat helpful to me.

**b)** very helpful to me.

**41.** The idea of doing homework in groups, with one grade for the entire group,

**a)** appeals to me.

**b)** does not appeal to me.

**42.** When I am doing long calculations,

**a)** I tend to repeat all my steps and check my work carefully.

**b)** I find checking my work tiresome and have to force myself to do it.

**43.** I tend to picture places I have been

**a)** easily and fairly accurately.

**b)** with difficulty and without much detail.

**44.** When solving problems in a group, I would be more likely to

**a)** think of the steps in the solution process.

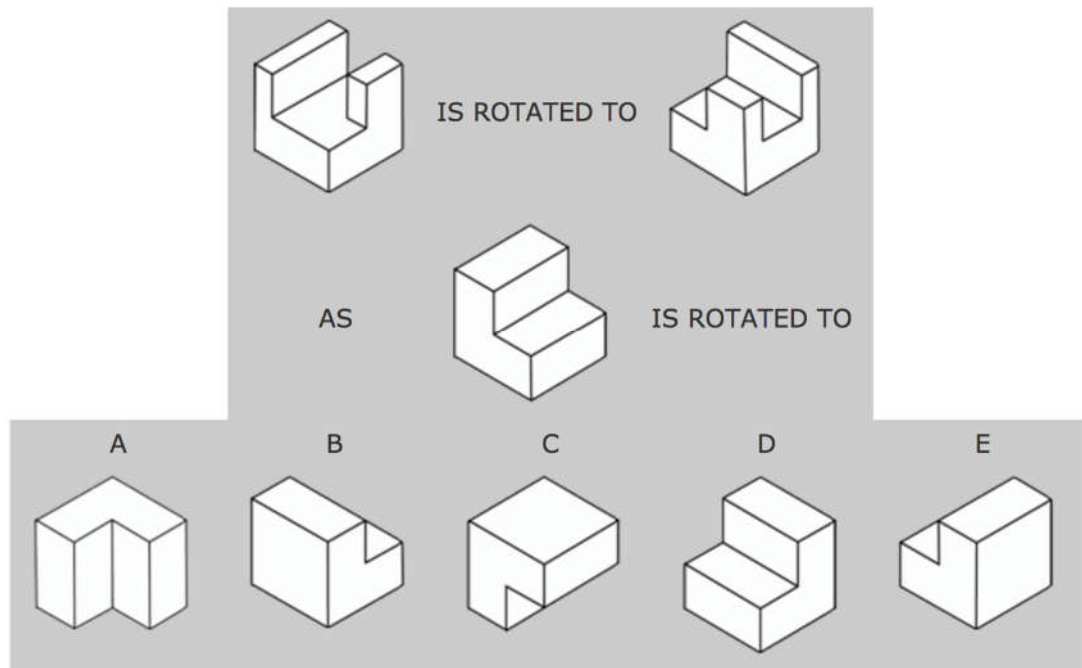
**b)** think of possible consequences or applications of the solution in a wide range of areas.



## Appendix 5 Part E – Spatial Ability Test

This test contains 30 questions designed to see how well you can visualize the rotation of three-dimensional objects. Shown below are two examples of the type of question that will be asked.

### EXAMPLE 1



You are to:

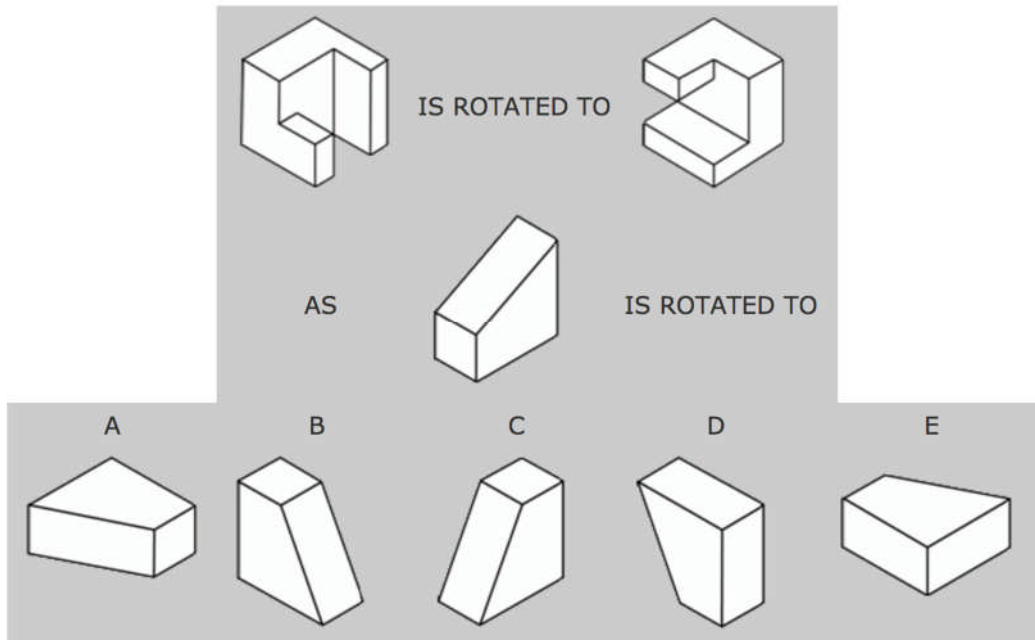
1. study how the object in the top line of the question is rotated;
2. picture in your mind what the object shown in the middle line or the question looks like when rotated in exactly the same manner;
3. select from among the five drawings (A, B, C, D, or E) given in the bottom line of the question the one that looks like the object rotated in the correct position.

What is the correct answer to the example shown above?

Answers A, B, C, and E are wrong. Only drawing D looks like the object rotated according to the given rotation. Remember that each question has only one correct answer.

## EXAMPLE 2

Now look at the next example shown below and try to select the drawing that looks like the object in the correct position when the given rotation is applied.



Notice that the given rotation in this example is more complex. The correct answer for this example is B.

### START THE TEST

You are now ready to start the test. In the test you simply select your answer and advance to another question. Your answer is automatically saved.

**IMPORTANT:** This is a timed test - once you click the button below you will have 25 minutes to complete the test.

### CLICK TO START THE TEST