CONNECTING TECHNOLOGY AND SENSORY DESIGN

A collaborative approach to designing university learning environments in a digital age

Submitted in fulfilment of the requirements of the degree of
Master of Applied Arts: Interior Design in the Faculty of Arts and Design
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ABSTRACT

This study explores how technology-enhanced learning (TEL) environments may be designed to stimulate the human senses. The research examines how interior designers can improve the design of learning environments to integrate seamlessly with emerging technologies, focusing specifically on how to provide students with an embodied and improved learning experience.

The research challenges the notion that a need exists to connect technology and sensory design. The aim was to discover how a collaborative design approach could be used to assist interior designers to overcome the challenges they face when accommodating technology and the senses in university learning environments. The study followed an action research approach, situated in the interpretative inquiry paradigm. The sample population was comprised of various professional specialists from South Africa and the United States of America. Online interviews, focus group discussions, reflection questionnaires and an academic research journal were used to gather data.

The findings describe and illustrate the challenges which interior designers face when designing learning environments in the digital age. To connect technology and the senses effectively, interior designers need to find a balance between integrating technology, stimulating the senses and encouraging collaborative learning. The study makes a strong case for a collaborative design approach when designing TEL environments, as the wider range of knowledge and skills leads to more informed decisions.

Keywords: Technology-enhanced learning, sensory design, collaboration, interior design

DECLARATION

I, Megan Parker, hereby declare that the work contained in this thesis is my own original work and that all sources have been accurately reported and acknowledged, and that I have not previously in its entirety or in part submitted it at any university in order to obtain academic qualification.

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CHAPTER 1

OVERVIEW OF THE STUDY

Design must find balance between the issues that technology and modern society have created while honouring primal desires, between the external world and the inner self, and between function and beauty. Good design is the result of a process that emerges from inside us and gives shape to what is around us.

- (Caan 2011: 33)

Chapter one presents the outline of this study. It will shed light upon the standpoint of the research and provide a general summary of the background information relevant to the topic. Vital research questions are clarified and problems of the study encountered are defined.

1.1 PURPOSE STATEMENT

Connecting technology and sensory design: A collaborative approach to designing university learning environments in a digital age.

1.2 BACKGROUND INFORMATION

Many universities around the world are excited about the potential of new technologies to improve students' learning experiences (Thompson 2013: 5; Coccoli *et al.* 2014: 1003). Moreover, at the height of a technology driven era, there has been an increasing body of knowledge that articulates how technological advancements can and should impact on learning space design (Milne 2006: 142).

Technology-enhanced learning (TEL) refers to how technology can be used to support and enhance learning (Kok 2009: 3) or how information and communication technologies are applied to teaching (Kirkwood and Price 2014: 1). These environments enable students to access a range of materials, learning tools and communication facilities. As a result of living in a technological age that is rapidly advancing, learning environments need to adapt to and accommodate emerging technologies (Thompson 2013: 5-8). However, as the future draws near, the effect of technology on various aspects of our lives continues to increase and, in turn, the challenge resides in

discovering how to combine technological advancements with fundamental sensual qualities (Breffeilh 2013).

Technology is known to assist learners in better grasping and understanding their studies (Keeling *et al.* 2012: 5). Yet it is rarely recognised or acknowledged as an appropriate tool to provide an embodied human experience for learners. Breffeilh (2013) emphasises that in the digital age in which we are living, it is common for technological implementation to overshadow multi-sensory design. Currently, there is more focus on universities being prompted by outside pressures, such as keeping up with technology, or the growing need for learning environments to be designed to evolve with technology as it changes (Collins and Halverson 2009: 1). The need for learning environments to accommodate emerging technologies that provide embodied learning experiences is gradually growing (Thompson 2013: 2). As a result, the challenge in today's society is not only learning how to keep up with technological changes, but rather how to orchestrate efficient change through design.

People have the ability to assess and perceive their surrounding environment through a range of senses (Henshaw and Mould 2013: 59). Therefore, human understanding of the world and the spaces designed within it, are clearly defined by the senses. Hence, interior designers need to be mindful of how learners gather sensory information through the design of the built environment. Sensory design explores how people respond to spatial constructs within the built environment and outdoor spaces (Malnar and Vodvarka 2004) and embraces the use of multi-sensory experiences (Bobby 2005: 88). However, Andreassi (2000: 273) highlights that only recently information has been gathered on how people respond to sensory spaces, because of new technologies and tools that support data collection and assessment of sensory designed spaces. As a result, sensory design has had very little impact on the implementation or design of such built environments thus far.

Interior designers need to consider how to keep students continually in contact with their physicality, as sensory perceptions are fundamentally linked to the process of how learners acquire knowledge and understanding. When focusing on giving students educational value, it is important to understand that learning is a complex, holistic, multi-centric activity (Keeling 2004: 5). The application of multi-sensory design is not an easy

task to delve into (Breffeilh 2013), and the process of design becomes more complex when considering both students' technology and sensory needs. Hence, there are many challenges that interior designers may face when designing technology-enhanced environments. For that reason, a collaborative approach was explored to discover if sensory design principles and guidelines could be established to assist interior designers. Interior designers often look to other professionals from various disciplines for information and practical guidance regarding how people experience their physical environment and how such environments must satisfy different human needs (Kaplan 1973: 275). With that in mind, I explore the effectiveness of a collaborative approach in assisting interior designers to provide technology enhanced learning environments that provide technology and multi-sensory learning experiences.

1.3 MOTIVATION FOR UNDERTAKING THE TOPIC

This study is based on my personal interest and academic motivation to explore how to create embodied learning experiences that are driven by emerging technologies. The research topic explores how technology and sensory design can connect, and closely examines how a collaborative approach can assist interior designers in overcoming challenges faced when designing university learning environments that provide multi-sensory learning experiences in a digital age.

The interior design of learning spaces in universities is intended to construct and shape learning experiences, whilst positively influencing how students interact with one another, and how they engage with the university environments (Blackmore *et al.* 2011). As a result, interior designers need to consider how to keep students continually in contact with their physicality as sensory perceptions are fundamentally linked to the process of how learners acquire knowledge and understanding. Although there is an endless range of opportunities that technology provides for creating new learning activities and experiences for the students of today, the major challenge presented to universities is in finding the right place for technology and ensuring that it benefits all students (Srinivas 2010). Therefore, by understanding the characteristics of TEL environments, sensory design principles and exploring the effectiveness of collaboration, interior designers may be able to improve learning space design and student academic success.

1.4 RESEARCH QUESTIONS

The following research questions guided the study:

- What challenges are interior designers facing when using technologies to enhance user experience in learning environments?

- What sensory design principles should an interior designer consider for technology-enhanced learning environments in universities?

- How can a collaborative design team assist interior designers to overcome technology and sensory design challenges in learning environments?

1.5. RESEARCH AIMS AND OBJECTIVES

The aim of this study is to explore how interior designers can provide for students' technology and sensory needs when designing university learning environments in the digital age. Moreover, while I was reviewing the literature I felt that there was a need to understand what challenges interior designers are facing when designing environments that need to accommodate both emerging technologies (Thompson 2013: 5) and multi-sensory learning experiences (Malnar and Vodvarka 2004).

There is a growing need for collaborative skills, to increase productivity and provide better quality projects (Sanker 2011: 4). Therefore, I use a collaborative approach to explore solutions to overcome the challenges interior designers encounter as they design technology-enhanced environments. The aim of the collaboration is to determine if the approach is effective in assisting interior designers and can be considered as a tool to establish sensory design principles and guidelines for university learning environments of the digital age that strive to connect technology and the human senses.

1.6. RESEARCH METHODOLOGY

Flowing from a review of literature in the areas of technology, sensory design and design management, a qualitative research approach that is situated in the interpretivist paradigm is adopted. Qualitative research strives for depth of understanding and

focuses on the experiences and perspectives of people that are socially constructed (Denby *et al.* 2008: 1). It is used as a means of inquiry into various dimensions of the social world, and gains insight into the everyday nuances of life and how the research participants act, feel or behave, and more importantly, the significance of the meanings that they conjure (Mason 2002: 1). Qualitative research can be described as characteristically exploratory, fluid, flexible, data-driven and context-sensitive (Mason 2002: 24). Moreover, the data generation process is considered intellectual, analytical and interpretative (Mason 2002: 52). In order to manage, shape and organize the data gathered I used a descriptive analysis in a bid to develop meaningful conclusions.

Secondary data is presented in the form of literature that specifically addresses technology-enhanced environments, sensory design and design management. To gain clarity and a deeper understanding of technology-enhanced environments of the digital age, I examine both local and international projects that are at the forefront of the digital and educational landscape.

I used purposive sampling to select participants as that meets predetermined criteria that were devised to answer the research questions (Given 2008: 562) and collected primary data in South Africa within the region of Durban, from online interviews, focus groups, reflection questionnaires and a research journal. The various specialists were chosen through purposive sampling as it offers a variety of professional advice and intellectual diversity. I selected eight participants to complete the pilot online interviews. Thereafter, four industry professionals with experience in designing technology-enhanced environments in South Africa and internationally were selected to complete the online interviews. The online interviews were semi-structured and included both open-ended and closed questions and were either distributed by hand or sent via e-mail. I then conducted two focus groups and a one-on-one meeting with a collaborative design team that consisted of a quorum of seven participants. The design team was used to explore whether or not a collaborative approach could assist interior designers in overcoming the challenges they face whilst informing how technology-enhanced learning environments can be more in touch with the human senses.

The focus groups were conducted at the Durban University of Technology (DUT) City Campus library, located in Kwazulu-Natal South Africa, and were used to yield insight

on the collaborative design process as opposed to the outcome (Barbour 2007: 30). At the completion of the first focus group discussion, reflection questionnaires, with open-ended and closed-ended questions, were distributed to the design team participants in order for them to describe their experience and opinions of a collaborative approach. Thereafter one-on-one meetings took place at the design team participants' respective working or learning environments to critique the practical result of the collaboration, which was a conceptual design of a university academic hub situated in Cornubia, KwaZulu-Natal (KZN). Essentially, focus group two was used to discuss and evaluate the effectiveness of the collaborative approach in improving the design.

I decided to use an action-reflection approach as it can be a powerfully liberating form of research enquiry that focuses on investigating and explaining the process of improving practice (McNiff and Whitehead 2009: 7; Kumar 2011: 131). Researchers who use their knowledge to conduct systematic enquiries that aspire to find solutions to problems, find it to be a suitable approach (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 203). Moreover, action research is considered to be appropriate for studies that have a dual focus concerned with changing social practice and developing academic theory to improve conditions (Dahlberg and McCaig 2010: 99). As design is experiential at its very core (Martin and Guerin 2010: 139) the integration of research in a reflective practice can give participants and researchers the opportunity to:

- Impact design decision making during the design process
- Document the findings, and
- Contribute to the larger body of knowledge within the profession of interior design

1.7. ETHICAL CONSIDERATIONS

To protect the wellbeing and confidentiality of the research participants, their identities were not included if they requested to be anonymous. Furthermore, I made an effort to appropriately conduct the research whilst maintaining a professional relationship with all participants in order for us to interact with care and mutual respect for one another. In line with the DUT code of ethics, an approval for ethical clearance was submitted as part of the research proposal. In addition to the ethics checklist submitted with the proposal, no research commenced until full permission was granted by the DUT's Institutional Research Ethics Committee (IREC). I also made a conscious effort to act

with integrity when dealing with people involved in this study by adhering to the following guidelines suggested by Mouton (2001: 244):

- Obtain consent from all participants prior to conducting the online interviews and focus groups
- Provide comprehensive outline of the research process, including online interview and focus group guidelines
- Consider the rights of all the participants
- Assure all participants that their confidentiality is respected
- Confirm that the participants would be protected from any harm
- Confirm that the participation in the study was voluntary and that the respondent may choose to opt out at any stage
- Explain that there were no risks involved
- Thank them for their participation

All participants were given options as to how they would like the data to be handled concerning anonymity and confidentiality, which included their name, the name of the project, and the name of their company. I also made an effort to ensure that the structure of the report is an honest representation of the findings based on the research study's outcome.

1.8 CHAPTER OUTLINE

The structure of this study consists of the following five chapters:

Chapter one: Overview of the study

Chapter one outlines the context of the study and I discuss the relevance of, and need to undertake the research. The study aims are defined and the research questions and objectives are addressed. An overview of the research methodology employed, ethical consideration, limitations and dissertation structure are also presented in chapter one.

Chapter two: Literature review

Chapter two presents a review of the literature concerned with the characteristics of TEL environments in a digital age, and I discuss the relationship between technology and sensory design in a bid to find ways to use emerging technologies to encourage multi-

sensory learning experiences. Existing theories are introduced that seek to contribute towards the establishment of sensory design principles and guidelines for TEL environments. I then conclude Chapter two by analysing whether a collaborative approach can be used as a tool to overcome challenges interior designers face when accommodating students' technology and sensory needs.

Chapter three: Research methodology

In chapter three I describe the research design and methodology adopted to answer the research questions. Reasons why a qualitative research approach situated within an interpretivist paradigm was appropriate for the study are discussed and the rationale for employing an action research approach is explained. Chapter three also provides a description of the chosen sample population, process of data collection, and how the qualitative data will be analysed.

Chapter four: Findings

Chapter four presents the findings of the study and discusses how the data are analysed. Essentially, the findings are analysed in relation to the research questions and objectives of the study. I discuss the research participants' perceptions, beliefs, attitudes, professional knowledge and understanding of how to better connect technology and the senses in a digital age in a bid to improve university learning environment design and student academic experiences. The challenges interior designers face when trying to improve user-experience of technology-enhanced environments are identified and the practical concept design is discussed. In turn, sensory design principles and guidelines for the design of TEL environments are established.

Chapter five: Conclusions

Chapter five provides an overview of the research study, answers the research questions, and presents the conclusions that I reached as a result of the key findings. Recommendations are then offered to interior designers, architects, product suppliers, manufacturers and other professionals who may be involved in the design of higher education institutions.

1.9 LIMITATIONS

Firstly, considering the nature of qualitative studies, it is usual to discover limitations that may hinder or alter the results of the research. A common disadvantage of a qualitative approach is that the findings cannot be extended to wider populations (Atieno 2009). Moreover, it is common for qualitative findings to be established based on the researcher's personal interpretation of the data gathered. For that reason, it would be unrealistic for me to consider the data interpretation to be objective. However, in a bid to strive for fairness and honesty I conducted this study by following a strict ethical code as set out in chapters one and three, but limitations cannot always be avoided and will influence the findings of the study.

Secondly, with regard to the online interview data collection strategy, not all participants were able to complete the online interview telephonically. Students and their experiences or perceptions of technology in learning environments were not fully explored, thus, providing less insight of their end-user experience. Some participants were only able to respond via email due to time constraints and busy work schedules. Hence, it was not possible to be fully immersed in the participants' environment and to analyse or further explore their views, feelings and responses to the research questions. It is also not possible to be spontaneous when exchanging online interviews via e-mail, as it is not conducted in 'real time'. This means that the conversation was not flexible or easy flowing in a way that may lead the interview into different directions or a deeper understanding. Furthermore, online interviews do not cater for participants who feel more comfortable expressing themselves verbally, rather than writing their responses.

Thirdly, planning for the collaborative design team to agree on meeting dates was more time-consuming than planned, and some participants had busier schedules than initially assumed. Therefore, it was challenging to co-ordinate dates and times that suited all the participants. This meant that it was not possible to gain full access to as wide a range of participants as initially planned. In addition, during the discussions, some participants' voices demanded more attention than others, and the overall analysis of the data and reporting of the findings took a considerable amount of time to complete due to the complexity of the research topic.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the relationship between sensory design, technology and a collaborative design approach is closely examined in order to establish guidelines that interior designers can use when designing TEL environments that provide for the senses. The following diagram illustrates the three pivotal parts that are examined in an attempt to achieve the above objectives:

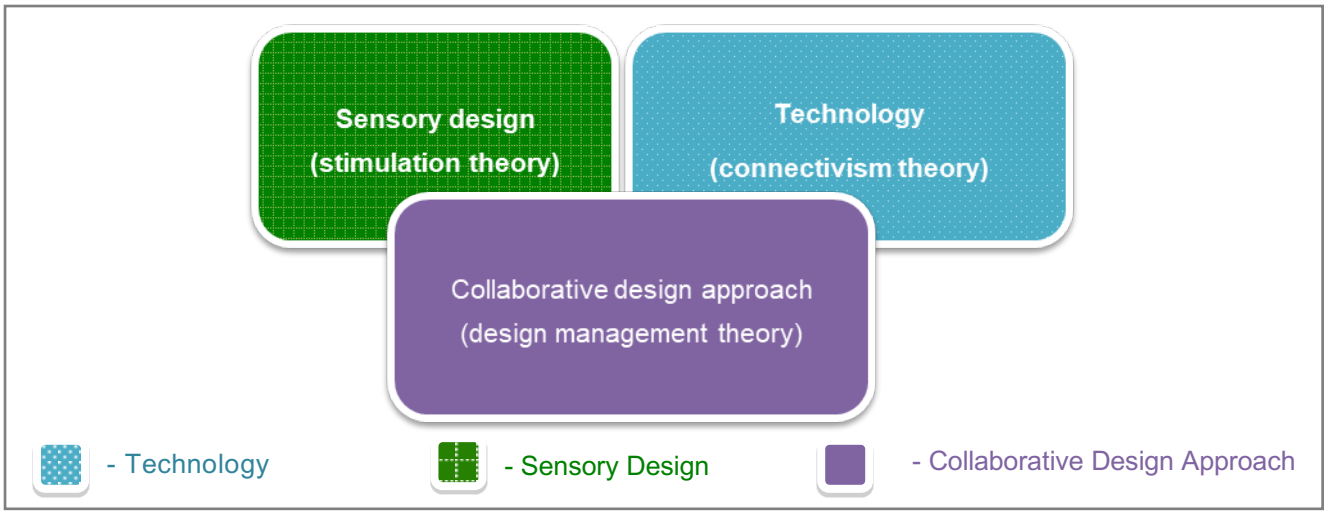

Figure 2.1.1 Literature review objective

In light of the diagram, the literature review is guided by the following research study questions:

- Question 1:
  What challenges are interior designers facing when using technologies to enhance user experience in learning environments?

- Question 2:
  What sensory design principles should an interior designer consider for technology-enhanced learning environments in universities?

- Question 3:
  How can a collaborative design team assist interior designers to overcome technology and sensory design challenges in learning environments?

Chapter two is divided into the following three parts[1]:

- Part 1 - Technology-enhanced learning environments
- Part 2 - Supporting principles of sensory design
- Part 3 - Innovation through collaborative design

Part one highlights the emerging technologies in a digital age, which focuses on the impact of technology and digital learning resources on student interaction and stimulation of the senses within university learning environments. In an attempt to explore how sensory design and technology can integrate seamlessly, the literature review analyses the characteristics of TEL environments and whether or not technology is serving as a tool to provide students with an embodied learning experience.

Part two addresses sensory design principles interior designers could consider when designing TEL environments.

Part three discusses the importance of design management, specifically exploring the use of a collaborative design approach to potentially assist interior designers in overcoming challenges in accommodating technology and the senses when designing TEL environments. The literature review then analyses whether or not interior designers should consider a collaborative design approach at the early stage of design conception.

The three parts aim to unravel some of the mysteries surrounding how interior designers can connect technology and sensory design in university environments using a collaborative approach. Due to the complexities of each part that will be addressed, the theoretical basis for the study is not derived from a single theory in isolation, but comprises a blend of selected aspects taken from the three theoretical frameworks as illustrated in Figure 2.1.1. As the study specifically focuses on how technology should be used as a platform to encourage multi-sensory learning experiences, the connectivism theory and stimulation theory naturally play a dominant role in outlining the research structure.

[1]Although the three parts will be examined separately at times links or connections between the parts will be assessed either in discussion or through the assessment of other projects that provide evidence of a relationship between technology, the senses and, collaboration.

Figure 2.1.2 below provides a clear overview of the intended review of literature:

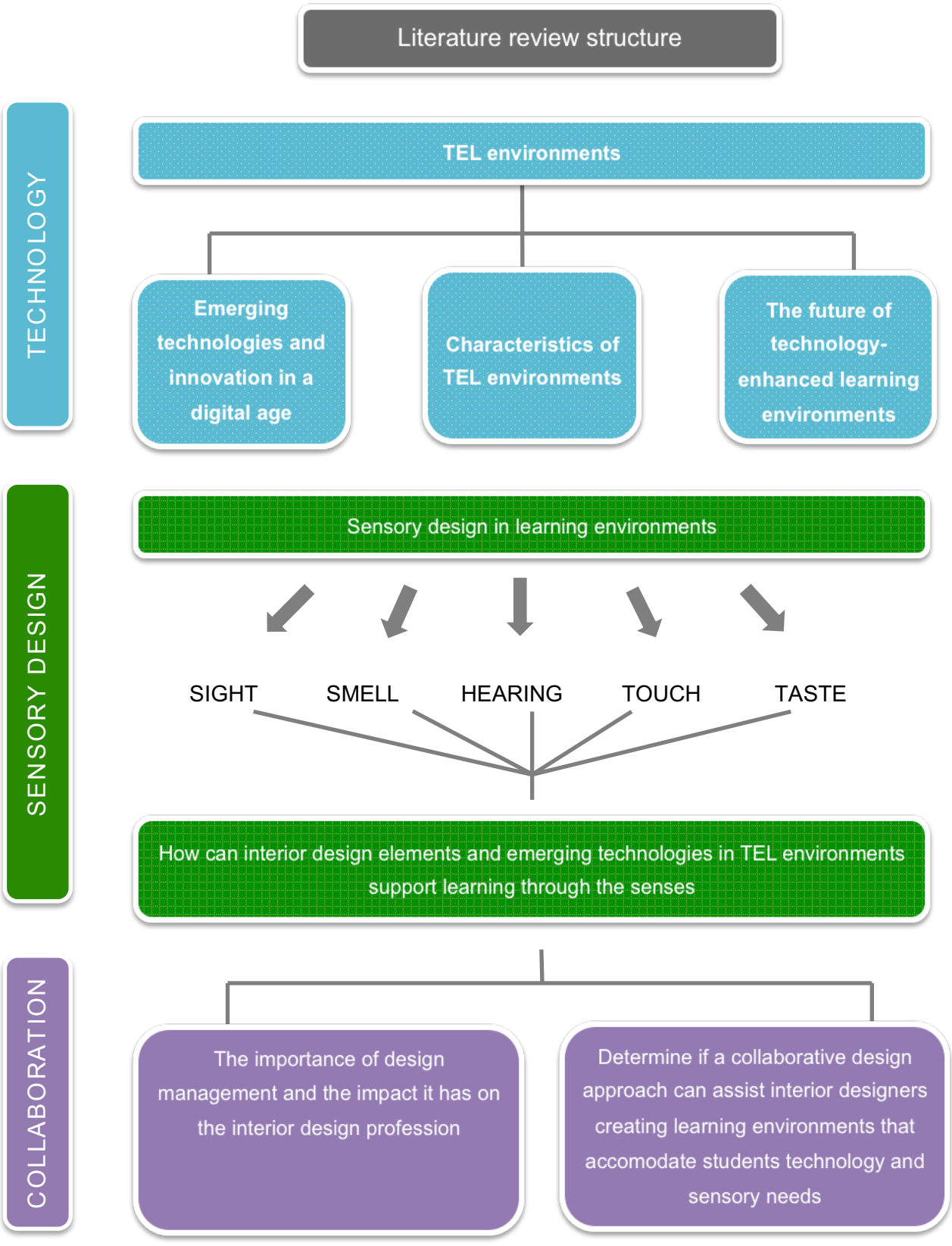

Figure 2.1.2 Structure of the literature review

PART ONE

TECHNOLOGY

In order to gain a deeper understanding of technology-enhanced university learning environments in a digital age, it is important for the discussion to:

- Firstly, examine emerging technologies and their impact on student interaction, learning experience and sensory stimulation
- Secondly, closely examine the characteristics of TEL environments
- Thirdly, analyse connectivism as a learning theory and future technology trends

2.2 EMERGING TECHNOLOGIES AND INNOVATION IN A DIGITAL AGE

Today's world is changing rapidly, and as a result of the development of technology, so are the environments in which we live, work and study. JISC (2006: 5) explains that the growing influence of technology within educational institutions is having a major impact on how learning environments need to be designed. It is a widely held view that social issues, recent innovations and emerging technologies are changing the way that people acquire knowledge on a day-to-day basis, which, in turn, is reshaping traditional methods of teaching and learning (Coccoli *et al.* 2014: 1004). We are living in the most remarkable times, although naturally as a result of technological advancements certain challenges are presented. According to Duderstadt (2000: 3) the "digital age" will manifest extraordinary implications that will offset the most profound changes that universities will experience. Traditional learning environments are gradually being replaced by more suitable and efficient learning experiences that integrate seamlessly with technology in order to accommodate today's university students' learning preferences (Gibson and Sodeman 2014: 64).

2.2.1 Considering emerging technologies in learning environments

According to Warger and Dobbin (2009: 3) a "learning environment encompasses learning resources and technology, means of teaching, modes of learning, and connections to societal and global contexts". Moreover, the term 'learning environment' is also comprised of other factors and influences, such as the significant role of human emotion, behaviour, and culture (Warger and Dobbin 2009: 3). One of the most

significant current discussions surrounding learning space design is the need for universities to re-think the critical role of technology and its impact on teaching and learning (Resnick 2002: 32).

Students are living in a technology-driven society that is evolving rapidly (Resnick 2002: 32). One cannot deny that the technologies today's students are using to learn are dramatically changing the way that they collect, manipulate, and transmit information (Resnick 2002: 32). Consequently, in order for students to thrive in the digital age, technological tools are needed to assist in completing study tasks efficiently, effectively and timeously. Due to the technological learning tools students use to study, that is, laptops, smart phones, tablets and so forth, students themselves have forced a paradigm shift of technology-enhanced learning on universities (Duderstadt 2000: 6).

New Media Consortium (NMC) emphasises that universities are progressively competitive, and in order to optimise their capacity, it is vital for campuses to constantly review and upgrade their infrastructure (Johnson *et al.* 2015: 10). On the other hand, Hartman, Moskal and Dziuban (2005: 66) affirm the notion that the growing influence of technology in the digital age will bring about challenges that higher education will have to face, such as the gap that is growing between many institutions' information technology (IT) environments and the technological tools that the "Net Generation" use in their everyday lives. More importantly, it is suggested that such difficulties can lead to a host of new concerns, namely the following:

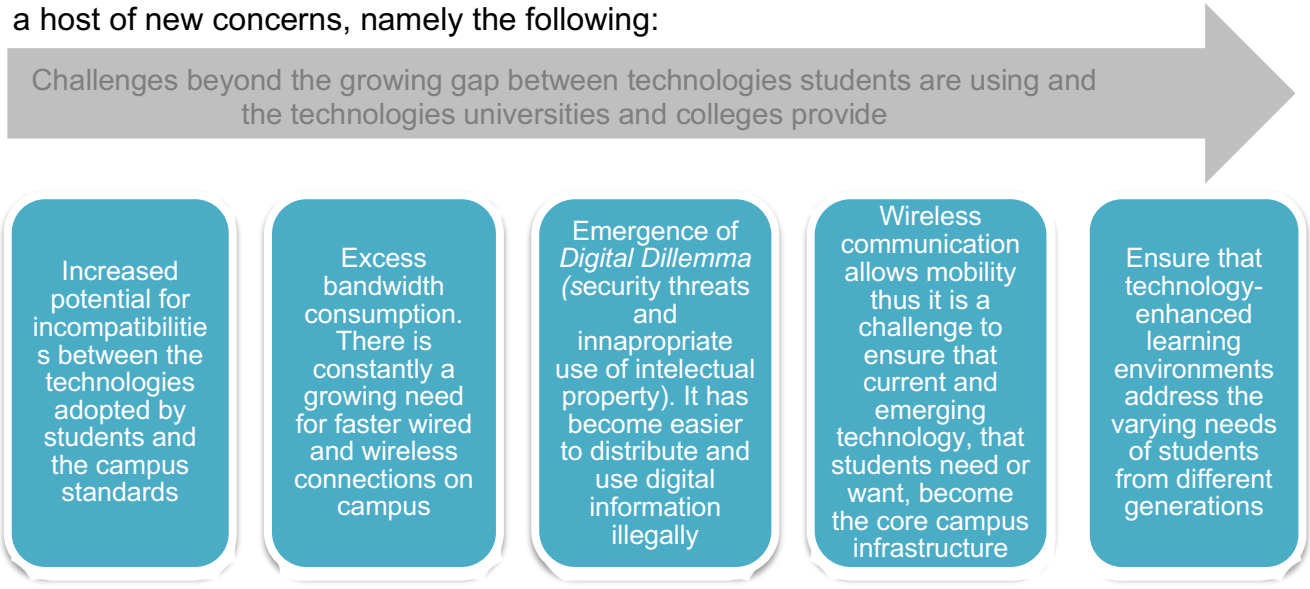

Figure 2.2.1.1 Increase in university challenges as a result of emerging technologies. Adapted from Hartman, Moskal and Dziuban (2005: 70)

The challenges mentioned by Hartman, Moskal and Dziuban (2005: 70) above suggest that learning environments are designed to accommodate new emerging technologies in an attempt to avoid the gap from widening further.

2.2.2 The universities' response to the current rapid development of technology

It is vital that universities are able to adapt and provide students with academic environments that have new learning devices. More importantly, learning environments need to be flexible and should accommodate for changes that are still to come. A broader perspective has been adopted by Laurillard *et al.* (2009: 292) who clearly explain the reason why innovation is an area of concern regarding research on TEL:

> "The context of implementation for TEL research is an education system that is changing, but not changing fast enough. Learners are being prepared for a world in which technology is increasing the speed of innovation and change, but they are being prepared by an educational system that is not oriented towards rapid change in the way it is managed and operated. TEL systems could help education adapt to a world that is rapidly changing in response to technology."

The above statement reveals a widely shared perception that there is a slowness of reform and resistance to innovation in society, or possibly among policy makers and external stakeholders. The statement also highlights that the educational landscape finds it challenging to keep up with technology.

There is a growing need for learning environments to be designed to evolve with technology as it changes (Collins and Halverson 2009: 1). The Joint Information Systems Committee (JISC) is a company from the United Kingdom that informs universities how digital technologies may improve research, teaching and learning (JISC 2015). JISC (2006: 10) affirms that embedding technology into learning and teaching spaces is becoming more of an evolutionary process than a revolutionary one. Perhaps universities are being prompted by outside pressures, such as keeping up with technology and meeting student demands to make advances towards more digitally-rich 21st century learning environments. Recently, great emphasis has been placed on

designing learning environments that meet and support students' ever-changing needs (Coccoli *et al.* 2014: 1004).

Researchers have been increasingly interested in the way technology is having an impact on learning, mainly focusing on Generation Y, also known as the "millennials" or "Net Generation", and Generation Z who are their successors. Researchers are trying to explore and understand why the educational system is not designed to teach students of today due to the rapid dissemination of digital technology (Prensky 2001: 1; NIU 2012: 1; Groff 2013: 1). The increase in interest in the millennial generation is because these students are the newest generation in higher education. Interestingly, many of the descriptions used to describe the millennials seem to go hand-in-hand with technology and the influence it has on their personal, cultural and academic lives:

> "Kids these days. Just look at them. They've got those headphones in their ears and a gadget in every hand. They speak in tongues and text in code. They wear flip-flops everywhere. Does anyone really understand them?" (Hoover 2009 cited in Gibson and Sodeman 2014: 3).

The above describes the millennials as a generation known for their multi-tasking abilities and simultaneous utilization of numerous technological devices. However, it is not only the millennials who have been classified according to the way they act, the clothing they wear, or how tech savvy they are. Every generation has their own identifiable characteristics, where certain cultural events have influenced their perspective on life (Gibson and Sodeman 2014: 3). Consequently, how universities try to accommodate each generation is important, as it may shape how they view the world socially, culturally and academically. Interestingly, Hartman, Moskal and Dziuban(2005: 66) point out that Generation Y and Generation Z are the first generation to have grown up surrounded by digital and electronic technology devices such as computers, video games, digital music players, video cameras, smart phones, IPads, laptops etc. which have gradually become an important part of their daily lives.

Hartman, Moskal and Dziuban (2005: 67) confirm that as a generation matures, the technologies that they are exposed to over time influences their behaviours, attitudes, and expectations. Warger and Dobbin (2009: 2) point out that technology and the way that

learners are taught will only continue to evolve, hence, the challenge for interior designers to create effective learning environments is essentially a journey and not a destination. Hirsch and Weber (1999: 42) and Prensky (2001: 1) explain that a re-conceptualisation is being provoked as today's students have spent their entire lives surrounded by robust technological tools where learning environments that provide digital engagement are found to be effective. Figure 2.2.2.1 shows the technological learning tools students of the digital age have adapted to using:

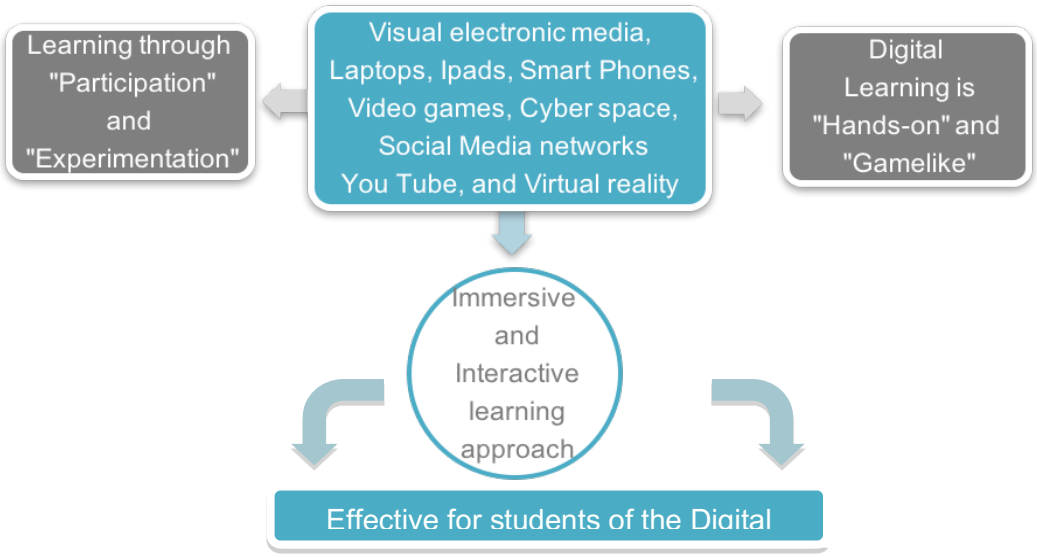

Figure 2.2.2.1 Learning technological tools for students of the digital age (Oblinger 2015).

Students of the digital age live in a highly interactive world whereby a technological culture has developed and influenced the way millennials and other generations approach higher education (Gibson and Sodeman 2014: 66). The emergence of social media has also influenced the way people learn and use their knowledge across shared environments in a trendy collaborative way (Coccoli *et al.* 2014: 1004). However, Gibson and Sodeman (2014: 66) believe there are various other human factors that affect the entire educational process. Which include that students of the digital age have different learning styles.

The Visual, Auditory, Reading and Kinaesthetic Learning model (VARK) as supported by Neil Fleming, identifies that students have preferences for different learning styles (Dirksen 2012). The VARK model suggests that people lean towards learning styles such as visual, auditory, reading and kinaesthetic learning and may learn better once identifying which learning style or styles suits them best (Dirksen 2012). Dirksen's (2012) discussion acknowledges that students do have different learning styles which can affect

how they learn or behave, however, also notes that there is much debate around assessing and evaluating if it does or does not increase students learning value.

Duderstadt (2001: 8) holds the view that technology will only have the greatest impact on the universities educational landscape once students' learning experiences are reconceptualised to encapsulate the full power and potential of technology. However, there is more to technology-enhanced learning environments than technology itself. According to Coccoli *et al.* (2014: 1004) it is not just technology alone that will assist universities in surviving the digital age. Technology can only help universities to a certain extent when looking for ways to cope with adapting to student needs of the digital age. Now a much-debated question is whether there is a need for a paradigm shift to transform smart universities into *smarter universities*. The following Figure illustrates the vision for *smarter universities*:

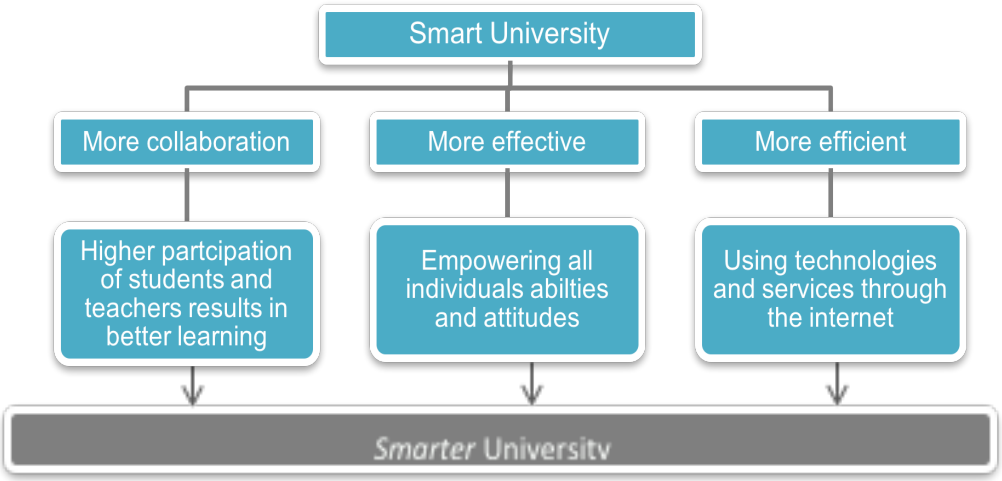

Figure 2.2.2.2 Transforming a smart university into a *smarter university* (Adapted from Coccoli *et al.*2014: 1004).

The term "smart" is associated with devices that have computing or network capabilities (Coccoli *et al.* 2014: 1003). Figure 2.2.2.2 above depicts the idea of Coccoli *et al.* (2014: 1004) which is in support of smart universities that can react instantly to change that is unexpected, and can provide technology rich environments that are effective for today's and tomorrow's learners. There is emphasis on the need for a more flexible education model, suitable for interactive learning environments where students can collaborate.

2.2.3 The culture of learning in a digital age

As new technology emerges, students' digital expectations will continue to rise (Marstio and Kivelä 2014: 67). Students have developed their own learning culture that stems from

the highly connected and interactive digital world they are accustomed to (Coccoli *et al.* 2014: 1004; Keppell, Suddaby and Hard 2015). Consequently, students now expect technology to be present in all aspects of their lives (Devine 2013). Such digital expectations do not exclude academic life on campus. Most students of today expect their universities to have the same high-speed availability and access to digital resources that they are accustomed to using at home. Warger and Dobbin (2009: 2) say that it is important for universities to work towards understanding what type of learning culture exists on campus today and what culture needs to be cultivated for future students:

> "Learning is always embedded in cultural environments. Learners carry their cultural commitments with them. The most effective learning strategies pay keen attention to these conditions, shaping strategies to draw on the mobilizing possibilities of learning cultures and environments. Cultural conditions have shifted in the wake of new digital technologies and the possibilities they have unleashed. These cultural shifts pose significant challenges for learning. It is time to reconsider the nature of learning institutions – what they look like, how they operate, and how they can be transformed and supported in new distributed configurations."
> - (Warger and Dobbin 2009: 2)

Therefore, to design effective university learning environments in the digital age, it is imperative to ensure that the technologies implemented and activities that occur are appropriate to the way students view learning. As universities come to grips with the rapid development of technology and the shifts of the local and global economies, there has been considerable debate as to whether the university will survive the digital age (Huff 2000: 635; Duderstadt 2001: 3; Brabazon 2013: 19; Davies 2014: 1).

2.3 CHALLENGES DISCONNECTING TECHNOLOGY AND THE SENSES

For those writing on the senses from the educational terrain, the sensory relation to the world is a subject for analysis, as are the many ways that technology has come to influence student learning, culture, and user experience. The digital age is upon

universities, and the way in which students engage with technology may influence the way they learn.

2.3.1 The influence of technology on end-user experience

There has been a substantial amount of literature surrounding the impact of technologies on learning, teaching and classroom transformation (Thompson 2013: 33; Gibson and Sodeman 2014: 63; Kemm-Stols 2014: 3; Kirkwood and Price 2014: 24; Johnson *et al.* 2015: 7; Keppell, Suddaby and Hard 2015). Yet, there has been little examination of how technology used in universities should remain focused on the human body through multi-sensory learning experiences. Instead, the majority of such literature resided in the field of Architecture (Hall 2008: 13; Caan 2011: 38; Keeling *et al.* 2012; Breffeilh 2013; Henshaw and Mould 2013: 57).

Thus, an extensive range of sources was analysed to find the most recent challenges[2] concerning technology and how it can negatively impact students' user experience regarding their senses or abilities to learn.

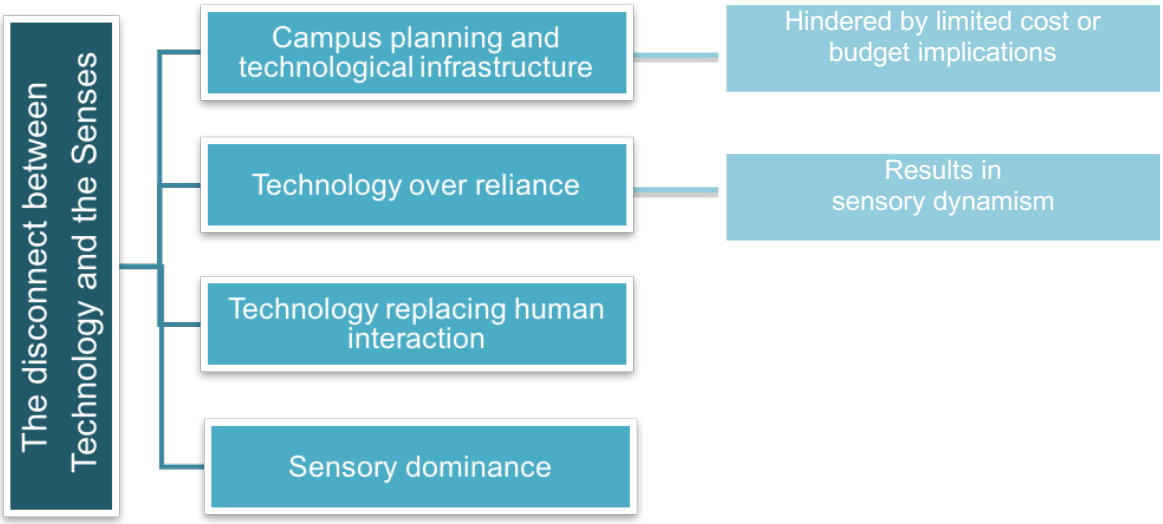

Figure 2.3.1 Disconnect between technology and the senses

[2]These 'challenges' are considered 'disconnects' which are important to assess and consider because it may be possible that the only way to forge a stronger connection between technology and the senses is to pay close attention to where there is a lack of connection and therefore focus on how to improve it. This concept is similar to the idiom "a chain is only as strong as its weakest link".

2.3.2 Campus planning and technological infrastructure

Many universities around the world are enthusiastic about the potential of new technologies to improve student academic potential and are spending large amounts of money to improve technological infrastructure (Ramaley and Zia 2006; Davidson, Goldberg and Jones 2010: 14; Johnson *et al.* 2015: 34). Yet there is little published data on the relationship between technology-enhanced learning and students' sensory needs. According to Lomas and Oblinger (2006: 62) students spend a substantial amount of time during their academic lives in and around campus as it is where learning takes place. Therefore, the way that these environments are designed will bestow a feeling of the campus culture upon learners. The connections students make with their faculty and other students are often the most memorable college experiences (Lomas and Oblinger 2006: 68). Such connections are not only verbal or spatial but they may also be visual, auditory, haptic, olfactory, and even gustatory.

Alternatively, it is not only sensory cues that can create meaningful experiences. Technology has the ability to forge important connections for students, whereby virtual and online platforms allow students to collaborate with other students and lecturers who cannot be physically present (Lomas and Oblinger 2006: 69). However, as technology has advanced over the years, universities are expected to adopt a hard budget line to support the purchase, maintenance or use of technology on campus (Clayton-Pedersen and O'Neil 2005). It is a double-barrel challenge, as the technological infrastructure is costly to implement and can be equally as costly for universities to keep up with the rapid advancements.

There has been an increasing sense that new technology will have a profound impact on the universities' educational activities and how their learning environments are designed. However, questions have been raised about whether the educational system or design of the university infrastructure within the digital age is still appropriate and provides for students' technological needs (Prensky 2001: 1; Warger and Dobbin 2009: 8; Gibson and Sodeman 2014: 66; Kemm-Stols 2014: 23). Students of the "digital generation" use technology as a platform to learn wherever and however they want, to create the learning experiences that they need. More importantly, it is vital to explore where or how to implement technology, as well as to discern trends that will allow for future-directed planning and design (Warger and Dobbin 2009: 6).

2.3.3 Technology over-reliance

Digital technologies and the internet have the ability to amplify human potential (Luke and Hunsinger 2012: 67). However, in the last few years there has been much debate about whether it has become detrimental to humanity (Caan 2011: 33; Laroya 2011; Brandon 2013). Although many digital innovations have come into existence, these rapid developments have also led to a rise in fear regarding the impact that technology has on the senses, and the way we interact with people or connect with the surrounding world.

Laroya's (2011) thoughts on human interaction and how technology can easily connect or disconnect people, provides useful insight. Light is shed on how people have become so accustomed to using technology to communicate that more time is invested in having an online presence than a physical one (Laroya's 2011). Although technology provides a platform for people to connect, it also provides a false sense of fulfilment from superficial online interaction (Laroya 2011). As a result, Laroya (2011) suggests that relying on technology often strips away personal face-to-face interaction, which can make people feel isolated or as if their connection with another person is less genuine.

It is no surprise that the over use of technology may have negative repercussions on the end user physically or mentally. One of the negative impacts as a result of technology-over use is "Sensory Dynamism" which is a term used by Neema Moraveji, that concerns the interrelation between sense of perception and sensory stimulus (Chakrabarti, 2014: 509).

Moraveji explains that technology may hinder people's "sensory judgement" as it does not display feelings or emotions, instead digital screens are flat surfaced and only provide the illusion of three-dimensional perspective (cited in Brandon 2013). As point of illustration Chakrabarti (2014: 509) states that people can percieve a sense of depth, colour, sound or feeling when looking in the distance or at scenic views, however, when looking at tablets, computers, laptops and other technological tools the brain and eyes are limited to perceive only a few variables in terms of stimulus. Moraveji also reveals that technology over use leads to feelings of isolation or disconnection, where people

will prefer to work on their own instead of in a group (cited in Brandon 2013). Moreover, Neema Moraveji clearly describes the correlation between sensory stimuli and learning:

> "I describe the brain as an organ whose job it is to learn through its physiochemical and cognitive senses. Without sufficient dynamism, the brain becomes focused on particular senses and inputs that are not representative of the natural world." (Neema Moraveji cited in Brandon 2013).

In-depth understanding of how sensory dynamism impacts student learning is still lacking, however, Moraveji is the director of an inter-disciplinary group of scholars, designers, and builders from Stanford University, called *The Calming Technology Lab,* who are currently looking towards discovering new ways to add more sensory stimuli to various technological devices. These discoveries strive to address the growing concern of over-reliance on computer technology that contributes towards dehumanisation.

On that account, universities becoming increasingly technology-enhanced should look toward creating learning environments that follow a human-centred design approach (Coccoli *et al.* 2014: 1004). Drawing on the concept of Sensory Dynamism, Fox News (2014) lists "single plane eye strain" as the third top tech ailment of 2014 and beyond. Staring at a screen on a daily basis causes the eye to focus on the same plane, resulting in pupil dilation and strain. It has become a serious problem that is caused by the over-use of computers and smart phones in today's digital society (Fox News 2014). Furthermore, there is a growing concern that people are increasingly relying on computers to determine what is true, and as a result may lose their ability to retain as much tacit knowledge or internalized information that is acquired though one's own insight or intuition (Ige 2013: 10). If the technology being used in the design is not fully considered it may have a counter effect, and if we do not consider the social impact of technology use, we will be failing students in many ways (Cotten 2008).

Technology has the ability to advance people's quality of life if the right attention and concern is given towards technology use and implementation (Srinivas 2010). However, people are living in a society that embraces technology without fully understanding the long-term repercussions of their decisions (Grohol 2009). Although it simplifies our lives, assists us in acquiring information, and enables us to make better-informed decisions,

the major drawback of technology reliance is that as people's demand for information increases, our infrastructure often fails to keep up with the pace (Grohol 2009).

2.3.4 Technology replacing human interaction

In light of the unprecedented use of technology, the debate about disembodiment has gained fresh prominence with many arguing that technology may be replacing personal interaction. Nilles (2012) says technological detachment is becoming a reality that is diminishing the quality of social interaction that we need as human beings. Discussions in the past few years have focused on how technology is distracting us from real-world interaction with one another (Cafferty 2011; Nilles 2012; Couros 2014). Cafferty (2011) questions whether technology has fostered or hindered human interaction in the digital age regarding how people have become disconnected to the real world. It is noted that some technological devices occupy the mind to a point where we have become accustomed to tuning out the people who are in the same room as us (Cafferty 2011).

Conversely, technology also allows people to stay in contact with friends and family. Cafferty's (2011) post sparked nearly 200 responses from online readers who joined the debate about whether technology has a positive or negative impact on how people interact in person. I found that the comments were imperative to the study as it provided insight on how technology may connect or disconnect students from interaction (see Appendix L).

The underlining problem at the forefront of the issue is that technology has given us great opportunities to connect, see and learn, but very often the ease of use and accessibility leads people to take advantage (Couros 2014). For that reason, Cafferty (2011) underlines the importance of remaining connected with people in person as opposed to relying on technology to substitute personal interactions. Learning environments may therefore need to encourage both personal and virtual engagement. As technology continues to advance there is also a growing need for people to find a healthy way of dealing with 'digital overload'. Kiss (2013) indicates that revival of the mind and meditation movements is growing in interest as people try to escape the 'technology craze'. The growing interest in clearing the mind suggests that some people need to achieve 'digital detox' in order to cope with the digital age.

2.3.5 Sensory dominance

Extensive research on the senses regarding the human body has been carried out over many years. To better understand the origins of sensory dominance, Malnar and Vodvarka (2004: 11) and Kearney (2014) discuss the basis of western philosophy concerning ancient Greek philosophers *Aristotle* and *Plato's* ideas on the most prevalent sense. In terms of primacy, *Plato* considered sight as the fundamental basis of philosophy, and *Aristotle* believed sight was the most dominant or highly developed sense (Everson 1999:16; Malnar and Vodvarka 2004:11: Kearney 2014). Sight was viewed as a way to enlighten one, visually bringing new understanding or perception to light. Although *Aristotle* considered sight as the most important sense, he still felt that touch was significant (Kearney 2014). Kearney (2014) maintains that sight continues to rule today by stating that "the world is no longer our oyster, but our screen (is)", which insinuates that vision is the most dominant sense of the digital age. Hence, the belief that sight is considered the primary sense is not surprising and seems to have derived from a hierarchy of senses which date back to the early history of philosophy. Kearney (2014) believes that touch screens may be replacing 'touch' itself as cyber engineers are looking towards the possibility of implanting transmission codes in the human brain for people to provide 'touchless' input. That way people can get what they want without having to put their fingers to touch screens or coming in contact with other people.

However, full humanity requires the ability to sense and be sensed in turn, as there is growing disembodiment and physical disconnection that is caused by technological advancements (Kearney 2014). Kearney (2014) underlines the impact of technology on intimacy within relationships by stating that there is a need to reconnect with our senses:

> "We need to find our way in the tactile world again. We need to return from head to foot, from brain to fingertip, from iCloud to earth. To close the distance."

Kearney's (2014) discussion signals that we are living in an increasingly virtual world where it is important to stay connected with the senses, as it is vital for all human relations. Awareness is therefore created about the impact of emerging technologies on people's mental and physical wellness, which can influence the way in which people communicate, learn or experience their relationships and their surroundings.

2.4 CHARACTERISTICS OF TECHNOLOGY-ENHANCED LEARNING ENVIRONMENTS

While a variety of definitions of the term TEL have been suggested, this study will use Kirkwood and Price's (2014: 2) interpretation. TEL is a widely used term in recent literature that, according to Kirkwood and Price (2014: 2), describes the application of information and communication technologies to teaching and learning. TEL is also closely associated with equipment, infrastructure and is considered synonymous with the older term "e-learning". The following terms have also been linked with TEL:

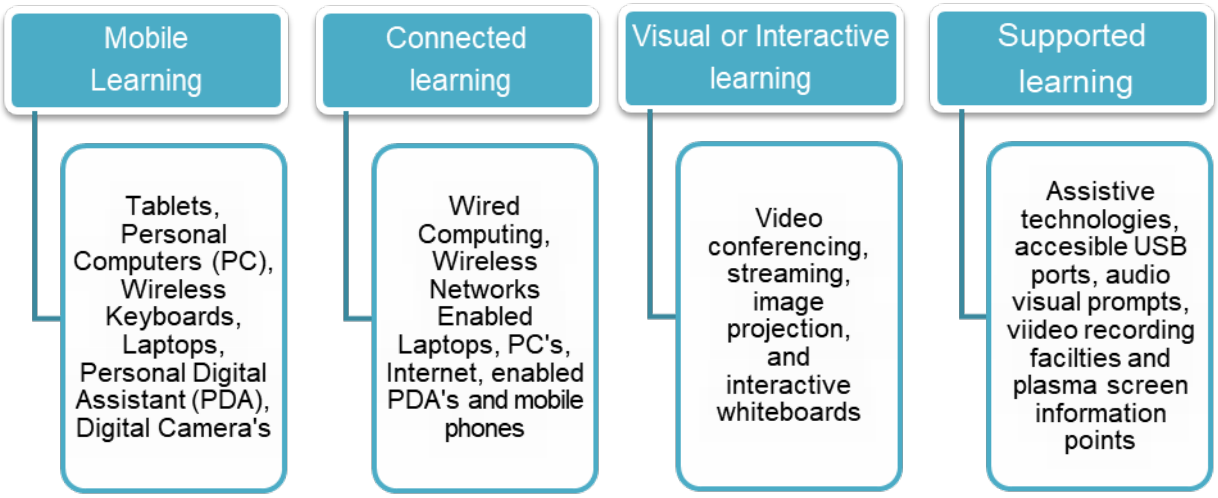

Figure 2.4.1.1 Terms associated with technology-enhanced learning. Adapted from (JISC 2006: 6).

2.4.1 Technology-enhanced learning in a digital age

Technology has an increasing influence throughout the educational landscape; however, Kirkwood and Price (2014: 24) say that there is still much to be learned about how it may further contribute towards effective education. According to Kirkwood and Price (2014: 24) the aim of technology-enhanced learning is to allow for:

- Change in the *means* through which teaching occurs in universities
- Changes in *how* students learn and university lecturers teach

Kirkwood and Price (2014: 24) confirm that the full potential of technology to transform teaching or learning education has not been implemented as most studies have focused on replicating or reinforcing existing practices. Transforming is considered a complex activity; however, it is vital to consider ways in which the full potential of technology can be reached in order to improve students' learning experience (Kirkwood and Price 2014: 24).

JISC (2009: 8) affirms that the term 'technology-enhanced learning' has gained favour over the years as it underlines how technology adds value to students' learning experience. From access to "Wi-Fi" on campus to special electronic equipment needed for various subject disciplines, learning environments are enhanced through presentational technologies that include interactive whiteboards, video conferencing facilities, electronic voting systems, display screens for distributed teaching and portable devices such as laptops, digital cameras, or hand held devices (JISC 2009: 8). TEL encompasses a wide spectrum of student activities. Hannafin and Land (1997: 168) believe that learning environments which are technology-enhanced are conducive to interactive activities that allow students to engage in their learning interests or needs, and study on complex levels that deepens student understanding. TEL environments enrich thinking and learning by using technology to provide flexible methods that support students learning processes (Hannafin and Land 1997: 168).

The figure below illustrates characteristics of a TEL environment and how it adds value to students' learning experience:

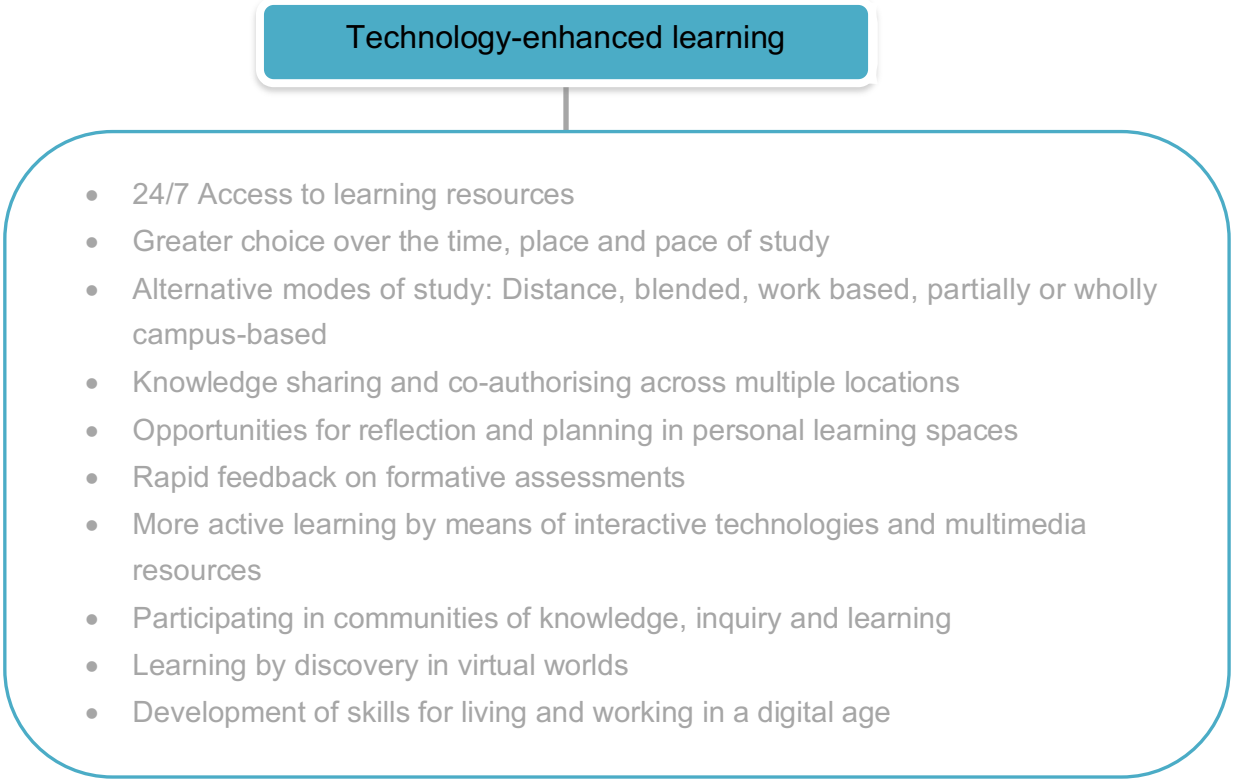

Figure 2.4.1.2 Characteristics of technology-enhanced learning environments (JISC 2009: 8).

2.4.2 The influence of the digital revolution

Karim Rashid, one of the world's most prolific designers of the generation, emphasises that digital technologies dictate how we interact. Rashid (2015) affirms that the digital age has altered our human behaviours and habits. As a leading figure in the product, furniture, lighting, fashion and interior design fields, Rashid (2015) believes that the digital revolution is very influential and impacting all aspects of design like never before. Moreover, he considers people as true "Bioneers" of the digital age, a term used to describe innovative people who find solutions to environmental or social issues (Rundell 2008). Rashid (2015) believes the "Bioneers" of today are striving to unleash the full potential of such a data-driven era:

> "Presently the physical world is being seduced by the lucrative, highly experiential infinite possibilities of the digital age. This is the realm where what we dream and imagine become tangible and interactive, giving more heightened experiences to our physical world. This is the shaping of our future."

Rashid (2015) confirms that the "Analog" age is outdated and disconnects people from the present time. Rashid (2015) also provides insight on how the digital age has evolved the way materials and interior spaces are designed:

Anolog Era	Digital Era
Rigid material	Dematerialized
Permanent	Temporary
Static	Kinetic
Overly-specialized	Transparent and relaxed
Wasteful	Digital weight
Based on scarcity	Extensive
Driven by craft and the Industrial Revolution	Four dimensional and technology advanced

Table 2.4.2.1 Differences between the anolog and digital era. Adapted from Rashid (2015).

On that account, in order for designers to advance and succeed in the future, Rashid (2015) argues that it has become vital that technology is utilized seamlessly from construction, production and process, to human interaction. Doing so will create both new technology experiences[3] and identity branding.

[3]Universities and designers could consider or explore the production methods and materials of the digital age as a platform to heighten students' experiences sensorially and technologically.

2.5 THE FUTURE OF TECHNOLOGY-ENHANCED LEARNING ENVIRONMENTS

Blackboard Inc., a leader in education technology for teaching, learning and student engagement, released a whitepaper called “Future forward: The Next Twenty Years of Higher Education”. The paper describes the way students are learning and interacting with the facilities offered on campus as “dynamic and rapidly advancing” (Blackboard Inc 2017: 5). Moreover, of the many issues highlighted, an interesting point made is that future academic experiences will give rise to learning systems that will adapt to end-users and become more personal and engaging, whereby artificial intelligence and virtual reality will be a driving force to achieve this (Blackboard Inc 2017: 38).

More importantly, it is noted that technological advancements of the future should not be expected to replace our human connection but be used as a way to assist students to learn and encourage connections:

> “Technology will evolve, but the need for connection and the desire for sharing and learning and advancing our global society will become very important. That’s where that human aspect will persist and technology can be a tool to help us map the network and reveal and enable those connections” (Blackboard Inc 2017: 42).

2.5.1 Learning theory of the digital age

Watkins (2010) says that in the field of psychology, learning theories have long been a subject of interest, and have resulted in controversial discussions, as there is no general agreement about which learning theory is the most effective. As the form of communication in society develops or changes, the way that people process data changes as well. This results in further exploration of which ‘paradigm of learning’ theory is the most compatible and relevant to modern life (Watkins 2010).

A learning theory is a term associated with how people learn, and essentially assists in the understanding of such a complex process (Sitt 2013). When considering how future TEL environments should be designed, there are multiple learning theories that one may consider in order to ensure that these academic spaces are built with the desired learning outcome in mind. Connectivism stood out in particular as it takes into consideration digital age students, the way in which they study, and the technology

learning tools or platforms that they use (Siemens 2014). However, to date there has been little agreement on if Connectivism should be considered a learning theory or not as will be further evaluated under heading 2.5.2 below. Figure 2.5.1.1 demonstrates various learning theories and how one acquires knowledge accordingly:

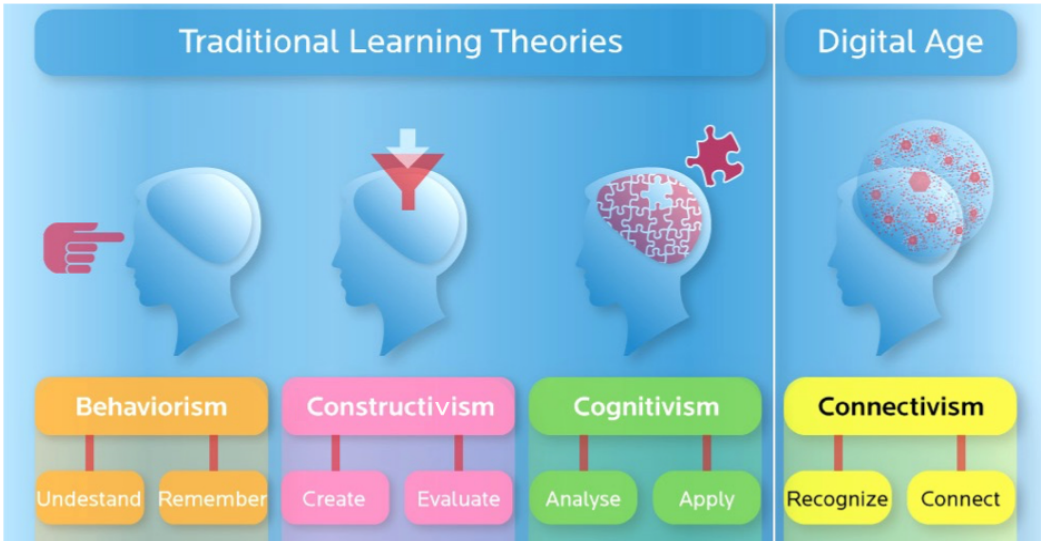

Figure 2.5.1.1 Learning theories. Adapted from (Sitt 2013).

2.5.2 Connectivism

At the turn of the millennium, George Siemens and Stephan Downes argued that the traditional learning theories were limiting and that a new theory was necessary (Epstein 2014). Students are living in a digital age that is experiencing an ever-increasing amount of knowledge, which in turn led towards the development of the modern skill of establishing important information amongst irrelevant information (Epstein 2014). Epstein (2014) also highlights that a new theory is essential to keep up with the various needs of the “net generation” and the overall development of technology.

The theory of Connectivism is suitable when considering the design of TEL as it acknowledges that the rapid development of technology has an impact on the educational landscape worldwide. In particular, the term Connectivism is a relatively new name for the integration of principles explored by chaos, network complexity and self-organisation theories (Siemens 2014). Connectivism was adopted for the study as it supports the idea that knowledge exists everywhere and is accessed and organised by students who learn through creating connections and developing a network (Siemens

2014). However, the debate about Connectivism has gained fresh prominence with many arguing that it is only a learning model that should not be considered as a learning theory.

Many current researchers feel that although technology has had an impact on the way students learn or acquire knowledge, the traditional learning theories are still valid and should be used as the foundation of any emerging theories and not cast aside as such (Bell 2011:104, Kop and Hill, 2008 :1). Verhagen (2006: 4) goes so far as to say as "We should forget about Connectivism". Kop and Hill (2008 :11) generally agree with the above notion that Connectivism should not be considered a learning theory, more so as they feel it lacks sufficient empirical research or anything new to offer the educational landscape. As a result, Connectivism has been the subject of intense debate and critique. Table 2.5.2.1 illustrates the differences between the different learning theories:

	Behaviourism	Constructivism	Cognitivism	Connectivism
How learning occurs	Observable behaviour is the main focus	Structured and computational	Social as meaning is created by each learner	Distributed within a network. It is social and technology-enhanced. Occurs when recognising and interpreting patterns
Influencing factors	Nature of reward, punishment and stimuli	Existing schema and previous experiences	Engagement, participation, social and cultural	Diversity of networks
Role of memory	Memory is hardwiring of experiences that are repeated. Rewards and punishment are most influential	Encoding, storage and retrieval of information	Prior knowledge is developed to current context	Adaptive patterns, representative of current state and existing networks
Types of learning	Task based learning	Reasoning, clear objectives and problem solving	Social	Complex learning, rapid changing core, diverse knowledge sources

Table 2.5.2.1 Differences between various learning theories. Adapted from (Sitt 2013).

Furthermore, the term "learning" is described by Siemens (2014) as *actionable knowledge* that resides out of people and focuses on:

1.) Connecting specialised sets of information
2.) Connections that allow one to learn more and develop ones' current state of knowledge.

The concept of Connectivism is propelled by the idea that decisions are based on foundations that are constantly changing whereby people are always acquiring new

knowledge (Siemens 2014). It also supports the notion of sharing new information with others, and for others to make connections with the person, and their information. Such exchange of knowledge is important and relevant to how learning occurs in the digital age, as students use multiple social and academic platforms to share new knowledge or information. Therefore, Connectivism is about nurturing and maintaining connections in order to facilitate continual learning (Siemens 2014). Even though Connectivism has not been able to influence major changes through developing educational practice in terms of curriculum, it seemed suitable for this study as it is dynamic, growing and recognizes the leading role technology plays within learning environments of the digital age. Siemens (2014) outlines the key principles of connectivism as a learning theory:

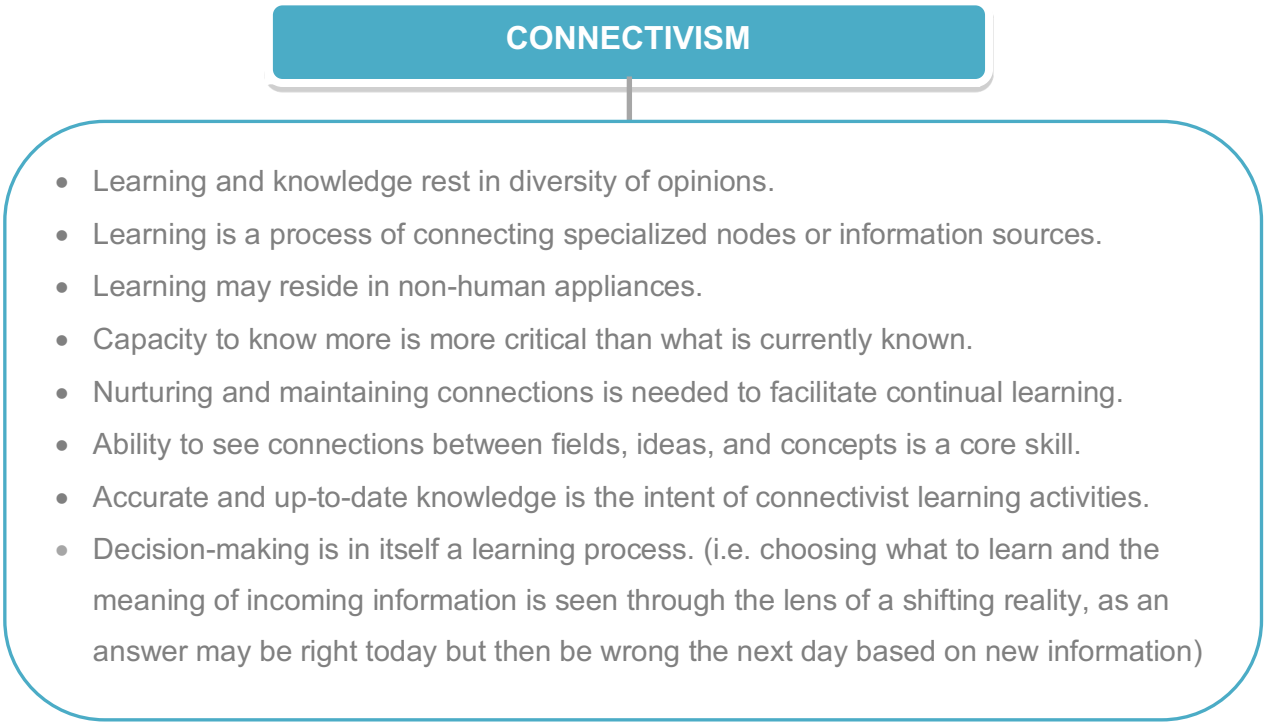

Figure 2.5.2.2 Principles of connectivism. Adapted from Siemens (2014)

Connectivism is a model of learning that acknowledges the “tectonic shifts” in society, where learning is not an internal or individual activity (Siemens 2014). New technology tools have altered the way people work and function, and currently there is a delay in the field of education to recognize the impact of these new learning tools or the environmental changes on what it means to learn in the digital age (Siemens 2014). Figure 2.5.2.3 below shows how Connectivism is the learning theory that provides insight into learning skills and tasks that students need to develop in the digital era:

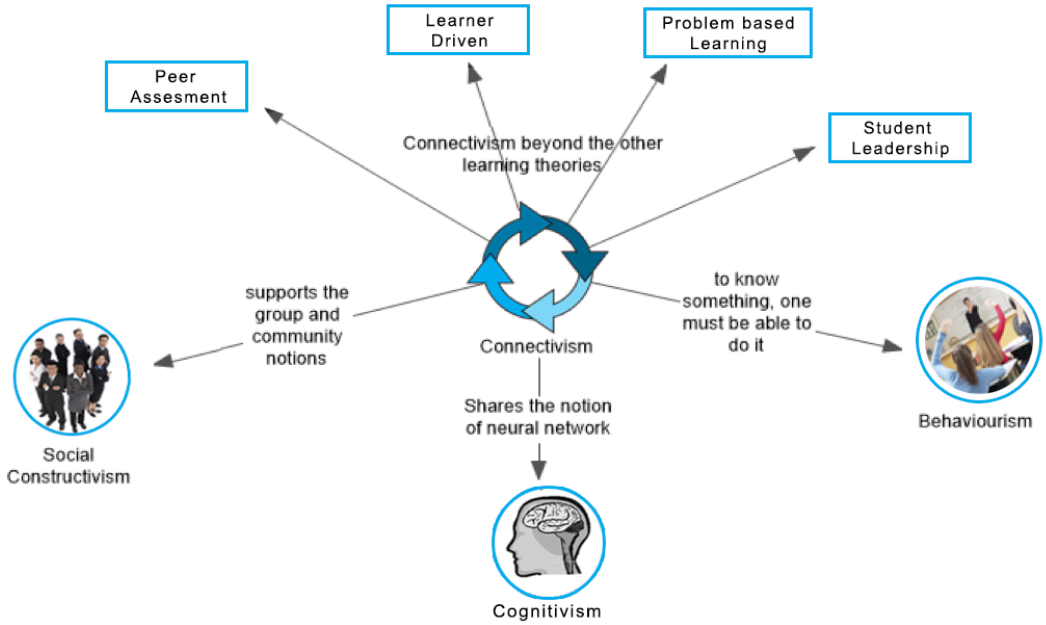

Figure 2.5.2.3 Connectivism as a unifier of learning theories. Adapted from Epstein (2014).

2.5.3 Designing future technology-enhanced learning environments

As the educational landscape changes due to the use and integration of emerging technologies, it is necessary for universities to be able to adapt to these changes and continue to encourage and cultivate a new learning culture. It is also important to understand how to implement effective practices that can evolve and improve the quality of learning and teaching through technology. Figure 2.5.3.1 provides a guideline of how to encourage TEL practices that are effective today and in the future (JISC 2009: 51):

Principles for technology-enhanced learning

- Blended learning. Exploits the affordances of technology to promote *Active Participative learning* in both face-to-face and online contexts
- Practitioners teach and learners learn in a context of increasing choice. Effective practice in a digital age includes selecting the most appropriate tools for the purpose
- Learners can be active makers and shapers of their own learning. They should be supported in using technologies of their own choice where appropriate
- It is a vital to understand how to use technology and how to learn in a digital world
- If unfamiliar technologies are integrated into learning designs, the benefits need to be clearly communicated to learners
- Benefits arise when there is coherence between technologies and media, the learning tasks, and outcomes and subject-specific demands of a course
- Where technology is used, it should extend the potential for learning and should not

Figure 2.5.3.1 Principles for technology-enhanced learning. Adapted from JISC (2009: 51).

PART TWO

SENSORY DESIGN

In order to understand how technology-enhanced environments should accommodate the senses it is important for the discussion to:

- Firstly, closely examine sensory design in its entirety and as a philosophy on its own.
- Secondly, examine the impact of the built environment on the human body (i.e. the perception of space and the importance of multi-sensory learning experiences).
- Thirdly, to analyse how advanced technology is used to enhance the senses.

2.6 SENSORY DESIGN

According to Malnar and Vodvarka (2004: ix) sensory design encompasses exploring the nature of human responses to spatial constructs within the built environment, gardens and outdoor spaces. The typology of sensory design has been developed through research in environmental sciences, anthropology, psychology, architectural theory and spatial analysis found in literary depiction. Sensory design is therefore considered a philosophy that embraces the use of multi-sensory experiences within a built environment (Franck and Lepori 2007: 20). Although emotions form the basis of thoughts, the five senses can essentially fuel emotions, which may persuade, relax and heal people (Leone 2008). When the full spectrum of human senses is considered in the design of an environment it can have a profound impact on end-users, evoking comfort and relaxation, which encourages them to spend more time in the space (Leone 2008).

2.6.1 The senses

Within a European context, the five senses were distinguished by Aristotle (Goody 2002: 17; Aquinas, White and Macierowski 2005: 33). The rise of sensory studies occurred at the turn of the twenty-first century (Howes 2006: 115). According to Howes (2006: 115), the 1990's were considered the "corporeal turn" as the field of anthropology increasingly focused on the body. The senses refer to one's capacity to engage with the world through the senses of sight, touch, smell, sound and, taste (Sawchuk and Josgrillberg 2011: 203). The fundamental principle of sensory design is to create and nurture an environment that is sensitive to all the human senses which endow us with the

ability to understand, to make sense of or to have common sense. In broader terms the senses mediate the relationship between the mind and body, idea and object, people and environment, the information received and how the brain processes it (Howes 2006: 122; Stein 2013: 4):

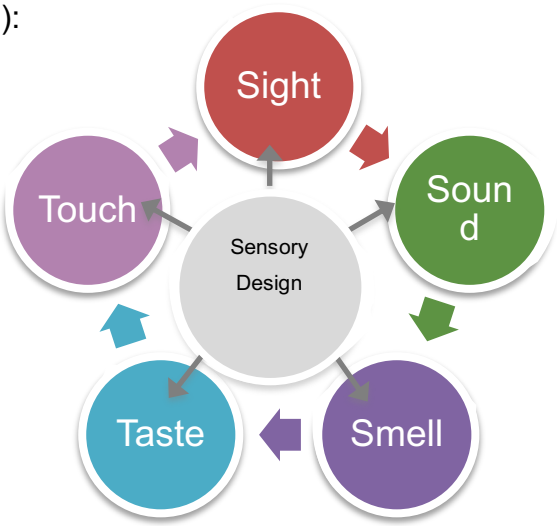

Figure 2.6.1.1 Sensory design and the five human senses

2.6.2 Perception of space

According to Breffeilh (2013) each person perceives things differently even if they are in the same situation or environment as one another. Moreover, each person interprets or applies their own meaning of what they perceive. Interior designers may therefore find it difficult to accommodate various people's preferences whilst designing spaces that are meaningful to each end-user, as well as meeting their individual needs. The fundamental aspect of sensory design is to consider the way in which design arrangements have an impact on people's emotional responses and what those responses mean to them (Lehman 2011: 46; Breffeilh 2013). Moreover, sensory design can be used to encourage a healthier mind and body connection (Lehman 2011: 46).

In recent years, data from several sources have drawn attention to the built environment and the influence it has on human perception (Lehman 2011: 50; Stein 2013: 24). To better understand perception and the significant role it plays in implementing sensory design, the nature of sensorial stimuli is discussed below. It is vital for designers to understand the causes of sensorial stimuli, the effects of sensorial stimuli, and which "design composition" of those sensorial stimuli will be the most effective in assisting to achieve an intended goal (Lehman 2011: 50). For instance, Pallasmaa (2005: 50 cited by Lehman 2011: 50), discusses the importance of how the sense of smell can be used

to leave end-users with a memorable impression of the environment, as the human sense of smell is considered to be the most memorable aspect of any space. The environment stimuli of one sensory modality have the power to negatively or positively affect the end-user's activity at any time. Therefore, the way that a space is designed has an effect on the human senses and perception or memory that the end-user has of the space, which may remain with them long after they have left. Furthermore, the senses can be triggered by various environmental stimuli that evoke a reaction (Stein 2013: 24). The diagram adapted from Stein (2013: 24) below shows why interior designers should understand these triggers:

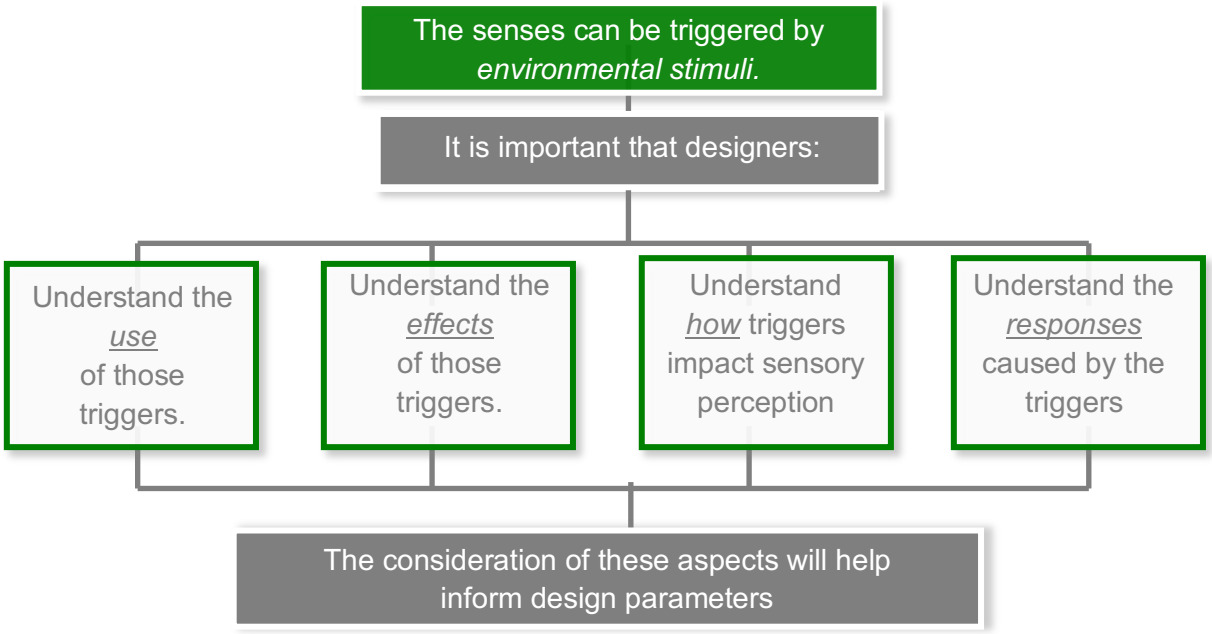

Figure 2.6.2.2 Informing design parameters through consideration of sensorial stimulus. Adapted from Stein (2013: 24).

Figure 2.6.2.2 illustrates the importance of environmental stimuli on the five senses as a tangible framework for sensory design. Lehman (2011: 50) holds the view that as soon as a sensorial stimulus has reached the end-user's human receptors, i.e. the eyes, nose, ears, skin and mouth, the information is then processed by the brain as an "initial perception" which results in memory that the end-user may recall at a later stage. These steps are crucial, as they play a role in effectively implementing sensory design.

It is also important that the design of the environment creates the right balance of sensory stimulation, as it has an impact on the way that people perceive the space. For instance, Stein (2013: 24) explains that when people are in an under-stimulated

environment, they may feel restless, irritable, emotional and less likely to concentrate. Conversely, people within an over-stimulated environment may feel an increase or decrease in heart rate, breathing pace, blood pressure, muscle tension or stress (Stein 2013: 24). Therefore, understanding the positive and negative effects of different stimuli, such as shape, colour, lighting, acoustics, material, and furniture is important in helping to determine the nature of various environmental characteristics (Stein 2013: 24).

2.6.3 Components of sensory design

Sensory design consists of how the spatial stimuli within built environments are orchestrated and arranged to enhance the quality of the end-user's experience (Lehman 2011: 46). In sensory design, the first step is to understand the senses, as it sheds light on an experience that occurs in a specific place at a specific time (Stein 2013: 4).

	Vision	Touch	Hearing	Taste	Smell
Representation	Colour, Shape and movement at a distance from our body in front of our eyes	Temperature, pressure, shape and movement at the surface of our body	Sounds, volume, pitch, objects being struck or vibrated at locations in and at a distance from and all around our body	Flavours (sweet, salty, bitter, sour, umami) in the mouth, on the tongue or in the food touching the tongue	Odours located in the nose or in the air around the nose that may come from a certain direction
Phenomenal Character	Visual experience	Tactile experience	Auditory experience	Taste experience	Olfactory experience
Proximal Stimulus	Electromagnetic waves	Mechanical pressure and temperature	Pressure waves in a medium such as air or water	Chemical that affect receptors on the tongue	Volatile molecules that affect the epithelium
Sense Organ	Eyes (The retina)	Skin (Skin receptors)	Ears (Cochlea)	Tongue (Taste buds)	Nose (Epithelium)

Table 2.6.3.1 The Aristotelian senses. Adapted from MacPherson (2011: 28).

Table 2.6.3.1above provides an overview of the five senses distinguished by Aristotle (MacPherson 2011: 28). Stein (2013: 4) views the senses as a significant and physiological link to the present moment and alternatively as a vital link to past memories. Exploring the positive impacts of sensory experiences assists in the shaping of environments which can benefit the end-user (Stein 2013: 4). It is equally important to identify negative impacts of sensory experiences as they can enlighten interior designers about the problems within an environment (Stein 2013: 4).

Initially, it was a widely held view that sensory design only had an impact on the five senses; however, Breffeilh (2013) reveals that the five senses only incorporate the basic concept of sensory design. Hapticity, kinaesthesia, and synaesthesia are the three other concepts that are systematic and related to human perception (Breffeilh 2013). The general function of perception is to provide an end-user with information about their surroundings and what is distant from them (Everson 1999). The three concepts presented in Van Kreij's (2008: 25) study are incorporated into sensory design to reformulate the five senses to improve the experience of the built environment. Essentially, how space is perceived is determined by how the senses are stimulated (Malnar and Vodvarka 2004: 51). Therefore, if a space stimulates more senses, it is easier to establish the perception of that space. One then experiences the place through the three concepts of hapticity, kinaesthesia, and synaesthesia as demarcated in Breffeilh's (2013) diagram below:

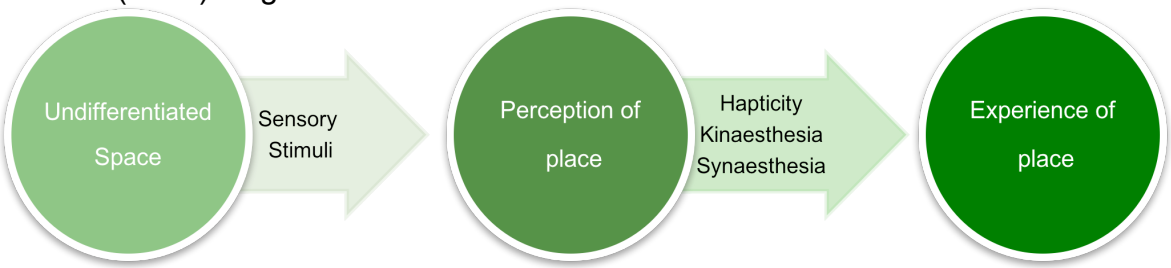

Figure 2.6.3.2 The creation of place. Adapted from Breffeilh (2013).

To provide a better understanding of hapticity, kinaesthesia and synaesthesia, the three concepts are dealt with separately below:

2.6.3.1 Hapticity

According to Breffeilh (2013) and Van Kreij (2008: 25) hapticity is similar to the act of touching. However, the difference is that haptic experience has a three- dimensional character, unlike touch, which is commonly has a two-dimensional character. The word haptic is used to describe the experience of an environment that is explored using the body (Pearson 2015: 2). Both Pearson (2015: 2) and Pallasmaa (2005: 42) agree that touch is the sense that integrates the experiences of the body and the world. More importantly, hapticity is considered as an impression of depth that can be seen through one's sense of sight, as it makes one aware of things that are extended away from the body (Pearson 2015: 2).

2.6.3.2 Kinaesthesia

Kinaesthesia is recognised as a subconscious experience used to assess the environment through awareness of body movement, from walking to head movements (Van Kreij 2008: 29; Pearson 2015: 2). Breffeilh (2013) states that kinaesthesia influences an experience as a result of the links that it has with touch, movement and hapticity. It is associated with bodily movements and is established as both a physical and reactive phenomenon (Van Kreij 2008: 28). According to Breffeilh (2013) Kinaesthesia's physical and reactive quality is essential to the way in which people form their perceptions. Therefore, considering kinaesthesia throughout the design process makes for a multi-layered experience that stimulates body movement.

2.6.3.3 Synaesthesia

Synaesthesia is experienced involuntarily through the collection of sensory information from one of the senses and then transferred by stimulation of another sense (Breffeilh 2013). As a point of illustration, Malnar and Vodvarka (2004: 221) provide empirical data about synaesthesia that show colours have been associated with temperature, smell, sound, weight and taste. The phenomenon is described as a physical, involuntary and cross modal experience. For example, some people associate the colour blue with cold or the colour red with hot (Pearson 2015). Thus, synaesthesia is driven by perception and enables connections between the senses whilst experiencing a space. Table 2.6.3.3 adapted from Malnar and Vodvarka (2004: 221) shows an expanded sensory system:

Sense or System	Anatomy of the Organ	Activity of the Organ	Stimuli Available
Sight	Ocular Mechanism (Eyes)	Looking or fixation	Variables of structures in ambient light
Taste	Oral Cavity (Mouth	Savouring	Composition of ingested object
Smell	Nasal Cavity (Nose)	Sniffing	Composition of the medium
Touch	Skin and Hands	Touching or Feeling	Texture and weight etc.
Hearing	Cochlear Organs (Pearson)(Pearson)	Orienting to Sounds	Vibration in the air
Haptic System	Skin, Joints and Muscles	Exploration through Touch	Varying configurations of touch
Kinaesthesia	Muscles and Joints	Exploration through Movemen	Various positions or movements of body parts
Synaesthesia	Neurological	Sensory connection and transference	Memories

Table 2.6.3.3 Expansion of the sensory system. Adapted from Malnar and Vodvarka (2004: 221)

Table 2.6.3.3 on the previous page, suggests that it is necessary to consider the sensory stimulation that an environment may cause as it has an impact on people's experience and perception of the space. Furthermore, it shows that the senses not only play a major role in the memories attached to the end-users' experience of a space but it also influences their emotions which, in turn, shapes their perception.

2.6.4 The dominance of vision in a digital age

In recent years, there has been increasing concern about the bias towards visual aesthetic when designing interior spaces and buildings, as it often results in the suppression of the other senses (Grice 2010: 10; Pallasmaa 2012: 10; Hadjiphilippou 2013: 3; Henshaw and Mould 2013: 10). Caan (2011: 51) argues that people do not only visually experience a space, as vision acts in conjunction with the other senses. Essentially, other experiences such as smell, sound, temperature and touch have the ability to change people's perception of space as they have an effect on comfort, well-being and are also linked to psyche and memory (Caan 2011: 51). Hence, the complete experience of a space cannot be reached purely through the stimulation of sight.

The western culture of today is dominated by an "ocular centric culture" that pays little attention to providing spatial experiences that engage the body and unite the senses (Chang 2006: 11; Bowring 2007: 81). "Ocularcentrism" is a term used to describe the focus of today's contemporary western culture on sight; however, the dominance of vision can also be traced back to the Ancient Greek civilisation (Bowring 2007: 81). Sight was thought to be validated, and consequently, the hierarchy or ranking of the senses over time, particularly in Western culture, inevitably resulted in some senses to be valued more over others (Malnar and Vodvarka 2004: 11).

Over the past few years the design of buildings and spaces has been increasingly influenced by technology, mass media and various digital media which, according to Breffeilh (2013), has gradually led to the adoption of a dominant visual sense and virtual image. Breffeilh (2013) suggests that this is because the design principles used in academics today are based on "verifiable elements" of architecture and not on "sensory elements", as the other four senses are not seen as reliable design parameters. Therefore, Breffeilh (2013) argues that today's society has developed an interest in the visual senses, which has resulted in the neglect of the other senses.

Grice (2010: 10) states that with the increasing use of computers to design buildings and spaces, environments are gradually becoming "de-*sense*-itized" and there is concern that such desensitisation may lead the visual realm to completely dominate people's experience. Similarly, Hadjiphilippou (2013: 2) maintains that our sense of sight, hearing, smell, touch and taste are sensory modalities that are crucial to the way in which people process spatial perception. Hence, if "visual environments" are designed, multi-sensoriality, user-friendliness and functionality would not have been considered, and such environments would prevent people from fully experiencing the place both physically and mentally (Hadjiphilippou 2013: 2). These arguments suggest that it is important that environments are designed to be sensitised and adapt to the human body, and not the other way around.

2.7 THE BUILT ENVIRONMENT AND THE HUMAN BODY

It has always been human nature to shape the spaces we inhabit (Caan 2011: iii). Each design discipline faces its own challenges in today's society. For that reason, Caan (2011: 9) says that many design disciplines now try to understand the effect that the built environment has on people, in order to overcome challenges in design disciplines and improve people's quality of life.

In the last decade, the field of architecture has indicated the urgent need to awaken the human senses in today's world of hyper-stimulated technology (Chang 2006: iii). Chang (2006: iii) explores how the adaption of a multi-sensory and corporeal element to architecture has the ability to restore sensory balance and connect the human body to its surroundings. From a global perspective, Pallasmaa (2005: 10 cited in Chang 2006: 13) established that reconnecting our bodies to our environment through the senses might possibly restore human identity. In subsequent published work on *The eyes of the skin: Architecture and the senses*, Pallasmaa (2012: 12) explains that it is important to address all the senses simultaneously.

Recent challenges underpinned in the technological culture of today's society have resulted in a distinct separation of the senses (Pallasmaa 2012: 18). Vision and hearing are now considered sociable senses, and touch, taste and smell have private functions that are often suppressed (Pallasmaa 2012: 18). However, every experience of the outside world is determined by all the human senses, as it is a form of communication

on both a physiological and cultural level (Goody 2002: 17). Thus, by neglecting the other senses it is likely that the human experience of the environment may be compromised. Therefore, when interior designers consider the sensory experience of a space, they are able to create more 'humane' built environments (Leone 2008: 36).

2.7.1 The influence of sensory design on end-user experience

A significant and detailed seminal article by Lehman (2011: 50) analyses how sensory design can bring value to a building and its end-users. The analysis confirms that the built environment plays a major role in the way that end-users process what they perceive. The article reveals that the built environment influences how effectively end-users can adopt that perception and turn it into a "positive" behaviour. Therefore, anyone who enters a building may experience a journey of their own as they explore the spaces within. Lehman (2011: 51) states that sensory design techniques provide a powerful way to engage with end-users:

> "Buildings that incorporate sensory design use environmental stimuli not only for aesthetic reasons, but also to unite function with form in such a way that occupants engage with their buildings on cognitive, behavioural, emotional, physiological and even spiritual levels."

Sensory design is therefore considered a tool to connect and engage end-users with their surroundings by using stimuli to trigger various human processes. Lehman (2011: 46) states that when sensory design is effectively implemented, it has the ability to find solutions to the challenges and problems that exist within many of today's buildings.

Therefore, by understanding the correlation between the end-users' mind and body processes, it is possible to design and build effective buildings that are in tune with the senses (Lehman 2011: 50). Lehman (2011: 48) highlights that the built environment must not only meet the needs of the end-user but it should also ensure that the mind and body processes are synchronised with the environment itself.

Sensory design involves a deep understanding of how end-users perceive and engage with a built environment (Lehman 2011: 46). To better illustrate the mind and body processes that sensory design principles can target, Figure 2.7.1.1 shows how sensory design can improve building quality and end-user experience:

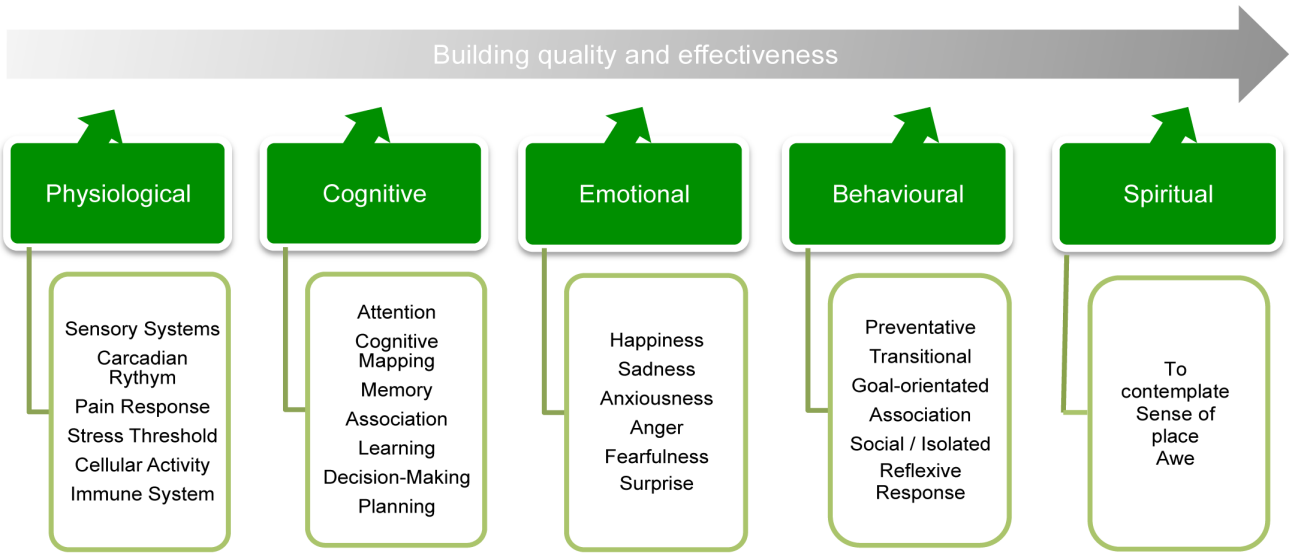

Figure 2.7.1.1 End-user mind and body processes that sensory design affects. Adapted from Lehman (2011: 48).

Hence, sensory design motivates awareness and empowerment to the built environment and the end-user. If an environment is sensorial and accommodates the end-users' needs, they will be more likely to engage with the space (Lehman 2011: 47). Sensory perception is also an active process, primarily because as a person enters a space they use their senses to navigate through the space (Lehman 2011: 49). Therefore, by understanding the interrelation between the mind and body processes, one can design a more effective and attuned built environments.

2.7.2 Multi-sensory learning environments

When students and educators communicate amongst themselves, they do not only use their sense of sight, but they also use their sense of touch, hearing, smell and taste. These multiple forms of communication allow students and lecturers alike to convey more information to one another whilst providing a multi-dimensional experience.

Baines (2008: 21) acknowledges that multi-sensory learning at its core is a way of teaching students to enjoy learning and be engaged through sight, hearing, smelling, tasting, moving, touching and thinking. Goody (2002: 17) describes the senses as "people's windows on the world" and confirms that the senses are used to acquire information and experience sensation. The stimulus for sensations or feelings is believed to reside in either "the outside or the inside" of the body (Goody 2002: 17).

Therefore, to enhance an interior environment, it is important that designers consider and employ all of one's senses throughout the design process (Hall 2008: 8).

Baines (2008: 23) indicates that the quality of learning is affected by both the physical environment of a learning space, as well as the interactions amongst students, lecturers, and learning materials. It has also been documented that neuroscientists have been surprised by "the capacity of brain cells to rewire themselves radically – forming new synaptic connections and dissolving old ones – in response to stimulation" (Horgan 2004 cited in Baines 2008: 23). Which means that the stimulation of the human senses encourages the creation of new pathways, which may develop the human thought process.

An interesting series of experiments by researcher Diamond (1988: 156) have also shown impressive results concerning the impact of the environment on the brain. It was discovered that the physical brain of animals who grew up in environments that were "sensory-rich" were not only larger, but were also healthier than the brains of animals who grew up in environments that were "sensory-deprived" (Diamond 1988: 156). Recent examinations carried out by Streidter (2006: 5) and the *Society for Neuroscience* (2005: 17) confirm that a link between sensory processing and brain development exists in both humans and animals. Which indicates that the brain develops according to the quality and nature of the stimuli in the environment. Despite the benefits of such environments, unfortunately, teaching in "sensory-deprived" environments is still the most popular method of delivering abstract information to students (Baines 2008: 23).

A more engaging approach would be to provide students with multi-sensory experiences to foster student intellectual and social development. According to Baines (2008: 23) stimulation by multi-sensory learning is beneficial as it

- Increases engagement
- Encourages deeper participation
- Makes learning enjoyable
- Improves academic performance

From the above assertions, the important corollary revealed is that supportive learning environments, that appeals to all human senses, is a significant factor in enhancing students' brain development and learning experience.

2.7.3 The influence of the environment and sensations on student attitude and behaviour

There is value in reflecting on the effect of the built environment on the end-user's behaviour (Keeling *et al.* 2012). For that reason, it is important to analyse the stimulation theory which is based on the concept that the environment is a source of sensory information that is derived from sight, sound, touch, taste and smell. The stimulation theory, according to Kopec (2012: 23), supports the notion that every living thing on earth reacts to sensory stimulation. The ideology is substantiated by Kopec (2012: 23) as he concedes that examining the different levels of sensory information deriving from an environment enable us to assess that environment's level of stimulation.

Song (2010: 3) says that how the built environment is perceived involves more than a sequence of steps resulting in experiences called *sensation*. He confirms that sensory inputs have a direct influence on the behaviour and attitudes of people. Most importantly, he suggests that the emotional and cognitive responses are affected by one's feelings from seeing, hearing, tasting, touching and smelling.

People live in a world alive with stimuli, which includes the objects or events that surround them, and sensation and perception are believed to be the processes that allow people to detect and understand these various stimuli (Diaz 2013: 78). Sensation, is described by Diaz (2013: 78) as the process of physically feeling or receiving stimuli from the environment and then transforming that energy into neural energy. Simply put, the brain takes in information from the world through sensation and the perception formed thereafter is used to identify meaningful patterns of that information. With that being the case, sensation and perception are closely related.

In view of the above statements, it is likely that stimulation through interior design can add multiple dimensions to students' sensory experience. In that regard, students' learning experience depends on their learning environment, as it has a great effect on their emotional response and attitudes. Similarly, Wolhwill's (1974: 168) research

supports the above notion as his behaviour settings theory[4] emphasises that the environment can shape and evoke patterns of behaviour in people. He highlights that behaviour is often unconscious, and that people are often unaware of the influence of the environmental stimuli. Figure 2.7.3.1 below depicts the environment as the source of sensory information:

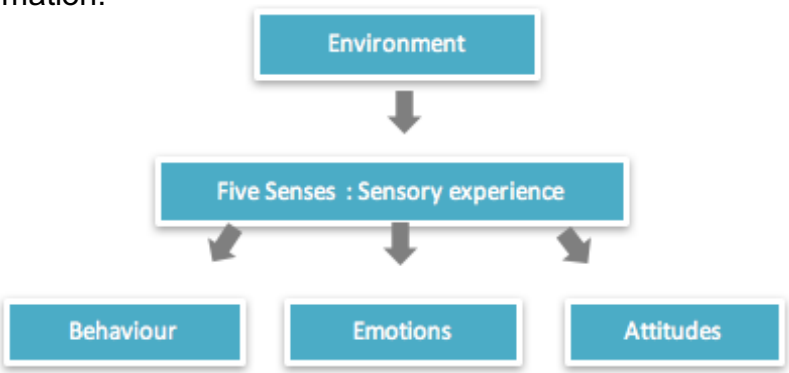

Figure 2.7.3.1 The environment as a source of sensory information (Wolhwill 1974: 168; Kopec 2012: 23; Song 2010: 3).

2.7.4 Crafting a sensitively responsive interior design profession

Recognising and understanding the connection between people and interior spaces will initiate the process of contributing towards the body of knowledge that is necessary to move design forward (Caan 2011: 13). Caan (2011: 14) points out that as industrial and technological development continue, the world is becoming increasingly digital and detached from our basic human requirements. It is therefore vital for the design profession to accommodate people's sensory, cognitive and bodily needs. With that in mind, the interior design profession plays a critical role in contributing towards the core body of knowledge that will inform all design practice (Caan 2011: 9):

> "…the interior fulfils, and always has fulfilled, our most basic need for shelter. While the future of humanity is tied to its past, the history of this past is expressed not in stylistic periods but in how we have evolved as human beings. This comes from within us. And thus design has to come from within to envision and craft a sensitively responsive and responsible future built world."

[4]The behaviour settings theory is derived from the studies of environmental psychology and explores how the physical environment influences the end-user (Kopec 2012: 23). This study is not focused on this theory; however if designers take time to observe and consider the interaction between students and their physical learning environments they may be able to develop a deeper understanding about how to enhance the end-user experience.

Conversely, Caan (2011: 8) does not shy away from the reality of advancements in the world, as challenges faced by the interior design profession are closely assessed:

> "…we are on the cusp of extraordinary global and societal changes that will profoundly impact requirements for how we live and thus the places where most of our lives are spent: inside, which will affect, for that matter, all design." – Caan (2011: 8)

Caan (2011: 9) reveals how the discipline of interior design must change. However, it has been noted that researchers and designers have only recently had access to technologies that allowed for the collection of data on human response to spaces that are sensory designed (Henshaw and Mould 2013: 60). Consequently, there has not been much opportunity for research to have a major impact on the design of built environments to date.

2.7.5 Advanced technology to enhance sensory design

Many issues have surfaced outside of the classroom, such as the advancement of technology, which has influenced students' needs, learning culture, and experience. Caan (2011: 33) emphasises that it is vital for the design to achieve: a balance between technology and human primal desires, a balance between the external world and one's inner self, and a balance between function and beauty.

As technology penetrates the educational landscape, designers need to consider how the built environment should be designed to adapt to students' ever-changing technology needs, and to fulfil their primal sensory needs. There should be a balance firstly, between the environmental stimuli that the building sends to the end-user and secondly, between the end-users' feedback sent to the building (Lehman 2011: 51). Such balance provides a pro-active sensory design loop that improves building effectiveness. Very often technology is only considered after the design is complete, which often results in a less effective building (Lehman 2011: 51). Technology should be fully integrated from the initial design process.

For instance, Lehman (2011: 51) says if an interior design element such as lighting is considered as an afterthought, various problems may arise, including lack of natural daylight or painful glare experiences which causes multiple issues that may have a

negative impact on people's health and well-being. Other cognitive, emotional or behavioural repercussions such as sensory dynamism, tired eyes, headaches, nausea or stress also impact end-users. Therefore, designers need to be thoughtful of how technology is implemented within university environments, as they may be harmful to end-users if considered as an afterthought.

Breffeilh (2013) highlights that multi-sensory design is not meant to be only a visual journey but it is focused on creating physical experiences too. The following three key elements (lighting, sound and touch) were closely analysed by Breffeilh (2013) to explore the relationships[5] between technology and each element, including the ambiance, they create. Various case studies were selected to support the analysis, which portray sensual elements using technological means.

2.7.5.1 Lighting

In terms of building elements, when it comes to lighting, windows act as a mediator between two worlds. Breffeilh (2013) says that light and architecture are interdependent concepts that are used to define the surroundings of a particular space. More importantly, light plays a significant role because of the shadows it casts on spaces.

According to Breffeilh (2013), light and shadows can affect the atmosphere of a place or influence how certain elements within a space are perceived. For instance, shadows can bring out the depth of texture or material. Advancement of technology has expanded the possibilities of how lighting can be used to manipulate the perception of a place (Breffeilh 2013). As a result, people no longer depend on natural light to create certain atmospheres, as artificial lighting now gives architects and designers control over how light can be used. As a corresponding example of work, Breffeilh (2013) analysed the Beijing Xicui Entertainment Complex.

[5]Assessing current and existing projects or works where the relationship between technology and the senses have been explored is important. Furthermore, it encourages critical self-reflection about how designers can or should be pushing the boundaries between the senses and technology in order to improve and heighten students' academic experience.

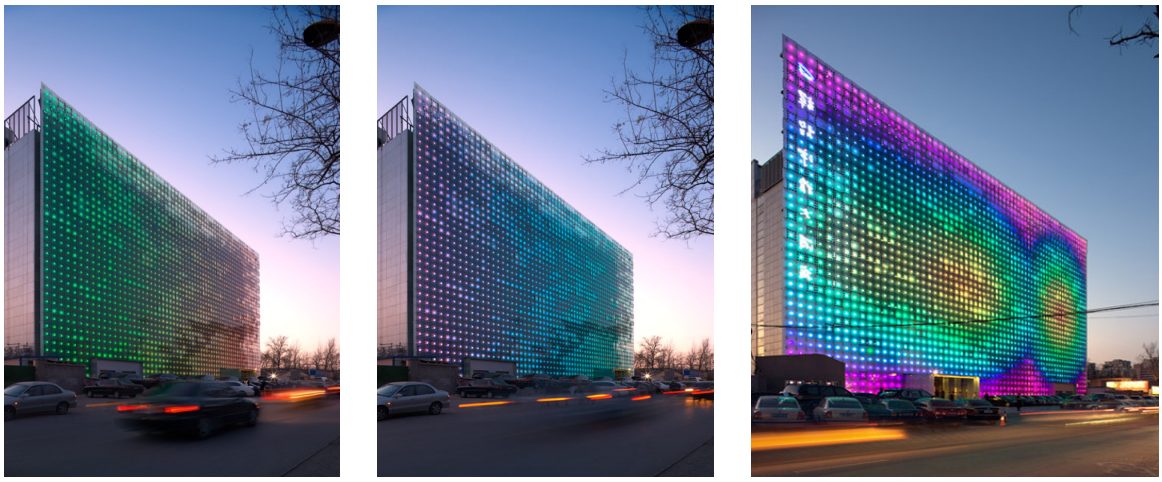

Figure 2.7.5.1 The Beijing Xicui entertainment complex. Adapted from Etherington (2008).

Completed in 2008, the building's media wall was Beijing's first venue that was dedicated to digital media art (Etherington 2008). During that time it was considered as one of the world's largest displays of coloured LED's combined with a photovoltaic system that converts sunrays into electrical energy (Breffeilh 2013). By gathering solar energy during the day, it is able to illuminate the LED screen in the evening, which demonstrates a radical example of sustainable technology applied to a building (Etherington 2008). From Figure 2.7.5.1 one can also observe how the building's change of lighting colour creates a different experience of the surrounding environment.

2.7.5.2 Sound

As a result of the development of technology, the ability of architects and designers to control and manipulate sound within the built environment has advanced (Breffeilh 2013). New digital and sound technologies provide new ways for musical sound properties to orchestrate physical spaces. This means sound will be able to affect the atmosphere of the building and the physical environment (Breffeilh 2013).

The perception and relationship between music, body and architecture is explored by Bonde (2012). To connect music and architecture, dynamic animations are used to transform the architectural space and programme by the action of music. Bonde (2012) declares that new digital technologies have provided a breakthrough for music to influence architectural spaces. Figure 2.7.5.2 on the next page, illustrates conceptual designs that a are generated from musical digitalization.

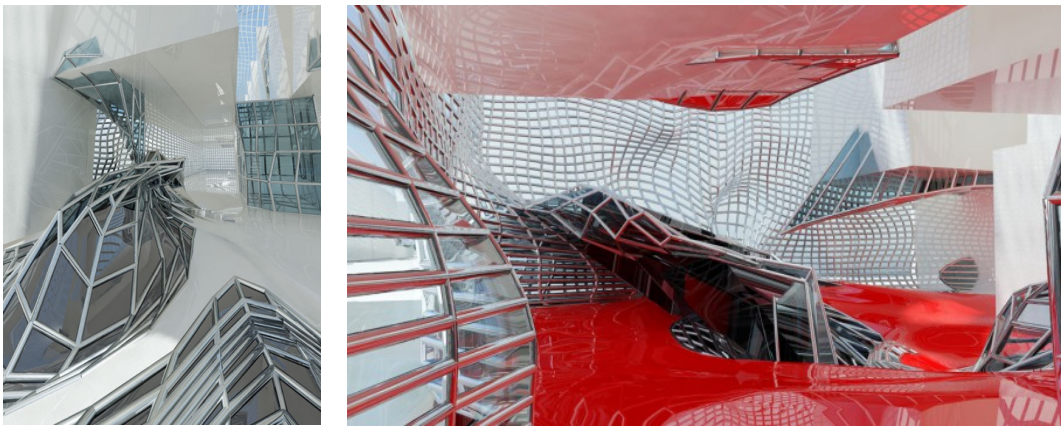

Figure 2.7.5.2 Sound-generated Space. Adapted from Bonde (2012).

2.7.5.3 Touch

According to Breffeilh (2013) the sense of tactility is important as it connects people with building materials, which provide a creative environment and sensory experience for end-users. Digital media and the technology advancements have played an important role in the use and design of textual materials. The development of technology also provides architects and designers with a much wider variety of material selections, as materials are always evolving (Breffeilh 2013).

One example of an innovative application of materials is the “Miranda” wall mural, which has over 650 000 polypropylene hairs attached to a silicone base layer (Miller 2009). What is interesting about the Miranda mural is that the surface tile hairs can be manipulated to create different shades of surface. Figure 2.7.5.3 below shows how the shades can be used as a medium of illustration, communication or visual effect. Moreover, depending on its use of application, it could be used to encourage freedom of expression, creativity or social engagement amongst people:

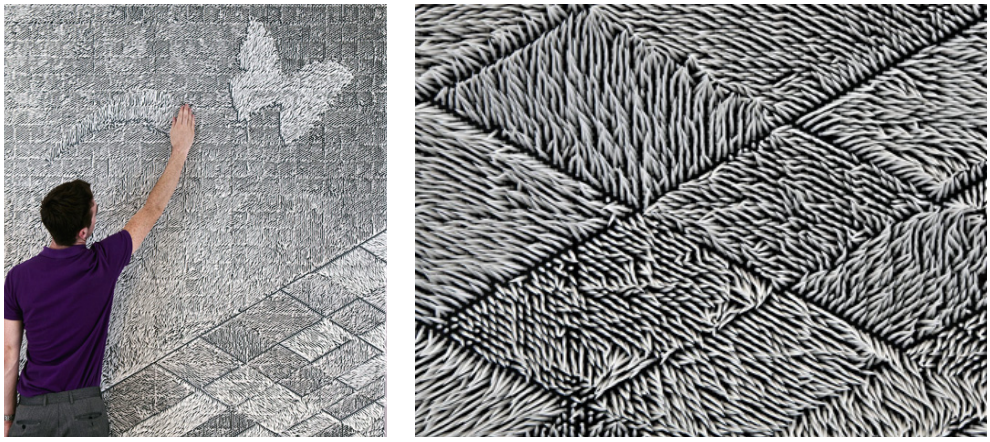

Figure 2.7.5.3 “Miranda” wall mural. Adapted from Miller (2009).

According to Breffeilh (2013), smart materials, including materials that use functional properties to react in response to a change in temperature, have become popular. For instance, thermo-chromic material can change in colour as a response to a change in temperature. Breffeilh (2013) suggests that the most interesting aspect of materials that are thermo-chromic is that they essentially take heat that is invisible and allows for it to be made visible to the human eye. According to Breffeilh (2013) various materials such as tiles, fabric, paint and jewellery can hold thermo-chromic qualities. Furthermore, thermo-chromic materials are believed to affect the perception of a place:

Figure 2.7.5.4 "Touch Me Wallpaper". Adapted from Berzini (2005).

The "Touch Me Wallpaper" in Figure 2.7.5.4 is an interactive sensory appeal textile that changes colour according to human or environmental heat. Each interaction with the wall allows people to create their own patterns made from body heat.

From Breffeilh's (2013) previously mentioned examples, technology can contribute to new and innovative design solutions that stimulate or enhance the human senses. This in turn could provide a better experience of the built environment. However, the examples discussed would have been more useful if they were not limited to a focus on just light, sound and touch. Sensory Design aims to encourage multi-sensory experiences, therefore, the seminal work would have been more effective if the relationship between technology and the five senses were considered in terms of building elements. Breffeilh (2013) also highlights that a balance needs to be achieved between technology and the senses, and that the design process needs to be re-examined in order to incorporate more concepts that stimulate the senses.

PART THREE

COLLABORATION

In order to better understand the dynamic of design management as a tool to foster and implement a collaborative approach, the discussion will

- Firstly, explore the background and value of design management
- Secondly, examine how design management impacts the design process and
- Thirdly, to analyse why collaboration is important in a digital age.

2.8 DESIGN MANAGEMENT

Bessant, Whyte and Neely (2005: 1) explain that design is a well thought out application of creativity carried out in numerous activities to bring about ideas into use. For the purpose of the study the term that will be used to describe design will be a structured process that transforms creative ideas into either products, services and systems that connects creativity to innovation (Knošková 2011: 91). The characteristics of 'design' in design management according to Gray and Hughes (2001: 24) are:

- A personal task whereby the project's design as a whole consists of the motivation and expression of various people
- When various project team members view design from their own perspective keeping their own needs and wishes in mind
- A process that should be discussed and needs to meet the client's briefs, aims and expectations

Gray and Hughes (2001: 25) indicate that design is also a personal statement of ideas, a form of art, a challenge to existing approaches, and a realistic solution to a problem. Interestingly, creativity and design have been linked to innovation and have specific roles in the broader business performances backdrop (Knošková 2011: 92). Knošková (2011: 95) says that the effective use of design is closely linked to design management.

However, the word 'management' refers to the co-ordination, motivation, leadership and various aspects of getting things done through other people (Gray and Hughes 2001: 8). Management plays a critical role in the design process by ensuring that all transfer of

information takes place at the right time, and that the required knowledge is both organized and contracted (Gray and Hughes 2001: 8). Therefore, design management concerns specific management activities, methods and skills that are necessary in order to make the most effective and efficient use of the design processes (Knošková 2011: 91).

2.8.1 The origin and value of design management

De Mozota (2003: 68) and Emmitt (2014: 22) note that design management had originated in Great Britain during the 1960's. At this time, the term was used to describe the relation between design agencies and their clients. Michael Farr was the first to provide a comprehensive discussion about design management. In 1966 he outlined the function and role of the design manager (De Mozota 2003: 68). The design manager's mission was believed to ensure the smooth execution of projects and to uphold an open communication line between design agencies and their clients. De Mozota (2003: 68) highlights that it was in Great Britain that the increasingly important role of designers in industry and the economy was recognised.

Recent literature affirms that design management is simply about "managing people and information" (Knotten *et al.* 2015: 121). Design management is an emergent discipline in the construction sector, and considered a rapidly changing landscape that is bound to lack clarity as industry is still refining its role and academic research direction (Emmitt and Ruikar 2013: 2). Construction projects have become increasingly complex over the years, and Emmitt and Ruikar (2013: 2) state that such developments coincide with "the growing need to co-ordinate information better and the desire of the specialists involved in construction projects to collaborate more effectively". More importantly, an earlier body of research supported the notion that there was a need to improve communication, and encourage collaboration and integration of work (Emmitt and Ruikar 2013: 2).

Design management is an asset or attitude that adjusts a company's state of mind and builds value, and involves the following scope of work (De Mozota 2003: 70):

- Managing design, which includes the creative process within the corporation
- Managing a company according to design principles
- Managing a design firm

According to Emmitt (2014: 21), understanding the value of good design management can provide better, more appropriate management that supports the creative process and encourages excellent service deliveries. It also requires the overseeing of all design activity to ensure a consistent and co-ordinated approach including an understanding of how designers, engineers and contractors work (Emmitt 2014: 22). Which means the need for a broad understanding of a wide range of discipline-specific knowledge. Therefore, to ensure the aforementioned is achieved, Emmitt (2014: 22) emphasises the need for a collaborative approach, excellent interpersonal skills and the ability to make informed decisions on a strategic and operational level.

Eynon and the Chartered Institute of Building (CIOB) say that there is value in considering design management, as it prevents mistakes in design, procurement and construction through communication review, and collaboration amongst the design team (Eynon 2013: 101). As design management assists in improving the working process and end solutions, the overall quality and delivery of the project design outcome is improved (Eynon 2013: 101). Hence, design management is a positive force that is used to provide more opportunities to better the project outcome, and lessen design mistakes that may occur from a lack of expertise or an inefficient design process.

2.8.2 The impact of design management on the design process

Throughout the history of humankind, people have been creating objects. However, before these objects were made there was an initial idea from which the design was derived, and at different stages of the design process, other people may have contributed to development of such an idea (Eynon 2013: 1). Eynon (2013: 1) states that “this process of conceiving an idea, designing, planning and making something a reality has always been managed by someone”. Therefore, where there is a design process occurring, a management process needs to happen simultaneously in order for the design to reach its full potential (Eynon 2013: 1).

Recently, more research has focused on production management in construction rather than management of the design process (Knošková 2011: 91). Furthermore, as a result of the competitive nature of the market place and the development of building complexity, Pektas and Pultar (2005: 99) point out that design professionals have been

pressurised to improve their processes with regards to time, quality and systematic design planning. Gray and Hughes (2001: ix) state that buildings have become complex, with an increasing amount of attention focused on reducing costs and ensuring better quality. Trying to achieve the aforementioned has an impact on the design process, which in turn results in a more complex and less manageable approach. However, there is a lack of understanding of the design process regarding the flow of information between the company and the people involved with the design prior to construction (Gray and Hughes 2001: x). Gray and Hughes (2001: 74) explain that in order to fulfil the needs of modern design, a suitable approach would be to aim for a degree of collaboration that enhances both the creative and decision-making processes.

According to Gray and Hughes (2001: 74) specialists cannot work in isolation. To achieve a better outcome or design they would need to combine their skills and work together. The task of management would then be used to foster a “collaborative” environment, which encourages the transfer of information and knowledge. Successful management therefore requires the following:

- Input of information from a variety of sources
- A continual exchange of information and knowledge without any barriers put forth
- Clear lines of authority but no restrictive boundaries so that information can flow freely between organisations
- The lead designers will be the final arbitrators even though the collaborating group provided a considerable amount of input
- The collaboration must be understood for what it is, therefore, unreasonable expectations must be dealt with at the outset
- The team must receive adequate recognition for their contribution

2.8.3 Design management to drive innovation through collaboration

According to Pektas and Pultar (2005: 99), the industries of architecture, engineering and construction are multi-disciplinary domains where collaborations play a critical role among the related parties. However, even with the abundance of knowledge and information amongst design professionals, there is not enough research to better understand and manipulate the flow of information and knowledge (Pektas and Pultar 2005: 99).

Pektas and Pultar (2005: 100) state that “successful management of design, however, is critical to quality, cost effectiveness and timeliness of projects”. Moreover, a survey by Arditi and Gunaydin (1998 cited in Pektas and Pultar 2005: 100) supports the above notion as architecture, engineering and construction companies in the U.S have ranked collaboration among the many factors that affect quality in the design phase. Over the years, the Arts and Sciences have been placed in separate disciplines; however, recently there has been a rise in the sharing of their understanding of the environment through renewed awareness from advancing studies on human interaction and the environment (McClure and Bartuska 2007: 8).

These developments indicate that collaborative efforts and sharing of information from different perspectives can better inform people. Additionally, the applied design and planning fields have merged their skills and talent to form a general field known as “environmental design”, which McClure and Bartuska (2007: 8) say, focuses on the built environment. McClure and Bartuska (2007: 8) shed light on the importance and need for integration, participation and collaboration across various fields. One of the points that is made highlights that “integration” is the key word in good design. According to Gray and Hughes (2001: 21), one of the most important themes with regard to interaction amongst designers with each other and with their clients and fellow builders, is the way in which they go about their collaboration. Very often the design teams consist of professionals or specialists from various organisations. The team count may vary, as the more complex the project task the more people may form part of the team (Gray and Hughes 2001: 21). Another crucial factor is the unity of the design team. Gray and Hughes (2001: 79) affirm that a group of professionals who are meant to collaborate require a shared and understood goal that unifies their activity. To do so, the design team will need to be committed and have regular contact with one another.

The process of design is complex and will only continue to grow in complexity because of the dramatic increase in specialist knowledge worldwide (Gray and Hughes 2001: 1). Hence, more contributors from various organisations will join the project design. As a result, Gray and Hughes (2001: 1) argue that there will be a rise in design processes, and a continual exchange and refinement of information and knowledge. Various strategies should therefore be in place to control the process and supply of information.

2.8.4 Design management as a tool to solve design problems effectively

Extensive literature exists that deals with design management as a subset of general project management (Rekola, Mäkeläinen and Häkkinen 2012: 81). However, literature regarding design management research that specifically focuses on design work "guidance" and design collaboration management is lacking. Rekola, Mäkeläinen and Häkkinen (2012: 81) say that such research needs to consider the nature of the design work and interaction of the design team, which provides a deeper understanding of how design solutions are created. The diagram below provides a guideline illustration of how design management can be used to effectively solve design problems:

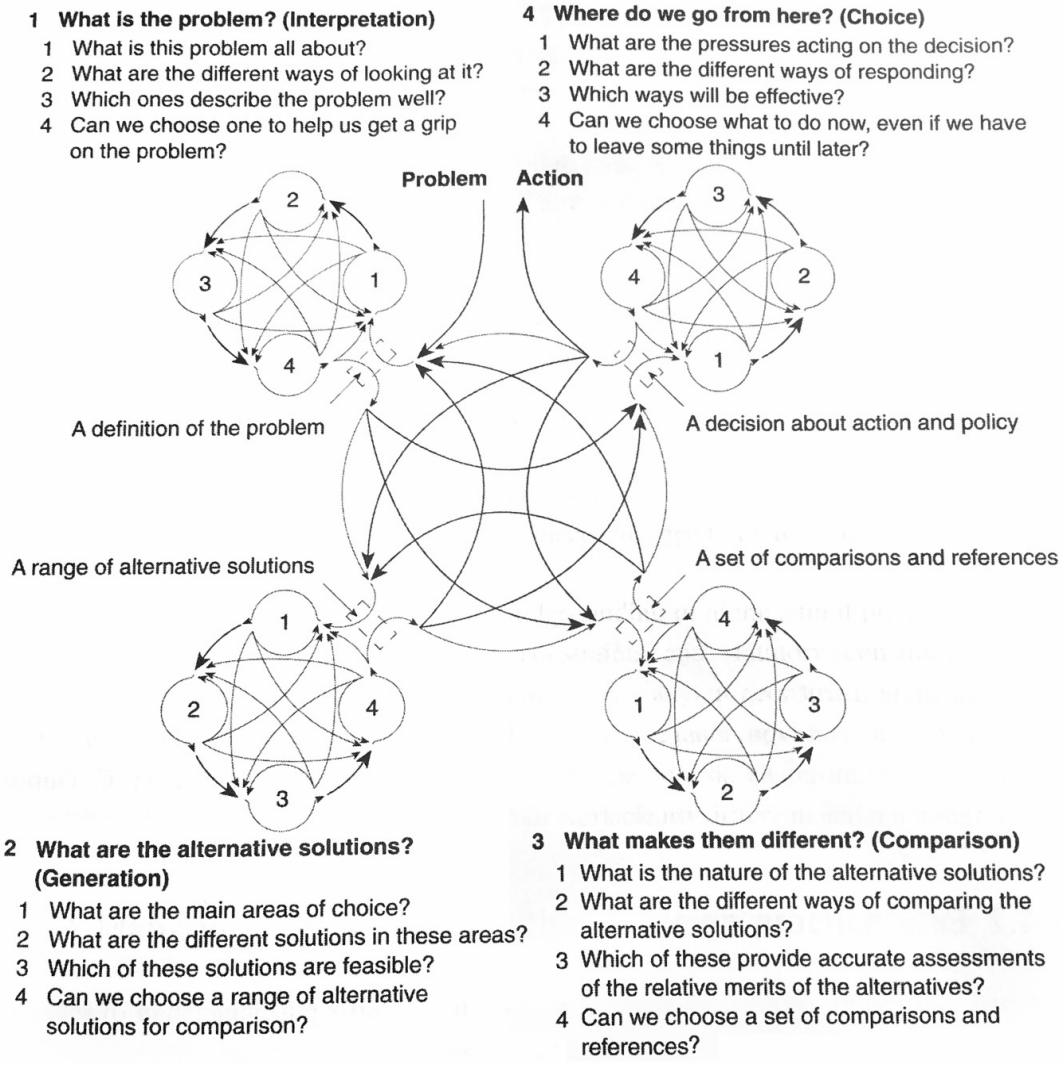

Figure 2.8.4.1 Problem solving strategy in design. Adapted from Gray and Hughes (2001: 29).

Design may be considered a social process that encourages communication that stimulates individual understanding of the design that needs to be produced collectively. Figure 2.8.4.1 above shows that design is not solely about problem solving but is also

about problem finding. Design management critically examines and reformulates both requirements and solutions (Rekola, Mäkeläinen and Häkkinen 2012: 81). Emmitt and Ruikar (2013: 16) say that good design management is one of the 'core values' of a successful architectural practice that has control over the chaotic creative process. As there are many similarities between architecture and interior design regarding the creative process, design management is regarded as a way to cope with the chaos and complexity of the design process. Design management has not yet penetrated the core of collaborative design conception (Rekola, Mäkeläinen and Häkkinen 2012: 82). Although there is new research aimed at improving building design management methods, existing research focuses more on the design process and product (Knotten *et al.* 2015: 125). Hence, there is room for further academic research on building design management on how to plan, coordinate, execute and control collaborative design conception.

2.8.5 The importance of collaboration in a digital age

Collaboration is defined by Sanker (2011: 3) as the synergistic relationship that is formed between two or more entities, for instance, people who work together to produce something that is greater than their individual abilities and contributions would amount to. McClure and Bartuska (2007) support the notion that collaboration has long been a question of great interest in a wide range of fields, and has existed in the workplace for many years. In recent years, collaboration has become increasingly important as the digital world continues to advance and become more globally connected (Elcom 2013). Today, cloud computing and internet connection speed is rapid, and is among the many tools that enable different professionals to collaborate effectively, resulting in more educated, skilled and engaged workers (Elcom 2013).

According to Deutsch (2011: 91), there is a growing need for the ability to collaborate and work productively in a team, as it is a vital set of skills that design professionals need to master to survive the current professional, economic, social and technological challenges. Moreover, the design of built environments in the digital age has become a complicated activity due to the impact of technology and human beings' ever-changing needs. As a result, a collaborative team approach to design and planning has become essential (McClure and Bartuska 2007: 8; Deutsch 2011: 91). In order for collaborations to be successful, the following elements need to come together (Sanker 2011: 76):

Essentials elements for collaboration success
• Ongoing communication • Willing particpation • Brainstorming • Teamwork • A common purpose • Trust • A plan for achieveing the goal • A diverse group • Mutual respect • A written agreement • Effective leadership

Table 2.8.5.1 Essential elements for collaboration success. Adapted from Sanker (2011: 76).

2.9 CONCLUDING REMARKS

The literature indicates that designing effective learning spaces requires more than the aesthetic improvement of an environment. It is about improving people's quality of life through considerate integration of technology and sensory experiences that support how students learn in the digital age. The literature provides an argument that, although universities of the digital age may look towards technological learning tools to meet student needs or redesign how learning and teaching takes place, the senses are equally as important, as they affect how students experience their built environment.

It is therefore imperative that university learning environments are designed to facilitate student connections technologically and sensorially, as doing so can potentially provide a place where students feel passionate about learning. To foster a connection between technology and the senses is a complex task. However, the literature shows that good management of building design and input from specialists can encourage teamwork and a drive to improve end-users' experience of their environment. More importantly, a collaborative approach functions effectively when there is an exchange of knowledge and skills from a variety of sources. This allows design problems to be resolved and informed decisions to be made. Hence, it is worthwhile for interior designers to consider using a collaborative approach to improve a learning environment's functionality and design.

The next chapter outlines the theoretical and methodological orientation of the study and how the research design pursues the objectives and research questions.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In chapter two, the literature that I reviewed focused on technology enhanced learning (TEL) environments within the digital age, sensory design and design management. In chapter three I explain the qualitative research methodology used to conduct the study that is situated within an interpretivist theoretical framework. To illustrate methods used, chapter three defines the research objectives and design process. I identify the sample population selected, and present the data collection and analysis techniques I used, such as the online interviews and focus group. As a result, the distribution of the online interviews and employment of the focus groups, are discussed in detail. Thereafter, I examine the ethics and limitations considered in the study.

3.2 QUALITATIVE RESEARCH AND THE INTERPRETATIVE PARADIGM

I decided to use a qualitative approach as the research method for this study as it primarily focuses on depth, as opposed to "quantity of understanding" (Henning, Van Rensburg and Smit 2004: 3). Qualitative research is outlined as a research strategy that gives prominence to words rather than numbers in the collection and analysis of data (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 30). In particular, it is considered as research that is based on human beliefs and feelings, and is used to gain insight on people's attitudes, behaviours, value systems, concerns, motivations, aspirations and daily lifestyles (Given 2008: 640). Locke, Spirduso and Silverman (2014: 97) specifically define the role of qualitative researchers as follows:

> "Qualitative researchers assume that there are aspects of reality that cannot be quantified…they believe it is both possible and important to discover and understand how people make sense of what happens in their lives."

As a result, research questions are used to explore the meanings that people assign to specific experiences. Qualitative research supports the idea that people construct their own accounts of particular events, and that these subjective constructions are considered a reality of the social world (Locke, Spirduso and Silverman 2014: 97).

On that account, this study uses a qualitative approach in an attempt to understand how interior designers can connect technology and sensory design in university learning environments, using a collaborative approach. This approach is specifically used to provide information on suitable ways to design TEL environments, in the digital age, that are considerate of the human senses. Another detailed description of the inquiry process commonly employed in a qualitative research study is closely examined below (Locke, Spirduso and Silverman 2014: 98):

> "…it is presumed appropriate and effective to enquire about specific social processes or particular person's perspectives through direct contact with those involved – observing, interacting, and asking questions – in natural contexts where people function."

Subsequently, as the researcher, I am the primary instrument for data collection. My subjective perspective and values therefore inevitably form part of the research process, findings and conclusions. Du Plooy-Cilliers, Davis and Bezuidenhout (2014: 30) say that it is common for qualitative researchers to become the primary research instrument who learns a great deal from their participants. Moreover, interpretivist researchers are known to study reality subjectively on a small scale using various primary data collection methods (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 31). Hence, the data gathered from qualitative research is often rich in description and detail (Denby *et al.* 2008: 62).

I decided to use the interpretative paradigm because it is concerned with people's experiences, and is appropriate for a small-scale research study. Interpretivists believe that reality is socially constructed and fluid (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 29). Moreover, humans are considered as subjects with a mind or sense of consciousness (Wisker 2008: 69). Therefore, human behaviour is affected by knowledge of the social world that exists relative to human beings. Interpretivist researchers also believe that the human mind interprets experiences or events, and then generates meaning from them. As a result, meaning does not reside outside the mind (Wisker 2008: 69). Interestingly, an interpretive paradigm is also concerned with the understanding of individual participants' experience and perceptions of their professional roles in their everyday working environment, from the outlook of their individual contexts and background (Henning, Van Rensburg and Smit 2004: 21).

I found an inductive approach for theory formulation within the interpretive paradigm to be suitable for this study, as it is an approach used to collect information, analyse it and then formulate a theory based on the information and analysis (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 30). Du Plooy-Cilliers, Davis and Bezuidenhout (2014: 28) indicate that interpretivism is used to try to gain an understanding that is both in-depth and empathetic, and often requires researchers to interact personally with those being studied. In order to strive for validity, interpretative researchers use a variety of data from many sources or analysis methods, and in particular, are concerned with a process that is communal and informed or scrutinised by participating practitioners (Henning, Van Rensburg and Smit 2004: 20).

Qualitative research is therefore associated with the underlying qualities of peoples' subjective experiences and the meanings accompanied with the phenomena (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 173). More importantly, using qualitative data collection methods is a means to obtain a richness and depth of data gathered from a multi-faceted or complex phenomena that can be found in a particular social context (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 173).

On that account, qualitative research that is situated in the interpretivist paradigm, is considered to be the best suited method for this study to understand the 'why', 'what' and 'how' of the phenomena. It is deemed the most appropriate method of exploring the perceptions and opinions of interior designers or specialists involved in the design of learning environments, which can, in turn, offer multiple points of view that can be used to answer the research questions effectively.

3.3 THE RESEARCH DESIGN

According to Leedy and Ormrod (2010: 85), research design is a general strategy for solving a research problem. A general strategy is pertinent to this study as it can provide the

- overall structure for the procedures that a researcher aspires to follow;
- data collected;
- data analysis that is conducted (Leedy and Ormrod 2010:85).

What the above on page 67 suggests, is that it is necessary to understand the refining process of the qualitative data within the study. In addition, it is equally important that the research is practical and built upon a precise and realistic plan that may be executed within a framework of a clearly formulated and feasible design. For that reason, I used the following research framework to guide the research design:

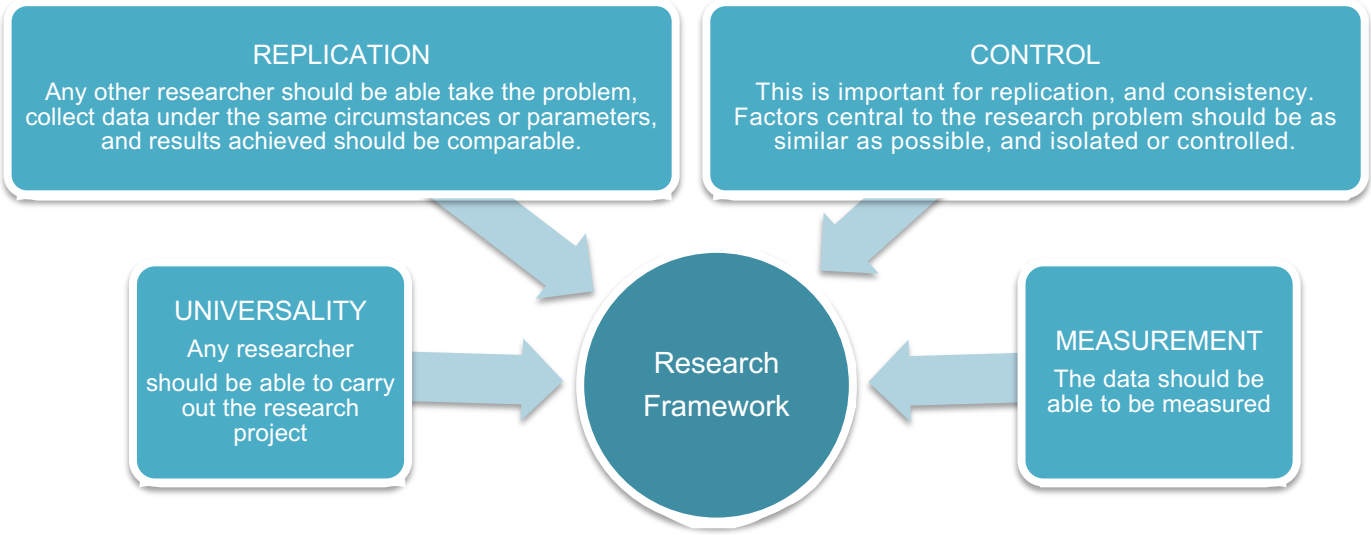

Figure 3.3.1 Research Framework. Adapted from Leedy and Ormrod (2010: 87).

Henning, Van Rensburg and Smit (2004: 31) state that the way in which the researcher perceives the world and knowledge fundamentally influences *what* will be researched and *how* the research inquiry will be designed. Putting together an effective study design process therefore provides this study with a useful conceptual, cohesive device that binds the methods together and indicates which paradigm I decided to work within (Henning, Van Rensburg and Smit 2004: 34).

To maintain research design coherence is crucial in any study as it relates to the concept of the 'golden thread' (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 175). Given (2008: 761) defines the meaning of 'research design' as the way in which a research idea is transformed into a research project or plan that can be executed in practice by the researcher. It also includes the methods and techniques selected for collecting the data and is comprised of decisions made about how the research may be conceptualized or add to the existing body of knowledge in a particular area (Given 2008: 761).

Sarantakos (2005: 105) says that the research design is a key factor in clarifying both how the researcher will conduct the study and how the questions asked in each step will be addressed. Figure 3.3.2 below shows that the research design process constructed was carefully considered, so that it may be possible to cross-link and relate all aspects of the study, from the data collection techniques through to the research aims and objectives:

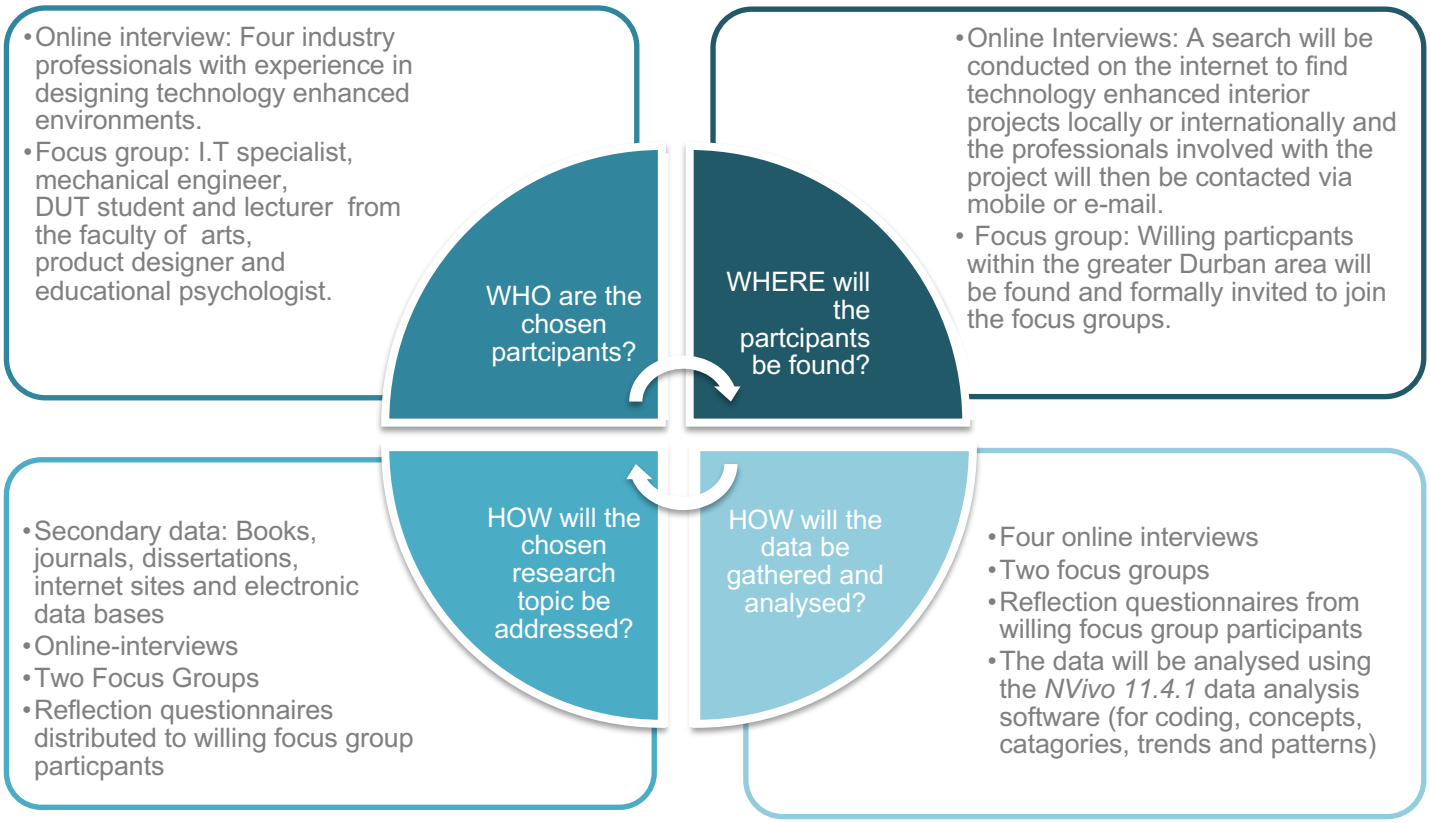

Figure 3.3.2

Research study design process

The principle of design coherence is linked to the arrangement of research questions, purpose, goals, and methods within a particular paradigm (Durrheim 2006: 37). To ensure validity and trustworthiness of a qualitative study, it is pivotal to align the data collection, analysis and interpretation methods to the research goal (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 175).

Table 3.3.3 was drawn up to align the above in order to ensure validity and trustworthiness of the study:

Research questions	Data sources and methods	Justification
1. What challenges are interior designers facing when using technologies to enhance user experience in the built environment?	Primary data: Pilot interviews (P.I. n=8) and Online Interviews (O.I. n=4) with two interior designers / architects who design high technology environments in South Africa. Secondary data: Books, journals, dissertations, internet sites and electronic data bases.	Online interviews will provide industry professionals accounts of what challenges are faced when using technologies to enhance user experience in built environments. Responses will also reveal how they overcame such challenges. i.e. based on their own experiences.
2. What sensory design principles should an interior designer consider for technology enhanced learning environments in universities?	Primary data: Pilot interviews (P.I. n=8) Online interviews (O.I. n = 4) and focus groups (F.G n=2) Secondary data: Books, TED conferences, journals, dissertations, internet sites and literature review.	Online interviews will provide a deeper understanding of how technology enhanced learning environments should accommodate the senses. Focus group discussions will bring to light design solutions and strategies to consider student technology and sensory needs.
3. How can a collaborative design team assist interior designers to overcome technology and sensory design challenges in learning environments?	Primary data: All methods in the study Pilot interviews (P.I. n=8) Online interviews (O.I. n = 4) and focus groups (F.G n=2) Secondary data: Literature review	Focus groups and interviews will yield different opinions or viewpoints on the ability of a collaboration to provide interior designers with solutions to technology and sensory design challenges. The evaluation checklist and literature review will provide detailed information and insight on collaborations.

Table 3.3.3 Research study design coherence

Qualitative research is explorative, fluid, flexible, data driven and context sensitive, whereby decisions concerning design and strategy are on-going and grounded in practice, process and context of the research study (Mason 2002: 24).

With that in mind, Figure 3.3.4 is a framework illustration that I formulated as a data collection guide, to address the research questions and encourage the process of strategic thinking and analytical reflection from the start of this study:

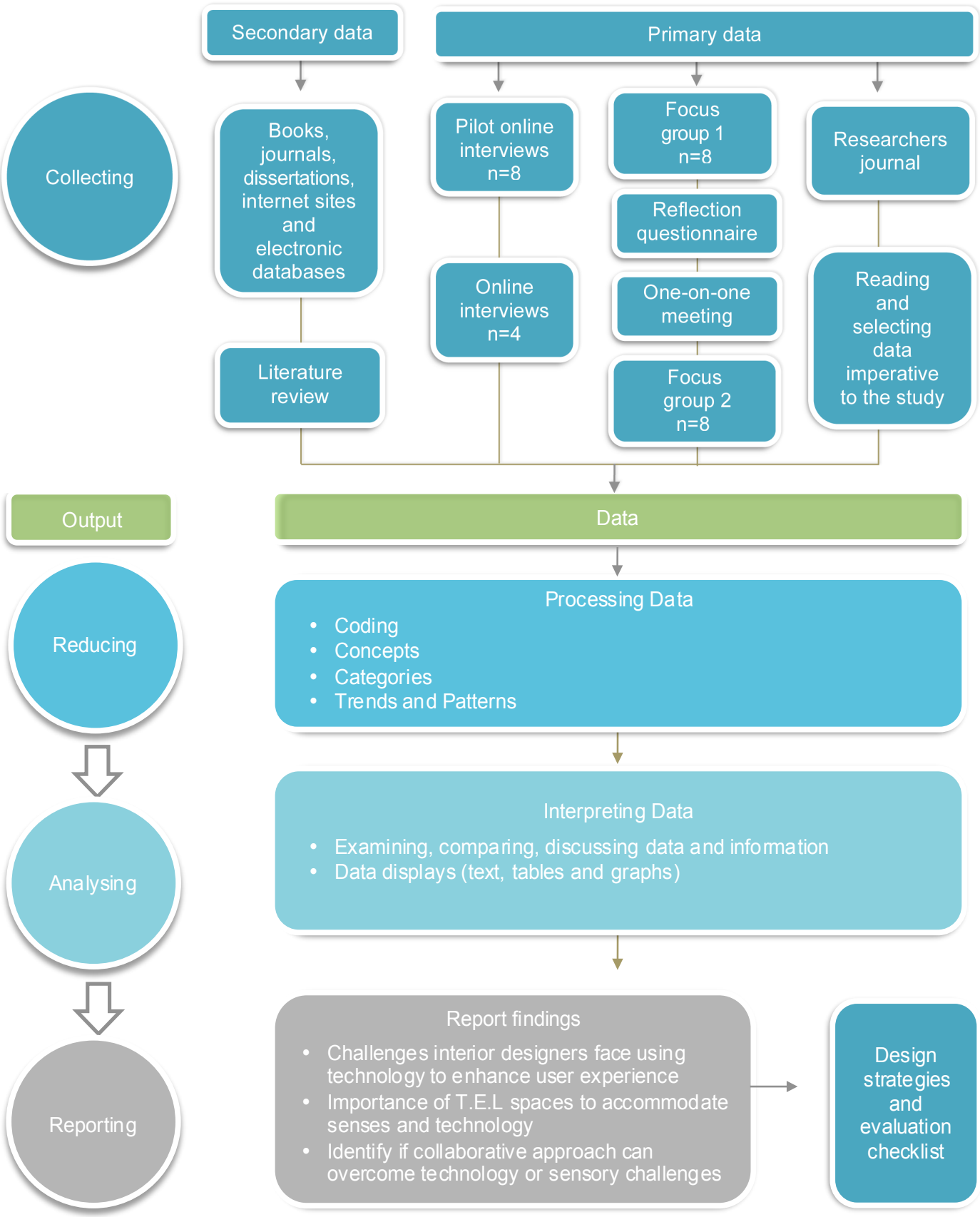

Figure 3.3.4 Research study methodology framework

3.4 ACTION RESEARCH

The methodology I adopted for this study is technical action research, as it is considered an appropriate means to answer the research questions. Technical action research aims to improve the effectiveness of practices (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 198). In addition, success thereof is determined by collaboration with the participants in the hope of finding ways to improve practice in a systematic way. Given (2008: 4) defines action research as follows:

> "Action research is a flexible research methodology uniquely suited to researching and supporting change. It integrates social research with exploratory action to promote development. In its classic form, action research involves fluid and overlapping cycles of investigation, action planning, piloting of new practices, and evaluation of outcomes, incorporating at all stages collection and analysis of data and the generation of knowledge."

McNiff and Whitehead (2009: 7) say that by using action research, practitioners from any profession or cultural background may be able to investigate or evaluate their work, and identify how it may be improved. For that reason, action research has gradually attracted widespread interest as a form of professional learning. Many practitioners now investigate their practices themselves, and explore new ways to live in the direction of their educational values. For that reason, the inquiry is now characterized as a powerfully liberating form of professional enquiry (McNiff and Whitehead 2011: 8).

Action research is reflective and focused on action in a series of cycles that entail a collection and analysis of data about a specific topic (Somekh 2006: 1). This includes the planning and introduction of strategies implemented to initiate positive change. The positive changes are a result of the action strategies, collection of data, interpretation analysis, and the evaluation of the subsequent changes.

Action research is considered to rely heavily on qualitative methods, and is often situated within an interpretative or critical inquiry (Henning, Van Rensburg and Smit 2004: 47). Interestingly, Henning, Van Rensburg and Smit (2004: 47) point out that it

has become a powerful methodology that is driven by a sense of social action, and implemented with the participants for whom the intervention is designed. Furthermore, data from several sources have identified that the outcomes of action research are both practical and theoretical (Tripp 2005: 447; Given 2008: 4; Gustavsen, Hansson and Qvale 2008).

Accommodating both the senses and technologies simultaneously may be challenging, and interior designers practising in industry often need to consult various specialists in order to successfully consider both aspects. When trying to consider the senses and technology, it is equally important to understand both the principles of sensory design and the characteristics of TEL environments. For that reason, I used a collaborative approach to integrate the strengths of both the interior designer and industry professionals in an attempt to improve the design of learning environments. It was necessary for me to participate in the collaborative design team as both the researcher and interior designer, so that I may assist the participants in finding solutions that may better provide for students' sensory and technology needs (McDonald 2014).

Du Plooy-Cilliers, Davis and Bezuidenhout (2014: 203) reveal that action research is an approach suitable for researchers who use their knowledge to conduct systematic enquiries to find solutions for problems. Similarly, Dahlberg and McCaig (2010: 99) believe that action research is fitting for studies that have a dual focus on both changing social practice and developing academic theory to improve conditions. As a result, I decided that action research is an approach well suited to this study, as it may bridge research about how technologies can be used to enhance the students' senses, which may in turn assist interior designers in creating more effective learning environments for all learners in the near future.

3.4.1 Characteristics of action research

Action research is recognised as a form of 'action enquiry' that employs recognised academic research techniques in order to inform the action taken to improve a particular practice (Tripp 2005: 447). It is considered as a flexible spiral process that allows both action and research that is conducive to change, improvement, understanding and knowledge to be achieved simultaneously (Costello 2003: 4). Fundamentally, the term

'action research' is known to embody a multitude of concepts that vary in definition among researchers. Although there are slight differences in definitions, Costello (2003: 4) says there appears to be some agreement that action research is:

- Commonly known or termed as a process, inquiry, approach and cyclic
- Emphasised as practical, problem solving
- Carried out by individuals, professionals and educators
- Involves systematic, critical reflection and action
- Aimed at improving educational practice
- Focused on using action as a means to understand, evaluate and change
- Related to gathering and interpreting data, often concerning teaching and learning
- Links critical reflection to the review of action undertaken and planning future actions

The nature of action research involves action in both the practical and academic fields and has characteristics that effectively respond to both. One of the reasons it is considered to be a balance between the practical and academic fields is because it is an approach that is pro-active to change, yet allows for change that is strategic and based on understanding that is developed through research information and analysis (Tripp 2005: 447).

Table 3.4.1.1 below articulates characteristics of action research:

Characteristics of action research				
Innovative	Continual	Pro-active strategically driven	Participatory	Interventionist
Problematized	Deliberated	Documented	Understood	Disseminated

Table 3.4.1.1 Characteristics of action research (Adapted from Tripp 2005: 447).

3.4.2 Stages of action research

Action research is useful when trying to solve problems and developing useful strategies to achieve a practical outcome (Wisker 2008: 74). It is also an approach that is considered a continuous learning process, whereby new knowledge is acquired and shared with other practitioners who may benefit from it (Denby *et al.* 2008: 67). On that

account, it is an inquiry that is used to transform practice, and because of its dual action, it is considered as an alternative approach to traditional research because it is:

Figure 3.4.2.1 Elements of action research

In that regard, it is possible as both a researcher and interior designer to integrate research into practice effectively. According to Zborowsky (2010: 136), the success of the outcome depends on the ways in which the problem and solution are addressed. It is therefore essential to challenge the traditional academic and practical approaches currently used, because by doing so the research integrated into the practice will be both sustained and embedded in the interior design process (Zborowsky 2010: 136).

Zborowsky (2010: 139) highlights that the core centre of design is naturally experiential and practice-based. However, even though action research is based in practice, research is used within, on and through the practice. Wisker (2008: 232) explains that the action research process requires and establishes a sustained and explicit assessment of:

- Decisions
- Relationships
- The knowledge base for decisions
- The critical interpretation of data
- The learning that can be derived from practice

An action research approach is therefore used in this study as a tool to identify strategies or solutions that may assist interior designers in overcoming sensory and technology challenges within learning environments. Moreover, I adopted an action research model frame to guide the collaborative approach and explore what was

causing these challenges. The model was also used to discover how practitioners involved in the design of learning environments could provide innovative solutions to address these design related challenges[6]. The following model is used to frame the action reflection research process:

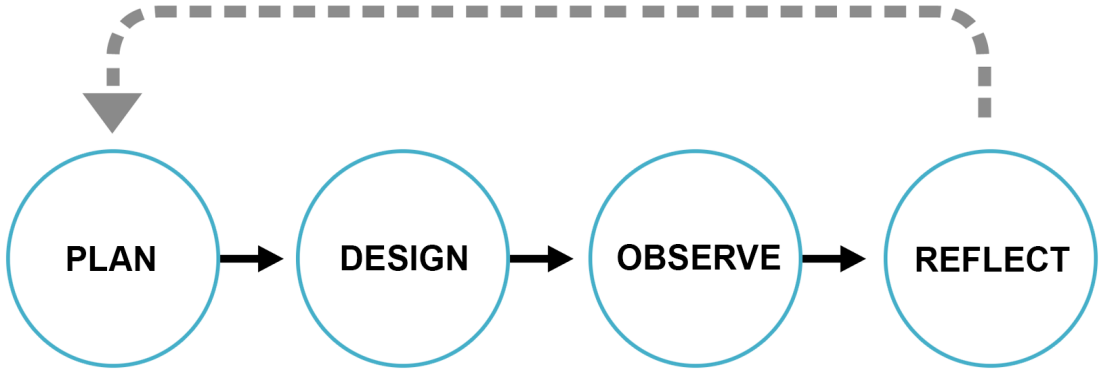

Figure 3.4.2.2 An action research model. Adapted from Costello (2003: 7) and McNiff and Whitehead (2011: 9).

Action research is known to co-generate new knowledge and analysis simultaneously with action that drives transformative and practical solutions to a problem (Blaxter, Hughes and Tight 2006: 67). In particular, it involves research, systematic, critical reflection and action. With that in mind, Blaxter, Hughes and Tight (2006: 68) state that the action research model, such as Figure 3.4.3.1, is specifically envisaged to:

- Examine the nature of the problem situation
- Devise an appropriate intervention
- Conduct a trial run of the intervention
- Evaluate the impact

By using the action research model in Figure 3.4.2.2 above, the study participants and I would encounter the following action research criteria:

[6]The action research process may provide a platform to reflect on design challenges and how to resolve them, but it is also important to keep in mind that it is a reiterative cyclic process of reflection and action that takes time to conduct. Therefore, solutions to such design challenges are not expected to be immediate but are expected to emerge over time using more than on cycle of action.

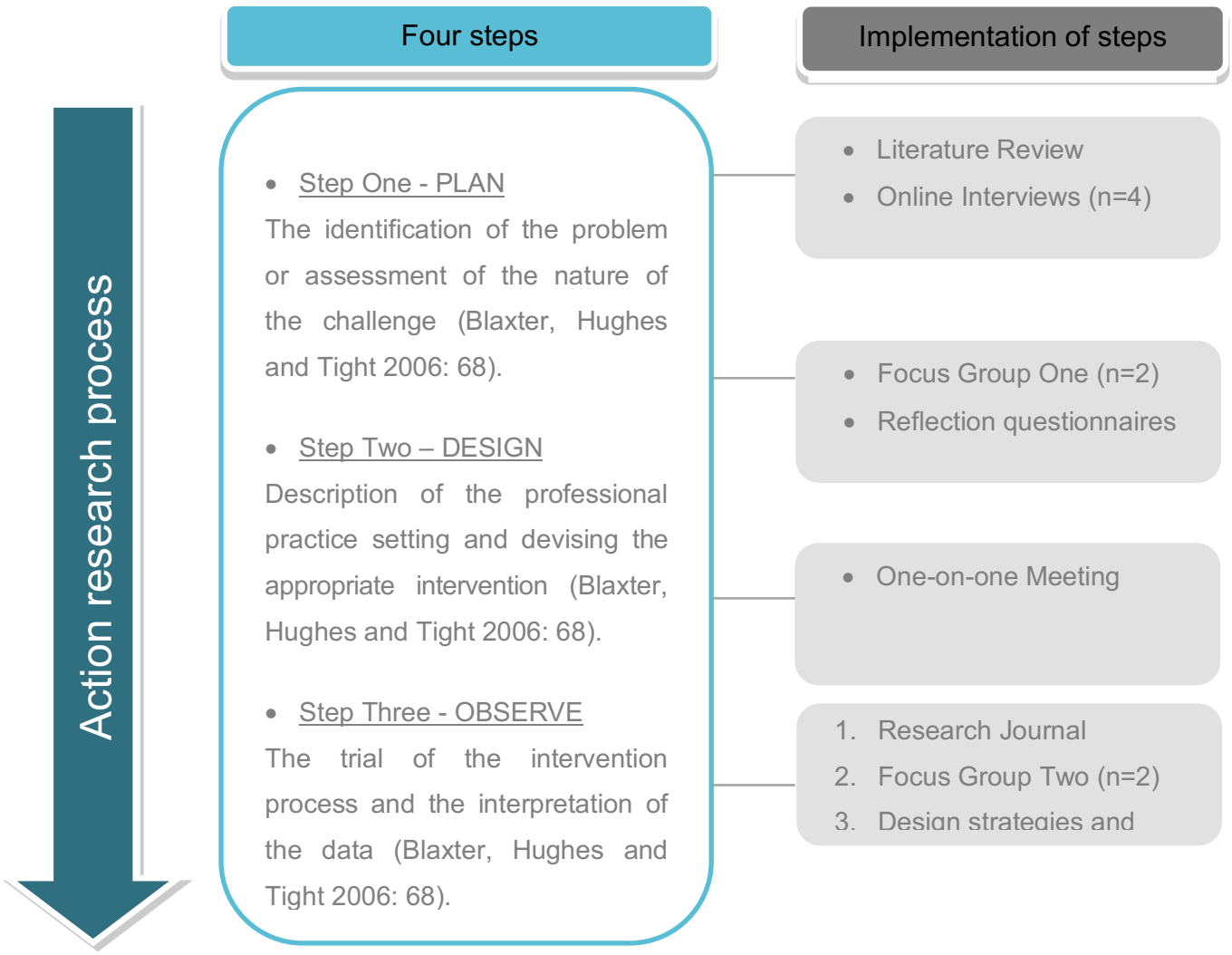

Figure 3.4.2.3 Illustration of the action research criteria for the study

3.4.3 Step one - PLAN (problem identification phase)

A key factor that is pivotal to the success of the inquiry at all stages is that the participants and the researcher are willing to be both flexible and reflective. Being flexible and reflective is an essential part of the process as all inquiry learning is 'messy', and, according to Timperley, Kaser and Halbert (2014: 6), working through the 'messiness' is an important part of the transformation.

An important part of the action research process is to ensure that each step of the process is well planned and documented (McNiff and Whitehead 2009: 15). It is essential that the environment that needs to be enhanced or modified first be identified. I found that by engaging in action research, it is possible to identify challenges and issues within a professional context and then work towards developing creative solutions to these challenges. However, the challenges cannot be addressed unless

they are first identified and defined. Thereafter, I strove to understand the nature of the challenges and how they can be solved.

Action develops into research when thought is given to what is being inquired and how it is being inquired (McNiff and Whitehead 2009: 15). Therefore, it is not only vital to describe the plan of action I took to address the challenges, but it is equally important that I show the processes that have led to articulating those challenges. Providing detailed explanations of the steps I take, and why each is important to the process, allows the description to become embedded within the explanation (McNiff and Whitehead 2009: 15). Table 3.4.3.1 below illustrates the steps I used in this action research study (adapted from Wisker 2008:235):

Steps taken in action research
• Experience • Focus on problem • Production of general plan of action • Building ways of working together with the participants (i.e collaboration) • Taking an action step • Monitoring the effects of the step • Collecting the data • Reflecting on, discussing and evaluating the results • Reformulation of plans • Taking another step and so on...

Table 3.4.3.1 Steps taken in action research study. Adapted from (Wisker 2008: 235).

As already mentioned, this study strives to discover how interior designers can ensure that university learning environments are mindful of students' technology and sensory needs, using a collaborative approach. Before the above steps were taken, the literature was reviewed (as illustrated in Table 3.4.2.3). The literature review provided deep insight and different perspectives on the study questions. It also shed light on megatrends predicted for the future digital world and highlighted key principles that should be considered when designing TEL environments. I also examined Sensory Design in relation to advanced technology and students' behaviour, emotions, and attitudes.

In order for me to identify the challenges faced when designing university learning environments that are mindful of technology and the senses, I needed to interview interior designers or architects who have experience in designing 'high tech' spaces. The architect and interior designers online interview responses were an integral part of the problem identification process because:

I. I used their professional first-hand experience to identify the specific challenges interior designers faced from concept design through to completion.
II. I asked them to explain how they overcome the challenges they face concerning technology and the senses.

3.4.4 Step two - DESIGN

3.4.4.1 Describing the professional practice setting and data gathering

After the challenges were identified and defined, the 'design' phase was then considered. The design phase is also known as the 'action' phase, which involves the describing of the professional practice situation and data that need to be gathered (Costello 2003: 8). The aim of the 'design' phase was so that I could closely examine the research questions and gather information in order to build a preliminary understanding of the situation (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 200).

There are many ways that the research data may be gathered. Using a variety of data collection methods may ensure the validity of the study results (Berg 2004: 199). Essentially the best data collected are data that are directly related to the research questions, as they can provide answers that are imperative to the study (Berg 2004: 199). I adopted the concept of triangulation in this study as it is used to obtain regularities in data by comparing various participants, settings, and activities in order to identify recurring results (Berg 2004: 199). I then decided that the best way to retrieve data relevant to this research study would be through online interviews, focus groups and a research journal.

During the 'design' phase, I used the focus groups to gather information from a design team of various professionals who would typically be involved in creating high technology learning environments. The purpose of the design team was to generate

specialist information and constructive feedback regarding how to overcome the challenges that arise when trying to consider students' technology and sensory needs.

Moreover, I used the collaborative approach to drive innovation with a practical conceptual design output that strove to establish design strategies that could assist interior designers to create learning environments that provide better technological and sensorial experiences. Thereafter, I used the reflection questionnaires, completed by the design team at the end of the first focus group and the research journal, to capture the critical design and reflective thinking that was experienced during the collaboration process.

3.4.4.2 Describing the action intervention

The intervention that forms part of the 'design' phase is important as it provides structure and identifies the actions that form part of the action research process (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 201). Action research is primarily known to drive action when a problem has been identified and adequate data have been gathered pertaining to the research study. For that reason, it is an approach that is rooted in the values and culture of the research participants who engage in the study (Given 2008: 6). According to Zborowsky (2010: 139), the integration of research in a reflective practice gives the participants and the researcher the opportunity to:

- Impact on design decision making during the design process
- Document the findings of working in a collaborative design team and
- Contribute to the larger body of knowledge within the profession of interior design

Due to the nature of this study, 'action' forms part of the research itself, which means various actions are applied during the 'design' cycle. This means that it is common for the most suitable action to become clear only after implementing a number of other actions (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 201).

The collaborative approach assisted in establishing design strategies that may help interior designers create learning environments that consider both the human senses and emerging technologies. I invited the design team participants to join two focus

group discussions to collaborate and work together to find the most effective design solutions. The specialists I chose were from different professional backgrounds and were selected based on their knowledge of emerging technologies, multi-sensory learning experiences or the design of the built environment.

The focus group discussions provided an opportunity for specialists from different industries to share expert advice and intellectual insight on the best ways to deal with the challenges interior designers face when designing TEL environments. The aim of the first focus group was to spark conversation around the research topic, and to draw out opinions from the design team participants on the best ways to overcome the challenges that were defined by the literature review and the online interview. The moderator encouraged the design team to listen to each other, considering that focus groups are characterised by discussions, conversations and exchange of knowledge (see Appendix I for more information on the moderator guidelines for the focus groups). To explore solutions that were innovative and appropriate for this study, all participants of the design team were expected to 'think out of the box' or challenge traditional ways of overcoming the challenges revealed. Part of the collaborative approach involved discovering what may or may not be the best solution for the practical conceptual design outcome.

I initiated the discussion with a PowerPoint slideshow that consisted of videos and images of emerging technologies and predicted technology advancements to come. The design team had much to debate about regarding the visual stimuli presented. The slideshow allowed the design team to get acquainted with the look and feel of futuristic technology and interior design concepts. It also encouraged conversation around students and learning environments of the digital age. There was extensive conversation surrounding the relevancy of multi-sensory learning in the digital age and how such experiences can be integrated into 'high tech' academic spaces in the near future.
The design team's responses to how learning environments of the future should be designed were interesting and often based on the participants' professional experiences and preferences. Overall, the purpose of the focus group discussions was for us to 'actively' explore how effective a collaborative approach is, and how it might be able to assist interior designers to connect technology and sensory design. The design team was supportive about addressing the challenges of designing university environments of the digital age. Their enthusiasm reflected their collective concerns about creating

learning environment designs that are conducive to how students can use technology and their senses to engage in their studies.

I used a video camera and handwritten notes to capture the dynamics of the collaboration and the comments made by all the design participants, and at the end of the focus group discussion I distributed reflection questionnaires to the design team to evaluate their experience of the collaborative process (see Appendix I).

3.4.5 Step three - OBSERVE (data interpretation)

After gathering data, the natural progression was for me to monitor the intervention process which is also known as the 'application of the action'. I carefully interpreted the data and reflected upon them, in order to arrive at a reasonable conclusion that is used to guide the direction of the research (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 201). I then used the collected data to establish the effect of the implemented action. In action research, data analysis involves the examination of the data concerning potential solutions to the research questions and challenges identified during the first stage of the research process (Berg 2004: 199). For that reason, the 'observe' phase is considered a key point, as the data are analysed against a set of criteria to determine whether the proposed collaborative solutions worked to solve the problem.

After the first focus group discussion, I commenced the design concept. My initial design concept was informed by the literature review and precedent works that I examined Breffeilh (2013). The built environment I chose for the conceptual practical design was an existing academic hub located in Cornubia within the Durban area of South Africa. This academic hub was selected because it was a valid reflection of an academic environment where university students might potentially study. Furthermore, the size of the building was also appropriate because it was possible to accomplish a full interior design concept within the limited time constraints. After completing the design concept, I read the handwritten notes and reflection questionnaires and watched the video recordings several times to interpret and understand the best way to implement the suggested design strategies into the conceptual practical design.

After the conceptual practical design was completed, the design team participants agreed on a date and time to meet one-on-one with me for an hour. The meetings were crucial as they allowed the design team participants and me to critically observe and evaluate the way in which their suggested design strategies were implemented into my conceptual practical design. Thereafter, I computer generated 3D realistic visual renders of the final outcome of the conceptual practical design which essentially was a TEL environment that was mindful of the human senses. The effectiveness of the interior design elements, furniture, finishes, product design, materials and multi-sensory learning experiences were evaluated and analysed in depth with the design team.

The one-on-one meetings offered the design team an opportunity to provide me with constructive feedback. I documented the design critique and evaluation into my research journal in the form of handwritten notes and sketches. The goal of the meeting was firstly to determine if the design strategies were implemented according to the specialist advice imparted in the focus groups discussions. Secondly, the meetings facilitated part of the action cycle which was to seek ways to improve the design strategies through a refining process. Subsequently, the task of interpretation was determined by the data gathering methods that I selected. The goal of the 'observe' phase was for me to understand the descriptive accounts based on the data gathered. Analysing the data involved exploring the links and connections between interdependent elements and the participants' perspective or experiences obtained during the collaboration. Hence, the data interpretation provided me with deeper understanding of the phenomena and assisted me to formulate the necessary interventions.

3.4.6 Step four - REFLECT (evaluation of the intervention)

According to Blaxter, Hughes and Tight (2006: 68), action research is linked to development, change and participatory action research, and is specifically undertaken to understand, evaluate and change. Generally, when interventions are carried out, it is important to establish whether the interventions had a meaningful impact or not. Therefore, I considered the 'reflecting' stage as a vital assessment process. By reflecting, it is possible to critically analyse the way the intervention was carried out, and to note the context and contradictions of the practice and to grasp an understanding of

the practice itself (Wisker 2001: 158). This aids the process of strategizing and is also consistent with the cyclic action research model (Figure 3.4.2.2) adapted for the study.

According to Du Plooy-Cilliers, Davis and Bezuidenhout (2014: 201), the findings, based on the data gathered, should be used as a reflective tool that in turn deducts what future course of action should be taken in an attempt to solve the identified research challenge. Simply put, the findings prompt reflection and examination, which consequently leads to the planning of a new action cycle. For that reason, the 'reflection' stage encourages a review of the research questions, or alters the concern of the research challenge, which in turn initiates the start of a new action research process (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 201). Townsend (2013: 109) explains that great consideration needs to be given to the process of reflection at the end of each action research cycle, and in addition should seek to answer the following questions:

1) What was the impact of the actions?
2) How does it relate to the research questions and challenges?

The process of reflection helps to make sense of what has been learnt from the intervention concerning whether the defined research challenges or questions can be solved. It also prompts questions about what is to follow, which may result in further inquiry into the nature of practice or inversely require changes to be made to the practice itself. The aim of an evaluation or reflection in action research is to gain a deeper understanding of the effect or influence of particular strategies and practices (Townsend 2013: 110). The following illustration graphically illustrates the basis for the two applications of evaluative perspectives in action research:

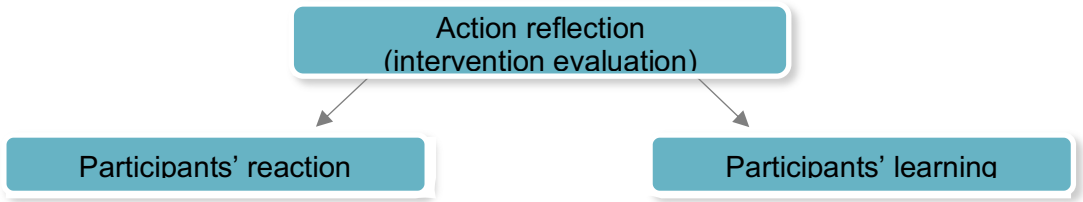

Figure 3.4.6.1 Reflective action research evaluation. Adapted from Townsend (2013: 110).

3.4.6.1 Participant's reaction

The way that participants act and feel is vital to the success or failure of the action research process. In order to gauge the participants' reactions, it is important to carefully

unravel how they initially perceived the progress of the action research, including their feelings about the specific changes linked to it (Townsend 2013: 110). It is also crucial to assess if they felt that the time spent during the action research study was valuable or worth their time. I analysed the participants' reaction in the following ways:

1.) Research tools used to evaluate the study participants' reaction
2.) Design teams' reflection of the collaborative process

1.) The study materials that I provided to the participants were used to gather their perceptions, opinions, feelings and professional knowledge on the study topic. Evaluating their reactions and level of understanding provided a way to assess if the study material made sense to them or if they found the information useful:

Data collection method	Study materials that I used	Tools that I used to gauge participants' reaction and understanding
1.) Online Interview (see Appendix D)	Images of futuristic learning tools, products and interior spaces	i.) Pilot online interviews ii.) Participants were questioned on their understanding of various definitions related to the study topic
2.) Focus Group 1 (see Appendix I)	Slideshow presentation of futuristic images and videos from high technology videos (cinematic and educational)	i.) Reflection questionnaires were distributed after the focus group to capture their understanding and reaction of the collaboration, research questions, solutions, their professional perspectives of the study topic and what was learned (see Appendix F) ii.) Study notes were taken and logged into a research journal. iii.) Focus group session was video recorded to capture the participants' reaction and responses during the collaboration process.
3.) Focus Group 2 (see Appendix I)	3D realistic visuals of the collaborative practical design outcome	i.) Study notes were taken and logged into a research journal. ii.) Focus group session was video recorded to capture the participants' reaction and responses during the collaboration process.

Table 3.4.6.2 Research tools for evaluating participants' reaction

2.) Following the one-on-one critique meetings with each design team participant, I thoroughly read the documented feedback and used it as a guideline to revise the conceptual practical design and improve the way that the design strategies were implemented. Due to time constraints, it was not possible for me to implement every

single proposed critique. For that reason, I selected only a few spaces within the academic learning hub to be revised and re-designed accordingly. Thereafter, I rendered computer generated 3D realistic visuals of the learning spaces once again, with the suggested changes from the design team. I then contacted each participant via telephone or e-mail again to arrange a date to meet for the second focus group discussion.

The second focus group discussion acted as a catalyst for extensive reflection on the changes that were made to the conceptual practical design. The main aim of the meeting was to encourage the design team to 'reflect' on the collaboration and process of action research implemented. Moreover, the discussion topics, guided by the moderator, were focused on their thoughts and views of the refining process concerning the design strategies that were implemented. The design team specifically evaluated whether or not the design changes that were made were an improvement. The 'reflecting' phase was therefore a means of analysing the collaborative effort that was built on the professional contribution of the design team participants. The discussions encouraged the design team to consider if the collaboration was harnessed to solve the challenging problems interior designers face when creating learning environments that acknowledge both the senses and technology. I used handwritten notes and a video recording to capture the design team's discussion.

Consequently, the second focus group critically looked at the design strategies and changes that were implemented, in a bid to establish whether or not the collaborative approach spurred innovation and was valuable to the development of the conceptual practical design. The design participants also shared their experience of the collaborative process and their reflective thoughts on whether the collaboration was a success or not.

3.4.6.2 Participants' learning

Action research is an educative approach for both the researcher and participants (Townsend 2013: 110). The main objective of the reflective process is not only to reflect on 'what is out there' in terms of research findings, but it should also reflect what is 'in here' in terms of personal and professional reflection (Du Plooy-Cilliers, Davis and Bezuidenhout 2014: 201).

Focus group discussion two was used to discover whether the participants learned something from the process. It was therefore necessary that I establish what was understood and learned by the participants. Wisker (2001: 230) states that one of the key features of action research is that the researcher and participants work in partnership. This means the aims, practices, strategies and findings of the research are in fact shared at each stage. Another key feature reveals that both parties learn specifically through involvement in the research and through their reflections. Ultimately, people are able to learn and create knowledge through their concrete experience (Wisker 2001: 158) by observing and reflecting on their experience through abstract concepts and generalisations. People are also able to learn by inspecting the effects of these concepts within new situations. This ultimately leads to new concrete experiences and, in turn, the start of a new action research cycle.

The main aim of the action research is to ensure that there has been a transfer of knowledge to participants with the hope that the new knowledge obtained can be used to improve their own professional practice. As the researcher, these were important study goals to implement so that new skills acquired would resonate with the participants throughout the rest of their personal and professional lives.

3.5 DESCRIPTION OF THE SAMPLE POPULATION

When considering the development of educational research on tertiary learning environment design, the most vital driving forces are the university learning facilities, interior designers, architects and other specialists who determine how the built environment should be designed or structured. Moreover, it is common for interior designers to look to other professionals from various disciplines for information or practical guidance regarding how people experience their physical environment and how such environments must satisfy different human needs (Kaplan 1973: 275). For that reason, it was important to include professionals who would usually be consulted by an interior designer on a practical project specific to learning environment design.

Therefore, I distributed the online interviews to two architects and two interior designers. The focus group that formed the design team consisted of seven participants, which included a moderator, an informational technology specialist, a DUT student and

lecturer, an educational psychologist and a product designer. On that account, it is important to ensure validity of all aspects of the research study such as how the study's accuracy, meaningfulness and credibility can assist in drawing meaningful conclusions from the data that are collected (Leedy and Ormrod 2010: 97). Hence, by conducting four online interviews and two focus group discussions, with reflection questionnaires distributed to the participants after the discussion, I could cross-examine the collected data with the literature to find common themes and crucial links to answer the research questions. Collecting data in many forms and from a variety of sources is a method known as triangulation, and is particularly useful when trying to assess if each set of data collected converges to support a specific theory or hypothesis (Leedy and Ormrod 2010: 97). For that reason, I used triangulation in the hope of ensuring internal validity.

I also used a research journal, which formed an integral part of reflection throughout the action research process, and strove to ensure external validity. With regard to the practical design, I documented journal sketches and notes when interacting with the collaborative design team on an individual basis and during the focus group discussions. These reflections captured the participants in both a formal and naturalistic environment to create transparency in the research process. With that in mind, research journals are useful as they provide a research 'trail' of how the analysis occurs and essentially have concrete effects on the research design (Ortlipp 2008: 696). I therefore used the journal throughout the design process to make all decisions, thinking, values and experiences behind those decisions visible to the reader and easy to understand.

3.6 THE SAMPLING PROCESS

It is vital to state explicitly the purpose of the selected research methods and carefully describe how the sample for this study was selected in the hope of fulfilling that purpose (Koerbet and McMichael 2008: 464). With that in mind, it was important for me to first identify the chosen and pre-defined population, and then to define a practical sample skeleton that was feasible to conduct.

I decided to use non-probability to select the sample population as it was chosen to meet pre-established criteria (Given 2008: 562). It is a common technique used in qualitative research where personal judgement is used to select a sample. Amongst the

different types of nonprobability techniques, I chose to use purposive sampling. According to Given (2008: 562), purposive sampling concerns the process of selecting participants because they meet predetermined criteria that are specifically set out to address the research questions (see Appendix I for the participant screening guideline). The sample population's design decisions, actions, thoughts and feelings were explored. These explorations provide a deeper understanding of the specialists' knowledge and skills that may be pertinent to answering the research questions.

3.6.1 Pilot online interview

I distributed the pilot online interviews to eight interior designers working in industry for various interior design companies within the greater Durban area. As the research questions were focused on the thoughts, actions, opinions and perceptions of interior designers, it was appropriate to distribute the pilot online interviews to various interior designers. It was vital for me to monitor their responses regarding whether the questions were arranged correctly and clearly understood or not.

Essentially, I used the pilot interviews to assess if there were any questions that the interior designers felt were difficult to answer or were found to be worded incorrectly. The pilot sample population consisted of both males and females of various ages and ethnic groups. In order to provide authenticity and a valid reflection of the diverse cultures that exists within the interior design industry of modern society, I decided to choose people of all ages and from all walks of life.

3.6.2 Online interview sample

After the pilot test, I distributed the online interviews to two interior designers and two architects who were specifically selected based on their knowledge and experience in designing technology-enhanced spaces. I also chose them because they were likely to understand the challenges interior designers face when using technologies to enhance user experience, or how the senses are accommodated in digital environments.

Prior to distributing the online interview, I conducted several online searches through Google search engine in a bid to locate the most recently designed technology-enhanced environments locally and internationally. I entered keywords such as 'High-

tech spaces', 'future digital interior design spaces', and 'learning spaces in high tech age' in the hope of finding suitable potential participants. These online searches were successful as many websites provided information on local and international interior designers and architects involved in technology-enhanced interior design projects.

Initially, I only set out to distribute online interviews to two architects or interior designers. However, suitable opportunities came forth, which led to encounters with more technology enhanced experts than expected at the outset of the study. So, for the benefit of the study, I decided to interview two architects and two interior designers.

I conducted the first online interview with an interior designer and architect who both worked at the same company dealing with leading technology-enhanced projects in South Africa. Both practitioners played a joint role in making crucial design decisions, and were equally involved in the same design projects, from concept through to completion. I selected the two professionals to provide dual insight and a deeper understanding of the high technology projects in which they were involved.

The third online interview that I conducted was with a specialist who worked in the broader design industry but preferred not to be mentioned by name. I specifically chose the interior designer for having specialised knowledge on assessing the impact of interactive technology and innovative strategies to improve end-user experience within digital environments. Additionally, the interior designer also had knowledge of design strategies that link education and human digital needs. As a result, I used the online interviews as a tool to explore the innovative strategies that were implemented in those designed spaces. More importantly, the interior designer was involved in up-to-date 'high tech' projects, and placed an intense amount of focus on the end-users' instinctive need for human interaction and engagement with technology.

Lastly, I conducted an online interview with Craig Dyker, a New York based architect, who is the co-founder of Snøhetta, which is considered one of the most prominent architectural firms in the world (Lee 2014). The architect briefly visited South Africa to attend a conference held in Cape Town. Therefore I made an effort to attend the conference so that I could personally extend the online invitation, as attempts to contact him telephonically a few months prior failed many times due to his busy work and travel

schedule. There was great interest in this specific architect due to the state-of-the-art university learning environments that he has designed (Archdaily 2013). One specific project of interest was the North Carolina State University library that was designed to accommodate the university's need to provide students with forward-thinking learning environments that were globally at the forefront of the educational landscape. The architect played a key role in ensuring that the library had academic spaces that accommodated collaborative and high technology learning. More importantly, there was great consideration in how the library would provide students with learning technologies that encouraged a 'hands-on' academic experience. For that reason, the online interview with the architect was valuable to this study and allowed for deeper insight into designing effective learning environments for students of the digital age.

The above four specialised industry professionals were important to this study as they provided expert opinions and information on design strategies that were implemented in technology-enhanced spaces to improve people's human and learning experience.

3.6.3 Focus group sample

The research design for the focus groups consisted of six industry professionals including:

1) an informational technologist,
2) a mechanical engineer,
3) a DUT student from the Faculty of Arts and Design
4) a DUT lecturer from the Faculty of Arts and Design
5) a product designer, and
6) an educational psychologist

From here onward, the focus group participants will be regarded as the 'collaborative design team' or as an individual 'design team participant'. I chose the six industry professionals to form part of a collaborative design team in a bid to assist interior designers in making informed design decisions to overcome challenges they face when designing university learning environments that accommodate both the senses and technology. These are specialists an interior designer may typically need to consult or seek guidance from, when designing any given university learning environment. Furthermore, specialists were suitable participants as they would be able to provide both

a variety of professional advice and intellectual diversity. Therefore, I selected the design team participants based on their various professions or knowledge as discussed below:

1.) Information Technology (IT) advancements have resulted in revolutionary changes in society and in turn have affected all aspects of human activities and institutions (Peyala 2011: 308). The use of technology in support of learning and teaching continues to evolve, with IT playing an extremely important role in the way universities function and support the faculty, students, researchers and staff on campus. The use of IT is also known to increase access to information or resources, improve the speed of operations, and facilitate networking and resource sharing (Peyala 2011: 308). For that reason, when IT strategies are well planned regarding how data and information flow, then the quality of information services at universities can be improved. For that reason I met with the director of IT support services for DUT and invited him to form part of the collaborative design team. Enthusiastic support was received from the IT specialist, which included valuable input to the design process, and deep insight into the changing needs and uses of technology across the DUT campus.

2.) A mechanical engineer was suitable to form part of the design team because they are known to perform a variety of tasks from the design to the management of equipment and machines (Dixit, Hazarika and Davim 2017: 1). More specifically, they use scientific knowledge to invent, design, build and maintain objects or systems (Dixit, Hazarika and Davim 2017: 2). Technology also plays a role in these factors, and for all the above reasons, mechanical engineering is considered a practical profession that may improve the design of a built environment such as a university. The design team participant I selected also had extensive knowledge on robotics and automation that integrates the application of mechanical, electronic and computer science. Higher education has increasingly implemented automation in the last decade, more in some parts of the world than others; however, it is assumed to improve learning and increase wider access (Noble 1998: 355).

3.) A DUT student from the Faculty of Arts and Design was a suitable participant I selected to join the design team. When designing TEL environments it is important for the primary focus to be on students and how to enhance learning and teaching. That means it is necessary to explore the impact of technology learning tools on

students and to understand the way students learn in a bid to create effective learning spaces (JISC 2009: 7). The participant was a willing post graduate student within the field of graphic design and provided valuable opinions, feelings and perspective from a standpoint of an end-user. With a learner on the collaborative design team there was a better chance to establish design strategies that could be used by interior designers to create meaningful and transformative learning experiences for students.

4.) I selected a DUT lecturer from the Faculty of Arts and Design as a participant. Lecturers are more likely to have a deep understanding of students' technology or sensory needs as they spend a considerable amount of time with learners. Moreover, they are expected to know how to integrate technology-mediated practice alongside other learning and teaching strategies (JISC 2009: 45). For that reason, the lecturer provided valuable insight on what students' pressing needs are and how universities in the digital age need to accommodate the way students want to learn concerning technology and multi-sensory learning experiences.

5.) Selecting a product designer to be a part of the design team was deemed appropriate as it goes hand-in-hand with the quality and effectiveness of certain interior design elements. Product design is defined as "conceiving and giving form to goods and services that address needs", and is considered as an idea that brings form to life (Moon, Park and Kim 2015: 225). For instance, product design includes the bodies of thought about technology, form, aesthetics and ergonomics (Dorst 2006: 15). A product used in any environment can only be successful if the end user perceives it to be created with unique and superior characteristics (Moon, Park and Kim 2015: 224). The manufactured product form may also be informed by a combination of technology and human needs (Moon, Park and Kim 2015: 225). Therefore, the product designer I selected was chosen to improve the design development process by providing a rich understanding of how the learners and teacher may need or want high technology products to look, feel and act.

6.) I selected an educational psychologist, as they are known to have extensive knowledge about learning, development, motivation, classroom management and assessment (Patrick *et al.* 2011: 71). These attributes are important when

considering how to encourage effective teaching and learning. Moreover, from a teaching perspective, educational psychology is used to shed light on how students develop and can be motivated to learn (Patrick *et al.* 2011: 74). An educational psychologist was therefore considered an asset to the design team as they are able to provide useful information that can assist interior designers in making more informed design decisions, by keeping the student and teacher in mind at all times. Unfortunately, I was not able to get an educational psychologist who was willing to form part of the design team. However, I found an educational psychologist who alternatively offered to complete an online interview on the topics to be discussed.

All design team participants were invited formally either face-to-face or telephonically. Thereafter, I printed a copy or e-mailed them a letter of information and letter of consent that thoroughly described this research study and what was expected of the potential participant. These letters also explained that participants could remain anonymous if they chose (see Appendices G and J).

Lastly, I selected a moderator based on her specialised background knowledge and understanding of interior design and learning practices in the digital age. The moderator was also a lecturer at DUT and therefore valuable to this study as she had experience in guiding discussions, uncovering what people think and appealing to them to provide an understanding of why and how their views are formed. I formally invited the moderator in a face-to-face meeting and the letter of information was submitted to the moderator via e-mail (see Appendix H). I e-mailed her a letter of consent regarding whether or not she would like to remain anonymous (see Appendix H). I provided the moderator with a guideline so that she had an understanding of what topics needed to be discussed, what probes may be used and the outline of the moderator's role so that the role was clear and understood (see Appendix I). The moderator adapted a structured approach for the design team's focus group one and two. According to Given (2008: 354) a structured focus group approach is when the moderator plays a directive role by making sure that the conversation remains focused on the research topic at all times.

3.7 DATA COLLECTION METHODS

Information and data were gathered in order to answer the research questions. As mentioned above, to collect the perceptual data I distributed pilot online interviews to a

selected sample of eight interior designers located in the central Durban area. Thereafter, I refined and developed online interviews for four local and international interior designers and architects with experience in designing technology-enhanced environments.

The two focus groups were conducted at the DUT City Campus library with a selected sample of six specialised industry professionals. At the end of the first focus group discussion, reflection questionnaires were distributed to each focus group participant for reflection (see Appendices E and F). As previously mentioned the educational psychologist was not able to attend the focus groups due to a busy schedule; however, the participant requested to complete an online interview of the questions and topics to be discussed at the focus group. In order to document personal notes and capture reflections during the action research collaboration, I used a research journal.

3.7.1 SEMI-STRUCTURED ONLINE INTERVIEWS

Due to the rapid development of technology over the last few decades, it is no surprise that there has also been a significant impact on methodologies (Given 2008: 498). Online interviews are considered a virtual means of data collection. The internet is used as a medium through which data are gathered from participants.

Qualitative interview research is considered unique, as the instrument for data gathering is the researcher (Salmons 2012: 1). Carried out by contemporary researchers, online interviews, also known as ‘e-interviews’, are defined as in-depth interviews that are conducted with computer-mediated communications (CMC’s) (Salmons 2012: 5). Online interviews that are qualitative usually follow specific fundamental steps and thinking. Interviews are consciously arranged, following certain procedures and rules (Gruber *et al.* 2008: 3). Salmons (2012: 2) states that in online interviewing, technology becomes more than a transactional medium, as the interaction between the researcher and participant occurs through CMC’s. As a result, the human qualities that are vital to interview communications are simply experienced in a different way.

Interviewing is known as a very common and powerful research method used by qualitative researchers in order to understand people (Gruber *et al.* 2008: 3; Augustin and Coleman 2012: 127). Online interviews are specifically used to gather information

through the internet, in the hope of providing new evidence that is imperative to the research topic or questions (Salmons 2012: 5). I chose the four selected participants specifically for their professional experience and skills in designing technology enhanced interior spaces. Therefore, the online interviews were used to establish challenges interior design practitioners face when using technologies to enhance user experience in learning environments. The questions were also focused on understanding how the practitioners overcome those challenges in order to design environments that consider people's sensory and technology needs.

As a researcher based in Durban, South Africa, it was not possible to interview participants face-to-face due to limited travel budget and time constraints. Interviewing participants online was the most appropriate and cost-effective way to probe for meaningful information, deep understanding and innovative solutions (refer to heading 'Sample population' for in-depth information on the process of identifying and selecting the participants). Salmons (2012: 12) explains that it is common to decide to conduct online interviews for data collection when the participants are geographically dispersed. Essentially, the distribution of interviews and communication between both parties are made over email or via real-time chat (Given 2008: 926). I noted that the participants I selected led very busy professional lives. Hence, the flexibility of online interviews provided them the opportunity to fill out their questions whenever they had the time and opportunity to do so. I used an interview guide approach, and the topics and issues covered were pre-determined to ensure that the data gathered were relevant to this study. The online interview consisted of both open-ended and close-ended questions. As a result, the participants could describe and provide an understanding of, the challenges interior designers face when accommodating technology and the senses.

According to Salmons (2012: 20), semi-structured online interview strike a balance between pre-planned questions, of an approach that's structured, and the spontaneity and flexibility of an unstructured online interview. I used online interview prompts and probes in order to clarify topics or questions. As a result, the respondents were able to elaborate further, providing rich and in depth responses. The online interview allowed the topic to be discussed, with possible questions for each issue and, if necessary, I was able to ask follow-up questions to clarify or justify their responses (see Appendix D). Regarding the immediacy between interview distribution and interview response, the online interview

style I chose was asynchronous. Asynchronous interviews have a time lapse between message and response. This means respondents who receive the online interview e-mail may not necessarily reply immediately (Salmons 2012: 22). Asynchronous methods such as e-mail reportedly have high-quality exchanges that only occur when participants are given the opportunity to think about the response or gain new experiences with the study topic between questions (Salmons 2012: 23). Figure 3.7.1 below, shows the time lapse between the message and response in asynchronous methods:

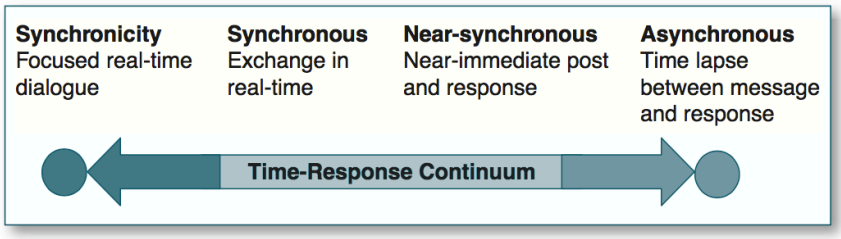

Figure 3.7.1.1 The time-response continuum. Adapted from Salmons (2012: 23).

Prior to the online interview, I distributed a letter of information to the participant along with a letter of consent to conduct the interview and follow up with questions to clarify if necessary (see Appendices C and D). The interviews provided valuable insight on how to design spaces that effectively integrate technologies to enhance user-experience. Interesting notes were obtained on how practitioners dealt with challenges they encountered during the design process, and if they considered the senses.

3.7.7.1 Pilot test of the semi-structured online interviews

Inspecting the individual questions and the design format determines the feasibility and practicality of the research (Given 2008: 624). Therefore, to examine if the objectives of the study were attainable or not, pilot tests were used. I distributed eight pilot online interviews to local interior designers based within the Durban inner city area. The pilot tests were useful to assess the clarity of the wording and instructions conveyed to the respondents prior to distribution of the final online interviews.

Pre-testing is considered important as it provides the researcher an opportunity to evaluate if there is a need to make any changes or incorporate revisions (Bell 2005: 147). After I received the pilot tests back I eliminated some questions to make the interview more concise. The pilot online interview participants understood the content and the feedback proved to be more valuable than expected. Very rich and in depth

responses were generated, and by the end of the pilot evaluations I rendered them important and relevant to the study topic. It became evident that I needed to analyse the data gathered from the pilots and that they would form part of the final research findings.

3.7.2 FOCUS GROUP DISCUSSIONS

Qualitative research strives to approach the world ‘out there’ in a bid to understand, or explain, social phenomena from the ‘inside’ (Barbour 2007: xii). One of the ways in which qualitative data can be collected is through focus groups. Focus groups are prearranged discussions that strive to analyse interaction and gather perceptions or opinions from a specific group of selected people with regards to a certain topic (Barbour 2007: 2).

As previously mentioned, the participants I chose for the focus group represented the design team and could have realistically been chosen in the work field on any given project for the design of TEL environments. The two focus groups were held at the DUT City Campus library in a private study group room, so that the participants felt comfortable in an environment immersed with students from all walks of life. The focus group discussions were used to develop knowledge and understanding of the sensory and technology challenges in learning environments and to explore solutions that may assist interior designers. Having two focus group discussions were considered appropriate for the study as they would be able to yield insight into the collaborative design process rather than merely the outcome (Barbour 2007: 30).

According to Mason (2002: 64) focus group discussions cover a various set of topics in order to observe how interaction takes place amongst the selected participants and how issues are conceptualized and negotiated. In hindsight, action process adopted for this study involved systematic action-reflection cycles of expressing concerns, producing action plans, acting and gathering data from the collaborative design team, and evaluating the effectiveness of changing practice. The moderator made sure that the discussions were simple and relayed in a manner that was easy for participants to understand. By making the discussion easy to relate to, the design team could feel comfortable about discussing their professional opinions and experiences without fear that they would be judged or treated with contempt by the other participants. The

discussions between the participants are valuable as they provided an opportunity to discuss issues that may not have emerged from interaction in a one-on-one interview (Williams and Katz 2001: 4). Focus groups also give more prominence to the participants' views and opinions and for that reason provides the design team with a voice to declare what may be important or not based on their own personal experiences. More importantly, researchers who use focus groups are able 'to get closer to the data' because the participants share how they see their own reality (Williams and Katz 2001: 4). In addition, visual stimulus materials are used as an alternate way to encourage discussion (Barbour 2007: 84). Thus, the visual stimuli I used encouraged the design team members to be more involved in the conceptual design.

Focus groups are therefore used to generate information, collect views and unravel the meanings behind those views. They also provide rich understanding of participants' experiences and beliefs (Gill *et al.* 2008: 293). Gill *et al.* (2008: 293) suggest that the following criteria should be taken into consideration when employing focus groups:

- Focus group discussions may be used as a stand-alone method of research relating to group norms, meanings and processes;
- It can be employed for use in a multi-method design to explore a topic or collect group language or narratives that may be used at a later stage;
- It is also a useful tool that could be used clarify, extend, qualify or challenge data collected through other methods and
- Focus groups can provide feedback results to the research participants.

Focus groups are ideal for action research approaches as they shine light on subjective experiences (Barbour 2007: 27). The focus group allowed the participants to speak out, interact and express themselves while I had a chance to step back and listen to the noteworthy points that they were willing to share concerning the research study.

3.7.2.1 What constitutes the 'group'

The aim of the focus group discussions is to bring together six to eight participants, who essentially are affected directly or indirectly by the same experiences or concerns (Gill *et al.* 2008: 293). These discussions inspire various reactions that, in turn, provide valued insights into the participants' behaviour, and views relative to the study topic.

Both focus groups provided a platform for the collaborative design team to reflect on issues and design concerns that would assist in creating improved learning environments that are mindful of the senses and technology.

3.7.2.2 Focus group discussion one and two

I contacted each design team participant telephonically or via e-mail, to confirm a date for both focus group discussions to take place. A date was then appointed that suited all design team participants and the moderator. Both focus group discussions took place at the DUT City Campus library in a study room that was quiet and of a suitable size. A cell phone with a good quality video camera was then set up in the room in the most unobtrusive position possible. Prior to both focus groups, I provided the moderator with a print of the moderator guidelines to guide the discussion (see Appendix I).

In focus group one I gave a hard copy of the letter of information and consent form to the design team upon arrival (see Appendix H). The moderator briefly described each participant's responsibility in the design team so that each participant had a clear understanding of their own role and the roles of those within the design team. The moderator then introduced herself and the project to the design team and informed them of all relevant ethical issues concerning their right to anonymity, confidentiality, and to withdraw from the study at any time. Participants were notified that they had a right to full disclosure about the research and were asked to sign the informed consent form prior to the commencement of the discussion.

As researcher, an effort was made to mention that both focus group discussions would be video recorded and that handwritten notes will be taken in order to record key issues and themes raised by the design team that would be analysed at a later stage. I then distributed stickers among participants so that it was easy for the design team to recognise and address one another during the discussions. At the same time I used icebreakers to allow the design team to feel comfortable and get to know one another personally. After the design members introduced themselves, I turned on the cell phone video recorder and the discussions commenced. During focus group one and two the moderator ensured that all design team participants' views were heard and they were each given an equal chance to share their opinions and comments. The probes and

prompts assisted the moderator in guiding the discussion topic and keeping the discussion pace steady. Moreover, the moderator made an effort to explore deeply all themes that were pertinent to the study.

The duration of both focus groups was between forty minutes and one hour. The flow of the discussion was good and the participants were comfortable and willing to share their concerns, ideas and views on the outline of the practical design project. The design team participants shared their personal and professional experiences that shaped their views and beliefs on how they would deal with the built-environment concerning technology and sensory needs within learning environments.

3.7.2.3 Focus group discussion tools

Preparation is considered one of the most critical and valuable tools at the researchers' disposal (Barbour 2007: 80). Therefore, I used a moderator guideline and hand written notes to gather data from the design team (see Appendix I). In addition, I displayed visual stimulus material to the design team in the first focus group to encourage discussion and to share visual imagery and videos of what technology-enhanced environments of the future may look like (see boards one to four of Appendix M). The visual stimulus provided a visual idea of the direction in which high technology design trends were heading. The video generated impassioned debate and important key words in the study were discussed.

3.7.2.4 Critique feedback in-between focus group one and two

To develop the practical design outcome using a collaborative approach, it was not possible to depend entirely on the two focus groups, as there would not be enough time, sufficient feedback or enough individual attention focused on the development of the design. For that reason, I conducted one-on-one feedback critique meetings with each design team participant for professional advice and clarification during the progress of the design. Each participant was happy to provide an hour on a date of their convenience, and the meeting took place at their respective working or learning environments. The one-on-one design feedback critique was crucial as it assisted in articulating the participants' suggestions regarding the design solutions that were implemented in the

practical concept design. More importantly, the critique played an integral part of the action 'reflection' process as it refined the design by carefully considering what elements worked in the interior designed space or what needed to be changed. The participants' feedback was constructive and assisted in improving the practical concept design.

When the collaborative design team was ready to meet for the second focus group, I took into consideration all the suggestions and I altered certain areas of the practical design according to their professional advice. The second focus group was essentially used as a platform for the design team to discuss the changes made, and reflect on all decisions made in order to determine if the design strategies implemented improved the design. I documented all notes, ideas, sketches and suggestions gathered from the critique in a research journal. The research journal provided a way for me to organise and make sense of the data gathered from each specialist, and to compartmentalise all the design changes suggested. In turn, the journal helped guide the practical design development from concept through to completion.

3.8 DATA ANALYSIS

According to Henning, Van Rensburg and Smit (2004: 103) the analysis process is considered the 'heartbeat' of the research. Furthermore, the competency of a qualitative researcher is determined by the way that the data are analysed, which calls for analytical craftsmanship and skills in capturing and understanding written data (Henning, Van Rensburg and Smit 2004: 103). On that account, I selected a data analysis approach based on how suitable it was to this study and the paradigm in which it was situated.

The data analysis process I used included two coding phases, described as an inductive 'top down' analysis or a deductive 'bottom up' analysis (LeCompte and Schensul 1999: 8). The two phases are a systematic approach to qualitative data analysis, which seek to join narrow and broad approaches to build theories (Madden 2017: 18). Qualitative researchers use coding when the text is open to subjective interpretation and has various meanings. By applying inductive reasoning, themes and categories are revealed from the data after thorough examination (LeCompte and Schensul 1999: 66). Thus, applying

deductive reasoning is an iterative process that begins with deep close reading of the text to reveal the less obvious context that is not directly covered by themes or categories.

Coding assists researchers to use words, phrases, or concepts from the text or message content (Nieuwenhuis 2010: 106). Using coding was particularly suitable for this study, as there was a need to analyse qualitative responses to open-ended questions for the online interviews, focus groups and academic research journal. The two coding phase analysis process I used reveals challenges, exceptions and problems from the inductive analysis, which then led me to reconsider the deductive analysis thereafter (Madden 2017: 19). This meant that I could look at data from different angles with the objective of refining the codes within the text.

According to Stacey and Gerbic (2003: 499), using qualitative software analysis programs often make coding more manageable and facilitate the above data analysis process when there is a larger quantity of data being handled. For that reason, I selected the software analysis program NVivo for the study. NVivo assists researchers in interpreting raw data and is used as a data management and searching program to establish trustworthiness of the qualitative research study. Therefore, I carried out the deductive “bottom up” analysis using software NVivo version 11.4.1. The data that I obtained from the online interviews and focus groups were analysed, to see if there were any key thoughts or concepts that could develop into codes and categories related to the following three theories that I discussed in the literature review:

- Connectivism theory - linked to learning through technology or technological learning tools
- Stimulation theory - linked to sensory design
- Design management - linked to collaboration

I then used the emergent categories to develop and identify themes from the data in a bid to reveal how university learning environments of the digital age can be designed to accommodate students’ sensory and technology needs.

3.8.1 Analysing data obtained from online interviews

I thoroughly read through the online interview responses in NVivo version 11.4.1 and the

codes and collection points for significant data was an emergent and fluid process. Then I analysed the four online interviews and once the codes were revised and refined the data were checked for consistency and then organised into groups. After using NVivo to carefully define the codes of the transcripts, thematic categories emerged from the codes. I analysed each category, subcategory and code that was developed to see if any themes or patterns emerged that addressed the research questions. Lastly, I summarised and prepared the data for the findings report.

3.8.2 Analysing data obtained from focus group discussions

Focus groups discussions are a common way to collect data from multiple people at the same time and are considered an economical, fast and effective method to gather rich and meaningful data (Given 2008: 352). I employed two focus groups with one critique feedback meeting held in between. The data obtained were complex and large in quantity, therefore I used a computer software analysis tool to organise the data.

The NVivo coding system assisted me to label certain aspects of the data and place the information into specific categories. This simplified how ideas and documents about certain topics were recorded. As a result, coding provided a way for me to capture the information using descriptive words. I then used the groups of codes to form categories based on relationships and links that emerged. Thereafter, I analysed the data to identify themes linked to categories, relationships and patterns critical to the research questions, and prepared them for the findings report in Chapter 4.

3.8.3 Collaborative design teams' conceptual design

The accounts of the collaboration with the participants, including their critical reflection and exchange of knowledge, were systematically collated and generated as evidence that I discuss in chapter four to reveal the nature of individual learning and collaborative innovation that occurred. The outcome of the collaborative approach was a practical conceptual design from which interior design guidelines emerged for TEL environments.

3.9 ETHICAL CONSIDERATION

In line with the Durban University of Technology's code of ethics, an approval for ethics clearance was submitted as part of my research proposal to the Faculty Research

Committee in August 2015. Provisional clearance was awarded by the Institutional Research Ethics Committee (IREC) in October 2015 subject to Gatekeepers permission being obtained from the Director of Research and Postgraduate support. Gatekeepers permission was obtained by the Director of Research and Postgraduate support on the in October 2016. In May 2017, a safety monitoring and recertification report was submitted to DUT IREC. Full ethical approval along with safety monitoring and recertification were subsequently granted in June 2017, respectively. Informed consent, confidentiality and anonymity are explained in more detail below.

3.9.1 Informed consent

Informed consent is an important ethical issue that needs to be considered when conducting research. It is important that the research participants understand they are giving their approval for them to be involved in the research study (Given 2008: 431). As a result, the participant acknowledges with a clear mind that they have voluntarily, without persuasion, given consent to be involved in the research. Given (2008: 431) explains that researchers need to provide potential participants with information about the research study's purpose, methods, demands, risks, inconveniences, discomforts and possible outcomes, including how the research results may be disseminated. It is also necessary to obtain informed consent as it prevents unnecessary assault on participants and ensures that their liberty is protected.

After I contacted the potential participants via telephone or email, I distributed a letter of information and consent, which outlined the participants' rights and intent of the study via email or printed and hand delivered. The letter of information and consent explained the procedures that would be followed and what was required of the participants if they agreed to participate in the research study. I ensured the participants that their privacy and sensitivity would be protected. The informed consent discussed the following rights that the participant had if they chose to partake in the study:

- The right to full disclosure about the research
- The right to privacy, reflecting that they are free to refuse to participate in the research or may withdraw from the study at any point in time
- The right to refrain from answering any questions they do not wish to answer

- The right to decide if they would like their name included or excluded from the research study in terms of confidentiality and anonymity

Furthermore, the letter of information and consent provided the participants with a description of what would happen to the information that would either be video recorded or hand written in the online interviews and focus groups.

3.9.2 Confidentiality and anonymity

It is essential to consider confidentiality and anonymity in research as it ensures that the participants' beliefs as individuals matter and are protected, as they have a right for their affairs to be private (Given 2008: 111). I offered the participants' identity protection, so that their identity would not be linked with their personal responses if they wished. I also disclosed that choosing to take part in the study is voluntary and no penalties are involved should anyone refuse to participate. It was necessary to be mindful of potential difficulties and how to minimize potential harm that can be caused to the participants. Raising such ethical issues when dealing with focus groups or interview participants assists in building protective measures for those involved in the research study (Barbour 2007: 100). Regarding the online interviews, focus group discussions, and reflection questionnaires, I provided all participants with options as to how they would like the data to be handled concerning anonymity and confidentiality, which included their name, the name of the project, and the name of their company. Prior to commencing the online interviews, focus groups and reflection questionnaires, I gave all participants a full disclosure of risks or benefits participation may bring. Thereafter, the consent forms were completed and signed. All participants involved in the study showed interest in the topics issues addressed, and appeared to be honest in the discussions surrounding those topics.

As previously mentioned, I watched the video recordings and read my hand-written notes several times to ensure reliability and validity. Palys and Lowman (2000: 41) say that researchers have an ethical obligation to protect the privacy of the research participants. For that reason, participants who chose to have their identity and professional work or company name protected, were safeguarded and protected in terms of their confidentially and anonymity. I wrote all chapters in the report in such a

way that the research participants would not be able to be linked or identified on the basis of the information presented if they chose to remain anonymous.

3.10 LIMITATIONS

Considering the nature of qualitative studies, it is usual to discover limitations that may hinder or alter the results of the research. A common disadvantage of a qualitative approach is that the findings cannot be extended to wider populations (Atieno 2009). As a result, there is less emphasis placed on the 'number of people' who think and behave in a certain way, and more emphasis on explaining 'why' people think and behave in a certain way. Qualitative findings are also known to be established based on the researchers' interpretation of the data gathered; as a result, it would be unrealistic for me to consider that the data I interpreted is objective.

With regard to the online interview data collection strategy, not all participants were able to complete the online interview telephonically. Some participants were only able to respond via email due to time constraints because of their busy schedules. Either way, it was not possible for me to be fully or physically immersed in the participants' environment to analyse or further explore their responses to the research questions due to time and travel budget constraints. In addition, exchanging online interviews via e-mail lack the spontaneity of a 'real-time interview' which means that there is less ability to have an easy flowing 'back-and-forth' conversation that could take the interview into a different direction that may elicit a deeper understanding. This may potentially mislead the data analysis in terms of further exploring the participants' theoretical understanding and could, in turn, result in limited conclusions. In addition, some participants may feel more comfortable expressing themselves verbally than in writing.

Planning for the collaborative design team to agree on meeting dates was more time-consuming than I had originally assumed, and it was challenging to co-ordinate dates and times that suited all the participants. This meant that it was not possible to gain full access to as wide a range of participants as initially planned.

3.11 CONCLUDING REMARKS

As previously mentioned, this research study begins with the aim of exploring how learning environments of the digital age can accommodate university students' technology and sensory needs using a collaborative approach. In chapter three I discussed the use of interpretivism as a theoretical framework for the study. The research design and methodology were then discussed regarding how the study would pursue the objectives and research questions in relation to the theoretical and methodological orientation. The research setting within which I decided to conduct the study was then described, and I explained the design process and sample population selection. Moreover, I discussed the online interview and focus group discussion in which the participants' responses and critique feedback were used to identify the challenges interior designers face and to develop guidelines for designing TEL environments. Lastly, I assessed the ethics and limitations considered in the study.

In the next chapter, I present the research findings in a bid to answer the research questions. The challenges that interior designers face are identified, guidelines for TEL environments are established and the effectiveness of a collaborative approach is evaluated.

CHAPTER 4

RESEARCH FINDINGS

4.1 INTRODUCTION

In chapter three, the research design process and data collection methods were explained and the objectives of the study were defined. The description of the findings is presented in chapter four. Essentially, the findings were driven by the research questions of the study, regarding how interior designers may connect technology and sensory design in university learning environments. Chapter four seeks to determine the effectiveness of using a collaborative approach to assist interior designers in overcoming technology and sensory design challenges within technology-enhanced learning (TEL) environments.

4.2 RESULTS OF THE RESEARCH FINDINGS

Using interviews and focus group discussions, the questions and discussions that occurred within these focus groups were focused on the research study questions and respective theories that guided the study to better understand how to design TEL environments that provided both technology and sensory learning experiences:

- Question 1:
  What challenges are interior designers facing when using technologies to enhance user experience in learning environments?

- Question 2:
  What sensory design principles should an interior designer consider for technology-enhanced learning environments in universities?

- Question 3:
  How can a collaborative design team assist interior designers to overcome technology and sensory design challenges in learning environments?

The three established theories examined in the study were also used to explore and discover themes that may answer the above research questions:

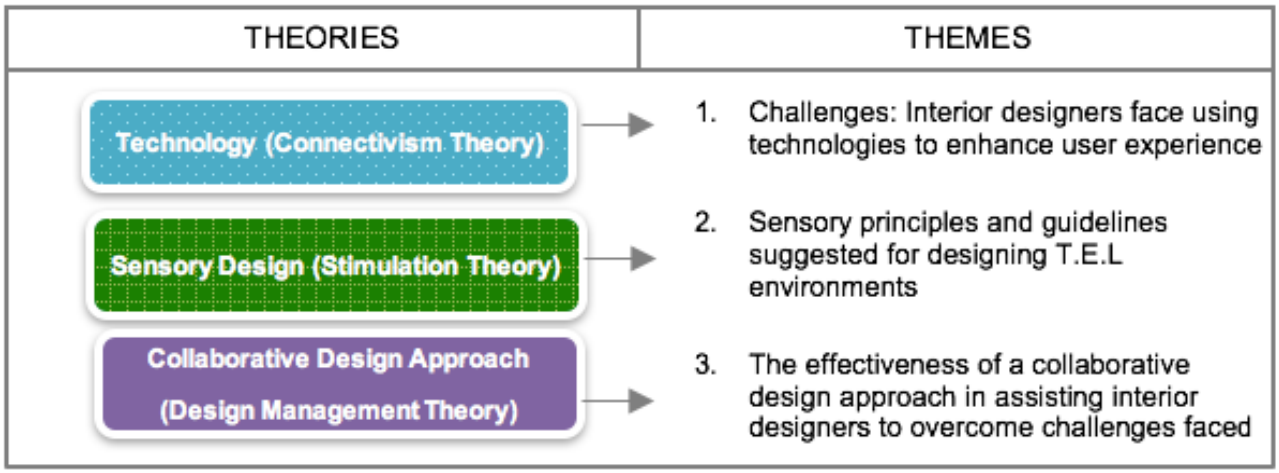

Figure 4.2.1 Research study theories direct and the guide themes

The theories were used to examine closely the relationship between sensory design, technology and a collaborative design approach. Due to the complexity of the research study, the questions explored in the findings were derived from the theories and research examined in the study. Moreover, each theme comprised several sub-themes that were derived from codes that emerged directly from the collected primary and secondary data. The codes, sub-themes and themes are supported by the literature review or sufficient evidence in the form of quotations from the online interviews, the focus group discussions or excerpts from the research journal and practical design outcome.

The data was collected first from a total of eight pilot online interviews and then from four online interviews. Thereafter, a design team of six participants attended two focus group discussions and a critique meeting to collaborate on a practical concept design outcome. The above collected data was rich and valuable. According to McNiff and Whitehead (2011: 150), researchers are then expected to turn the collected data into evidence in a bid to support their claim to knowledge. Producing evidence is therefore considered an integral part of the action research process as it establishes the validity or truthfulness of the claims, and it is also deemed a rigorous process (McNiff and Whitehead 2011: 150). As illustrated in Figure 4.2.1 above, the findings will be broken down according to the following three themes that are briefly introduced below:

- *Theme one: Challenges interior designers are facing using technologies to enhance user experience in learning environments*

In order to design university learning environments that provide students with both technology and sensory learning experiences, it was important to establish what existing challenges interior designers were experiencing when accommodating technology and the senses in learning environments. The online interview and focus group participants were asked to explain challenges that they encountered on previous or current projects. In addition, they were asked to elaborate on how they overcame those particular challenges in order to enhance the end-user experience forming the basis of the sensory design principles and guidelines discussed in theme two.

- *Theme two: Sensory design principles and guidelines for designing technology-enhanced learning environments*

All participants were asked to discuss their views and opinions on the consideration of end-users technology and sensory needs within TEL environments. Focus group and online interview participants were invited to share if and how they are currently mindful of the human senses. Furthermore, they were requested to describe any design strategies or guidelines that interior designers could use for designing learning environments that accommodate the human senses and emerging technologies.

- *Theme three: The effectiveness of a collaborative design approach assisting interior designers in overcoming sensory design and technology challenges*

Online interview participants were asked if they were currently participating in any collaboration and to rate the advantages and disadvantages of a collaborative approach based on their professional experiences or personal opinions. On the other hand, focus group discussions were framed around extracting views and perceptions from the design team of what contributes towards a successful collaboration. After the completion of the practical conceptual design the design team was then asked to fairly critique the collaborative approach that they participated in to determine if it was considered a success or not.

In order to make sense of how the research findings will be organized and presented, Figure 4.2.2 and Figure 4.2.3 below illustrate the "Body of the data" and the "Analytical process":

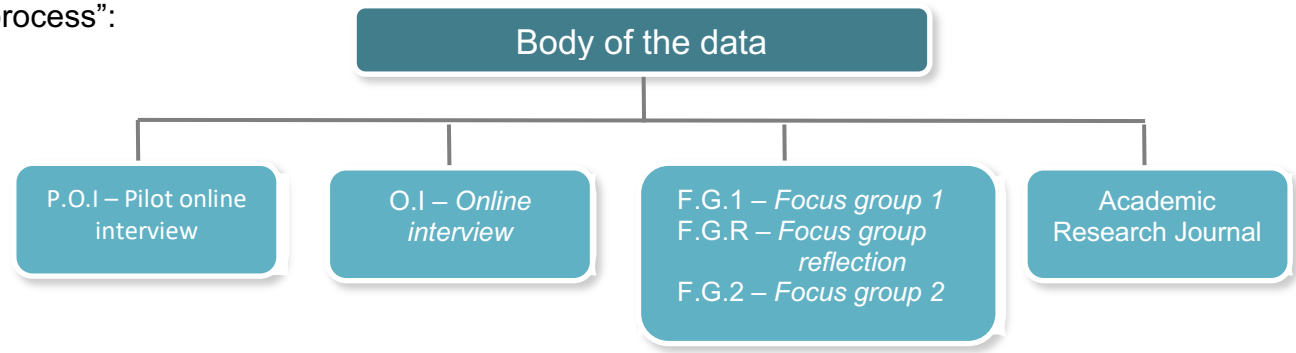

Figure 4.2.2 Body of the data

The analysis process then consists of two coding phases, also known as inductive and deductive phases, which are used to join narrow and broad approaches to build theories (Madden 2017: 18). The inductive phase is identified as a 'top down analysis' and deductive analysis identified as a 'bottom up analysis' (LeCompte and Schensul 1999: 8). The discussion surrounding the findings will therefore follow an analytical process informed by the research questions in order to identify thematic relationships from the various codes, according to an inductive and deductive reasoning process. This means that the sub-themes were either pre-formulated, or they emerged from the data as illustrated:

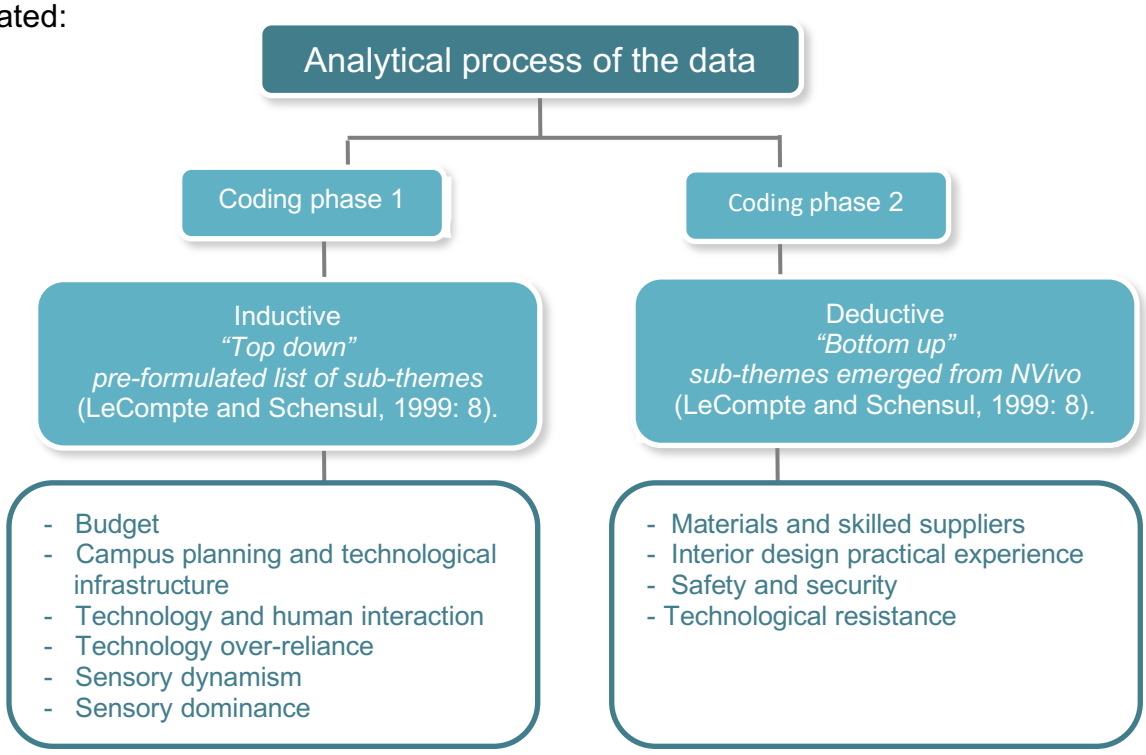

Figure 4.2.3 Analytical process of data

4.3 THEME ONE - CHALLENGES INTERIOR DESIGNERS FACE WHEN DESIGNING TECHNOLOGY- ENHANCED LEARNING ENVIRONMENTS

The online interview and focus group participants described various pressing challenges that interior designers encounter when designing technology-enhanced environments. To be clear from here onward, referring to the term 'challenges' will entail any issues that hinder interior designers from designing an effective learning environment that offers the most optimal learning experience. Thus, ten sub-themes were identified namely:

1) Lack of readily available materials and skilled suppliers
2) Budget restrictions
3) Lack of interior designer practical experience
4) Safety and security of high technology equipment
5) Campus planning and technological infrastructure
6) Technology and human interaction
7) Technology resistance
8) Technology over-reliance
9) Sensory dynamism
10) Sensory dominance

As learning environment design plays a key role in facilitating student connectivity (Lomas and Oblinger 2006: 68), theme one comprises a discussion on the above sub-themes that emerged, surrounding the identified challenges faced when designing technology-enhanced environments. With that in mind, theme one will involve a discussion about how or why these challenges came about, what interior designers think about encountering such challenges and, more importantly, how they feel these drawbacks hinder them from enhancing user experience in learning environments.

Interestingly, as each theme emerged, it gradually became apparent that there are some challenges that interior designers are facing that are specific to South Africa. These issues first became evident when the pilot online interviews were thoroughly read and coded. The eight participants were all practising interior designers located in South Africa, and for certain reasons seemed to be experiencing the same difficulties over the years from the various projects they were involved in. These challenges were confirmed by the responses from interior designers and architects who had specialist knowledge

on “high tech” environment design in South Africa. The challenges described in Table 4.3.1 below were experienced by interior designers working in South Africa.

4.3.1 Sub-theme 1: Lack of readily available materials and skilled suppliers

An unexpected challenge that was mentioned by most of the participants was that South Africa is yet to develop a competitive “high-tech” sector within the interior design industry, as there has been very slow growth with regard to improving and expanding the country’s materials necessary to create cost-effective technology-enhanced spaces.

In Table 4.3.1 that can be found on the next page, online interview participant two highlights these challenges, stating “South Africa lags behind not just in adoption but also in readily available materials”. The same participant supports the notion that South Africa is still at the early stages of developing a “high-tech” sector, stating “the look was quite new to the industry in South Africa, very high tech, a lot of high gloss finishes, lighting…the challenge for us was to get the design to work with the type of materials we had available”. Unfortunately, for local interior designers, South Africa has been very slow to embrace new technologies or materials for the design of “high-tech” environments. Another important finding was that there is a massive shortage of locally skilled suppliers or manufacturing companies that can stimulate faster growth in the sector. Online participant two explains that it “remains a slow and tedious process to source cost-effective materials and skilled suppliers”. Pilot online interview participant two goes so far as to say, “there are few competent experts or installers”. The above-mentioned challenges appear to have a direct impact on the design, making it difficult to have a quick project time lead if materials are not readily available.

4.3.2 Sub-theme 2: Budget restrictions

A significant finding to emerge was the lack of locally sourced materials. Interior designers feel that they are left with no other choice but to import materials that are manufactured overseas for “high-tech” spaces. This in turn has had a negative impact on the cost of implementing these designs. Online interview participant four shares their view, “we are very limited in terms of our manufacturing in South Africa unless you go to more expensive products such as Corian”. This challenge seems to have a negative impact on both the client’s budget and the interior designer’s fee. Online interview participant two

reflects on the current situation in the interior design industry and how helpless one feels: “considering the volatility of the rand, it also remains a challenge for designer to accurately cost for imports…due to the fact that South Africa is not manufacturing or producing the materials required”. Participant two also says, “there is no overcoming the shortage of both other than searching for products online or suppliers via the web…or driving around”.

Online interview participant two shares in frustration the fact that they are not paid for the extra effort made to source these materials outside the country, “the time taken to source cost effective materials and skilled suppliers are not budgeted for…time is money and much of our time and efforts are not remunerated”. Table 4.3.1 on the next page depicts how these challenges have left some participants feeling underappreciated and undervalued. Focus group participant two states, “Design has no value in South Africa in the sense that your design charges are often lowered, which means that you have to hide or build in your design fee.” This might then mean that because materials are expensive, clients may shy away from embracing technology-enhanced environments, or do not fairly remunerate interior designers for their efforts to outsource the material required.

4.3.3 Sub-theme 3: Lack of interior design practical experience

Pilot online interview participant two felt that in South Africa there is a “lack of knowledge of the designers or end users”, as seen in Table 4.3.1 that can be found on the next page. However, as the South African “high-tech” interior design sector is still growing, it is not surprising that such a challenge was raised. As a result, very few interior designers have practical experience in designing technology-enhanced interiors or little knowledge of the materials and technologies required to enhance user experience within such an environment.

4.3.4 Sub-theme 4: Safety and security of high technology equipment

Online interview participant two indicates in Table 4.3.1 on the next page, that an area of concern regarding South African learning institutions is that the integrated technology or equipment is always at risk in terms of safety and security: “No matter how designers want to include technology within spaces, importantly learning spaces, the question of

safety is their first priority and because it is costly to safeguard it, it is often not included…".

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme one Challenges Interior designers in South Africa are faced with	Lack of readily available materials and skilled suppliers	Time-consuming process finding skilled suppliers and cost effective materials for technology enhanced environments, as they are not readily available in South Africa.	"South Africa lags behind not just in adoption but also in readily available materials." "I think because the look was quite new to the industry in South Africa, very high tech, a lot of high gloss finishes, lighting…The challenge for us was to get the design to work with the type of materials we had available. A lot of this was manufactured in Formica…especially having a lot of curved furniture items and design, we found that very difficult. The suppliers found that very difficult to manufacture, because we are very limited in terms of our manufacturing in South Africa unless you go to more expensive products such as Corian." "Despite many a website that do exist listing products and suppliers it remains a slow and tedious process to source cost-effective materials and skilled suppliers. There is no overcoming the shortage of both other than researching / searching for products / suppliers via the web / word-of-mouth and or driving around." "Our biggest challenge was and still is readily available locally produced materials and skilled suppliers…More often than not, the time taken to source cost-effective materials and skilled suppliers are not budgeted for…Time is money and much of our time and efforts are not remunerated."	O.I.2 O.I.4 O.I.2 O.I.2
		Technology enhanced environments require interior designers to have knowledge on "high tech" materials	"I think because the look was quite new to the industry in South Africa, very high tech, a lot of high gloss finishes, lighting…I think the challenges for us was to get the design to work with the type of materials we had available" Challenge understanding how to work with the materials.	O.I.2
		South Africa has a shortage of skilled suppliers to install	"Few competent experts or installers"	P.O.I.2
	Budget	Challenge when designing technology enhanced environments	"Considering the volatility of the rand, it also remains a challenge for designers to accurately cost for imports which has to be imported due to the fact that South Africa is not manufacturing or producing materials required."	O.I.2
		Lack of design education results in lack of value interior design fee	"I feel like the public here in South Africa are simply not design educated. Design has no value in South Africa in the sense that your design charges are often lowered, which means that you have to hide or build in your design fee"	F.G.1 35:30:00
	Safety and security	Protecting the environment and its resources	"A variety of learning institutions face the challenge of safe-guarding equipment...No matter how designers want to include technology within spaces, importantly learning spaces, the question of safety is their first priority and because it is costly to safeguard it, it is often not included…the creations of these solutions remain costly."	O.I.2
	Interior Design practical experience	South African interior designers considered to lack knowledge in "High Tech" design	"Lack of knowledge of the designers or end users"	P.O.I.2
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.3.1 Challenges interior designers are facing in South Africa when designing technology-enhanced environments

On the other hand, challenges described in Table 4.3.2 below can relate to both local and international interior designers working on technology-enhanced environments:

4.3.5 Sub-theme 5: Campus planning and technological infrastructure

As noted in the Table 4.3.2 below, tertiary institutions that wish to adopt technology-enhanced environments should carefully assess how the infrastructure can meet students' growing technology and sensory demands. Focus group participant two says, "ensuring seamless integration of old and new technology is a challenge". Hence it is difficult to future proof and to accommodate both existing and new technology.

Pilot online interview participant one points out in Table 4.3.2 that it is a challenge to use technology to enhance end-users experience, "I think it makes the design more difficult. There are items that are not standard that have to be worked into the design to accommodate technology". This shows that integrating technologies into the furniture or interior design elements of 'high tech' environments is challenging as it is customised and requires specialised knowledge for it to function or fit seamlessly. These findings are significant as the literature review highlights that future proofing technology integration is a pivotal connection that needs to be well understood and well planned in order for universities in the digital age to see real benefits (Warger and Dobbin 2009: 6).

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme one Challenges Interior designers locally or internationally may be faced with	Budget	Budget restrictions	"Creating technology-enhanced environments are costly."	O.I.2
			"Double edged sword of getting the look within the clients' budget"	O.I.4
			"Another challenge for interior designers is creating cost effective technology enhanced environments for everyday customers."	O.I.3
			"The kind of ideal solution is to go to the specialists, but often there isn't money for that. "	F.G.R.4
		Maintenance and cost issues	"Some clients resist change and are put off by future maintenance issues, cost is a factor"	P.O.I.6
	Campus planning and technological infrastructure	Integrating emerging technologies is complex and requires more time	"I think it makes the design more difficult. There are items that are not standard that have to be worked into the design to accommodate technology"	P.O.I. 1
		Emerging technologies	"Future proofing. When integrating a new installation, the existing technology is considered the old technology. Ensuring seamless integration of old and new technology is a challenge"	F.G.R.1
			"It is difficult to keep up with all the emerging technology when you are required to teach design basics. Sometimes I feel that technology makes things unnecessarily complicated."	F.G.R.4
			"Mainly, around lighting. Lighting is crucial."	F.G.R.2
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.3.2 Challenges interior designers are facing locally or internationally

4.3.6 Sub-theme 6: Technology and human interaction

A strong relationship between technology and human interaction was pointed out in the literature review and is consistent with the online interview participants' findings. Nilles (2012) argues that technological detachment is becoming a reality that is diminishing the quality of social interaction that we need as human beings. Similarly, many participants felt that technology often discourages personal interaction or prevents spontaneous conversations that could spark ideas that wouldn't necessarily arise on their own.

In Table 4.3.3 on the next page, pilot online interview participant one says, "I feel that there is a sense that can be gained from human interaction that is lost in technology, like bouncing ideas off people and their reactions, and people's reactions to touch". Participant four agrees by stating, "there is room for technology to better stimulate the senses and encourage human interaction". Some participants felt that technology creates a digital world where you can become detached from others. In Table 4.3.3 Pilot online interview participant five highlights that "technology is known for isolating individuals". Pilot online interview participant two agrees by stating, "people are slowly being drawn into this 'techno' world and losing contact with normal human interaction".

As mentioned in the literature review, there is concern about whether technology connects or disconnects people through human interaction and engagement (Cafferty 2011). As seen in Table 4.3.3 on the next page, pilot online interview participant two feels that human interaction is a fundamental need: "there isn't enough human interaction. We don't want to live in a world where technology removes human interaction". In Table 4.3.3 online participant four agrees: "customer research indicated that the human element is still preferred". In order for interior designers to overcome these challenges, there is a need to be digitally responsible by ensuring that technology-enhanced spaces are designed to encourage human interaction and spontaneous face-to-face encounters (Nilles 2012).

Another underlying key issue, as indicated in the literature review, is that there is a fear that technology may remove our sense of personal interaction (Laroya 2011). For that reason, it is important that interior designers provide spaces where students can take a break from technology or have more intimate areas that encourage personal interaction and student engagement.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme one Challenges Interior designers locally or internationally may be faced with	Technology and human interaction	Lack of human interaction	"People are slowly being drawn into this 'techno' world and losing contact with normal human interaction"	P.O.I.2
			"There isn't enough human interaction. We don't want to live in a world where technology removes human interaction."	P.O.I.8
			"Technology is known for isolating individuals. However, there are some forms of human interaction that should definitely be looked into."	P.O.I.5
		Demand for more Human interaction	"I feel that there is a sense that can be gained from human interaction that is lost in technology, like bouncing ideas off people and their reactions, and people's reactions to touch"	P.O.I. 1
			"There is room for technology to better stimulate the senses and encourage human interaction by still involving humans to think and not for technology to think for us."	P.O.I.4
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.3.3 Challenges interior designers are facing locally or internationally

4.3.7 Sub-theme 7: Technology resistance

Interestingly some participants provided very compelling statements against technology advancements of the digital age. Certain design team participants felt very strongly against students' adoptation or usage of technology to learn or engage with their studies. The statement made by focus group participant four as seen in Table 4.3.4 on the next page, describes the lecturing experience, "I have noticed in my classes that there are students who actively resist technology". Moreover, focus group participant three agrees with the above notion: "the problem is that some students are reluctant to engage with technology or the platforms provided".

This suggests it is possible that tertiary learning institutions may or may not find it difficult to move students to digital learning platforms or environments. In addition, when online interview participants were asked to describe the challenges interior designers face when accommodating emerging technologies, the sixth pilot online interview participant said "mostly just clients resistance to change". This suggests that clients may also be resisting the idea of adopting advanced technology. The findings reveal that interior designers creating 'high tech' university environments should be thoughtful about how the design encourages technology adoption. Table 4.3.4 on the next page also shows that online interview participant four expected people to resist technology adoption, "we know that migration won't naturally happen". Therefore, strategies may need to be put in place to make people feel at ease with technology use and integration. Furthermore, the literature review supports the above notion, as one of the TEL principles

noted by JISC (2009: 8) emphasises that students should be supported in using appropriate technologies with which they are comfortable.

With regard to technology resistance, some focus group participants believed that universities of the digital age would not look or feel futuristic and technology-enhanced. It is noted in Table 4.3.4 on the next page that focus group participant five says, “You have this wonderful vision but the vision is way beyond what I’ve experienced with students and online environments” and “I think a lot of people resist technology in terms of trends. The movement is away from that, it is getting back to what we as humans fundamentally need”. These statements reveal that some participants were overwhelmed or at times felt uncomfortable about the future digital trends supported by the literature review (see concept boards one to three of Appendix M). Furthermore, focus group participant four expressed a dislike of ‘high tech’ spaces by stating, “too much shiny, too much plastic, too much glass, I would feel so weird, but this is not for us it’s for 30 or 40 years from now”. This shows that the idea of future technology trends does not appeal to everyone.

In addition, focus group participant four pointed out, “There’s so many people choosing to live off the grid altogether”. This statement links with the literature review, which reveals that some people may experience ‘digital overload’ and look for ways to escape the ‘technology craze’ (Kiss 2013). Therefore, people who experience digital overload may be more likely to resist technology in order to cope with living in the digital age.

4.3.8 Sub-theme 8: Technology over-reliance

Contrary to the above, the findings also revealed that some participants believe we are living in a society that has people who are embracing technology extensively. As students’ demands for more information and access to the virtual worlds in which they live increase, universities require infrastructure that can keep up with the pace at which technology is advancing (Clayton-Pedersen and O’neil 2005).

The pilot online interview participants felt that there are some drawbacks as people become more dependent on technology use. As seen in Table 4.3.4 on the next page, pilot online interview participant four believes: “We are becoming very lazy, because we rely on technology to work everything out for us”. Furthermore, pilot online interview participant three highlights how integrated technology has reduced our physical

movements or relationship with our surroundings by saying, “people become lazier, whereby they could switch the lights on and close curtains with the push of a button on your iPad”. As a result, the above statements show that some people have become accustomed to a certain lifestyle with technology as it offers ease of use, security and minimal effort. These findings link with the literature review, which emphasised that as technology continues to advance it becomes more accessible, more in demand, and more convenient for people to use (Ige 2013: 10).

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme one Challenges Interior designers locally or internationally may be faced with	Technology over-reliance	People have become dependent on technology	“We are becoming very lazy, because we rely on technology to work everything out for us.”	P.O.I.4
			“People become lazier, whereby they could switch the lights on and close curtains with the push of a button on your iPad…”	P.O.I.3
	Technology resistance	Students resistance against technology	“I have noticed in my classes that there really are students who actively resist technology.”	F.G.R.4
			“You have to be pro-active. The problem is that some students are reluctant to engage with technology or the platforms provided.”	F.G.1.3
		Clients resist against rapid advancements of technology	“mostly just clients’ resistance to change”	P.O.I.6
			“we know that migration won’t naturally happen…but if you play a key role in educating customers or teaching them how to do it themselves, they will start to adopt over time.”	O.1.4
		Participants thoughts on future universities	“YouhavethiswonderfulvisionbutthevisioniswaybeyondwhatI’veexperiencedwithstudentsandonlineenvironments”.	F.G.C.5 (00: 20, 00 sec)
			“I think a lot of people resist technology in terms of trends. The movement is away from that, it is getting back to what we as humans fundamentally need”.	F.G.C.5 (01: 40, 57 sec)
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.3.4 Challenges interior designers are facing locally or internationally

Interestingly, the two sub-themes in Table 4.3.4 above oppose each other. These findings suggest that some people may want or need technology to be ever present in their lives and some people prefer to completely avoid technology use for various reasons. This means that perhaps the best way to approach future learning environment design is to be mindful and create spaces that strike a balance for learners regarding how technology is integrated into their academic lives. Technology should therefore keep students productive, contented and connected both personally and digitally, within reason.

4.3.9 Sub-theme 9: Sensory dynamism

The findings showed that the way in which the surrounding environment is designed has a direct impact on the human body and the senses. Sensory dynamism is a challenge concerned with the negative impact technology may have on the body if not adequately

considered. The literature review sheds light on the concept of sensory dynamism, which is associated with human perception that occurs when the brain recognises depth (Neema Moraveji cited in Brandon 2013). Looking at digital screen only allows a few variables to be sensed which have no depth. However, when a person looks out the window into the distance Moraveji explains that our eyes are able to perceive many planes, colours, sounds, feelings and perspectives.

With that in mind, pilot online interview participant four as seen in Table 4.3.5 describes the effects of technology on the senses, “Technology impacts sight badly as we now stare at screens all day long...” and “More people are wearing glasses and we get headaches from staring at screens”. In the literature review, the same descriptions are linked to the repercussions of sensory design (Chakrabarti, 2014: 509). This indicates that people need to have multiple levels of sensory input as the flat layer of input from screens negatively affects the eyes. For that reason, interior designers need to ensure students have windows with scenic views or spaces that encourage social interaction to prevent students staring at their screens at all times.

4.3.10 Sub-theme 10: Sensory dominance

The findings on sensory dominance are consistent with data obtained from the literature review, which show that the sense of sight is most commonly referred to as the most dominant sense. Technology has provided a heightened visual experience in many ways.

An online interview participant’s comment shared in Table 4.3.5 on the next page exemplifies how evident sensory dominance is in the digital culture of today: “technology has given people an overload of visual stimulation…people no longer go outside and engage to interact or be entertained. Audio-visual stimulation has been heightened to the max, while stimulation of the other senses has been atrophied”. These comments signify that sensory imbalance exists and is a challenge that interior designers should play an integral role in overcoming. Learning environment design needs to connect technology with all our senses equally so that students can have an all-rounded sensory learning experience.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme one Challenges Interior designers locally or internationally may be faced with	Sensory dynamism	Technologies negative impact on the senses	"Technology impacts sight badly as we now stare at screens all day long…"	P.O.I. 4
			"More people are wearing glasses and we get headaches from staring at screens"	P.O.I. 4
	Sensory dominance	The senses are not equally stimulated in "high tech" spaces	"Technology has given people an overload of visual stimulation, it is always at the ready…People no longer go outside and engage to interact or be entertained. Audio-visual stimulation has been heightened to the max, while stimulation of the other senses has been atrophied."	P.O.I.6
			"Sensory experience only accommodates for touch, sight and sound. The incorporation of taste and smell needs to be looked into."	P.O.I.5
			Technology has given people an overload of visual stimulation, it is always at the ready" "People no longer go outside and engage to interact or be entertained. Audio-visual stimulation has been heightened to the max, while stimulation of the other senses has been atrophied."	P.O.I.6
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.3.5 Challenges interior designers are facing locally or internationally

4.3.11 Identified challenges interior designers face when designing TEL environments

From the above findings, designers might come across a number of difficulties when constructing new or existing TEL environments. It also appears that there are many connections between the literature review and findings collected from the study participants.

The identified challenges that emerged can be used as a powerful preparation tool that can caution interior designers about the issues they may encounter from design conception through to completion of TEL environments. Therefore, the list of identified challenges can play a major role in making sure that interior designers are prepared and know what to expect when undertaking a new TEL environment project at a tertiary institution. Moreover, it is possible that these challenges can be assessed and may result in more informed decisions regarding the design of the interior space, how to go about the project and how to deal with the client. This way, interior designers will be more likely to ensure that the end-user experience is enhanced.

By creating awareness of the challenges that interior designers may face, designers could use the list as a catalyst for positive change which is aimed at improving the design process and design expectation, and encouraging people to seek solutions to overcome the challenges. From the above findings, interior designers are believed to face the following challenges when designing TEL environments:

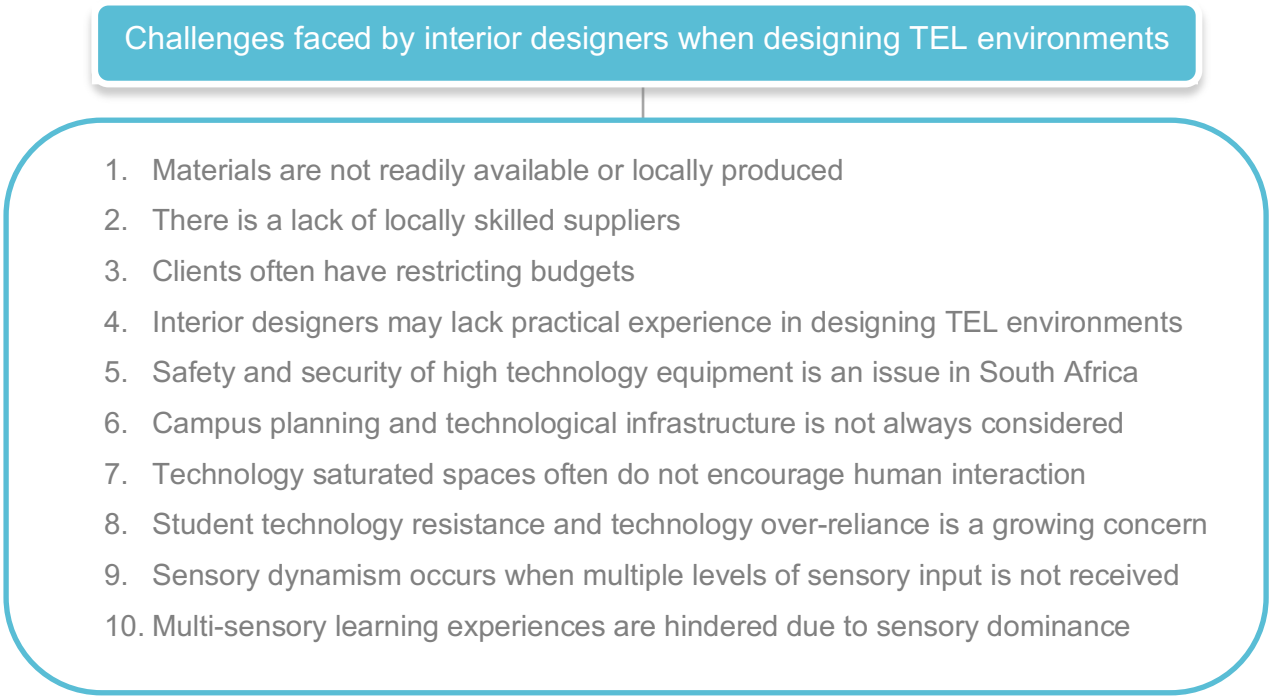

Figure 4.3.6 Challenges that interior designers face when designing TEL environments

In summary, it is not uncommon for projects that involve design and construction to go through a series of setbacks, as the design process is often unpredictable and entails experiences that are unique to each project. Therefore, the above-identified challenges are provided to forewarn interior designers of any challenges that may arise so that they are better equipped to design TEL environments. In addition, the following points established from the findings were considered key factors for interior designers to take into consideration during the design and development of TEL environments:

1.) It is important to have a thorough understanding of the clients' strategic objectives and the end-users needs.
2.) It is essential to have good knowledge of the latest technology and how it may be integrated into the new or existing built environment.
3.) If the client's budget is restricting, try to find a costing balance between the design solutions (i.e. provide the client with effective low cost and high cost solutions).
4.) It is important to work closely with the specialists and suppliers from an early design concept stage in order to make more informed design decisions and to prevent unnecessary design faults at a later stage.
5.) Take advantage of physical prototyping to test the design and gain an understanding of its strengths and weaknesses.

6.) Be mindful of technology use in the digital age. Use innovative design solutions that encourage technology adoption or provide breakaway areas where students can learn through collaboration, interaction or engagement with one another.

4.4 THEME TWO - SENSORY DESIGN PRINCIPLES AND GUIDELINES

The online interviews and focus group discussions played an integral role in establishing sensory design principles and guidelines for TEL environments of the digital age. The comments, feedback and critique from the participants with regard to the practical concept design were valuable and pertinent to the study, as they contributed toward the development of the guidelines for interior designers. The reiterative cycle of the action process assisted in the initial testing and implementation of the design strategies. After I refined the tested strategies with the collaborative design team, some design strategies were improved and others were validated as they stood.

When the study participants described the challenges they faced they were also asked how they overcame such challenges. “Theme two” therefore unpacks the study participants’ suggestions and solutions that contributed towards the guidelines to be considered when designing TEL environments. The findings of “theme two” emerged with the following four over-arching sectional parts that established the sensory design principles and guidelines:

1. Accommodating technology
2. Accommodating the senses
3. Collaboration
4. Learning styles

The ten sub-theme challenges as discussed in “Theme one” form part of the foundation of these four over arching sections. For that reason, the sub-theme challenges are interlinked and ever present in the discussions and tables that follow in “Theme two” and “Theme three”. I coded and tabled the responses, which then formed an amalgamation of solutions suggested by study participants and, in turn, created guidelines for academic environments that offer students both technology and multi-sensory learning experiences.

4.4.1 Accommodating technology

It is no surprise that technological advancements of the digital age have had an impact

on the dynamic of universities regarding the way students learn and how academic environments are designed. Pilot online interview participant six highlights in Table 4.4.1 below, “Tablets have already begun to replace traditional teaching tools”. This indicates that learning institutions are trying to accommodate students’ technology needs. Universities are being transformed through the use of digital technologies and learning tools. The above notion is supported by the literature reviewed which explains that learning environments are being re-conceptualized and those that provide digital engagement are found to be effective (Hirsch and Weber 1999: 42; Prensky 2001: 1; Resnick 2002: 32). Therefore, technology has become a part of student academic life and is changing how learning takes place in and around campus.

4.4.1.1 The demand for access to technological learning tools

In recent years, it has become evident that technology can be used to enhance students’ educational experience, and there has been a greater demand for easy access to technology learning tools across the university. When online interview participant one was asked how digital innovation could be used to positively influence the way learning environments are designed, his response was “by allowing a wider range of connectivity across geography and discipline” as noted in Table 4.4.1. Therefore, universities are expected to improve their IT infrastructure and the design and use of academic environments. This statement matches JISC’s (2009:8) description of TEL environments. Moreover, JISC (2009: 8) reveals that students need Wi-Fi across campus, special electronic equipment for various disciplines, presentational technologies and display screens for distributed teaching and portable devices because they are able to enhance students’ learning experience.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Campus planning and technological infrastructure	Students need access to emerging technologies that they may not own	“Tablets have already begun to replace traditional teaching tools in schools. If tools like these can be integrated into learning spaces it creates an environment for learners to compete on equal footing regardless of socio-economic backgrounds.”	P.O.I.6
			“one needs to understand and be exposed to new technologies that is out in the work space.”	
		Design strategies to encourage digital innovation	“Yes by allowing a wider range of connectivity across geography and discipline”	O.I.1
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.1 Guidelines and sensory principles for designing TEL environments

4.4.1.2 Improving the safety of technological learning tools

Online participant three suggested that smart technology could be used to resolve the equipment safety and security concerns by explaining, “smart technologies will also help designers create safer environments that protect learning equipment”. Therefore, the participant is suggesting that, as universities adopt new technologies, they may also need to use smart technology to protect expensive equipment. Focus group participant one supports the above notion by stating, “Clients often complain about equipment safety issues. Perhaps a solution to this problem would be to use a routers IP table to track and notify a staff member that a device has fallen off or out of the local network” (i.e. if a device is removed or stolen).

4.4.1.3 Characteristics of TEL environments in a digital age

With regard to the integration of future technology, the findings revealed that some participants felt that learning environments need to be flexible and able to adapt to technologies that may emerge in the future. In table 4.4.2 on the next page, pilot online interview participant seven says, “Technology is constantly changing and one needs to adapt with it”. Focus group participant one agrees, saying, “it is essential to ensure flexibility integration of new technology into old”. This is acknowledged as ‘future proofing’ by pilot online interview participant six.

A strong link exists between the above findings and the literature review. Coccoli *et al.* (2014: 1004) are of the opinion that universities need to be smart and react instantly to change that is unexpected, as it is important to provide effective technology rich environments that are mindful of the students of today and tomorrow.

In addition, as noted in Table 4.4.2 on the next page, some participants shared their idea of what they think TEL environments should look and feel like. Online interview participant two describes the interiors to have “a slick ‘digital’ look that provides an engaged customer experience”. In addition, online interview participant one explains that designers should consider using “acoustics and lighting to enhance user well-being”. On the other hand, online interview participant two explains that the future of technology-enhanced environments may have a “Continuous fluid layout” where the “latest tablets and interactive surfaces contain augmented reality experiences”. Interestingly, online participant two’s description of technology-enhanced environments

is reminiscent of how Karim Rashid views the digital age as mentioned in the literature review: “tangible and interactive, giving more heightened experiences to our physical world. This is the shaping of our future” (Rashid 2015).

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Campus planning and technological infrastructure	Descriptions of TEE finish, look, feel, materials, specs	“A slick ‘digital’ look that provides an engaged customer experience.” “Continuous fluid layout establishes a unifying touch point for FNB smart product usage and services…Smart device pods…The latest tablets and interactive surfaces contain augmented reality experiences”	O.I.2
			“Lighting is crucial”	F.G.R.2
			“Acoustics and light to enhance user well-being”	O.I.1
		T.E.L need to be designed to adapt existing and emerging technologies	“Technology is constantly changing and one needs to adapt with it.” “One needs to understand and keep evolving the space as technology evolves” “Technology is influencing everything. Technical age. One needs to adapt with change.”	P.O.I. 7
			“We will always be one step behind the latest technology in my automation field, therefore, it is essential to ensure flexibility integration of new technology into old.”	F.G.R.1
			“Future proofing is a factor to be taken into consideration, people move with trends and if these can be predicted they should be provided for to avoid major overhaul costs to add technology in later.”	P.O.I.6
			“We need to make sure there are the correct, adequate power points for the technology in the spaces”	P.O.I.8
			“It would need to plug into what I currently use rather than re-learning stuff”	F.G.R.2
		Future predictions of solutions to protect equipment	“Naturally smart technologies will also help designers create safer environments that protect learning equipment”	O.I.3
			“Clients often complain about equipment safety issues. Perhaps a solution to this problem would be to use a routers IP table to track and notify a staff member that a device has fallen off or out of the local network (i.e. if a device is removed or stolen)	F.G.R.1
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.2 Guidelines and sensory principles for designing TEL environments

4.4.1.4 The physical environment influencing learning

The findings suggest that when technology is integrated into learning spaces, it can have an impact on the human body and how a person may learn.

It is noted in Table 4.4.3 on the next page that focus group participant five says that “some parts of your brain are actually activated by placing information within the context of your environment”. This statement strongly correlates with the literature review focused on perception of space and multi-sensory learning experiences. According to Baines (2008: 23) the quality of learning is influenced by the physical environment and

the interactions amongst students, lecturers, and learning materials. More importantly, as soon as sensorial stimulus has reached the human receptors it is stored in memory (Lehman 2011: 15). Simply put, end-users may recall information related to the environment or sensory input at a later stage.

The above statements indicate that technology integration needs to be carefully considered as the way that learning environments are designed determine how students have access to technology. In turn, this has an impact on students' experience of their environment through their senses. Moreover, how the students experience their environment influences how they processes information and recall the memory attached to it.

The findings also revealed that the technology provided to students and the way that learning environments look and feel have an impact on students' academic drive and motivation. Pilot online interview participant four noted in Table 4.4.3 that "Digitally we can enhance learning by visually[7] attracting learners…to keep the learner focused and captured by the technology. When the learner is involved in the teaching method, they remember information more easily". Pilot online interview participant five agreed by saying, "Yes, more visual interaction making learning easier and fun".

The above statements suggest that by making learning environments more visually appealing students can be more engaged and enjoy learning. Therefore, the findings reveal that the learning environment design and technology that is integrated needs to be considered as they can have a positive or negative impact students learning experience.

In Table 4.4.3 on the next page, focus group participant five also reminds us that universities need to keep in mind that not all students understand how to use advanced technology tools or learning equipment by saying, "Not all students are computer literate". Moreover, the participant suggests that universities need to educate students about the technology learning tools that are available to them: "The solution is that

[7]This statement also focuses on appealing to students' sense of sight. This suggests that sensory domination does exists as previously discussed in 'theme one'. The onus is on interior designers to overcome such a challenge, by equally considering the senses throughout the design process.

curriculum should include computer literacy classes". This may help alleviate the problem and allow students to feel better equipped and knowledgeable about the resources available to them on campus.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Campus planning and technological infrastructure	Guidelines for designing TEL environments	"Allow space for the body to move in addition to promoting comfort"	O.I.1
		Design strategy to enhance end user technology experience	"Digitally we can enhance learning by visually attracting learners with visually appealing, interesting methods. To keep the learner focused and captured by the technology. When the learner is involved in the teaching method, they remember information more easily"	P.O.I.4
			"Yes, more visual interaction making learning easier and fun. This will also help individuals with different advantages (sight, sound)."	P.O.I.5
		Learning environment design affects perception	"Some parts of your brain are actually activated by placing information within the context of your environment."	F.G.1.5 35:30:00
		Interior designers need to have a good understanding of new technology	"New technologies are constantly evolving and bridging the gaps. Having a good understanding of new technology helps when trying to stimulate or replace a sense."	F.G.R.1
		Universities need to empower and educate students about the technology available	"With the way technology is evolving I think it's necessary that students have basic knowledge of these items"	P.O.I.1
			"Not all students are computer literate. The solution is that curriculum should include computer literacy classes."	F.G.R.6
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.3 Guidelines and sensory principles for designing TEL environments

4.4.1.5 Encouraging student engagement and interaction

Another valuable finding shed light on the need for TEL environments to be designed in a way that encourages more student engagement and interaction. As noted in Table 4.4.4 on the next page, pilot online interview participant three explains, "There is less interaction[8] between people and the environment because of technology".

The literature review emphasises that people should still remain connected in person as opposed to relying on technology to substitute personal interactions (Cafferty 2011). Student personal interaction needs to be considered and implemented in a positive way that encourages digital innovation and student engagement across campus. In Table 4.4.4 on the next page, online interview participant four explains that furniture design can influence the way people engage and interact with one another. Therefore, interior designers need to carefully consider the interior design layout and furniture design.

[8]The quality of social interaction that we need as human beings is diminishing due to technology (Nilles 2012). The relationship between technology and human interaction is also discussed in Chapter two and identified as a challenge in 'theme one'.

Online interview participant one pointed out that more emphasis needs to be placed on creating 'high tech' spaces that encourage interaction by saying, "creating spaces for social interaction in relation to technology saturated spaces". This indicates that interior designers need to consider how design elements such as furniture, floor, wall and window treatments, product design, and lighting can encourage students to engage with each other and their studies. As noted in Table 4.4.4, such a solution was achieved by online interview four, who said, "if you look at the design and recall the pods, they had side-by-side seating, I think that also aided the customers to sit alongside the sales assistant…and to explain things to the customer…making them feel more secure". This shows that design elements can encourage student interaction and engagement.

4.4.1.6 Understanding the client's objectives

With the above in mind, one of the most important factors to consider when designing a new environment is working in collaboration with the client and understanding their objectives for the project (Blaxter, Hughes and Tight 2006: 21). The literature reviewed was consistent with this finding. Online interview participant one shared the same view as Blaxter, Hughes and Tight (2006: 21) by stating, "Design is a process and good design begins by understanding a client's strategic objective" as seen in Table 4.4.4. Therefore it is crucial to maintain a good relationship with the client in order to understand how they would like to improve the end-users experience, what requirements they have or rules you need to adhere to in order to achieve project success and client satisfaction.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Campus planning and technological infrastructure	Students need to engage more with their learning environment	"There is less interaction between people and the environment because of technology everything is at your fingertips (literally)."	P.O.I.3
		Design strategy used to encourage human interaction	"Creating spaces for social interaction in relation to technology saturated spaces."	O.I.1
			"If you look at the design and recall the pods, they had side-by-side seating, I think that also aided the customers to sit alongside the sales assistant and see what's going on and to explain things to the customer obviously making them feel more secure"	O.I.4
		Digital innovation required to stimulate the senses	"Yes, digital innovation is interactive learning and is a lot more common today, therefore, it should only be a positive influence on learning environments if implemented correctly."	P.O.I.8
		It is important to understand the clients objective	"Design is a process and good design begins by understanding a clients strategic objective" "e.g. we had to design environments that help bridge the gap between early adopters of technology and those reluctant to adopt / use this technology (mostly out of fear)…making banking simpler and easier 24/7."	O.I.2
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.4 Guidelines and sensory principles for designing TEL environments

4.4.2 Accommodating the senses

The findings below revealed that 'vision' emerged as the dominant sense and that when Designing, the participants give less attention to the other senses. On the other hand, the findings highlighted that the senses enable us to perceive our physical surroundings and plays an important role in how students learn and process information.

4.4.2.1 Designers' responsibility to curb sensory dominance

Interior designers are closely associated with the client and end design product, and therefore play an integral part in the decisions made regarding the end-user experience. I selected eight practising local interior designers for the pilot interviews and asked if they consider the senses when designing technology-enhanced environments.

The responses revealed that some senses were considered more than others. All the pilot online interview participants considered the sense of sight which was consistent with the literature review regarding Plato's idea of sight being the most dominant sense (Kearney 2014). Of the eight pilot online interview participants nobody considered the sense of taste and only two considered the other senses such as hearing, touching and smelling. The findings facilitated validation through triangulation, as the online interviews, focus group discussions and literature review all yielded the same results, which is that sensory domination exists (Kearney 2014) and that some senses are neglected by interior designers. Therefore, in order for end-users to reap the benefits of sensory design, the onus is on interior designers to encourage designs that implement multi-sensory experiences. Interior designers should therefore avoid neglecting some of the senses, as people experience their environments with their entire body using all their senses. Interestingly, online interview participant two said that interior designers consider the senses when designing technology-enhanced environments: "they try to trick the senses into believing that they find themselves in natural environments". This suggests that technology may be used to create artificial "outdoor experiences" indoors.

4.4.2.2 The importance of the senses to process and learn information

Focus group participant five felt that the senses are still considered an essential part of the learning process for students, regardless of the advanced technology of the digital age: "In my experience, students that are kinetic are not afraid of using technology…

Even though the delivery platform has changed, their brains still work the same in terms of how they process information; you still have to use the senses". More importantly, focus group participant five's above statement correlates with the stimulation theory discussed in the literature review, which supports the notion that people react to sensory stimulation (Kopec 2012: 23). These findings are also consistent with those of Baines (2008: 23) who says stimulation of the human senses encourages the creation of new pathways, which may develop the human thought process. Therefore, multi-sensory learning at its core is a way of encouraging students to enjoy learning, and be engaged through sight, hearing, smelling, tasting, moving, touching and thinking (Baines 2008: 21).

Furthermore, in Table 4.4.5 on the next page, online interview participant two highlights that advanced technology can be integrated into the environment to provide a certain sensory experience: "Getting customers future ready also requires a sensory experience that leverages future forward technology and products to deliver experiences to their current and potential customers in which they almost receive, perceive, feel, interpret and encounter the future of banking". This supports Lehman's (2011: 49) idea that sensory perception is known to be an active process, primarily because as a person enters a space they use their senses to actively navigate through the space. On that account, interior designers need to be considerate of the way technological learning tools are integrated as they have the ability to create multi-sensory learning experiences.

The above findings regarding the senses and technology are consistent with the literature discussed in Chapter two. The key point is that the environment, with or without integrated technology, has an impact on the senses and in turn may influence the way information is processed or the way people perceive their surroundings. Therefore, interior designers need to ensure that there is firstly, a connection between the technology and the senses, and secondly, that a balance is achieved so that none of the senses is neglected, and that technology is implemented in a manner that positively influences the senses.

4.4.2.3 Strengthening the relationship between interior designer and supplier

Online interview participant two felt that interior designers working on technology-enhanced environments rely on their suppliers and manufacturers for a smooth design process from concept to completion by explaining that they "work closely with suppliers".

In addition, the same participant stresses the use of prototyping: “Prototyping is key…it is important to physically see the items”. This highlights that testing and manufacturing products through a trial and error process is vital for designers.

4.4.2.4 Parties that could be appealed to for the reduction of costs

Online interview participant three felt very passionate about getting to the root of the problem with regard to the cost issues caused by importing materials due to the lack of local sourced materials or manufacturers. The suggested solution involved appealing to the government for assistance regarding export and import costs and to provide more technical training institutions that could allow interior designers to have more skilled suppliers or workers to depend on: “Government interventions and legislations around issues of export, import vs. relatively high South African labour costs, lack of technical training institutions, calibre of skilled / unskilled employees”. Therefore, by harnessing more skilled workers, the government would be supporting interior designers by reducing the necessity to outsourcing material or assistance from overseas countries.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Sensory experience	Consideration of the philosophy of sensory design	“Getting customers future ready also requires a sensory experience that leverages future forward technology and products to deliver experiences to their current and potential customers in which they almost receive, perceive, feel, interpret and encounter the future of banking” “Aesthetically we had to answer this fundamental question: what do innovative and virtual technologies feel like if it were to be an environment?”	O.I.2
			“We then set out to design a 3D space dedicated to a sensory experience which essentially had to make customers feel good about themselves…Feeling good within the space opens the mind to new experiences”	O.I.3
		Existing design strategies being used in high tech spaces to consider the senses	“Interior designers are considering the five human senses when they design technology enhanced environments as by its very nature they try to trick the senses in believing that they find themselves in natural environments”	O.I.2
		Scope for development in design	“I would add the sense of rhythm, the sixth sense”	O.I.1
			“Work closely with suppliers” “Prototyping is key…it is important to physically see the items”	O.1.2
		Connectivism theory- Technology aids learning but the senses are still relevant in the digital age	“In my experience, students that are kinetic are not afraid of using technology… Even though the delivery platform has changed, their brains still work the same in terms of how they process information, you still have to use the senses”	F.G.1.5 36:50:00
	Budget	Suggested parties that can cut back costing	“Government interventions and legislations around issues of export, import vs. relatively high South African labour costs, lack of technical training institutions, calibre of skilled / unskilled employee’s”	O.I.3
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.5 Guidelines and sensory principles for designing TEL environments

4.4.3 Interactive and collaborative learning

Focus group participant six highlights in Table 4.4.6, which can be found on the next page, the need to encourage interaction and collaboration across students from various disciplines: “Learning environments that are effective create opportunities for students to interact with one another and solve problems together” and focus group participant five agrees by stating “Students need to able to interact with learners from other disciplines”.

These findings also concur with the beliefs of Coccoli *et al.* (2014: 1004) and Duderstadt (2001: 7) who say that there is indeed a growing need for a flexible education model, suitable for interactive learning environments where students can collaborate.

Creating interactive learning environments provides a platform for students to collaborate. What online interview participant four says in Table 4.4.6 on the next page, supports previous literature on the necessity of human interaction in the digital age: “We clearly understand from our research that a human element is still preferred in this day and age to make customers feel comfortable with technology.” The participant then states that end-users still need human interaction despite impressive technology advancements of today: “People still like human interaction. As much as the branch can go technological they still need that human interaction”.

The second pilot online interview participant as shown in Table 4.4.6 on the next page provides another possible reason as to why collaboration is so important. Interestingly, the statement made confirms that collaboration is closely associated or linked with new ideas and innovation: “Technology by itself does not allow for spontaneous interactions and possible deviations that lead to new insights.”

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Technology and Human interaction	T.E.L need to encourage student collaboration and interaction across disciplines	"Students need to able to interact with learners from other disciplines"	F.G.1.5 45:30:00
			"Yes, they can learn from technology but there is still a need for human contact or interaction…Learning environments that are effective create opportunities for students to interact with one another and solve problems together."	F.G.R.6
		Technology needs to allow or encourage spontaneous interaction	"(Technology) must be used in conjunction with traditional forms of informational gatherings" "Technology by itself does not allow for spontaneous interactions and possible deviations that lead to new insights."	P.O.I.2
		Interior design elements should encourage human interaction	"Having a virtual person or welcome point can ensure technology doesn't neglect the senses…Customer research indicated that the human element is still preferred"	O.I.4
		Human interaction can be used to make people feel secure and familiar	"I learned from the new models…that people still like human interaction. As much as the branch can go technological they still need... So that's why we actually brought back our welcome desk, where you would have a person to meet you." "By having that front contact point someone can approach the end-user to make them feel secure and familiar…We clearly understand from our research that a human element is still preferred in this day and age to make customers feel comfortable with technology."	O.I.4
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.6 Guidelines and sensory principles for designing TEL environments

4.4.4 Learning styles

As the educational landscape changes due to emerging technologies, it is important that universities are able to adapt to these changes, by using technology to have a positive impact on students, and to foster a new learning culture. In Table 4.4.7 found on the next page, focus group participant one explains why technology can assist students to engage and learn more, "I think technology allows students to create connections much quicker. You can crunch information much quicker by using technology".

The above statement links with Siemens' (2014) connectivism learning theory which supports the idea that knowledge exists everywhere and is accessed and organised by students who learn through creating connections and developing a network (Siemens 2014). More importantly, it is noted that it is common that learning resides in non-human appliances. The statement made by focus group participant four, as shown in Table 4.4.7 to follow, is closely associated with the connectivism learning theory and

elaborates on how students have different ways in which they learn through technology "As lecturers, we have to consider how students learn. Some might prefer to learn via tutorials, or videos, while others prefer printed materials or 'spoken' lectures".

Surprisingly, focus group participant four then elaborates on the various learning styles in line with the VARK theory (Dirksen 2012), "Each student has their own learning style. There are different learning styles, some students learn through their sense of sight, other students learn through listening, some students need to literally read or write and there are also kinaesthetic learners who learn through different textures and materials. Students need to know their learning style and their learning environment need to be flexible." This statement sheds light on the importance of learning environments to accommodate all students' learning styles so that students feel motivated to spend more time learning. The VARK theory acknowledges that learners engage with their studies in different ways and that the teacher or physical environment can stimulate or shape this learning process (Dirksen 2012).

Lastly, as found in Table 4.4.7 on the next page, focus group participant two addresses the heart of the matter that draws the above findings together by stating, "Learning environments need to be adaptable. It needs to be able to change so that your brain can make an association to the different spaces. It also needs to have furniture that can be personalized and adapt to each person's best learning condition".

Such a statement, as depicted in Table 4.4.7 that can be found on the next page, is consistent with Stein's (2013:33) idea that understanding the positive and negative effects of different stimuli, such as shape, colour, lighting, acoustics, material, and furniture, is vital. Subsequently, there are many human factors that affect the entire educational process, including students' different attitudes and learning styles that are influenced and rooted from the highly connected and interactive digital world to which they are accustomed (Coccoli *et al.* 2014: 1004).

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme two Sensory design principles and guidelines for designing TEL environments	Technology resistance	T.E.L need to accommodate or reach out to students who resist technology	"We need to consider how to augment their environment. We need to look at how we can reach out to students who aren't interested in using technology."	F.G.1.3 15:90:00
		Student resistance against technology adoption	"We have this idealistic way of how things are moving along, but maybe that is not the case. Some students don't want to or feel the need to use technology. We can't presume everybody is on board with technology."	F.G.1.5 09:15:00
	VARK theory	T.E.L environments need to be flexible and accommodate students with different learning styles	"Learning environments need to be adaptable. It needs to be able to change so that your brain can make an association to the different spaces. It also needs to have furniture that can be personalized and adapt to each person's best learning condition"	F.G.1.2 40:20:00
			"Each student has their own learning style. There are different learning styles, some students learn through their sense of sight, other students learn through listening, some students need to literally read or write and there are also kinaesthetic learners who learn through different textures and materials. Students need to know their learning style and their learning environment needs to be flexible."	F.G.1.5 42:35:00
			"Some people prefer absolute silence, and some people prefer baffled noise"	F.G.2.3 14:31:00
			"My students in the drawing class, I use music… a certain type of music to stimulate their alpha waves. Alpha waves are only produced when your brain or body is relaxed and peaceful."	F.G.1.5 16:40:20
	Interior design strategies	T.E.L. environments need to provide students with access to ubiquitous learning technology tools	"Already we have a great amount of information available. The key would be to allow for spontaneous access to it in a flexible manner to allow connections between information and therefore greater understanding."	F.G.R.1
		Connectivism theory – learners want ubiquitous learning with technology	"I think technology allows students to create connections much quicker. You can crunch information much quicker by using technology."	F.G.1.1 22:35:00
		Prototyping is an integral part of the design process	"When designing furniture, we have to conceptualize the structure, the form and the function, which involves prototyping many times."	F.G.1.2 27:16:00
		T.E.L environments need to be flexible and provide face-to-face learning and digital activities	"Blended learning would definitely assist us as lecturers"	F.G.R.4
			"As lecturers we have to consider how students learn. Some might prefer to learn via tutorials, or videos, while others prefer printed materials or 'spoke' lectures"	F.G.R.5
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.4.7 Guidelines and sensory principles for designing TEL environments

The main points from the above findings, both valuable and necessary in order to better connect technology and the senses, are summarized in Figure 4.4.8 and 4.4.9 on the next two pages to follow.

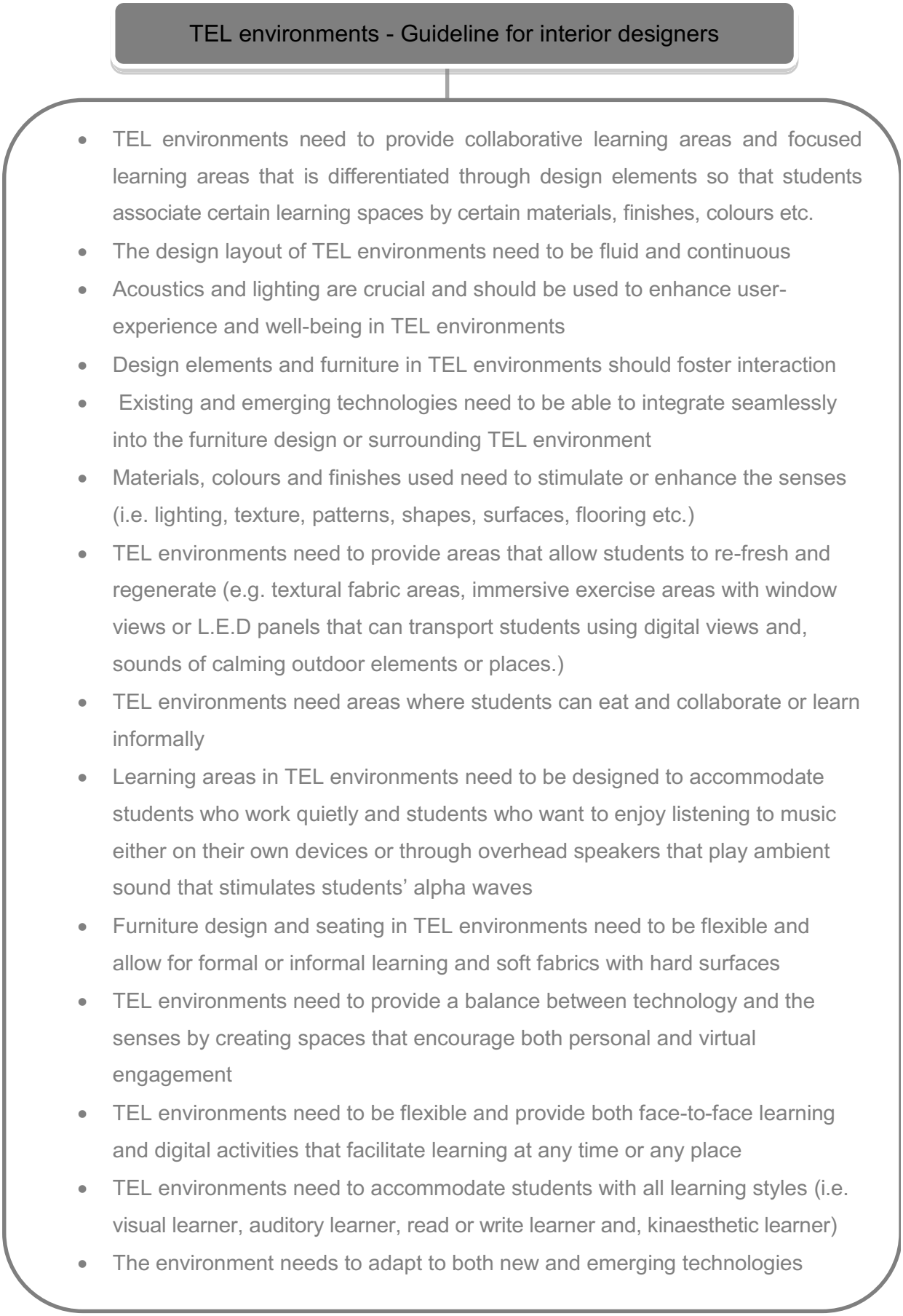

Figure 4.4.8 TEL environments - Guideline for interior designers

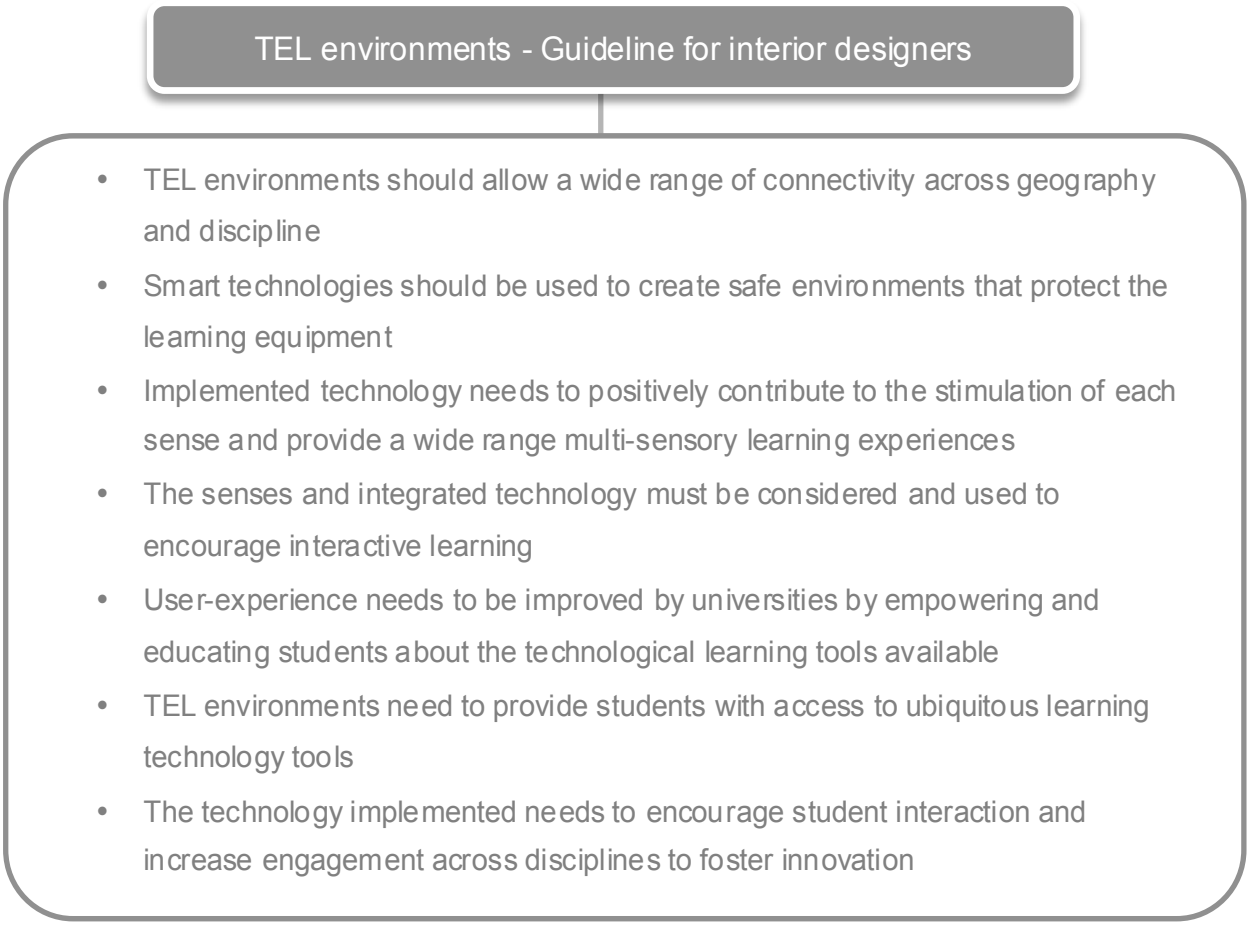

Figure 4.4.9 TEL environments - Guideline for interior designers

4.5 THEME THREE – EFFECTIVENESS OF A COLLABORATIVE APPROACH

After the sensory design principles and guidelines were established, they were used in the practical concept design in order to fully engage with the solutions as reviewed in the literature and suggested by the participants. The design team then evaluated the outcome of the practical concept design during the critique meeting and focus group discussions. Design team members had an equal opportunity to clarify their suggestions and solutions, as well as to provide feedback on how to improve the design.

The practical outcome was also considered a fundamental step in discovering how to design environments that may offer learning experiences that connected technology and the senses. The collaborative approach provided objective expert advice from professionals who were willing to share their solutions or contribute towards finding ways to solve the problems we face within learning environments. The responses from the participants were carefully analysed and then cross-verified with the literature review, where applicable. Thereafter the solutions were tabulated and used to guide the design of a futuristic ‘academic hub’ that provided both technological and sensory experiences.

The participants’ feedback was therefore essential in not only exploring the challenges that exist, but also in determining how to find innovative solutions to overcome the challenges, as certain ideas only came about as result of the collaborative effort. Realistically, not all the challenges can be tackled (i.e. such as budget, costing or the fact that South Africa has not yet developed locally available materials to reduce material and labour costs). However, as universities advance and technology develops, the sensory design principles may be extended and the guidelines may be refined or modified to continue strengthening the connection between the senses and technologies in learning environments so that students of the digital age may truly reap the benefits of collaborative innovations.

Theme three will look at the findings that emerged from the focus group discussions and online interviews, which deal with drive innovation using a collaborative approach. Thereafter the discussion will focus on the development of the practical design concept, which will be sectioned into four stages namely, the design team reflection, critique, refining process and evaluation of the collaboration.

4.5.1 The initial design concept

Prior to sketching and designing the initial design for the TEL academic hub, I created conceptual ‘info boards’ which summarized the major challenges that were reviewed in the literature, and gathered images from Pinterest to visually develop a look and feel for the academic hub. I entered keywords like ‘futuristic’, ‘high tech’, and ‘technology-enhanced learning environments’ to see images of the most recent and up to date design projects across the world. Thereafter, I put together the images with the summarized literature to create ‘information boards’ that could guide and direct the initial concept design. The ‘info boards’ helped me to bridge the gap between the literature I reviewed and the vision I believed would best represent the concept design of the academic hub. As a result the info boards were an amalgamation of visual illustrations, precedent designs and challenges that needed to be resolved by the collaborative design team:

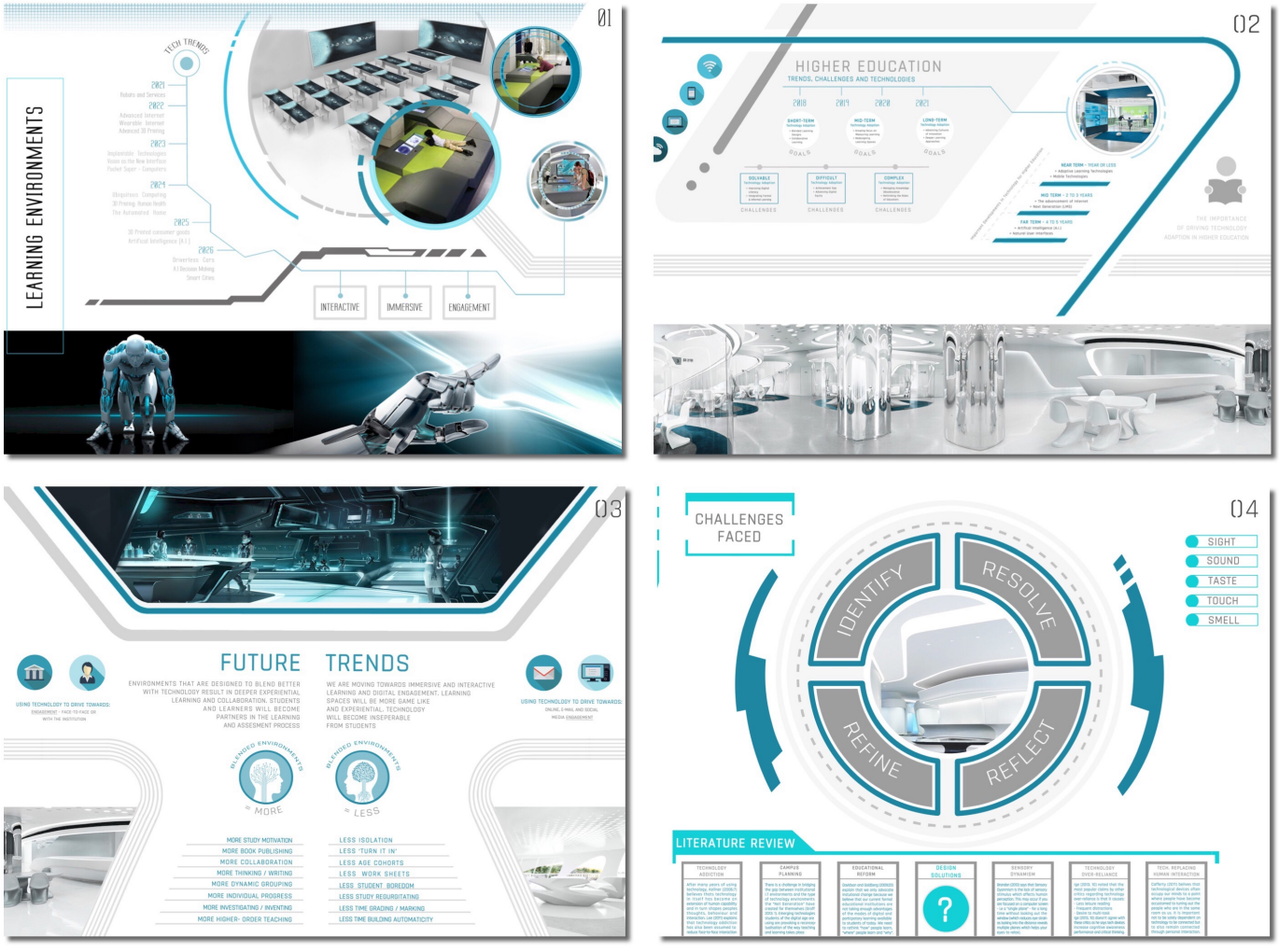

Figure 4.5.1.1 Information boards (see Appendix M for full size of info boards)

The ‘information boards’ played a key role similar to that of a design brief, as it also guided and directed the discussions with the collaborative design team. They were therefore considered useful, especially during the one-on-one critique meetings, as the boards summarised the challenges that needed to be explained to each participant.

Thereafter, I commenced the concept design of the TEL academic hub. The precedent works that were examined by Breffeilh (2013) in Chapter two influenced the initial design concept. There were various design elements that forged a strong connection between technology and the senses. As a result, I used some of the materials and concepts behind the designs to positvely influence and shape the design of various spaces within the academic hub, namely the entrance area. The advanced LED screens I used in the design were inspired by the Beijing Xicui Entertainment Complex, as analysed by (Breffeilh 2013). In Figure 4.5.1.2 on the next page, LED boards were used to manipulate the perception of space in various areas throughout the academic hub. To further expand on the idea, I decided it would be useful to students if the LED screens also acted as a newsfeed that provided information or live updates to them.

Materials and shapes that were used in the concept design were inspired by the works of Karim Rashid. Table 2.4.2.1, as presented in Chapter two, was analysed so that the materials and design processes of the digital age were embraced. The academic hub had areas that extensively used reflective materials such as glass partitions and epoxy flooring. The organic shapes symbolised in the furniture, drywall and ceiling, represented the kinetic fluid-like motion I interpreted from Table 2.4.2.1 as mentioned above.

Karim Rashid’s vision for the digital age heavily inspired how I went about developing the initial design, as he pushes the boundaries of technology in many ways. This encouraged me to ‘think out of the box’ and, in turn, I tried to create areas where students could be interactive with one another and technology so that the academic hub could offer a heightened sensory experience. Moreover, the initial design reveals spaces with heavy digital weight regarding advanced technological tools that students would have access to if they were to use this academic hub. On that account, figure 4.5.1.2 on the next page illustrates the initial concept design, which includes various spaces within the academic hub that were inspired by the precedent works previously mentioned.

Figure 4.5.1.2 Initial design concept influenced by Rashid (2015) and works analysed by Breffeilh (2013) (see Appendix M for full size of information boards).

4.5.2 Collaboration in a digital age as a vehicle to drive innovation

Prior to the commencement of the collaboration, all participants were asked if they were currently working in a collaborative design team, and if they felt that it was important to work in collaborative design teams. Interestingly, seven of the eight interior designers were currently part of a collaborative design team. This indicates that their views and opinions on the effectiveness of collaborations were based on professional experience and their understanding of the process. The findings also confirmed that the majority of the interior designers felt working in a collaborative design team is important.

A frequent theme to emerge regarding the study participants' views and thoughts about collaboration, was that early engagement and interaction between specialists working on a design team can assist in refining design objectives and design solutions, which in turn leads to a larger pool of ideas. As indicated in Table 4.5.2.1 that can be found on the next page, focus group participant one is of the opinion, "collaboration will broaden the views and increase the number of potential ideas. Collaboration also gives rise to new ideas". Furthermore, the above notion coincides with the literature review. Elcom (2013) states that effective collaborations result in more educated, skilled and engaged workers. The descriptions shared are broadly consistent with good design management, which provides better, more appropriate, management that supports the creative process (Emmitt 2014: 21).

The statement made by pilot online interview participant two, as noted in Table 4.5.2.1 on the next page, corroborates the aforementioned findings: "Different skill sets and knowledge always rub off on others and spur people to explore new avenues." Therefore, the finding demonstrates that many of the participants felt that collaborations were considered beneficial for many reasons. The statement also matches Blaxter, Hughes and Tight's (2006: 74) idea that specialists can achieve a better outcome or design if they combine their skills and work together. It is important also to note that many ideas and suggested advice are not ideal or the most suitable for the design outcome; however, working in a collaborative team allows for others to step in and justify why those decisions or ideas should not be explored or implemented. Participant four of the pilot online interviews states that collaborative teams "can pick up if something isn't going to work, making sure the project is going to be a success".

The participants also mentioned a few key barriers that can create conflict, such as the human ego or strong opinions that decrease the quality of information, as indicated in Table 4.5.2.1 below:

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme three Effectiveness of a Collaborative approach	Collaboration as a platform to encourage innovation	Collaborations may offer new approaches and innovation	"Different skill sets and knowledge always rub off on others and spur people to explore new avenues."	P.O.I.2
			"In a creative environment collaboration will always lead to new approaches and innovation."	P.O.I.2
			"By bringing people together, they can bring in their strengths on a project. When there are more people on a project, they can pick up if something isn't going to work, making sure the project is going to be a success."	P.O.I.4
			"More creative minds result in more creative ideas."	P.O.I. 8
			"Collaborative approach in any design challenge should encourage innovation. A holistic approach will always provide more complete solutions to the challenge at hand."	P.O.I.6
			"By bringing people together, they can bring in their strengths on the project."	P.O.I.4
			"Everyone has different backgrounds and levels of experience and they can feed off each other. Balancing practicality and innovation."	P.O.I.5
			"Yes. Collaboration will broaden the views and increase the number of potential ideas. Collaborations also give rise to new ideas."	F.G.R.1
			"Team work is the 'buzz-word'. Major inventions are products of collaboration."	F.G.R.6
	Barriers that hinder collaborations	Behaviour and themes of belief that prevent effective collaborations	"While new ideas may emerge from collaborations, humans' egos will seep in and one sided opinions will decrease the quality of information."	F.G.R.1
			"There's too many opinions involved in making decisions. I think it depends. It's better to have one person leading the project."	F.G.2.2 15:30:00
	Indications of a successful collaboration	Complexity of group thought and processes needs to be considered by all involved in the collaboration	"The epitome of collaboration is that people from different spheres, when the outcome of the result (whatever you guys are creating) if you can get to a point at the end of the project where: • Your client understands what you're saying • You as the people who collaborate understand what you're saying and; • The intended end-user of the space understands what was said Then that's a successful collaboration!"	F.G.2.1 03:10:00
			Communication is of paramount importance. Paramount importance!"	F.G.2.1 22:53:00
		Successful collaborations share resources	"Helps to widen the understanding of needs"	O.I.1
			Successful collaborative partnership is all about shared resources that could contribute to the development of locally produced products required to produce cost effective technology enhanced interiors."	O.I.3
		Collaborations require a committed partnership and common goals	"Most definitely, however collaborative working is not for everyone and it should be done through partnership agreements that encourage commitment and most importantly guidelines that help each party to keep the other party accountable."	O.I.2
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.5.2.1 Interior designers' perceptions of a collaborative design team

The development of the practical concept design followed the action research criteria for the study as listed in Figure 3.4.3.1 of Chapter 3. The design development comprised the following four stages that will be discussed below:

- Design team reflection
- Design team critique
- Design team refining process and
- The evaluation of the collaboration

4.5.3 Design team reflection

The time spent with the collaborative team during the focus group discussion and one-on-one critique meetings was insightful and had a positive impact on the design process and development. Each design team member provided a substantial amount of input that helped inform data driven decisions that were made earlier in the process. Furthermore, the design team had time to reflect on the design, and to consider and clarify the best way to implement the solutions that were discussed as a team.

One of the most surprising findings that were re-iterated by various design team members was their concern about students' resistance to technology. As seen in Table 4.5.3.1 on the next page, focus group participant four says, "we try to do everything digital and they resist it constantly…Even watching video tutorials is bothersome for the students to do". When the design team discussed the future trends that were predicted for learning environments (See Appendix M), focus group participant five reacted with the following statement, "I think a lot of people resist technology in terms of trends. The movement is away from that, it is getting back to what we as humans fundamentally need..." These findings therefore coincide with the challenges as discussed in "Theme one" and Chapter two, suggesting there is a concern that some students actively resist technology and are perceived to be uninterested in adopting as easily as people assume.

Focus group participant five then emphasises how difficult it is to keep up with technology: "The way technology is moving forward is out of sync. Technology is moving faster than what we as people can adapt to". A similar issue was highlighted in

the literature, as the rapid development of technology has increased the potential for incompatibility between the technologies adopted by students and the technologies offered at campus (Hartman, Moskal and Dziuban 2005: 70). This finding indicates that it is challenging trying to keep up with technology in the digital age.

COLLABORATIVE DESIGN TEAM - REFLECTION OF THE DESIGN SCHEME

OPENING DISCUSSION				
THEME	**SUB-THEME**	**CODING**	**QUOTATION**	**SOURCE OF QUOTATION**
Theme One Challenges interior designers face	Technology resistance	Not all students want to adapt to advanced technology	"You have this wonderful vision but the vision is way beyond what I've experienced with students and online environments."	F.G.C.5 (00:20,00 sec)
			"With the online classrooms we try to do everything digital and they resist it constantly, and now we have gone back to printing briefs. Even watching video tutorials is bothersome for the students to do"	F.G.C.4 (00:33,90 sec)
Theme two Sensory design principles and guidelines for designing technology enhanced learning environments	Campus planning and technological infrastructure	Technology needs to adapt to the environment	"The way technology is moving forward is out of sync. Technology is moving faster than what we as people can adapt to"	F.G.C.5 (00:05,82 sec)
		Technology improving learners user experience	"If theres no windows there should be a camera inside that projects exactly whats outside"	F.G.C.4 (26:18,60 sec)
		It is important to have plants in T.E.L environments	"You should include more natural plantation if possible, because it can increase energy efficiency. Plants reduce the energy consumption in the building (i.e plants conserve energy by keeping the place warmer or cooler which decreases the demand for air conditioning)."	F.G.C.1 (00:10,00 sec)
Theme One Challenges interior designers face	Technology resistance	Not all technology trends make people happy	"I think alot of people resist technology in terms of trends. The movement is away from that, it is getting back to what we as humans fundamentally need...because that is what makes you happy"	F.G.C.5 (01:40,57 sec)
		Some people avoid technology	"And theres so many people choosing to live off the grid all together."	F.G.C.4 (02:05,40 sec)
Theme two Sensory design principles and guidelines for designing technology enhanced learning environments	Campus planning and technological infrastructure	Large windows and natural light is important	"You need natural lighting"	F.G.C.2 (04:05,00 sec)
		"Academic hubs" of the future predicted to be transient	"Its been proven that our attention span is getting less and less...so no ones going to go to these spaces the whole day.I really see this as a very transient environment. "	F.G.C.2 (12:29,60 sec)
	Interior design strategies	T.E.L environments need to foster extreme learning	"Its important to list what aids high speed or extreme learning"	F.G.C.2 (14:08,73 sec)
	Campus planning and technological infrastructure	Importance of natural materials and spatial differentiation	"Natural materials have proven to aid learning, like natural light or timbers...it creates environments that are familiar to what we know. Whereas slick plastics and glass - I think thats where the differentiation between the "focus" areas and "collaboration" areas should sit."	F.G.C.2 (19:03,00 sec)
Theme One Challenges interior designers face	Technology resistance	Increasing resistance	"The six years that I've had with online learning theres more resistance as the years have gone on"	F.G.C.4 (02:30,55 sec)
	Budget	Universities have limited budgets	"Theres alot of ideas you can come up with but what you will discover is that we can't afford most of them..."	F.G.C.3 (38:46,96 sec)

Table 4.5.3.1 Focus group participants' reflection on the practical concept design

Another interesting finding noted in Table 4.5.3.1 on the previous page, is the design team members' frequent suggestion to integrate natural elements into the design. If one analyses the 'before' and 'after' 3D renders in Figure 4.5.3.2 below, the design team members felt that it is necessary to include natural elements such as plants, natural light infiltration and to create an experience that is in touch with the outside world.

The following comments as mentioned in Table 4.5.3.1 on the previous page, show that 'high tech' spaces should be integrated with elements from nature so that people feel more comfortable in the space. Focus group participant four explains, "If there're no windows there should be a camera inside that projects exactly what's outside". Focus group participant two agrees by saying, "you need natural lighting". Furthermore, focus group participant one reflects on the importance of including plants within the environment: "You should include more natural plantation if possible, because it can increase energy efficiency". This statement shows that elements from nature may be used to create an environment that is aesthetically appealing, reduce the running cost of the building and reduce energy use. The findings from Table 4.5.3.1 on the previous page suggest that despite technological advancements in the digital age, people still want and need natural elements to be incorporated into their surrounding environments.

Figure 4.5.3.2 Practical concept design reflection on the use of natural elements

4.5.4 Design team critique

The design critique was important, as the design team members needed an opportunity to share their concerns and feedback on how the concept design would function as a learning environment, and whether or not the design solutions implemented were appropriate. The design team provided constructive feedback for all areas of the 'academic hub' design (see Appendix M for full practical concept design).

However, due to time constraints, only some areas were revised according to the feedback. Therefore, the discussion to follow will only cover the four selected areas that were revised:

- Sensory pod area [Study seats with heads up display and state of mind recognition]
- The Com go area [Augmented reality and online work space for students]
- The Tech lab [Student classrooms for workshops or lectures]
- The Digi room [Learning area with digital tools integrated into the furniture]

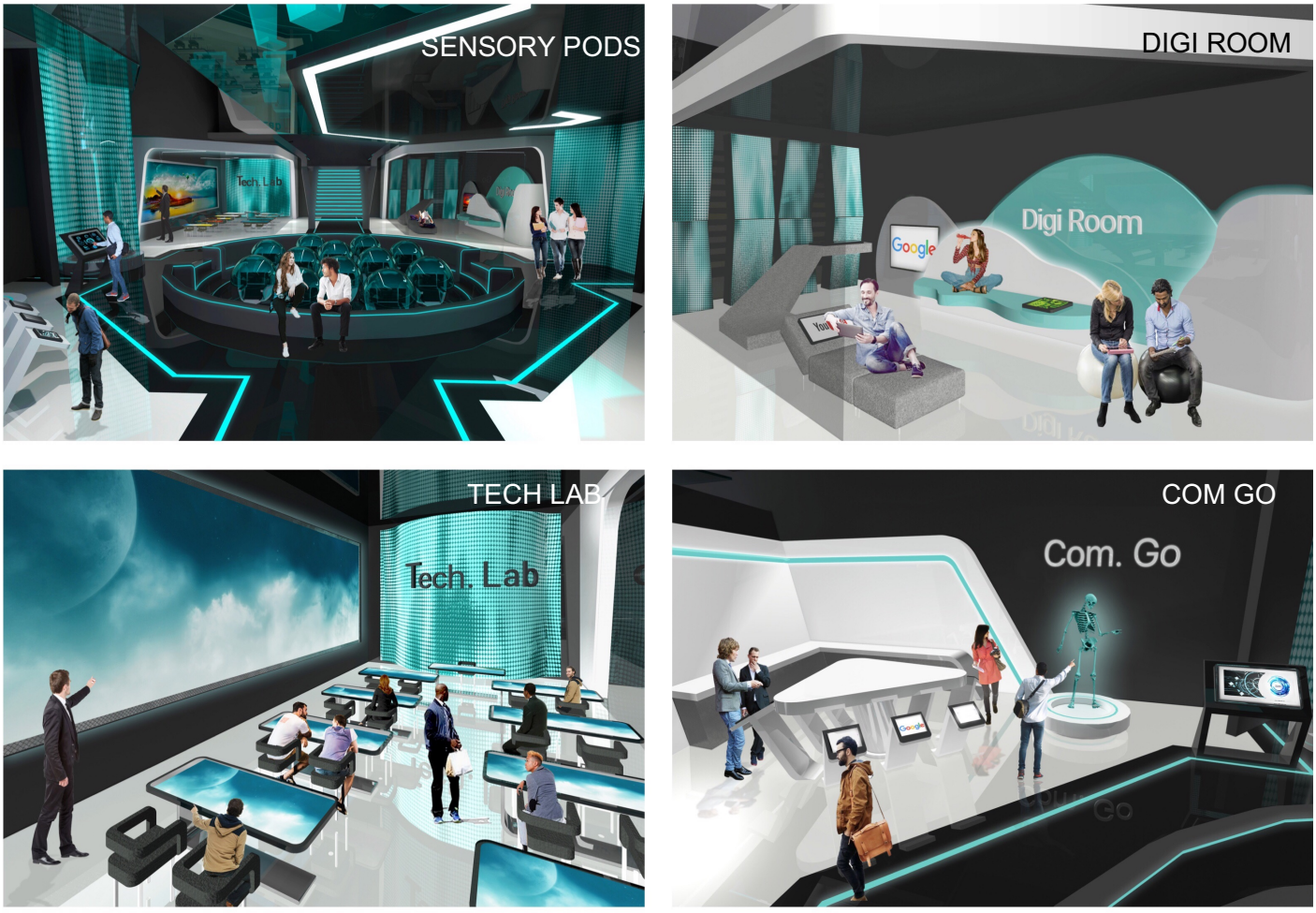

Figure 4.5.4.1 Revision of four learning areas in conceptual academic hub

Each of the four areas revised will be discussed and can be read in conjunction with the illustrations of the design that show the ‘before’ and ‘after’ so that the design changes and reasons for the changes can be easily understood.

- **Sensory pod area**

With regard to the “Sensory pod area”, an interesting critique was shared as seen in Table 4.5.4.2 below by focus group participant two concerning the seating: “If this is a focus area and you’re on display, no one likes that.” The critique received by the participant revolved around the issue of privacy, as described in the statement. This statement is significant as it highlights that designers need to take into account the effects that the design has on the end-users sense of privacy as this may determine whether or not they feel comfortable learning in the space or not.

CRITIQUE AND REFLECTION ON DESIGN		
LEARNING ZONE IN ACADEMIC HUB	**REMARKS FROM DISCUSSION**	**SOURCE OF QUOTATION**
SENSORY PODS: Individual study pods with HUD to watch lectures taking place locally or internationally. Automated networks can track one’s state of mind (i.e relaxed, concentrating etc.) the select state of mind would light the pod up in an associated colour to inform surrounding people.	“That in itself is quite scary, in a way you are relying on something digital to take over something you should know as a person” “That petrifies me, you’ll be relying on something digital to gage someone’s emotions” “If this is a focus area and you’re on display, no one likes that. Thats why glass boxes as boardrooms don’t work in corporate environments, they all look beautiful and they’re all over Pinterest but they are not efficient user space.”	F.G.C.5 (08:42,75 sec) F.G.C.4 (08:49,70 sec) F.G.C.2 (00:21,60 sec)

DESIGN REVISIONS		
LEARNING ZONE IN ACADEMIC HUB	**SUGGESTIONS TO IMPROVE DESIGN**	**SOURCE OF QUOTATION**
SENSORY PODS A dome like smart “frosting” glass was used to encase the sensory pods for privacy	“It encourages human curiosity. You have to have a barrier and transition materials, it can’t be this exposed. It can be with glass or rope or chain, or perforated steel.”	F.G.C.2 (01:24,40 sec)

Table 4.5.4.2 Focus group participants’ critique on the “Sensory pod area"

As a result, the solution discussed in Table 4.5.4.2 above was to take into account students who would not like to be on display. Therefore a smart glass encasement was suggested by focus group participant two that could offer the flexibility of being clear or frosted at various times of the day: “You have to have a barrier and transition materials…It can be with glass or rope or chain or perforated steel”. The solution of having a frosted glass encasement was ideal as it allowed for flexibility and accommodation of students’ different learning styles and preferences.

Figure 4.5.4.3 on the next page illustrates the “Sensory pod area” ‘before’ and ‘after’.

Figure 4.5.4.3 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

- **The Com go area**

The response from the design team with regard to the “Com go area” was insightful. This space was initially meant to be an area where students could access computers or augmented reality pods. However, most of the participants felt that learning environments, especially within the arts, require spaces that allow students to be ‘hands on’ and physically in touch or engaged with their work.

Moreover, focus group participant two suggested that students might appreciate a workshop that interior designers, fashion designers, jewellery designers or fine artists could take advantage of. Focus group participant two stated the following: “I think you need to look at a workshop...if it’s for designers, they need to cut fabrics and have somewhere where stuff could be delivered or received...If they are going to be designing they need a workspace where they can sketch”. This revealed that ‘open plan’ and ‘flexible’ workspaces may be more suitable in the digital age as it offers more effective and interactive learning spaces for students from different courses within the arts.

CRITIQUE AND REFLECTION ON DESIGN		
LEARNING ZONE IN ACADEMIC HUB	**REMARKS FROM DISCUSSION**	**SOURCE OF QUOTATION**
COM GO: Computers for students rushing in or out the academic hub with an augmented reality display floor unit.	“Presuming we will still have computers 30 years from now” “what spaces work for extreme learning? I think you need to look at a workshop.”	F.G.C.5 (10:29,00 sec) F.G.C.2

DESIGN REVISIONS		
LEARNING ZONE IN ACADEMIC HUB	**SUGGESTIONS TO IMPROVE DESIGN**	**SOURCE OF QUOTATION**
COM GO] Changed to a workshop area to provide students with a “hands on” space to learn through craft.	“I think you need to look at a workshop...if it’s for designers, they need to cut fabrics and have somewhere where stuff could be delivered or received...cause we’re living that life where everyone orders on Takealot. If they are going to be designing they need a workspace where they can sketch”	F.G.C.2 (02:27,80 sec)

Table 4.5.4.4 Focus group participants’ critique on the “Com go area"

Therefore, a handcraft workshop area would offer more interaction and engagement than the ‘Com go’ area. For that reason, Figure 4.5.4.5 and Figure 4.5.4.6 show how the “Com go area” transformed to accommodate a flexible space where students who belong to different courses within the arts could engage with their projects. Figure 4.5.4.5 and Figure 4.5.4.6 to follow show the ‘before’ and ‘after’ of the “Com go area”.

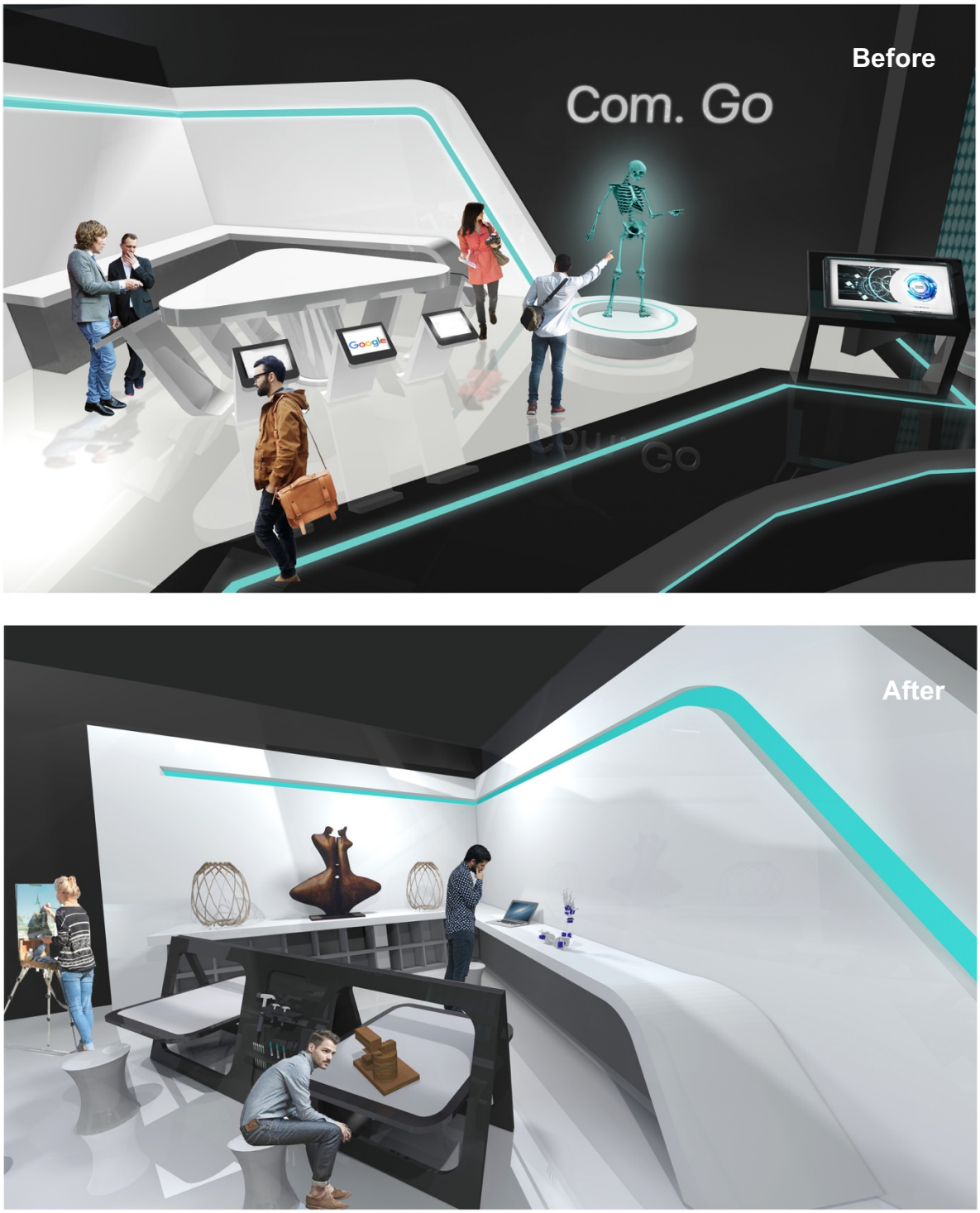

Figure 4.5.4.5 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

Figure 4.5.4.6 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

- **Tech lab**

As previously mentioned, with regard to the "Tech lab", many of the design team members' feedback focused on the need for natural elements. Furthermore, focus group participant two revealed in Table 4.5.4.7 below that an auditorium style layout would be more effective with regard to the way that learning occurs in the digital age: "I don't know if this is correct, people sitting at tables listening to someone…well judging by what happens now, you all watch YouTube videos or attend a TedTalk or Design Indaba. That seems to happen away from a learning environment". Therefore the feedback highlighted that it is important that learning environments of the digital age reflect the way in which information and knowledge is shared nowadays.

CRITIQUE AND REFLECTION ON DESIGN		
LEARNING ZONE IN ACADEMIC HUB	**REMARKS FROM DISCUSSION**	**SOURCE OF QUOTATION**
TECH LAB: A lab with interactive projector screens and tablet tables for workshops or lectures held in the academic incubator.	"I don't know if this is correct, people sitting at tables listening to someone...well judging by what happens now, you all watch a YouTube video or attend a TedTalk or Design Indaba. That's seems to happen away from a learning environment."	F.G.C.2 (08:11,80 sec)

DESIGN REVISIONS		
LEARNING ZONE IN ACADEMIC HUB	**SUGGESTIONS TO IMPROVE DESIGN**	**SOURCE OF QUOTATION**
TECH LAB The tech lab was changed to a theatre with an auditorium style layout and space that encourages learning through immersive technology	"I think it is collaborative...So in an auditorium, you'd go in and plug in a phone and there's an app you can take notes with and thats immersive technology in the chair...you can also add Evernote, you can find YouTube videos and create a project outline.... "I think thats where integrated technology is going, is because you carry it with you or carry it in the cloud.It's like somewhere between Evernote and the iCloud "	F.G.C.2 (08:58,90 sec) F.G.C.2 (11:07,80 sec)

Table 4.5.4.7 Focus group participants' critique on the "Tech lab"

The participants' statement also closely relates to the view of Coccoli *et al.* (2014: 1004) who explain that students of the digital age are learning and using their knowledge across shared environments in a trendy and collaborative way. As a result, the design was transformed to an auditorium style layout, which could accommodate more students in terms of space, and was more flexible with seating. The auditorium seating layout could also accommodate different learning styles, for instance, students could sit in formal chairs or on informal cushions.

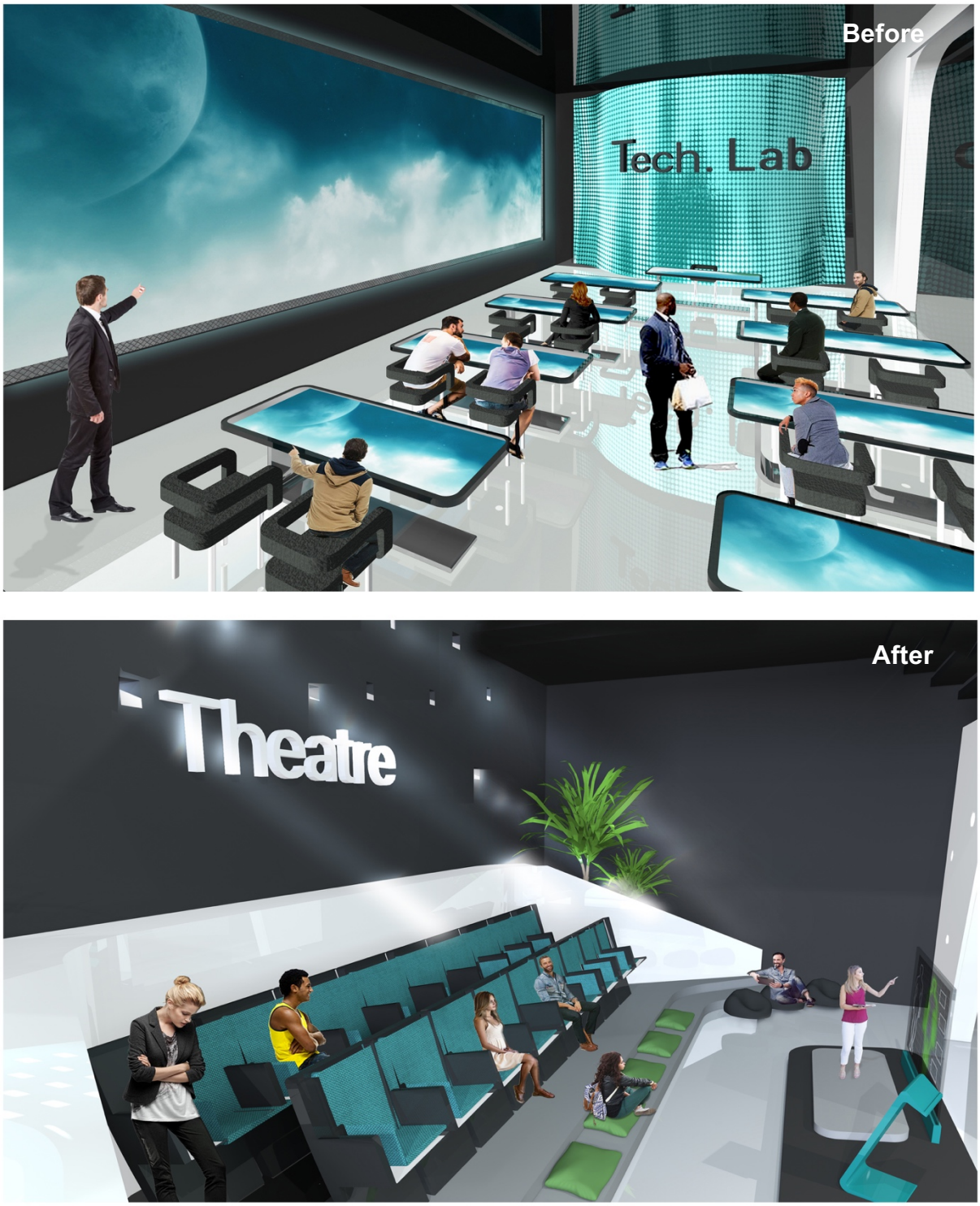

Figure 4.5.4.8 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

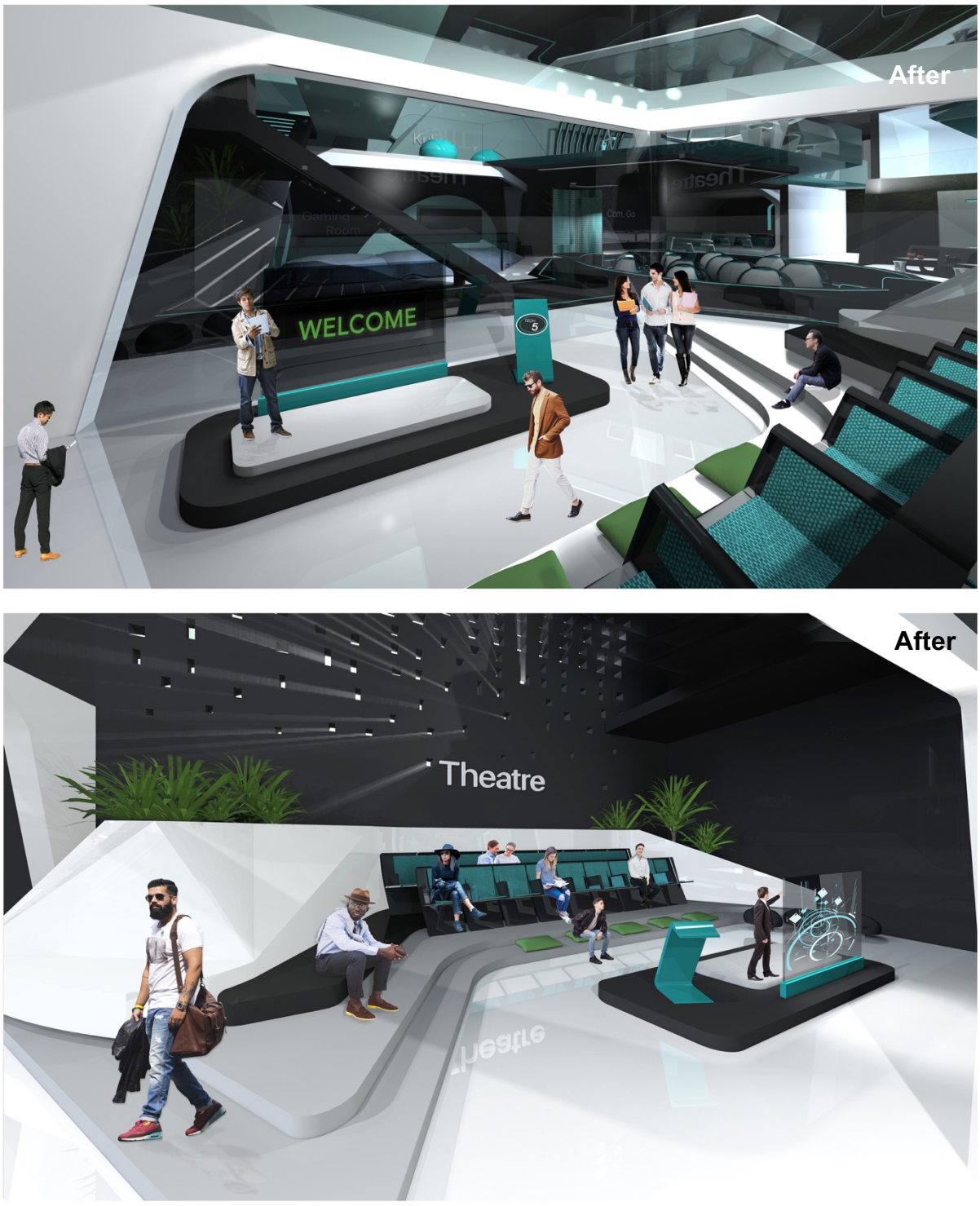

Figure 4.5.4.9 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

- **Digi room**

There was interesting feedback with regards to the “Digi room”, as noted in Table 4.5.4.10 below. Some participants felt that the “Digi room” was not tactile enough. As seen in Figure 4.5.4.9 on the previous page, the design materials used in the “Digi room” were sleek, high gloss materials that were reflective. Moreover, the focus of the room was on the integration of technology into the furniture design.

However, focus group participant five pointed out that this room would not accommodate learners that are kinaesthetic: “I almost see a room that has a sensory overload, room that’s tactile” and “I almost see a room that was just completely organic, like shapes where you could sit wherever you wanted, there would be options for seating but no seating”. These comments suggest that hard surfaces and reflective materials might not be associated with comfort or sensory enhancement.

CRITIQUE AND REFLECTION ON DESIGN		
LEARNING ZONE IN ACADEMIC HUB	**REMARKS FROM DISCUSSION**	**SOURCE OF QUOTATION**
DIGI ROOM: A learning area with digital screen displays and extensive built-in or custom technology integration into the furniture and seating. The objective was for technology to work seamlessly with the furniture to provide a better end-user experience.	“I almost see a room that has a sensory overload, room thats tactile.“ “I almost see a room that was just completely organic, like shapes where you could sit wherever you wanted, there would be options for seating but no seating.” “You would want to feel fabric” “Too much shiny, too much plastic, too much glass, I would feel so weird, but this is not for us it’s for 30 or 40 years from now.” “Despite the fact that technology is moving, you are not going to evolve physically and mentally as quickly...you still need to learn through the senses.”	F.G.C.5 (17:25,80 sec) F.G.C.4 (17:42,80 sec) F.G.C.4 (20:24,24 sec) F.G.C.5 (20:44,00 sec)

DESIGN REVISIONS		
LEARNING ZONE IN ACADEMIC HUB	**SUGGESTIONS TO IMPROVE DESIGN**	**SOURCE OF QUOTATION**
DIGI-ROOM The Digi-room was converted into a textural Gaming room where students could take their mind of studying during their breaks.	“Your brain needs a break...like a break area that takes your mind off whatever you’re doing so that you can reboot or regenerate. Physical exercise of some sort is a must...I can see like maybe an immersive treadmill ” “A room like goo, if you press it, it would make pockets of spaces and shapes for you to sit in...you need tactile, a room like where you lock crazy people in” “Its sounds a bit crazy...theres a foam that bends.”	F.G.C.2 (15:26,40 sec) F.G.C.5 (18:44,00) F.G.C.4 (19:00,00 sec)

Table 4.5.4.10 Focus group participants’ critique on the “Digi room"

As noted in Table 4.5.4.10 which can be found on the previous page, focus group participant five also emphasised, “despite the fact that technology is moving… you still need to learn through the senses”. This statement concurs with Baines (2008: 21) who says that multi-sensory learning should make learning enjoyable for students and allow them to engage with their studies using all the senses.

The design team then suggested converting the “Digi room” into a “Gaming room" as they felt that students may need a break from technology; a space where they can refresh, interact with their colleagues or be fully stimulated through the senses in between lectures or intense learning sessions as stated by focus group participant two in Table 4.5.4.10 above: “Your brain needs a break…like a break area that takes your mind off whatever you’re doing so that you can reboot or regenerate”. This indicates the importance and necessity for students to take a break from studying.

Moreover, in Table 4.5.4.10 on the previous page, focus group participant two also suggests how students could take periodic breaks: “Physical exercise of some sort is a must…I can see like maybe an immersive treadmill”. This statement made supports the concept of retaining focus and concentration by restoring the body with rest or other physical activities. In addition, the statement reveals that immersive technology can be used as a tool to assist student physical and academic performance. For that reason, it is important that universities or academic environments have spaces that accommodate students who need to rest and refresh their mind and bodies.

The “Gaming room” was therefore designed to provide a tactile and kinaesthetic sensory experience for students who wanted to give their minds a rest from being engaged with their study tasks at hand. Figure 4.5.4.11 that can be found on the next page, illustrates the ‘before’ and ‘after’ of the “Gaming room”.

Figure 4.5.4.11 Practical concept design changes made due to the design team's critique (see Appendix M for full size images)

Academic Journal

Throughout the suggested critiques and revisions of the areas previously discussed, I used my academic research journal to reflect on the feedback and design solutions that were suggested by the design team participants. I then compared the design team's suggestions to my journal notes regarding how to apply the sensory design principles and on what basis the changes would need to be applied i.e. to encourage human interaction, sensory experience and so forth. The role of the academic journal will be discussed further under the next heading 4.5.5 "Design team refining process".

Use of interpretative approach to understand design team feedback

The data collected from the focus group discussions, online interviews and research journal assisted me to make detailed explanations and interpretations of the data, which held deep and rich meaning concerning how to improve the conceptual design and develop the guidelines. More importantly, what I notice from all the participants' responses in "Theme one", "Theme two" and "Theme three" is that there was meaning and motivation behind each design decision that was discussed and made. This supports Wisker's (2008:69) view that the interpretative paradigm thrives on meaning that is hidden in the mind. More importantly, the professional backgrounds of each participant had shaped their experience, which I interpreted from the outlook of their individual context (Henning, Van Rensburg and Smit 2004: 21)

4.5.5 Design team refining process

The design team provided critique and feedback for each of the spaces within the 'academic hub' as previously discussed, and in order to cope with the refining process regarding the suggested changes, the academic research journal was beneficial and assisted in clarifying the decisions made through notes, sketches or ideas that came to mind when talking to the design team. The journal allowed the thinking, values and experiences behind the decisions to be explicit and visible.

Therefore, reflecting on the textual excerpts and sketches of the journal at each stage of the design process provided a way to acknowledge that the design thoughts that were

documented were experiences, feelings and opinions from the mind that influenced how and why the design decisions made were appropriate and approved by the design team:

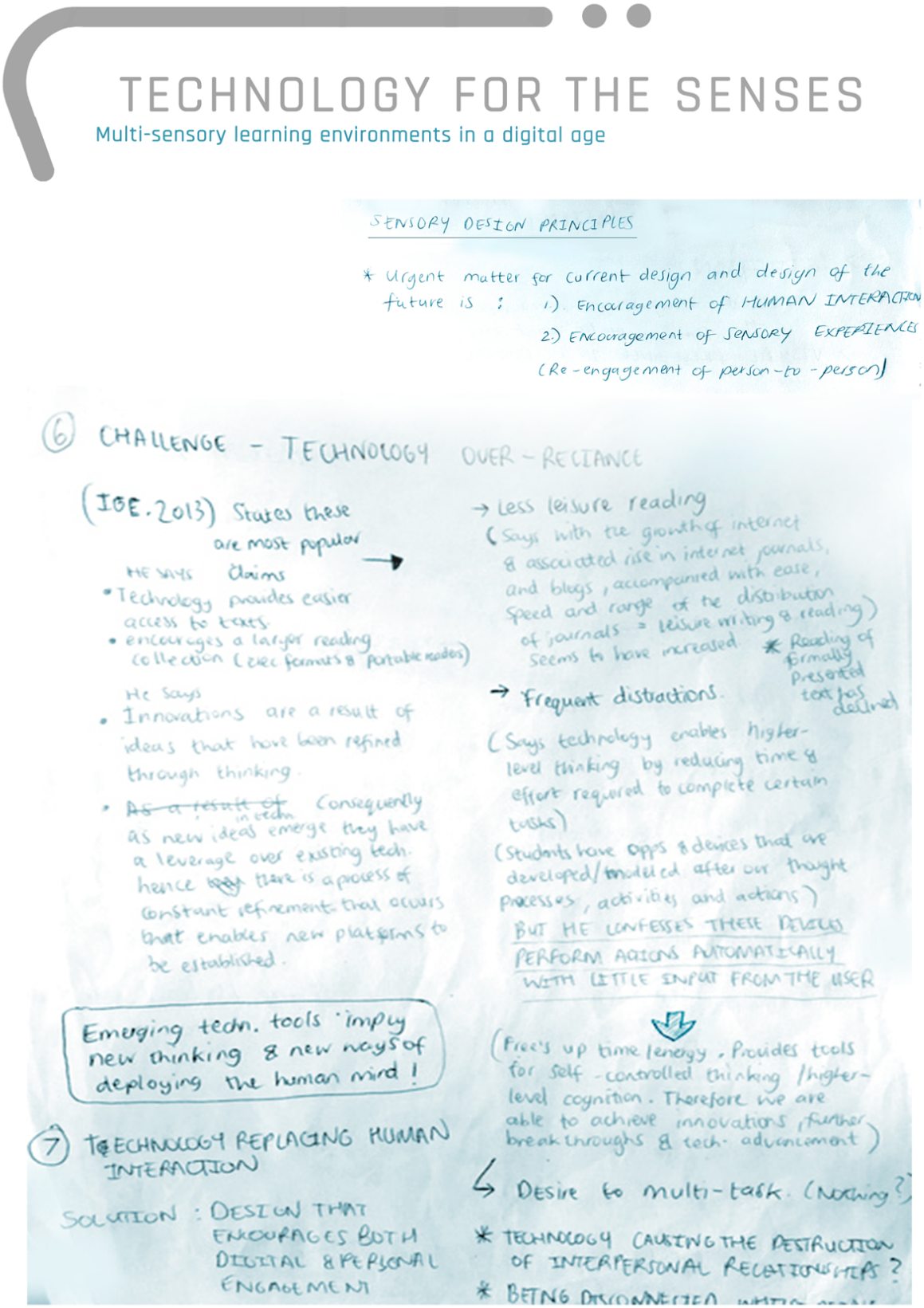

Figure 4.5.5.1 Textual excerpts from the academic research journal

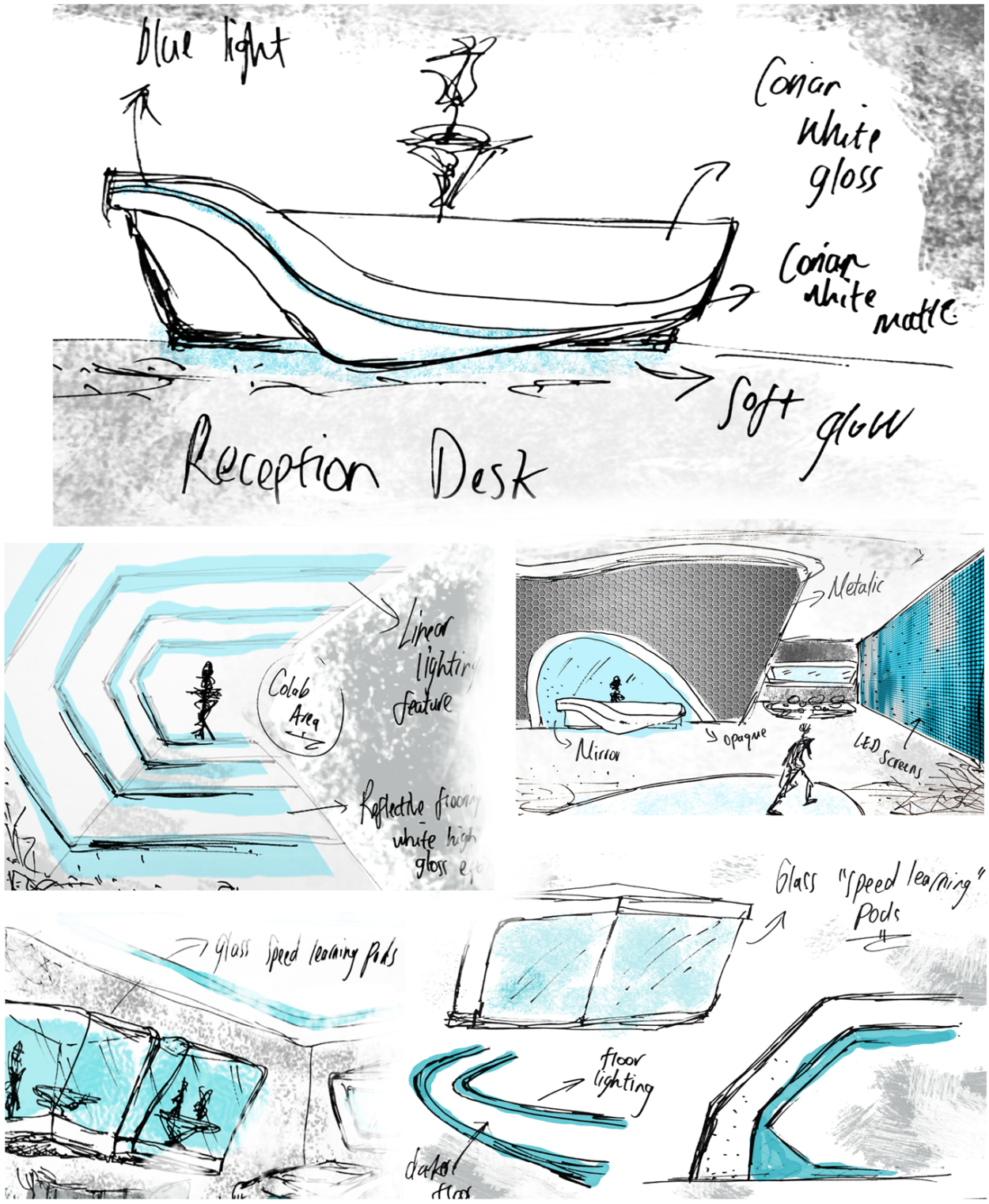

Figure 4.5.5.2 Visual sketch excerpts from the academic research journal

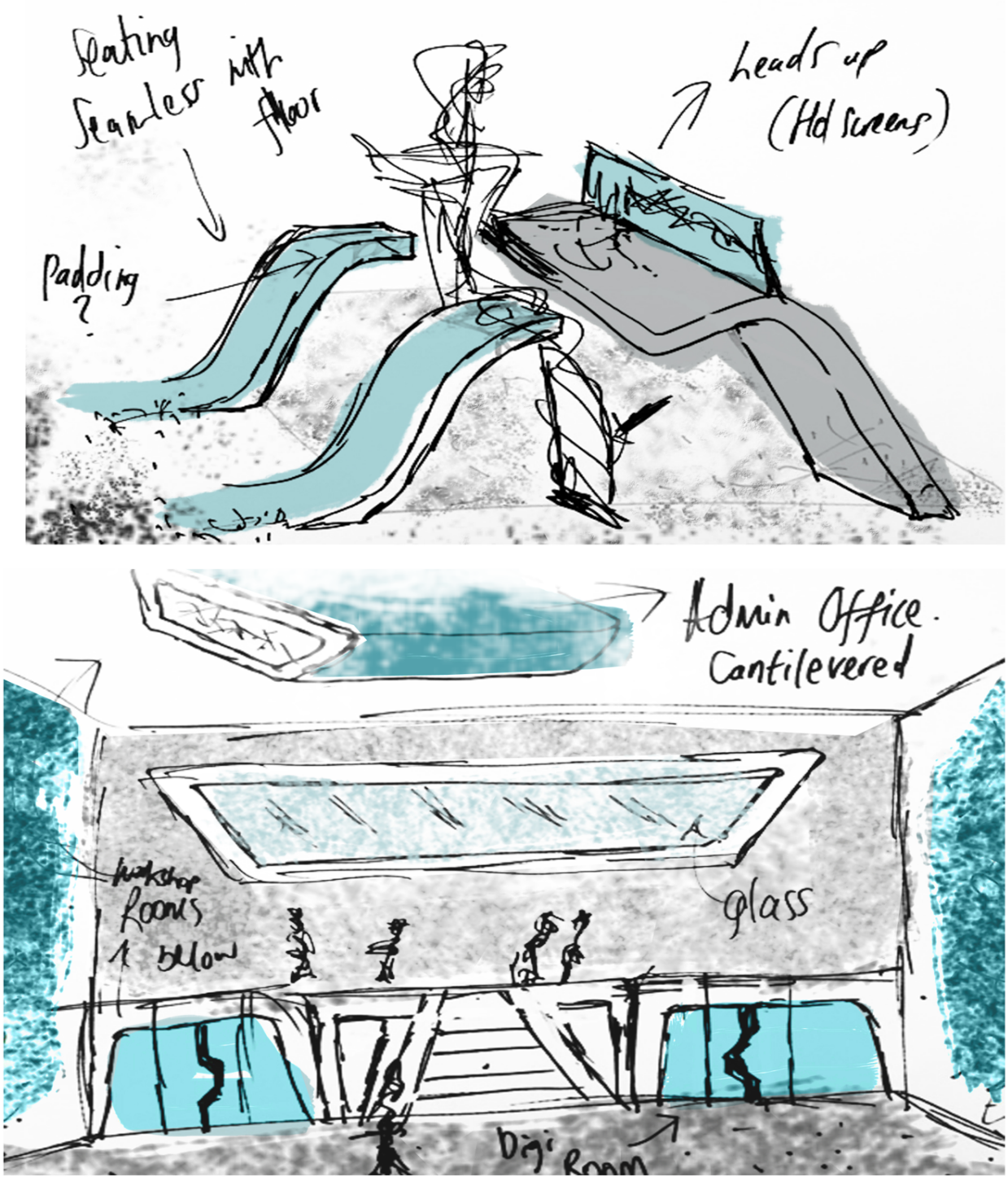

Figure 4.5.5.3 Visual sketch excerpts from the academic research journal

4.5.6 The evaluation of the collaboration

The above findings from the focus group discussions, online interviews and academic research journal provided opportunities to consider the flaws and success of the established interior design solutions and guidelines implemented in the practical concept design. Light was shed on the importance of a collaborative approach as a tool to assist designers. In the last focus group discussion, the design team shared their final remarks on the practical concept design and reflected on how or if they felt the design had improved.

In Table 4.5.6.1 on the next page, focus group participant two says, “It’s changed quite a bit now…it’s sensory and that’s important”. Moreover, focus group participant four was satisfied with the “Tech lab” change to the “Auditorium”: “The auditorium looks much better with natural light and plants”. As a result, the design team seemed content with the changes that were made as a result of the collaboration. Thereafter, we evaluated the overall success of the collaboration in a bid to reveal whether or not the approach was effective and brought value to the research study or not.

Interestingly focus group participant two, as seen in Table 4.5.6.1 on the next page, said, “Yeah it’s improved because the design decisions made were more informed”. This statement correlates with the literature review, which explains that good design management requires the overseeing of all design activity to ensure a consistent and co-ordinated approach, which encourages informed decisions on a strategic and operational level (Emmitt 2014: 22).

The comments made by the collaborative design team in Table 4.5.6.1 on the next page also confirms that the design team believed that there was an improvement from the first attempt, and when asked, all agreed it had improved. Their critique and analysis of the design assisted in understanding the solutions and how they should be implemented. More importantly, the responses from their evaluation of the collaboration suggest that the process was considered to be a success. The relevance and effectiveness of the collaboration were highlighted and revealed that a collaborative approach can enable interior designers to articulate the best ways to overcome challenges concerning TEL environments. Therefore, the shared voices and opinions of a design team can assist interior designers to make better-informed decisions.

THEME	SUB - THEME	CODES	QUOTATION	SOURCE OF QUOTATION
Theme three Effectiveness of a Collaborative approach	Indications of a successful collaboration	Design team describes a successful collaboration	"Happy clients or end-users" and "Multi-disciplinary" "Open-minds" and " Common goals" "Shared needs" "Listen"	F.G.2.1 F.G.2.3 F.G.2.2 F.G.2.5
	Barriers that hinder collaborations	Design team describes an unsuccessful collaboration	"Ego's" "Time-consuming"	F.G.2.2 F.G.2.2
	Evaluation and reflection of the collaborative approach	Comments on design changes	"It's changed quite a bit now…I love it…It's sensory and that's important" "The Gaming room looks comfy, I want one" "It's a problem to work with a laptop in the Gaming room. I noticed the colour scheme slightly changed" "The auditorium looks much better with natural lights and plants" "There is more thought on the sensory experience and it feels much warmer."	F.G.2.5 F.G.2.4 F.G.2.3 F.G.2.4 F.G.2.5
		Comments on effectiveness of the collaboration	"Yeah, it's improved because the design decisions made were more informed." "I think that this discussion brought further clarity on the one-on-one meetings."	F.G.2.2 F.G.2.3
	Impact of collaboration on design participants	Design team comments on if they learned anything new	" I have definitely heard things through these focus group discussions that I didn't know about or haven't considered before" "We learned things unintentionally, in a good way" "We learned things inadvertently."	F.G.2.3 F.G.2.4
* Key to abbreviations: O.I - *Online Interview*; P.O.I - *Pilot Online Interview*; F.G.1 - *Focus Group 1*; F.G.2 - *Focus Group 2;* F.G. R - Focus Group Reflection				

Table 4.5.6.1 Focus group participants evaluate the effectiveness of the collaboration

Moreover, the solutions suggested by the design team in Figure 4.5.6.2 below indicated that the strategies planned with the design team were ready to be implemented in the practical design concept.

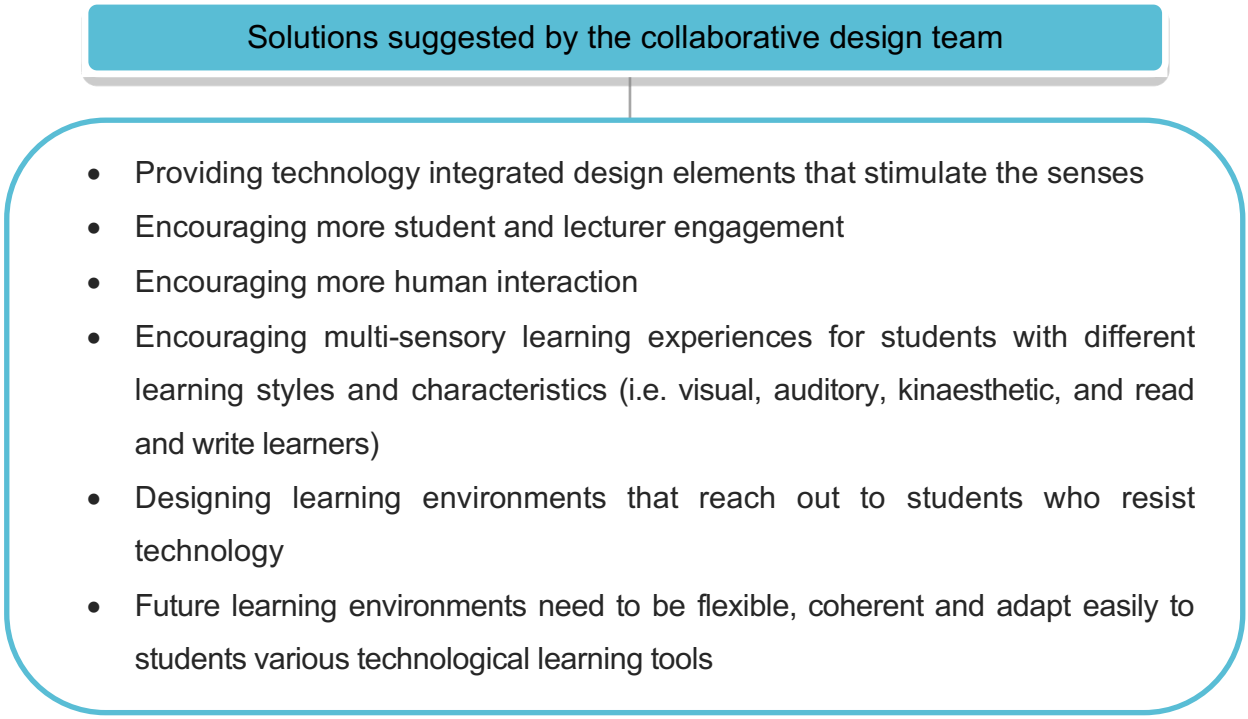

Figure 4.5.6.2 Solutions suggested by the collaborative design team.

4.6 DISCUSSION OF THE FINDINGS

It was enlightening to discover the challenges that interior designers face when using technologies to enhance user experience. Furthermore, engagement with the participants led to the establishment of design solutions that could be used to assist interior designers. The valuable insight from the collected data also revealed how and why a collaborative approach can be used to assist interior designers to overcome the challenges they encounter when designing TEL environments.

The findings revealed ten challenges that interior designers face when designing TEL environments. Interior designers' perceptions of these challenges highlighted that some of these challenges were specific to South Africa, and others global issues. The participants provided detailed accounts of their feelings about the challenges and how it affects the way they work including the end result of the design. In addition, the findings from the focus group discussions and practical concept design showed that collaborating with various skilled professionals when designing TEL environments is effective as it offers broadened knowledge skills, which results in better informed design decisions. From the specialists' feedback, guidelines were developed and refined. For clarity and ease of understanding the guidelines that were established were then sectioned into four parts that were deemed the most pertinent to the study:

- Accommodating technology
- Accommodating the senses
- Collaboration
- Learning styles

4.7 TEL ENVIRONMENT GUIDELINES FOR INTERIOR DESIGNERS

The findings discussed in chapter four provide interior designers with insight into how sensory design principles and technology should be considered within universities of the digital age. The guidelines that were established from the findings encourage interior designers to embrace collaboration in order to improve the educational environments and learning experiences that students are provided with in the digital age.

The goal of the established guidelines is to build a framework that interior designers and specialists involved in the design or construction of TEL environments can actively use to ensure that the user-experience is enhanced and the overall interior design elements are both seamlessly integrated with technology and fully attuned with the human body. These design guidelines are intended to be used by interior designers, architects, product suppliers and manufacturers, educators, administrators and policy makers and those involved in the design and construction of new or existing universities environments that are technology-enhanced.

Figures 4.4.8, 4.4.9 and 4.5.6.2 as listed at the end of “Theme two” and “Theme three”, were refined and joined to form the guidelines. It is important to note at this point that, due to the complexity of the study, I chose to examine “technology”, “sensory design” and design management” in three separate sections in their entirety. Therefore, it was imperative to bring together all three figures in a bid to ensure that a unified set of guidelines is developed to assist interior designers to create “connected” TEL environments as presented in Figure 4.7.1 below and Figure 4.7.2 on the next page:

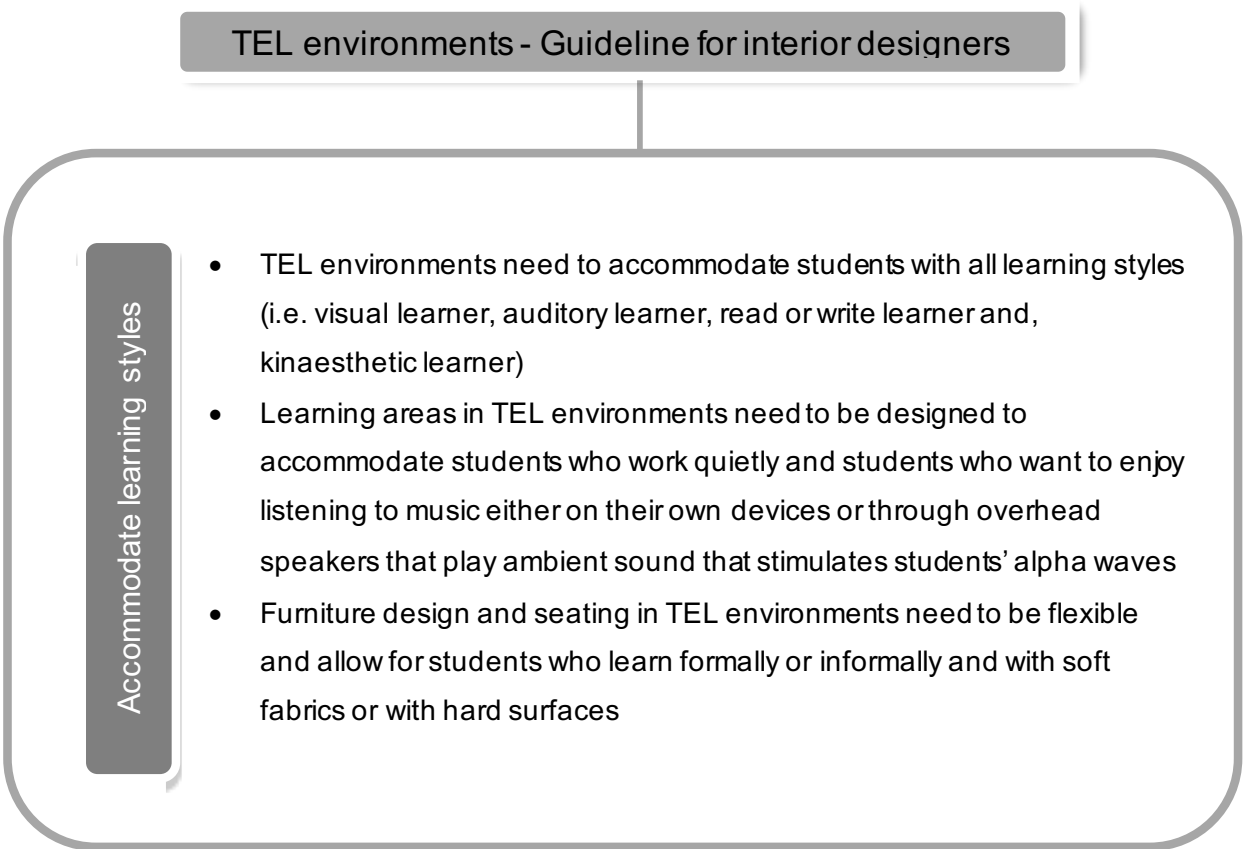

Figure 4.7.1 TEL environments – Interior design guidelines

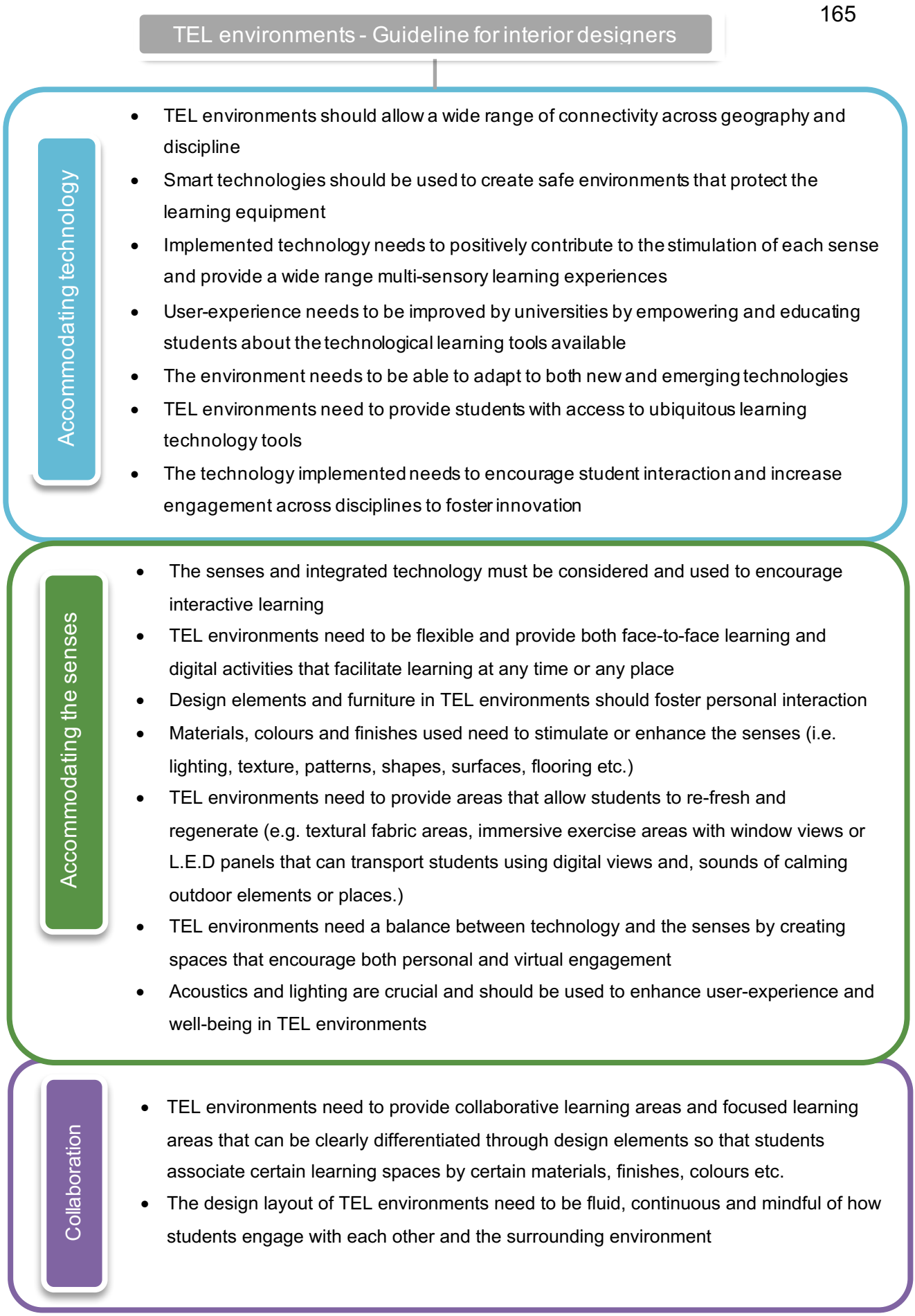

Figure 4.7.2 TEL environments – Interior design guidelines

From the design guidelines depicted in Figure 4.7.1 and Figure 4.7.2 on the two previous pages, the underlying value is that interior designers need to strive to keep students' technology and sensory needs at the heart of students' learning experience. Universities of the digital age require environments that are sensitive and technologically at the forefront of the educational landscape. The guidelines can be used to assist and administrate the bringing to life of a vision of learning environments that are engaging, collaborative, accommodating to all students with various learning styles, and integrate existing and emerging technologies that are attuned with the human senses. Even though interior designers play an integral part in formulating and executing the design, these guideline discussed can be used by all professionals who influence the design of learning spaces.

It is also important to acknowledge that sensory design builds on the philosophy that embraces all the senses and modes of understanding which assist in perceiving the environment and how the body reacts to it (Malnar and Vodvarka 2004: ix). On the other hand, the idea behind connectivism, as a learning theory of the digital age, is that the student is placed at the centre of the learning experience and technology is a tool to connect them to one another. Therefore, the guidelines established consider how emerging technologies can support learning through the senses. On that account, collaboration can be used in the digital age for both learners and professionals, as the findings suggest that it is an effective approach or tool to positively transform the way academic environments are designed and in turn the way learning takes place.

4.8 CONCLUDING REMARKS

The findings from the study suggest that interior designers should feel encouraged to participate in more collaborative practices amongst various disciplines, as all professions within the built environment have an important role to play in leading the way toward developing technologically and sensorially connected universities of the digital age.

The online interviews, focus group discussions and academic research journal encouraged reflective thinking and positively influenced my design concept and understanding throughout the action research process. In particular, the academic research journal provided a way to engage in critical self-reflection and prompted many informed decisions that were made throughout the study concerning the research design and practical concept. In some instances, the reflection resulted in the adaption or change of certain design approaches that were not initially planned to be used. For that reason, it is through the academic research journal and data collected from the focus group and online interviews that the challenges were firstly identified, and secondly, that design solutions and guidelines were established and refined. Above all, the design team demonstrated that interior designers might overcome challenges using a collaborative approach.

CHAPTER 5

CONCLUSION

In the previous chapter I presented the primary data collected for the study. I collected the primary data from online interviews, focus group discussions and an academic research journal that led to significant findings that were imperative to the study. The data provided information that was meaningful and assisted in the establishment of sensory design principles and guidelines for technology-enhanced learning (TEL) environments. Furthermore, as part of the action research process, the design team evaluated the collaborative approach that was adopted. I then compared the findings of the literature review against the results obtained from the sample population in order to draw final conclusions.

In chapter five I present the key findings in order to answer the research questions presented in Chapter one. Thereafter, I outline the recommendations for future research and share other areas of interest around the topic that future studies may further develop and explore. The effectiveness of a collaborative approach and the established sensory design principles and guidelines are then discussed.

5.1 STUDY OUTCOME

The three research questions below were used to guide the study. I collected both primary and secondary resources to establish how interior designers can use a collaborative approach to create university learning environments that are technologically and sensorially connected in a digital age:

1.) What challenges are interior designers facing when using technologies to enhance user experience in learning environments?

2.) What sensory design principles should an interior designer consider for technology-enhanced learning environments in universities?

3.) How can a collaborative design team assist interior designers to overcome technology and sensory design challenges in learning environments?

With regards to question one, I used the literature review and online interviews to explore how interior designers cope with designing technology-enhanced environments in the digital age. The findings identified challenges interior designers encounter both locally and internationally when they are designing TEL environments that improved user experience through technologies or sensory stimulation. Engaging with participants who have designed high tech spaces provided findings that revealed a deep understanding of the concerns interior designers have.

With regard to question two, through the focus group discussions and literature review, the challenges were evaluated and possible solutions to the challenges were explored. To gain a better understanding of how to design TEL environments that are attuned with the human body, the relationship between emerging technologies and multi-sensory learning experiences was explored. In the process of doing so, sensory design principles and guidelines for TEL environments were established.

Lastly, with regards to question three, I decided to use a collaborative approach as a tool to explore solutions to overcome the challenges interior designers encounter when creating technology-enhanced environments. The outcome of the collaboration was a practical concept design of an academic hub located in KwaZulu-Natal (KZN). The design team evaluated if and why the collaboration was considered effective in assisting interior designers. Ultimately the design team deemed the collaboration a success, as there was a substantial improvement made to the design. Evidence showed that the collaboration encouraged a dissemination of professional knowledge that allowed more informed decisions to be made. Moreover, creative solutions emerged that can alleviate the problems that interior designers face when accommodating students' technology and sensory needs.

Figure 5.1.2 to follow provides an overview of the study findings that were discussed in Chapter four. The three themes presented in Figure 5.1.2 on the next page and in the findings, were specifically set out to answer the research questions and will be discussed individually.

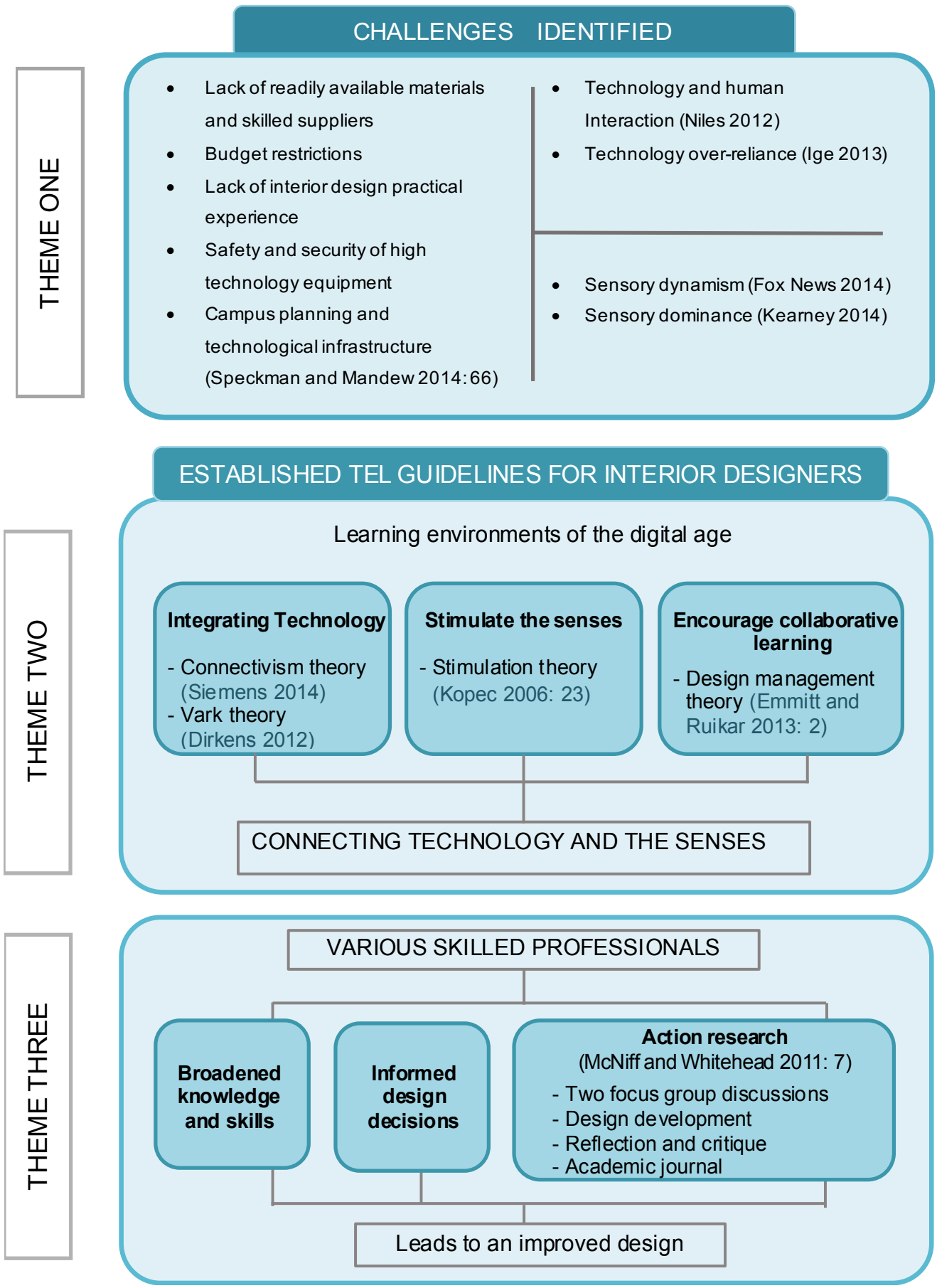

Figure 5.1.2 Overview of the studies key findings

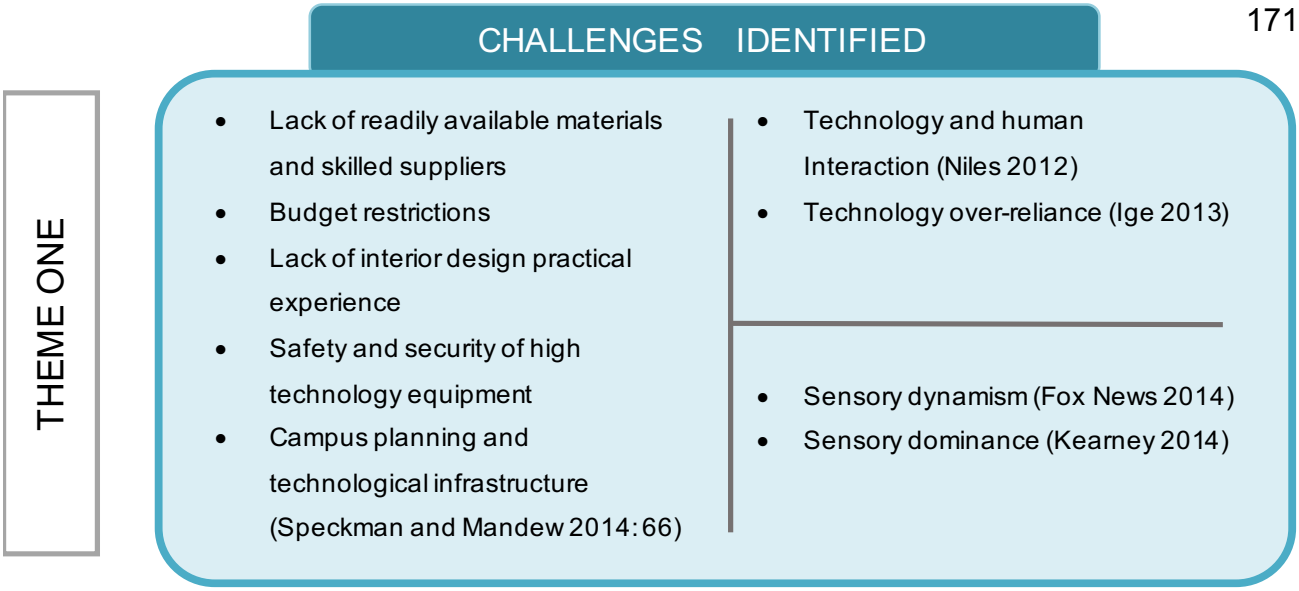

Figure 5.1.3 "Theme one" key findings

The findings revealed that designing technology-enhanced environments is a complex task. Although the digital age provides endless opportunities to enhance end-user experience through advanced technologies, it also entails many challenges that interior designers need to overcome from design concept to completion. While every designer may face problems that are unique to each project, the list presented in Figure 5.1.3 above highlights the major challenges that interior designers face when designing technology-enhanced environments to enhance end-user experience.

The first group of challenges presents issues encountered between the designer and the suppliers, the designer and the client, or as a result of the existing conditions of the universities built environment. Most of the design challenges in this group were specifically applicable to South African interior designers. The study showed that the profession of interior design in South Africa is dealing with some issues that hinder designers from working efficiently and cost effectively. Projects that are 'futuristic' or 'high tech' are less likely to appeal to designers and clients because there are few skilled installers and workers who have a deep knowledge of materials needed to design TEL environments. Moreover, these spaces are costly to design because the majority of the manufacturers of the materials and products needed to design TEL environments are based overseas. This means interior designers cannot easily source local materials and, due to import costs and clients' budget restrictions, designers spend time for which they are not remunerated, for sourcing products and materials internationally. Consequently, South African designers and clients may shy away from these projects or simply feel that they have little access to what they need in order to execute the design effectively.

The findings also indicate that these challenges cause a snowball effect, as designers in South Africa will have less exposure to such projects, which equates to less practical experience or fewer design experts specializing in ‘high tech’ spaces. Due to high crime rates in the country, many participants shared their concern about the safety and security of technology equipment. In addition, another challenge was campus planning of new and existing campus technological infrastructure. With the rapid advancement of technology it is difficult for universities in South Africa and across the world to keep up with this advancement. The findings showed that it is expensive to install advanced infrastructure and just as expensive for universities to remain current in order to keep up with student demands and trends (Clayton-Pedersen and O’Neil 2005).

The second group of challenges that emerged from the findings was related to technology. The results yielded from the study indicated that technology, if not implemented carefully, can cause isolation or lack of personal interaction (Nilles 2012). The findings and literature review were consistent with the findings that indicated many students of the digital age are reliant on technology (Laroya 2011). The two extreme findings show that perhaps it is difficult for students of the digital age to strike a technologically balanced academic life.

The last group of challenges dealt with students’ sensory experiences. Sensory dynamism was identified as a challenge and was reported in the literature review to be caused by staring at digital screens (Brandon 2013). The findings noted that people suffer from eyestrain and headaches when their eyes are focused on ‘flat planes’. This negatively impacts learning as the eyes need to relax by looking out the window where there is perspective, sensory stimulus, depth and a vast array of planes. Lastly, sensory domination is still a challenge for interior designers to overcome (Kearney 2014). The data was consistent with the literature review, which confirmed a strong bias towards the sense of sight. The digital age is driven by a visually-heightened technological society, which results in the other senses being neglected.

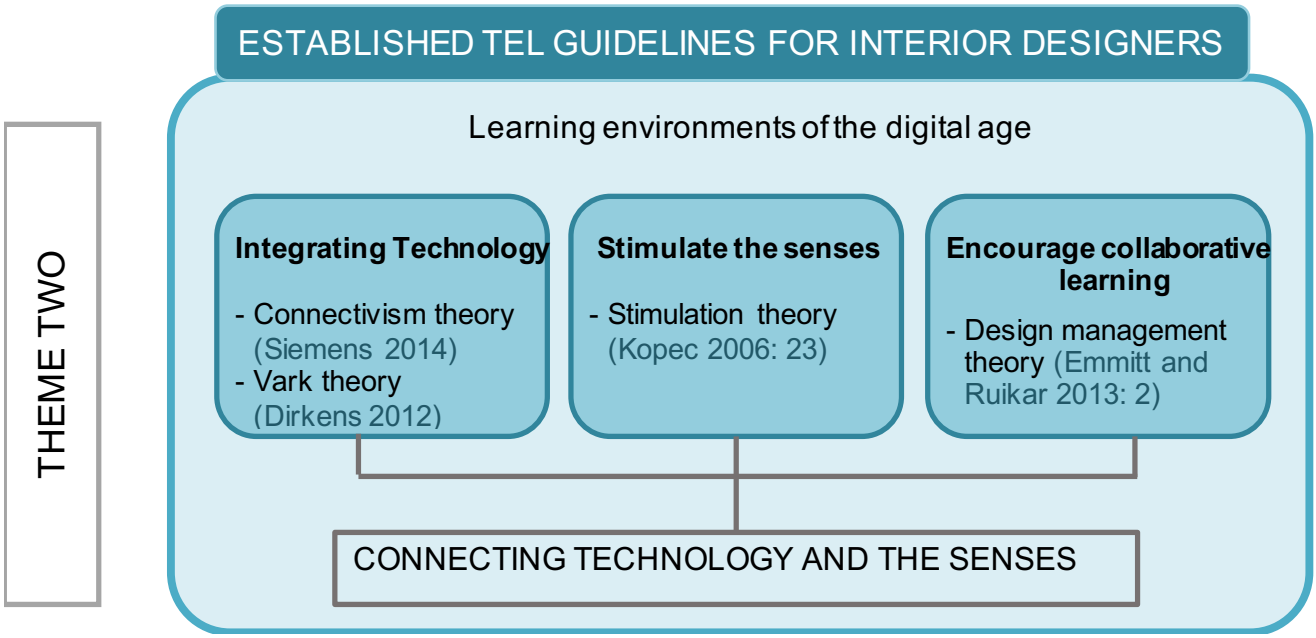

Figure 5.1.4 "Theme two" key findings

As technology within the digital age continues to advance at a rapid pace, it is inevitable that interior designers are going to face many challenges in the years to come. Therefore, it is important to document the challenges and more importantly, to strive towards finding the solutions. Once refined, these solutions form the foundation of a guideline, which can assist interior designers in connecting technology and the senses in order to meet the needs of students.

With regard to technology integration, the guidelines establish how learning environments need to be reconceptualised in order to adapt to the way students of the digital age are learning (Coccoli *et al.* 2014: 1004). Universities are facing pressure to meet students' demands; as a result, the guidelines provide insight into what infrastructure or design elements should be implemented, and how designers need to be considerate of students' different learning styles (Dirksen 2012). More importantly, the strategies in the guidelines support the data that suggest TEL environments need to be interactive, flexible, adapt to new technologies and encourage knowledge exchange through collaboration. These strategies correlate with the connectivism learning theory (Sitt 2013; Siemens 2014).

With regard to the senses, the findings showed that the environment omits sensory information that has an impact on learners' perception and is closely associated with their memory and how they process information (Kopec 2012: 23). Therefore, the

guidelines established suggest which multi-sensory learning experiences need to be accommodated, and how they should be accommodated. Furthermore, the solutions suggested by the participants were useful and gave insight into the way design elements should be built and implemented so that students can have a better technology and sensory experience of their learning environments

Above all, the guidelines were refined and established to assist interior designers in exploring how to design better technology-enhanced environments in the digital age, and to expand their design skills to ensure that students' technology and sensory design needs are prioritized throughout the design process.

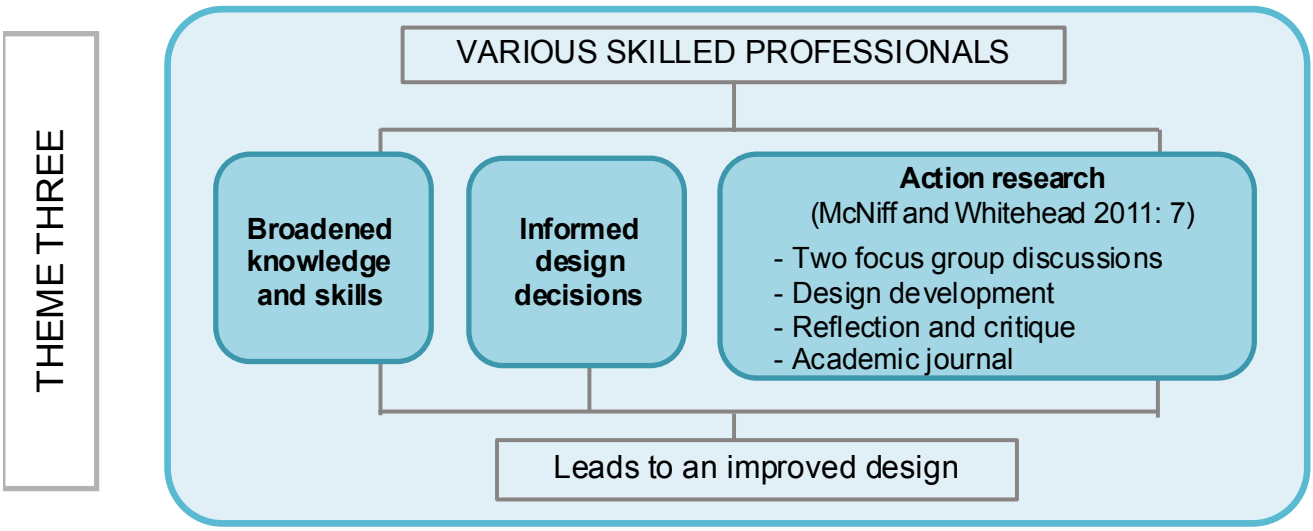

Figure 5.1.5 "Theme three" key findings

The collaborative design team worked well together to brainstorm and implement the most appropriate design solutions and strategies. As a result, the practical concept design of the academic hub improved substantially. The collaborative approach offered a unique opportunity for academia and industry specialists from various professional backgrounds to share their skills and expertise on how to effectively solve the challenges interior designers face when providing for students' technology and sensory needs. The findings that emerged from the focus group discussions, critique meetings, and academic journal provided a critical evaluation of how interior designers should deal with the problems they encounter. Design solutions that stemmed from the collaboration were innovative and aimed to add value to students' learning experience. Therefore it can be seen as a powerful tool that can drive TEL environments into a future that is

more attuned with the senses. The design team agreed that the practical concept design improved as the decisions made were more informed. More importantly, all who took part in the collaboration felt that they had learned from the action research process. Therefore, interior designers should consider exploring a collaborative approach as it can accelerate the design process and increase their capacity for innovation.

5.2 CONTRIBUTION OF THE STUDY TO THE FIELD

Very little research was found on the topic of technology and sensory design concerning the dynamic and relationship between emerging technologies and multi-sensory learning experiences. Therefore, the study should make a fair contribution to interior design research locally and internationally.

The sensory design principles and interior design guidelines established, as listed at the end of chapter four, should provide the interior design profession with a deeper understanding of how to create technology-enhanced environments that are mindful of students' technology and sensory needs in a digital age. In addition, challenges that interior designers may encounter now or in the near future are identified. However, it is important to note that these guidelines were developed only from the views of the study sample who participated, which was limited, as it was not possible to gain full access to as wide a range of participants as initially planned. Furthermore, as mentioned earlier in the study, using a qualitative approach often means that the findings cannot be extended to a wider population (Atieno 2009: 17).

Nevertheless, the study indicates that a collaborative effort can lead to innovative solutions and assist interior designers in overcoming challenges they may face by making more informed decisions through developing and co-ordinating effective design strategies that strive to enhance end-users' experience of the environment.

5.3 SUGGESTIONS FOR FUTURE RESEARCH

The nature of the study may assist interior designers, tertiary institutions, design professionals, architects, product suppliers and manufacturers, educators,

administrators and policy makers, in the formulation of decisions concerning effective university facility design and construction.

With regard to future research, the guidelines for designing TEL environments may be refined, as advancements in the digital age are rapid, and so the improvement of learning environment design will require researchers to continuously apply themselves in order to stay relevant and up to date. In addition, as new technologies emerge, interior designers may also explore new and innovative ways to improve sensory learning experiences. Other future research that could arise from the study may include the perceptions of students and/or lecturers of technology-enhanced learning environments, to gain a better understanding of the issues at stake.

Overall, the findings indicated that there is certainly a need to connect technology and the senses in order to create university learning environments that are considerate of how students are affected by emerging technologies and the impact they have on the human body. Interior designers' experiences and professional views on the many challenges they encounter were explored and the collected data has provided a deeper understanding of the problems or issues that are encountered both locally and internationally.

By applying the sensory design principles and suggested guidelines to a practical concept design, it became apparent that a collaborative approach has many advantages as well as disadvantages. However, the positive attributes outweighed the negative, and after critical evaluation the design team agreed that the collaboration was effective, and contributed substantially to the improvement of the design. The design decisions that were made were more informed due to the professional advice received from a wide range of specialists from different professional backgrounds. Interior designers, architects and the governing bodies of universities may use the established sensory design principles and guidelines for the design of technology-enhanced university environments. Above all, the information from the study may be used to assist interior designers who are striving to improve students' learning experiences in the digital age by considering students' technology and sensory needs.

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APPENDICES

APPENDIX A: IREC Provisional Approval

Institutional Research Ethics Committee
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20 October 2015

IREC Reference Number: **REC 123/15**

Ms M K Parker
309 Suttonmere
2 Sutton Crescent
Morningside
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4001

Dear Ms Parker

Connecting technology and sensory design: A collaborative approach to designing university learning environments in a digital age

I am pleased to inform you that Provisional Approval has been granted to your proposal REC 123/15 subject to:

- Obtaining and submitting the necessary gatekeeper permission/s to the IREC.

Full approval is subject to meeting the above condition.

The Proposal has been allocated the following Ethical Clearance number **IREC 122/15**. Please use this number in all communication with this office.

Approval has been granted for a period of two years, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2015 -10- 20
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

APPENDIX B: IREC Full Approval

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

1 June 2017

IREC Reference Number: **REC 123/15**

Ms M K Parker
309 Suttonmere
2 Sutton Crescent
Morningside
Durban
4001

Dear Ms Parker

Connecting technology and sensory design: A collaborative approach to designing university learning environments in a digital age

The Institutional Research Ethics Committee acknowledges receipt of the **late submission** of your gatekeeper permission letter. Provisional approval was granted to you on 20 October 2015. Please be advised that you were required to submit the necessary gatekeeper permission to the IREC before commencing with data collection, failure to do so could result in penalty.

Please note that FULL APPROVAL is granted to your research proposal.

Yours Sincerely,

Professor J K Adam
Chairperson: IREC

APPENDIX C: Online Interview information letter and consent form

INFORMATION LETTER AND CONSENT TO PARTICIPATE IN AN ONLINE INTERVIEW

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: _____

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

Brief introduction and purpose of the study:

I am a Master of Applied Arts Interior Design student at the Durban University of Technology (DUT). I write requesting your participation in my study in the form of an online interview which is looking at how a collaborative approach can be used to design university learning environments in a digital age that accommodate both technology and the human senses.

Outline of procedures:

Participants will be expected to fill out an online interview that involves a number of predetermined open-ended and close-ended questions prepared by the researcher. Participants will be free to discuss their understandings of concepts, opinions, views and experiences surrounding the interior design of technology-enhanced learning environments:

The interview aims to determine:

- The challenges that South African interior designers are facing when designing for the human senses and technology.
- Opportunities for collaboration with other professionals to address technology and sensory challenges.

As a valued research participant you will have the right to:

- Privacy, indicating that you are free to refuse participation in the research or withdraw from the study at any point in time.
- Refrain from answering any part of the interview questionnaire that you do not wish to answer.
- Decide whether your name is included or excluded from the research study in terms of confidentiality and anonymity.

Confidentiality:

If you choose not to reveal your name or identity, a reference code or pseudonym will be assigned to you so that information collected from the interview will be stored against this code instead of your name.

- All data collected from the interview will be interpreted and transcribed by the researcher.
- All data in a non-electronic format will be kept in locked storage.
- All data in electronic format will be stored in password-protected files.
- Only the researcher, co-supervisor and supervisor will have access to all materials and confidential data obtained.

Anonymity:

Anonymity will be handled in one of three manners, dependent on the participant's preference and selection. There are three degrees of anonymity namely fully anonymous, partially anonymous and not anonymous. The participant will also have be able to choose if they would like their company or project names to remain anonymous as well.

- The researcher will use direct quotations that will be pertinent to the study. However, if you wish to remain fully anonymous the researcher will ensure that direct quotations will be used without identifying information.

Kindly make your preferred selection in the tick box below:

Please tick which box appeals to you most with regards to your name and identity:		
Fully Anonymous	Partially Anonymised	Not Anonymous
☐	☐	☐

Please tick which box appeals to you most:	YES	NO
Keep company name anonymous	☐	☐
Keep project name anonymous	☐	☐

Regarding how the data is recorded and stored:

- The researcher will keep all project records for five years after the study is completed and thereafter will be disposed of in a safe and non-recoverable manner.
- Only the researcher, supervisor and co-supervisor will have access to all records.

Statement of agreement to participate in the research study:

Kindly fill in your details below if you agree to participate in the online interview and return to the researcher via e-mail:

- *I hereby confirm that I have been informed by the researcher, Megan Parker, about the nature, conduct, benefits and risks of this study*
- *I have received, read and understood the above written letter of information regarding the study.*
- *I am aware that the results of the study will be processed into a study report.*
- *In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.*
- *I may, at any stage, without prejudice, withdraw my consent and participation in the study.*
- *I have had sufficient opportunity to ask questions and of my own free will and declare myself prepared to participate in the study.*
- *I understand that significant new findings developed during the course of this research that may relate to my participation will be made available to me.*

Full name of participant: _____

Company/ firm name: _____

E-mail address and telephone number: _____

Signature: _____Date: _____Place: _____

I, Megan Parker, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full name of researcher: _____

Signature: _____Date: _____Place: _____

Cell phone no.: (076) 091 6129 Home: (031) 312 3745 E-mail : megan.parker95@yahoo.com

Kind regards,

Megan Parker

APPENDIX D: Online Interview

TECHNOLOGY-ENHANCED INTERIORS

Exploring how technology can be used as a tool to provide digital interior environments that are innovative and create engaging human experiences

Figure 1

Online Interview

Full name: _____

Qualification: _____

Years experience: _____

Last completed hi-tech project: _____

Year: _____

Company Name: _____ Position held: _____

Definitions:

Technology-enhanced learning environment:
Technology-enhanced Learning (TEL) is a widely used term in recent literature that describes the application of information and communication technologies to teaching and learning. TEL is also closely associated with equipment, infrastructure and is considered synonomous with the older term "e-learning" (Kirkwood and Price, 2014: 2)

Sensory Design:
Sensory design is exploring the nature of our responses to spatial constructs within the built environment, gardens, and outdoor spaces (Bobby, 2005:88).

Digital innovation: is how digital tools and digital infrastructure are applied to the challenge of offering end-users enhanced or unique value (Szimanski, 2014)

Images used in the interview were chosen to represent various technology-enhanced interiors or tools relevant to the study

Question 1: We live in a digital era. Do you think that technology has an impact on how interior designers carry out their work? Why?

_____

_____

_____

Question 2: What led you to designing "high-tech" interior environments?

Question 3: What challenges are facing the Interior Design profession in South Africa with regards to designing technology-enhanced environments?

Question 4: Kindly describe challenges you have faced in your experience with designing technology-enhanced interior environments:


Figure 5

Technology-enhanced environments

We are living in a digital era Do you think that technology has an impact on how interior designers carry out their work? Why?

Question 5: Kindly explain how you've overcome challenges that you've face when designing technology-enhanced interiors:

Question 6: Do you believe that digital innovation can be used to positively influence the way that learning environments are designed? If so, explain how?

Question 7: In your opinion are technology-enhanced environments currently considering the five human senses? Tick for yes, and omit for no.

☐	☐	☐	☐	☐
TOUCH	HEAR	TASTE	SMELL	SIGHT

Looking forward, do you think that there is scope for development in the senses that technology does not currently considered?

Question 8: In the technology-enhanced environments that you have designed, was a sensory experience for the users considered, if at all? How and why?

Question 9: What guiding principles would you suggest for designing a technology-enhanced interior for the first time?

Figure 6

What challenges are facing the Interior Design profession in South Africa?

Figure 7

Technological learning tools are developing rapidly!

Are technology-enhanced environments currently considering the five human senses?

Question 10: When designing technology-enhanced interiors did you consult with specialists from other fields? If so, kindly share which fields:

Question 11: Do you think that collaborations with specialists from other fields can add value to the process of technology-enhanced interior design? If so, kindly elaborate on why?

THANK YOU FOR YOUR TIME AND CONSIDERATION ☺

REFERENCES:

Bobby, O. (2005).Sensory Design (Review of the book *Sensory Design*). The Architectural Review (online). Available: http://dutlib.dut.ac.za:2057/docview/201135614?accountid=10612 (Accessed: 16 February 2015)

Kirkwood, A. and Price, L. 2014. Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? A critical literature review. *Learning, Media and Technology*, 39 (1): 6 -36.

Szimanski, J. 2014. Graduates of tomorrow will push digital innovation even further. *The Beacon Heral* Available: https://docs.google.com/viewer?url=http%3A%2F%2Fwww.ppforum.ca%2Fsites%2Fdefault%2Ffiles%2FGraduates%2520of%2520tomorrow%2520will%2520push%2520ditital%2520innovation%2520evern%2520firther%2520-The%2520Beacon%2520Herald.pdf (Accessed 11 May 2015).

Figure 1. *Direct manipulation interface*. 2010. Blast Analytics and Marketing. Available: http://www.blastam.com/blog/wp-content/uploads/minority-report.jpg (Accessed 21 May 2015).

Figure 2. *14 Amazing Interior Designs In High-Technology Style*. 2014. Pouted Online Magazine. Available: http://www.pouted.com/14-amazing-interior-designs-high-technology-style/ (Accessed 20 February 2015).

Figure 3. Andrien, A. 2012. *Future Technology*: Sinarmas World Academy. Available: http://blogs.swa-jkt.com/swa/11216/tag/future-technology/ (Accessed 12 May 2015).

Figure 4. Gilbert, J. 2012. *ExoPC and panama team up to bring 'tablet desks' to students* Hufington Post. Available: http://www.huffingtonpost.com/2012/04/23/exopc-panama-exodesk-tablet-desk_n_1435365.html?ref=technology (Accessed 22 February 2015).

Figure 5. Carpenter, C. 2013. *'Nothing human remains': Tom Cruise blasts off in the trailer for post-apocalyptic film Oblivion*: Daily Mail Online. Available: http://www.dailymail.co.uk/tvshowbiz/article-2246095/Tom-Cruise-blasts-trailer-post-apocalyptic-film-Oblivion.html (Accessed 01 June 2015).

Figure 6. Darrel, R. 2014. *Adam Benton's iDesk touchscreen desk office solution*: Bit Rebels. Available: http://www.bitrebels.com/technology/touchscreen-desk-office-solution/ (Accessed 02 March 2015).

Figure 7. *Virtual Keyboard From Brookstone*. 2014. The Gadget Flow. Available: http://thegadgetflow.com/portfolio/virtual-keyboard/ (Accessed 16 March 2015).

THANK YOU FOR YOUR TIME AND CONSIDERATION!

APPENDIX E: Questionnaire information letter and consent form

INFORMATION LETTER AND CONSENT FORM FOR QUESTIONNAIRE

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: _____

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

Brief introduction and purpose of the study:

I am a Master of Applied Arts Interior Design student at the Durban University of Technology (DUT). I write requesting your participation in my study in the form of a questionnaire, which will reflect on how a collaborative design approach can assist interior designers in overcoming the challenges they face when designing university learning environments that accommodate emerging technologies and the senses. More importantly, participants will reflect on the affectivity of the focus group discussion in achieving the above.

Outline of procedures:

Participants will be expected to fill out a questionnaire that involves a number of predetermined open-ended and close-ended questions prepared by the researcher. Participants will be free to discuss their understandings of concepts, opinions, views and experiences surrounding the collaborative design approach and focus group discussions.

As a valued research participant you will have the right to:

- Full disclosure about the research.
- Privacy, indicating that you are free to refuse participation in the research or withdraw from the study at any point in time.
- Refrain from answering any part of the questionnaire that you do not wish to answer.
- Decide whether your name is included or excluded from the research study in terms of confidentiality and anonymity.

Confidentiality:

If you choose not to reveal your name or identity, a reference code or pseudonym will be assigned to you so that information collected from the questionnaire will be stored against this code instead of your name.

- All data collected from the questionnaire will be interpreted and transcribed by the researcher.
- All data in a non-electronic format will be kept in locked storage.
- All data in electronic format will be stored in password-protected files.
- Only the researcher, co-supervisor and supervisor will have access to all materials and confidential data obtained.

Anonymity:

Anonymity will be handled in one of three manners, dependent on the participant's preference and selection. There are three degrees of anonymity namely, 'fully anonymous', 'partially anonymous' and 'not anonymous'. The participant will also be able to choose if they would like their company or project names to remain anonymous as well.

- The researcher will use direct quotations that will be pertinent to the study. However, if you wish to remain fully anonymous the researcher will ensure that direct quotations will be used without identifying information.

Kindly make your preferred selection in the tick box below:

Please tick which box appeals to you most with regards to your name and identity:		
Fully Anonymous	Partially Anonymised	Not Anonymous
☐	☐	☐

Please tick which box appeals to you most:	YES	NO
Keep company name anonymous	☐	☐
Keep project name anonymous	☐	☐

Regarding how the data is recorded and stored:

- The researcher will keep all project records for five years after the study is completed and thereafter will be disposed of in a safe and non-recoverable manner.
- Only the researcher, supervisor and co-supervisor will have access to all records.

APPENDIX F: Reflection questionnaire

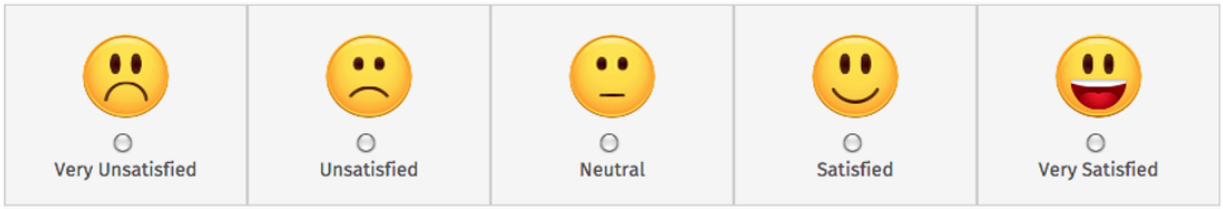
Focus Group Discussion - Reflection questionnaire

Participants details:

Name:	Years experience:
Surname:	Company Name/ Institution:
Qualification:	Position held:

Question 1:

How satisfied are you with the group discussion? (Please tick one box below)



Question 2:

Do you feel that the project brief was explained well?

- ☐ No, I did not understand the project brief
- ☐ Kind of. I understood some of the projecy brief
- ☐ Yes, the project brief was clearly outlined

Other: _____

Question 3:

Did you feel comfortable with the other partcipants in the focus group?

- ☐ No, I did not feel comfortable with the other participants in the focus group
- ☐ I only felt comfortable with some of the partcipants
- ☐ Yes, I felt comfortable with all the ther partcipants

Question 4:

After the group discussion, do you think that your profession can assist interior designers in over coming some of the challenges they are facing (regarding technology and the senses) ? Explain.

[redacted]

Question 5:

Do you feel that the focus group is adressing an issue that you feel can relate to/ is relavnt to your field? Why?.

Question 6:

Do you think that a design collaboration is a good way for specialists in your / other professions to ensure innovation? Why?

Question 7:

What challenges do professionals in your field face when accomodating or considering emerging technologies?

Question 8:

What challenges do professionals in your field face when accomodating or considering the human senses?

[redacted]

Question 9:

Do you think that technology can be used to enhance students senses or learning experience? How?.

Question 10:

In your experience and professional field, have you faced any challenges trying to keep up with technology? If so, do you believe that there are solutions to such challenges?

Question 11:

In your experience and professional field, have you ever faced any challenges trying to enhance /accomodate the human senses? If so, do you believe that there are solutions to such challenges?

Question 12:

In your view, kindly name some of the strengths and weakness of using a team collaboration when working on a (design) project:

APPENDIX G: Focus group information letter

INFORMATION LETTER FOR FOCUS GROUPS

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: _____

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

Brief introduction and purpose of the study:

I am a Master of Applied Arts Interior Design student at the Durban University of Technology. I am conducting a research study as part of the requirements and would like to invite you to participate. The study will look at how interior designers can improve technology-enhanced learning environments in universities by analysing the impact they should have on the senses.

Outline of procedures:

It is very common for interior designers to look to professionals (i.e specialists and consultants) from other disciplines for advice and practical guidance when designing an interior space. For that reason, the study will explore how a collaborative design approach from the fundamental stage of the design process can assist interior designers in providing learning environments that accommodate the users senses and technology needs. A design team will be required in order to meet the criteria of the study and will consist of the following five participants':

- A mechanical engineer
- An information technology specialist
- An educational psychologist
- A product designer
- A DUT student

I will take the responsibility of both the interior designer and the researcher, and I would like to conduct a focus group discussion at DUT City Campus to discuss how interior designers can overcome the challenges they face when accommodating the senses and emerging technologies in learning environments. The duration of the focus group discussion will be approximately one hour long.

The researcher would like to commence the focus groups in September 2015 however the date can

As a valued research participant you will have the right to:

- The right to full disclosure about the research.
- The right to privacy. Indicating that you are free to refuse participation in the research or withdraw from the study at any point in time.
- Refrain from answering any questions in the focus group discussions that you do not wish to answer.
- Decide whether your name is included or excluded from the research study in terms of confidentiality and anonymity.

Confidentiality:

If you choose not to reveal your name or identity, a reference code or pseudonym will be assigned to you so that information collected from the focus group will be stored against this code instead of your name. However, while the researcher will maintain confidentiality, we cannot promise this on behalf of the other participants, although it will be requested.

- All data collected from the focus group will be interpreted and transcribed by the researcher.
- All data in a non-electronic format will be kept in locked storage.
- All data in electronic format will be stored in password-protected files.
- Only the researcher, co-supervisor and supervisor will have access to all materials and confidential data obtained.

Anonymity:

Anonymity will be handled in one of three manners, dependent on the participant's preference and selection. There are three degrees of anonymity namely, 'fully anonymous', 'partially anonymous' and 'not anonymous'. The participant will also be able to choose if they would like their company or project names to remain anonymous as well.

- The researcher will use direct quotations that will be pertinent to the study. However, if you wish to remain fully anonymous the researcher will ensure that direct quotations will be used without identifying information.

Kindly make your preferred selection in the tick box below:

Please tick which box appeals to you most with regards to your name and identity:		
Fully Anonymous ☐	Partially Anonymised ☐	Not Anonymous ☐

Please tick which box appeals to you most:	YES	NO
Keep company name anonymous	☐	☐
Keep project name anonymous	☐	☐

Regarding how the data is recorded and stored:

- The researcher will keep all project records for five years after the study is completed and thereafter will be disposed of in a safe and non-recoverable manner.
- Only the researcher, supervisor and co-supervisor will have access to all records.

The design team will be expected to sit down with the researcher in a semi-structured focus group where the discussion will be facilitated and guided by two neutral moderators. The discussion will be video recorded using a video camera, and handwritten notes will be transcribed and analysed to expand on findings that are pertinent to the study. The researcher will keep the recordings for five years after the study where only the researcher and neutral moderators will have access to it.

The researcher will discuss the conceptual design projects brief, aims, and team management. Participants' will be free to share their opinions, views and experiences surrounding how learning spaces should accommodate technologies and the human senses. All team participants' will also be free to discuss their understandings of effective solutions relevant to their profession and field of expertise.

If you wish to participate in the study or have any questions related to the study, please fill out the attached letter of consent. I look forward to your favourable response!

Yours Sincerely

Megan Parker

Cell Phone no.: (076) 091 6129
Home no.: (031) 3123745
E-mail: megan.parker95@yahoo.com

APPENDIX H: Focus group moderator information letter and consent form

INFORMATION LETTER AND CONSENT FORM FOR FOCUS GROUP MODERATORS

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: _____

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

Brief introduction and purpose of the study:

I am conducting research into how interior designers can improve the design of university learning environments by accommodating technologies and the senses. Furthermore, I will be conducting a focus group, and for that reason would like to invite you to participate.

I have considered you because of your knowledge and experience in conducting focus groups and would like for you to take on the role of the neutral moderator.

Outline of procedures:

It would be important to use a moderator, as I will be a participant researcher. During the focus group discussion I will have the responsibility of both the researcher and interior designer and for this reason found that it would be necessary to have two neutral moderators. Should you consent to participation you will be expected to carry out the following responsibilities:

- To facilitate and lead the discussion.
- To address the topic questions and issues at hand.
- To use a moderator guideline drawn up by the researcher.
- To conduct a screening process and select the participants of the focus group.
  (The screening will consist of several questions that the potential participant will be asked)

The following will outline the screening process:

- Research objectives
- Brief respondent profile
- Where and when the focus group discussion take place
- Introduction
- Topics
- Questions and activities
- Close

The focus group quorum will consist of five design team participants: A mechanical engineer, an information technologist, an educational psychologist, a product designer and a DUT student. The researcher will explore how a collaborative design approach can assist interior designers to overcome technology and sensory design challenges in learning environments. The discussion will be video recorded using a video camera and handwritten notes will be transcribed to capture and highlight important key issues and themes pertinent to the study.

The focus group discussion will take place at DUT City Campus in the month of September. However, the dates will only be specified once the researcher has received all consent forms from both the participants' in the design team and neutral moderators.

As a valued research participant you will have the right to:

- The right to full disclosure about the research.
- The right to privacy. Indicating that you are free to refuse participation in the research or withdraw from the study at any point in time.
- Refrain from asking or prompting any questions in the focus group discussion that you do not wish to.
- Decide whether your name is included or excluded from the research study in terms of confidentiality and anonymity.

Confidentiality:

If you choose not to reveal your name or identity, a reference code or pseudonym will be assigned to you so that information collected from the focus group will be stored against this code instead of your name.

- All data collected from the focus group will be interpreted and transcribed by the researcher.
- All data in a non-electronic format will be kept in locked storage.
- All data in electronic format will be stored in password-protected files.
- Only the researcher, co-supervisor and supervisor will have access to all materials and confidential data obtained.

Anonymity:

Anonymity will be handled in one of three manners, dependent on the participant's preference and selection. There are three degrees of anonymity namely, 'fully anonymous', 'partially anonymous' and 'not anonymous'. The participant will also be able to choose if they would like their company or project names to remain anonymous as well.

- The researcher will use direct quotations that will be pertinent to the study. However, if you wish to remain fully anonymous the researcher will ensure that direct quotations will be used without identifying information.

Kindly make your preferred selection in the tick box below:

Please tick which box appeals to you most with regards to your name and identity:		
Fully Anonymous	Partially Anonymised	Not Anonymous
☐	☐	☐

Please tick which box appeals to you most:	YES	NO
Keep company name anonymous	☐	☐
Keep project name anonymous	☐	☐

Regarding how the data is recorded and stored:

- The researcher will keep all project records for five years after the study is completed and thereafter will be disposed of in a safe and non-recoverable manner.
- Only the researcher, supervisor and co-supervisor will have access to all records.

Statement of agreement to participate in the research study:

Kindly fill in your details below if you agree to participate in the focus group discussion and return to the researcher:

- *I hereby confirm that I have been informed by the researcher, Megan Parker, about the nature, conduct, benefits and risks of this study*
- *I have received, read and understood the above written letter of information regarding the study.*
- *I am aware that the results of the study will be processed into a study report.*
- *In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.*
- *I may, at any stage, without prejudice, withdraw my consent and participation in the study.*
- *I have had sufficient opportunity to ask questions and of my own free will and declare myself prepared to participate in the study.*
- *I understand that significant new findings developed during the course of this research that may relate to my participation will be made available to me.*

Neutral Moderator's name: _____

Institution: _____

Position held: _____

E-mail address and telephone number: _____

Signature: _____Date: _____Place: _____

I, Megan Parker, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full name of researcher:

_____

Signature: _____Date: _____Place: _____

Cell phone no.: (076) 091 6129 Home: (031) 312 3745 E-mail: megan.parker95@yahoo.com

Kind regards,

Megan Parker

APPENDIX I: Focus group moderator guidelines

FOCUS GROUP MODERATOR GUIDELINES

Structure and layout adapted from (Dixon 2005: 13) and (Hankinson 2012: 122).

Initial main questions for main themes	Checklist of themes mentioned /not mentioned	Probes	Prompts
	Subordinate questions for the main themes	To alert the interviewees to keep elaborating on the main themes	To clarify specific aspects of the main themes
Question One: To discover what challenges interior designers are facing when using technologies to enhance user experience in the built environment			
Understanding the term 'technology-enhanced learning environment' (TEL). Whilst considering your professional background and expertise, can you tell me what TEL means to you?	• Concept or definition of 'technology' • How did you come to this understanding? (i.e. literature, higher education, conference) • How do you think interior designers can or should accommodate for future technological changes? (social networking, RSS, VoIP, podcasts, virtual interface projection)	• Please go on • Could you elaborate on that? • Does anyone have a different understanding that they would like to share? • Does anyone have a similar understanding they could share?	• Could you repeat that concept / idea again • You mentioned that technology is rapidly changing. Do you feel that this has an affect on how an interior space is designed? Do you think technology can be used as a tool to enhance learning?
Question two: To establish what sensory design principles should an interior designer consider for technology-enhanced learning environments in universities?			
Understanding the term 'sensory design' Whilst considering your professional background and expertise, can you tell me how your particular field can accommodate for the senses? Can you tell me what technology-tools are most used in learning spaces?	• How do you think the senses can enhance learning? • Have you ever considered the senses in your field of practice or any specific project? Why? • How do you think your practice can have an impact on the student or their senses? • Do you feel technology-learning tools could stimulate the senses? • Do you have any innovative ideas of how technology in a learning environment can stimulate the senses?	• Why do you think that is so? • That's very interesting do you think it was a positive or negative experience? Why? • What impact do you think that will have on students? Why? • Do you think students would enjoy technology-learning tools that positively stimulate their senses? • How can you be sure that it will have that affect on students?	• You used the word / term_____ could you explain what it means or what you meant by it? • How/why do you think that will benefit the students?

Initial main questions for main themes	Checklist of themes mentioned /not mentioned	Probes	Prompts
	Subordinate questions for the main themes	To alert the interviewees to keep elaborating on the main themes	To clarify specific aspects of the main themes
Question 3: To explore how a collaborative design team can assist interior designers to overcome technology and sensory design challenges in universities			
Understanding the term 'collaborative design team' Can you tell me what a collaborative design approach means to you means to you? What challenges do you think universities are facing when accommodating senses and technology? Do you think design collaborations are help or a hindrance to the outcome of the project?	• Concept or definition of 'collaboration' • Relative to your field of expertise what problems do you think interior designers may have when designing TEL? • Relative to your field of expertise what problems do you think interior designers may have when designing to stimulate the senses? • How do you feel these challenges can be overcome? • How do you think a team of professionals from various disciplines working together can assist an interior designer at the early stages of a project?	• Please go on • Could you elaborate on that? • Does anyone have a different understanding that they would like to share? • Does anyone have a similar understanding they could share? • Do you believe there are solutions to such problems?	• Do you think many universities in South Africa are struggling with these challenges? • Do you foresee any problems in the near future regarding the design of learning spaces and how they accommodate future technologies? • Can you elaborate on what you mean by that? • What would the ideal collaborative approach or design team be like? • Can you explain why?

GUIDELINE FOR PARTICIPANT SCREENER:

QUESTIONS	EXCLUDE CANDIDATE
Would you be interested to work in a collaborative team to find new and innovative design solutions?	If candidate is not interested in working in a collaborative team they are not suitable and should not be considered to participate.
Would you be happy to share your (professional advice) opinions, and perspectives on your profession with people from other various disciplines?	If the candidate is not interested in sharing their opinions and professional advice with other participants' they are not suitable and should not be considered to participate.
Do you enjoy being challenged in your professional field and have a desire to think out the box?	If the candidate is not interested in being challenged to find new and innovative solutions they are not suitable and should not be considered to participate.
Have you ever thought of challenges that your professional field may experience in the near future? (E.g. how difficult it is to keep up with technology or client demands on product quality)	If the candidate is not forward thinking they are not suitable and should not be considered to participate.
Are you open-minded toward working with professionals that are from diverse walks of life and multi- cultural groups and of different ages?	If the candidate is not comfortable working in a team that is diverse and of different cultural or ethnic groups they are not suitable and should not be considered to participate.

APPENDIX J: Focus group consent form

CONSENT FORM FOR FOCUS GROUP PARTICIPANTS

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: _____

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

As a participant of the research study I hereby confirm:

- I have been informed by the researcher about the conduct of the study.
- I have received, read and understood the participants' letter of information regarding the nature of the study.
- I am willing to participate in the study.

In view of the research requirements I understand that I have the right to:

- Full disclosure about the research.
- Privacy. Indicating that I am free to refuse participation in the research or withdraw from the study at any point in time.
- Refrain from answering any questions in the focus group discussion that I do not wish to answer.
- Decide whether my name is included or excluded from the research study in terms of confidentiality and anonymity.

Statement of agreement to participate in the research study:

Kindly fill in your details below if you agree to participate in the focus group discussion and return to the researcher:

- *I hereby confirm that I have been informed by the researcher, Megan Parker, about the nature, conduct, benefits and risks of this study*
- *I have received, read and understood the above written letter of information regarding the study.*
- *I am aware that the results of the study will be processed into a study report.*
- *In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.*
- *I may, at any stage, without prejudice, withdraw my consent and participation in the study.*
- *I have had sufficient opportunity to ask questions and of my own free will and declare myself prepared to participate in the study.*
- *I understand that significant new findings developed during the course of this research that may relate to my participation will be made available to me.*

Full name of participant: _____

Company/ firm name: _____

E-mail address and telephone number: _____

Signature: _____Date: _____Place: _____

I, Megan Parker, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full name of researcher: _____

Signature: _____Date: _____Place: _____

Cell phone no.: (076) 091 6129 Home: (031) 312 3745 E-mail: megan.parker95@yahoo.com

Kind regards,

Megan Parker

APPENDIX K: Gatekeeper permission letter

GATEKEEPER PERMISSION LETTER

Student Name: Megan Parker
Student number: 21342637
Course: Master of Applied Arts (Interior Design)
Date: 23-09-16

Supervisor:	Mrs. Michelle Reynolds	Co-supervisor:	Professor Rolf Gaede
Contact no.:	(031) 337 36507	Contact no.:	(031) 373 6651
E-mail address:	michelleh@dut.ac.za	E-mail address:	rolfg@dut.ac.za

Dear Professor S. Moyo:

REQUEST FOR CAMPUS FOCUS GROUP DISCUSSION AND DISTRIBUTION OF QUESTIONNAIRES ON MY RESEARCH FOR MY MASTER OF APPLIED ARTS IN INTERIOR DESIGN

Brief introduction and purpose of the study:

My name is Megan Parker, and I am currently a master's student at the Durban University of Technology. I am studying interior design and looking to establish how interior designers can improve university learning environments, that accommodate technologies and the human senses. My research topic is "Connecting Technology and Sensory Design: A collaborative approach to designing university learning environments in the digital age ".

Request for permission:

Knowing your utmost interest in the value of research as a tool for development, I would like to request your permission to do the following in order to complete my research:

1. Conduct a focus group discussion on campus (without interfering with staff or students).
2. To distribute questionnaires to the focus group participants after the discussion.

I believe that by distributing the questionnaires I will be able to get a better understanding of the participants' experience of the focus group and empirical evidence that may guide and support my proposal.

Please can you be so kind as to inform me should you feel it is necessary for me to make an appointment to see you to personally explain my intentions. Should you require any other information regarding this subject, please don't hesitate to contact my supervisor Mrs. Reynolds at the DUT on 031-3736507 or via email: michelleh@dut.ac.za. Thank you very much in anticipation of your favourable action and support.

Yours Sincerely

Megan Parker

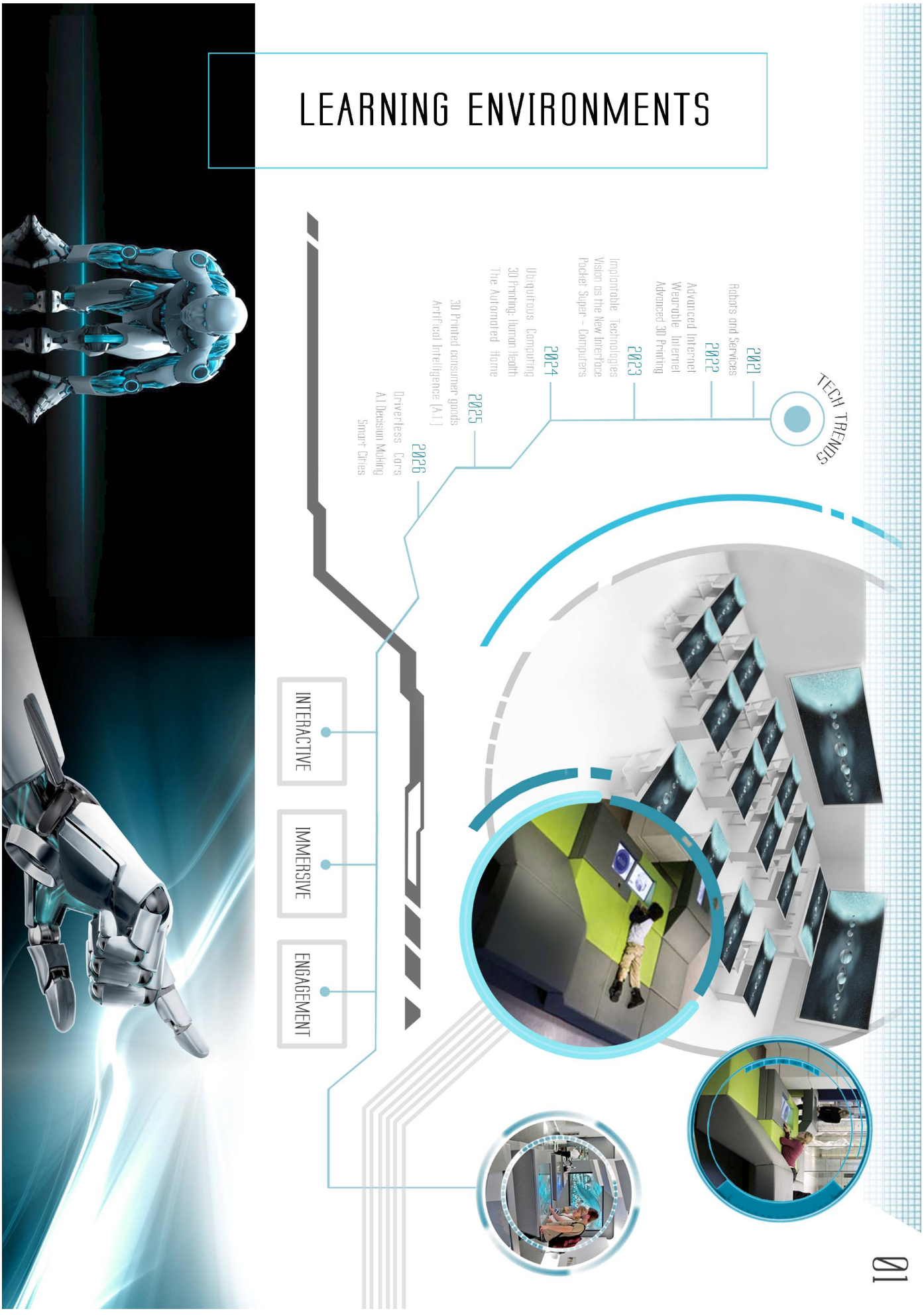
Cell no.: (076) 091 6129 Home no.: (031) 3123745 E-mail: megan.parker95@yahoo.com

APPENDIX L: CNN online reader responses

Human interaction in the digital age: Responses from CNN online readers (Cafferty, 2011)

Cafferty (2011) At what cost has technology replaced personal interactions?		
Positive Comments	Neutral Comments	Negative Comments
"A lot of the social technologies out these days are developed to enhance real world person to person interaction not isolate it to the digital world. Do people ignore those around them while texting? Yes. They also do it while reading the newspaper, listening to their 1980's Walkman, sing to themselves, or if you are in NYC like myself just sit on the train…This is not a matter of technology, it is a matter of disinterest."	"Jack, I am considered a 'Gen Xer' and use technology everyday. My career is in the information technology space. Technology is at the forefront of my business, financial, social and yes sometimes personal interactions. As to whether technology replaces personal interactions, to some degree, it will. As for the cost, I leave it up to parents to teach those good old 'fashion tips to their kids... Adaptation will undeniably succeed."	"…People's obsessive addiction to technology not only has re-defined inappropriate and rude behaviour in public, but has promulgated social isolation and indifference to others. We're rapidly becoming a society where personal interaction is being replaced with ear buds and personal electronic devices to the point where it's rare when you can even greet a passing stranger on the street."
"..communication changes. People associate now with more people than they did in past times. It is not necessary to have a "face to face" over everything anymore. If anything the new age of technological communications shows how well people can multi-task. Out with the old in with the new."	"It's truly a double-edged sword: technology has replaced face-to-face interpersonal communication but it has also progressed our world so much in the sense that we can connect with anyone anywhere we are. We haven't stopped talking to everyone; we've just stopped physically speaking. We now talk with our fingers instead of our mouths…"	"I am a teacher of young children and they show signs of this technological age…They are much more interested in video games, computers, many have cell phones and their families are also caught up in our wired age which takes time away from human interaction. As a teacher it's difficult to compete."
"Texting allows you to stay in touch with people you DO know, so what's so impersonal about that? I'd say we've increased our interpersonal interactions due to technology."	"Stepping away from technology is stepping away from the future"	"We feel a need to connect with others, but our connection is solely with a text message, not real interaction with an appeal to our true senses (touch, see, hear, etc.)."
"Technology has not replaced personal interactions; rather, it has given us more peace of mind. We find ourselves enveloped into our device, thereby tuning out those that would have been a nuisance."	"While technology IS replacing personal interactions, at least people are able to use say "Face Time" or Video Chatting to interact with people on the other side of the country, or even relatives on the other side of the world…"	"Absolutely people are becoming socially isolated, especially the younger generations. I've seen two teens sitting next to one another, both texting, and neither sharing anything with the other one."
Technology has added a new dimension to personal interaction. In most cases the only time I am even able to talk to my dispersed family and friends via cell phones and Facebook. They are useful tools.	There pros and cons for just about everything, but this is truly sad when, not only the average person is wasting 7-9 years of their life watching TV, but also becoming more assimilated by more gadgets... The cost is not worth your life!	"The youth of the world have become so desensitized to human interaction they can barely look at each other, nevertheless an adult; so sad"

APPENDIX M: Academic hub conceptual design



HIGHER EDUCATION

TRENDS, CHALLENGES AND TECHNOLOGIES

2018 2019 2020 2021

SHORT-TERM
Technology Adoption
> Blended Learning Designs
> Collaborative Learning

GOALS

MID-TERM
Technology Adoption
> Growing focus on Measuring Learning
> Redesigning Learning Spaces

GOALS

LONG-TERM
Technology Adoption
> Advancing Cultures of Innovation
> Deeper Learning Approaches

GOALS

SOLVABLE
Technology Adoption
> Improving Digital Literacy
> Integrating Formal & Informal Learning

CHALLENGES

DIFFICULT
Technology Adoption
> Achievement Gap
> Advancing Digital Equity

CHALLENGES

COMPLEX
Technology Adoption
> Managing Knowledge Obsolescence
> Rethinking the Roles of Educators

CHALLENGES

Important Developments in Technology for Higher Education

NEAR TERM - 1YEAR OR LESS
> Adaptive Learning Technologies
> Mobile Technologies

MID TERM - 2 TO 3 YEARS
> The advancement of Internet
> Next Generation (LMS)

FAR TERM - 4 TO 5 YEARS
> Artifical Intelligence (A.I.)
> Natural User Interfaces

THE IMPORTANCE
OF DRIVING TECHNOLOGY
ADAPTION IN HIGHER EDUCATION

FUTURE TRENDS

ENVIRONMENTS THAT ARE DESIGNED TO BLEND BETTER WITH TECHNOLOGY RESULT IN DEEPER EXPERIENTIAL LEARNING AND COLLABORATION. STUDENTS AND LEARNERS WILL BECOME PARTNERS IN THE LEARNING AND ASSESMENT PROCESS

WE ARE MOVING TOWARDS IMMERSIVE AND INTERACTIVE LEARNING AND DIGITAL ENGAGEMENT. LEARNING SPACES WILL BE MORE GAME LIKE AND EXPERIENTIAL. TECHNOLOGY WILL BECOME INSEPERABLE FROM STUDENTS

USING TECHNOLOGY TO DRIVE TOWARDS:
ENGAGEMENT - FACE-TO-FACE OR WITH THE INSTITUTION

USING TECHNOLOGY TO DRIVE TOWARDS:
ONLINE, E-MAIL AND SOCIAL MEDIA ENGAGEMENT

BLENDED ENVIRONMENTS = MORE

BLENDED ENVIRONMENTS = LESS

- MORE STUDY MOTIVATION
- MORE BOOK PUBLISHING
- MORE COLLABORATION
- MORE THINKING / WRITING
- MORE DYNAMIC GROUPING
- MORE INDIVIDUAL PROGRESS
- MORE INVESTIGATING / INVENTING
- MORE HIGHER- ORDER TEACHING

- LESS ISOLATION
- LESS 'TURN IT IN'
- LESS AGE COHORTS
- LESS WORK SHEETS
- LESS STUDENT BOREDOM
- LESS STUDY REGURGITATING
- LESS TIME GRADING / MARKING
- LESS TIME BUILDING AUTOMATICITY

CHALLENGES FACED

- SIGHT
- SOUND
- TASTE
- TOUCH
- SMELL

LITERATURE REVIEW

TECHNOLOGY ADDICTION

After many years of using technology, Kellner (2006:7) believes thats technology in itself has become an extension of human capability and in turn shapes peoples thoughts, behaviour and interaction. Lee (2011) explains that technology addiction has also been assumed to reduce face-to-face interaction

CAMPUS PLANNING

There is a challenge in bridging the gap between institutional I.T environments and the type of technology environments the "Net Generation" have created for themselves (Groff 2013: 1). Emerging technologies students of the digital age are using are provoking a reconceptualisation of the way teaching and learning takes place

EDUCATIONAL REFORM

Davidson and Goldberg (2009:20) explain that we only advocate institutional change because we believe that our current formal educational institutions are not taking enough advantages of the modes of digital and participatory learning available to students of today. We need to rethink "how" people learn, "where" people learn and "why".

DESIGN SOLUTIONS

?

SENSORY DYNAMISM

Brandon (2013) says that Sensory Dyanmism is the lack of sensory stimulus which affects human perception. This may occur if you are focused on a computer screen - i.e a "single plane" - for a long time without looking out the window (which reduces eye strain as looking into the distance reveals multiple planes which helps your eyes to relax).

TECHNOLOGY OVER-RELIANCE

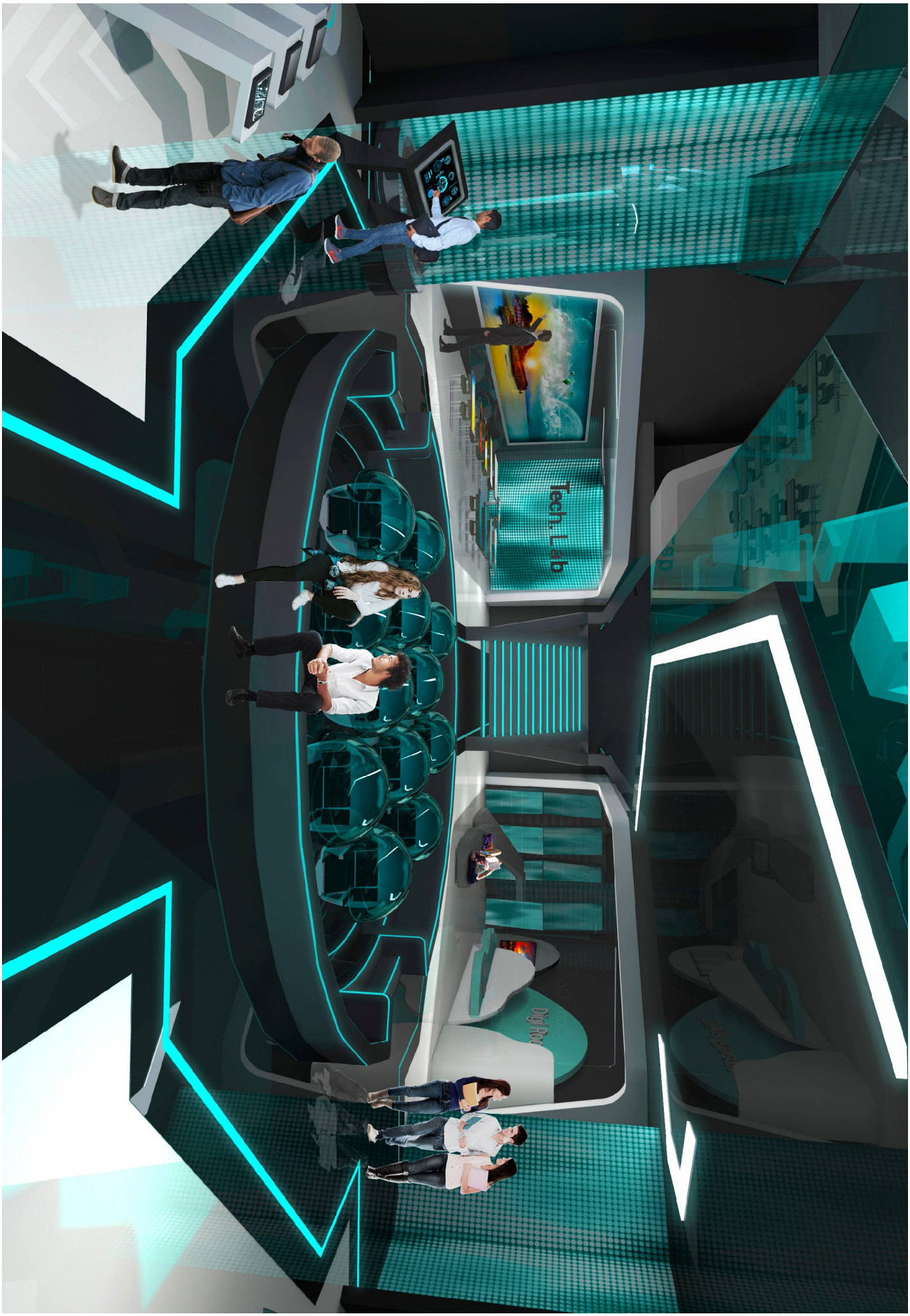
Ige (2013, 10) noted that the most popular claims by other critics regarding technology over-reliance is that it causes:
- Less leisure reading
- Frequent distractions
- Desire to multi-task

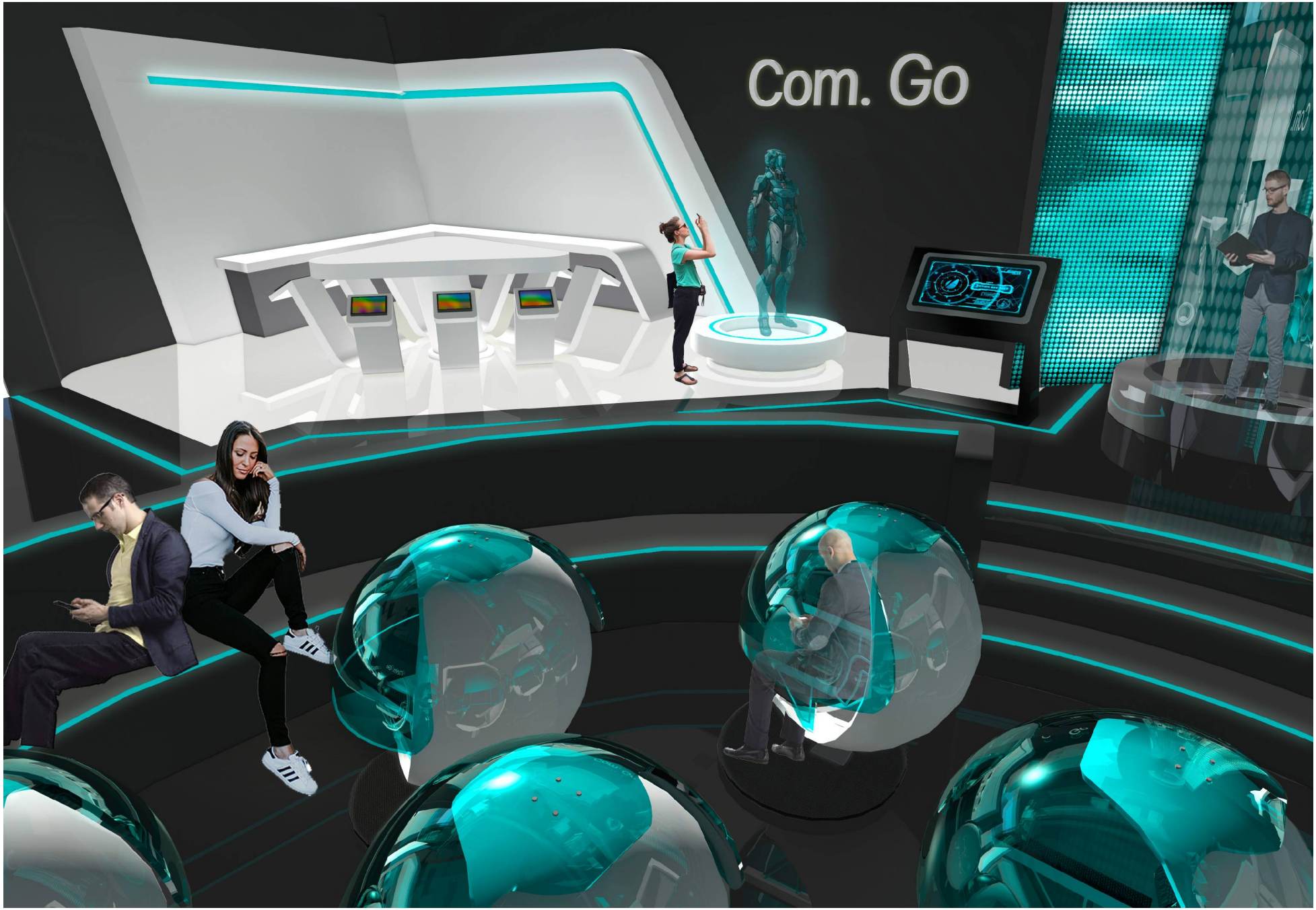
Ige (2013, 10) doesn't agree with these critics as he says tech devices increase cognitive awareness performance and critical thinking.

TECH. REPLACING HUMAN INTERACTION

Cofferty (2011) belives that technological devices often occupy our minds to a point where people have become accustomed to tuning out the people who are in the same room as us. It is important not to be solely dependent on technology to be connected but to also remain connected through personal interaction.

TECH
After School is a private
newsfeed and message
board for university students


Tech Lab


Com. Go


Become someone else
Com. Go

com. GO

Think Pod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point
y - y₁ = m(x - x
y - 3 = 2(x - (-1
y - 3 = 2(x + 1)
y - 3 = 2x + 2
y = 2x + 5
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