PERSUASIVE TECHNOLOGY AND USER EXPERIENCE DESIGN GUIDELINES TO MOTIVATE USERS FOR AUTONOMOUS LEARNING ON A DIGITAL LEARNING PLATFORM IN THE CONTEXT OF A CORPORATE ENVIRONMENT IN SOUTH AFRICA

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Persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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PERSUASIVE TECHNOLOGY AND USER EXPERIENCE DESIGN GUIDELINES TO MOTIVATE USERS FOR AUTONOMOUS LEARNING ON A DIGITAL LEARNING PLATFORM IN THE CONTEXT OF A CORPORATE ENVIRONMENT IN SOUTH AFRICA

ABSTRACT

Organisations are increasingly relying on digital platforms for autonomous learning for skills development. The COVID-19 pandemic has forced many employees to work from home, and as a result, the use of autonomous learning increased to the point where it became the preferred learning mode. Persuasive technologies (PT) can improve employees' motivation for completing autonomous learning tasks on digital learning platforms in corporate organisations. Despite the potential for supporting autonomous learning, the application of PT in the South African corporate organisation context remains limited. The research problem identified was the lack of users' motivation to learn autonomously on digital learning platforms. The study was novel in drawing on the theoretical lenses of both PT and user experience (UX) to investigate the motivation for autonomous learning in a corporate utility in South Africa. For corporate organisations to improve employees' motivation in autonomous learning, the digital learning platform may use persuasive strategies such as competition, self-monitoring, and cooperation; or UX attributes such as effectiveness, efficiency, and satisfaction in contributing to motivate employees' learning needs.

The methodology applied in the study was guided by design science research (DSR). Fourteen subject matter experts in focus groups validated the persuasive strategies and UX attributes extracted from literature. The validated constructs used as the basis for the design guidelines informed the design and development of a prototype aimed at testing the motivation of employees in autonomous learning in the digital learning platform. The prototype was presented to 76 users, their interactions with the prototype were captured, and their perceived user experience was evaluated in a survey. The triangulation of the findings from the user interaction captured via mouse movement and the survey confirmed that the design guidelines based on the nine constructs (PT and UX) were appropriate for designing a PT prototype system to motivate employees in autonomous learning in the digital learning platform. The study was limited to one organisation and one module within the digital learning environment. The focus was on motivation only and excludes other pedagogical aspects of the teaching and learning process. The study makes a theoretical contribution in terms of the literature-based, empirically refined design guidelines and a questionnaire for evaluation of the prototype by users; and a practical contribution by the

development of a prototype as a PT system to test the motivation of the employee in autonomous learning in the digital learning platform.

KEY TERMS:

Persuasive technology; User experience; Autonomous learning; Digital learning; Design science research; ARCS; Prototype; Focus group; Thematic analysis; Exploratory factor analysis; Descriptive statistics; Usability; Usability testing

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LIST OF ACRONYMS AND ABBREVIATIONS

ARCS	Attention Relevance Confidence Satisfaction
COVID-19	Coronavirus Disease 2019
DSR	Design Science Research
HCI	Human-Computer Interaction
H&S	Health and Safety
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers

ISO	International Standards Organisation
MOOCs	Massive Online Open Courses
SWOT	Strengths, Weaknesses, Opportunities and Threats
PSD	Persuasive System Design
PT	Persuasive Technologies
QUIS	Questionnaire for User Interaction Satisfaction
SHEQ	Safety, Health, Environment and Quality
SUS	System Usability Scale
UEQ	User Experience Questionnaire
UNISA	University of South Africa
UTAUT	Unified theory of acceptance and use of technology
UX	User Experience
WBL	Web-based Learning
WOS	Web of Science

1. CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction and background to the research

Organisations are increasingly embracing digital online learning technologies as a platform to deliver training to improve their employees' skills and knowledge in order to improve knowledge and productivity in the work environment (Rana, Ardichvili, & Polesello, 2016). Khiat (2015) and Rana et al. (2016) found digital online learning technologies to be more cost-effective than on-site training that requires travelling, as the online learning technology platforms used for facilitating online discussions are usually free, such as MOOCs (Massive Online Open Courses) and Moodle (Rana et al., 2016). The COVID-19 pandemic accelerated the digital transformation for organisations worldwide, with employees working remotely and migrating to online technologies to deliver their work (Nachmias & Hubschmid-vierheilig, 2021). Working remotely affected how training was conducted, and organisations rely on online learning platforms to deliver the training to their employees (Merdzhanov, 2018). Autonomous learning is a style of learning, also known as self-directed learning (Rana et al., 2016), and characterised by independent learning, self-managed and self-monitored (Ellingson & Noe, 2017). Autonomous learning empowers employees to own the learning initiatives to meet their learning goals (Ellingson & Noe, 2017; Khiat, 2015; Rana et al., 2016), especially through online digital technologies. Digital learning technologies complement traditional forms of learning by allowing flexibility in anytime and anywhere accessibility in online learning (Merdzhanov, 2018). However, one of the challenges employees face when conducting autonomous learning on digital platforms was identified as self-motivation (Ellingson & Noe, 2017; Khiat, 2015; Rana et al., 2016). The research problem identified was the lack of users' motivation to learn autonomously on digital learning platforms. Autonomous learning on a digital learning platform relies on the employees' self-motivation (Khiat, 2015).

The theoretical constructs of Persuasive Technology (PT) and User Experience (UX) (namely: Competition, Cooperation, Satisfaction, Effectiveness, Efficiency, Attention,

Relevance, and Confidence), have been identified as relevant to self-motivation on digital platforms.

What is PT?

The first theoretical construct was Persuasive Technology (PT), which refers to using of computer technologies designed to change users' behaviours, attitudes and thoughts without coercion or deception (Fogg, 2009). PT involves moving the act of persuasion to the digital domain (Fogg, 2009) since it uses techniques referred to as persuasive strategies aimed at modifying or changing users' behaviours (Gamberini et al., 2012). Related literature by Oinas-Kukkonen and Harjumaa (2009) identified 28 persuasive strategies; amongst them, the common persuasive strategies; are competition, social comparison, cooperation (R. Orji, 2017), and self-monitoring (Segerståhl, Kotro, & Väänänen-Vainio-Mattila, 2010). Competition and social comparison were found to belong together since competition is a by-product of comparison (R. Orji[1], Vassileva, & Mandryk, 2014). As it was not feasible to investigate all 28 persuasive strategies, the selected set of common strategies, namely; competition, cooperation, and self-monitoring were prioritised because they can enhance users' motivation in online learning support systems (R. Orji, 2017). Section 2.3 presents a detailed discussion on PT.

What is UX?

UX relates to the field of human-computer interaction (HCI) (Albert & Tullis, 2013). UX is defined as a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service, as defined by the International Organization for Standardization (ISO9241-210, 2010). In the process of a user interacting with the system, the positive user experience influences the perception of user motivation (Pilloni, Mulas, Piredda, & Carta, 2013). Studies indicated that a positive user experience is an essential antecedent of effective computerised persuasion as advocated by Segerståhl et al. (2010), and UX may positively influence users' motivation to persuasion (Adaji, 2017; Kaplarski, 2015).

[1] R. Orji – Note: where the authors of multiple references share the same surname but have different initials; the first authors' initials are included in all in-text citations, even if the year of publication differs (APA, 2020).

By drawing on both PT and UX as theoretical bases, studies indicated that persuasive technologies inspire users' motivation for behaviour change (Fogg, 2009); and that users' experiences may positively influence users' motivation (Kaplarski, 2015; Adaji, 2017). Pilloni et al. (2013) found that redesigning an application interface may motivate users, leading to increased application use and satisfaction with user experience, and provides the rationale for drawing on both PT and UX. There were limited studies in literature covering both PT and UX, and the reason was that studies in PT and UX, respectively, have different disciplinary origins (Daud, Sahari, & Muda, 2013; Kaplarski, 2015). Persuasion in PT originates from psychology seeking to understand human behaviour (Gram-Hansen, Stibe, de Vries, & Langrial, 2018). UX studies resort to the interdisciplinary field of human-computer interaction, which involves psychology but focuses on the interfaces between people and computers, as well as people and devices (Hassenzahl & Tractinsky, 2006). This study adds value by integrating the theoretical lenses of PT and UX to motivate users for autonomous learning on online digital learning platforms. Therefore, the purpose of this study was to investigate the use of PT and UX to improve employees' motivation for autonomous learning in digital learning platforms in corporate organisations.

Section 1.2 provides detailed discussions of the problem statement, the research problem and the motivation of this study. Section 1.3 introduces the main research question and sub-questions. Respectively, Sections 1.4, 1.5, 1.6 and 1.7 provide the context, research methodology, contribution, and the study's scope and limitations. Section 1.8 presents the research access and research ethics. In conclusion of this chapter, the research planning and a research chapter map are provided in Sections 1.9 and 1.10, respectively.

1.2 Problem statement

Research problem and motivation for the study

As a learning style, autonomous learning is becoming more critical for organisations wanting to improve employee skills and knowledge (Rana et al., 2016), especially for remote working employees relying on digital learning technologies due to COVID-19 restrictions (Adedoyin

& Soykan, 2020). Autonomous learning requires self-motivation for learners to achieve their learning goals (Khiat, 2015; Rana et al., 2016). Khiat (2015) and Rana et al. (2016) identified the challenge as a lack of "*motivation for users engaging in autonomous learning on digital learning platforms"*. However, designing digital learning platforms as an information system requires a set of guidelines to keep users engaged and motivated. The literature on information systems in related studies consists of several design guidelines to support the design of user interfaces for different contexts (Ormeno, Panach, Condori-Fernandez, & Pastor, 2013), which is potentially overwhelming to designers and developers. For example, Nielsen Norman Group (2009) identified 874 UX design guidelines, while Oinas-Kukkonen and Harjumaa (2009) provided 28 persuasive design guidelines. Furthermore, Némery and Brangier (2014) proposed eight persuasive interface guidelines and 25 sub-criteria based on their research study conducted on 164 studies linked to technological persuasion. The numerous guidelines challenged designers when designing the most suitable user interface for a persuasive system with improved user experience. Another challenge was the fragmented presentation of these guidelines, which span different subject areas such as PT and UX.

Studies in HCI indicated a growing interest in technological persuasion (Gram-Hansen et al., 2018). With so many fragmented design guidelines; there was a need to prioritise user-centred design guidelines (ISO9241-210, 2010). From the literature Daud et al. (2013) and Kaplarski (2015) posit that research studies covering PT and UX for improving users' motivation are under-researched, this is also evident in the limited number of articles found in the databases searched for studies based in the African continent for PT and UX, as indicated in Section 2.2. Therefore, the researcher endeavours in this study to investigate learning through the theoretical lenses of PT and UX on how the prioritisation of persuasive and UX design guidelines improves users' motivation.

1.3 Research question, sub-questions, and objectives

The main research question, relevant sub-research questions and objectives are discussed as follows:

Main research question (RQ):

What are the insights obtained from persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa?

Sub-Research questions (sub-RQ)

a. What are the persuasive strategies and UX attributes for improving the users' motivation for using digital learning platforms for autonomous learning?
b. What are the design guidelines on the literature-based set of persuasive strategies and UX attributes required to improve the users' motivation for using digital learning platforms for autonomous learning?
c. What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that need to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?

Objectives of this study

The primary objective was to provide the design guidelines for improving user motivation on digital learning platforms through the design science research approach to support autonomous learning of employees in corporate organisations in South Africa.

Sub-Objectives of this study

The secondary objectives were to determine:

- the persuasive strategies and UX attributes to use as a basis for the design guidelines. These were used to answer the sub-research question (a) and (b), respectively.
- users' insights on the motivation from the persuasive strategies and user experience of the digital learning platform. These were used to answer sub-research question (c).

The research questions, relevant research actions and the research outputs have been summarised in Table 1.1.

Table 1.1: The main research question, sub-questions, research actions, and outputs

Main research question (RQ): What are the insights obtained from persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa?		
Sub-Research questions (Sub-RQ)	**Research Actions (RA)**	**Research Outputs (RO)**
a. What are the persuasive strategies and UX attributes for improving the users' motivation for using digital learning platforms for autonomous learning?	a.1 Literature review on PT and UX. a.2 Literature review for questionnaires for evaluating PT and UX.	a.1 The persuasive strategies and UX attributes (see Table 2.8: *ConstructsVersion1* - The literature-based set of constructs). a.2 Produce an evaluation questionnaire (see Table 3.6: *QuestionnaireVersion1*- questions from various literatures).
b. What are the design guidelines on the literature-based set of persuasive strategies and UX attributes required for improving the users' motivation for using a digital learning platform for autonomous learning?	b.1 Focus group sessions with the subject matter experts based on *ConstructsVersion1* to validate the suitability of the constructs for users' motivation. b.2 Literature review on PT and UX for design guidelines.	b.1 *ConstructsVersion2 (The* validated constructs) suggested improving the users' motivation for autonomous learning on the digital learning platform. b.2 The validated constructs (see Table 3.3) served as the basis for the design guidelines of the prototype.
c. What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that need evaluation to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?	c.1 Design and develop a prototype based on findings of (RQ. b) design guidelines to gain user perspectives. c.2 Using the findings of (RQ. b), namely *ConstructsVersion2*, update *QuestionnaireVersion1* by selecting relevant questions and producing an evaluation questionnaire c.3 Prototype evaluation using *QuestionnaireVersion2* to obtain user perspectives.	c.1 Prototype system (see Figure 5.1). Mouse movement results in Section 5.6.1, 5.6.2, 5.6.3) c.2 *QuestionnaireVersion2* (The selected questions used as evaluation tool) was used to evaluate the prototype system by the users (see Appendix C). c.3 Prototype system evaluation results used to validate *ConstructsVersion2* (see Table 6.4 Rotated Component Matrix).

As detailed in Table1.1, the sub-research questions (RQ) and corresponding research-action (RA) and research-output (RO) discussed:

a) The research question (RQ. a) seeks to guide the literature review (as research actions (RA. a.1 and a.2) to *identify all of the available persuasive strategies and UX*

attributes to motivate users in autonomous learning on the digital learning platforms. The research outputs (RO. a.1 and a.2) were a list of persuasive strategies and UX attributes (named *ConstructsVersion1*) and evaluation questions from various literature (named *QuestionnaireVersion1*), respectively.

b) The RQ. b seeks to *validate and provide the selected* PT and UX constructs serving as the basis for design guidelines. *ConstructsVersion1* was used to guide the focus group with the subject matter experts to validate them (RA.b.1). RA.b.2 was focused on a literature review for design guidelines. The research outcome (RO.b.1) was the validated constructs (*ConstructsVersion2*) that informed the basis for the design guidelines of the prototype (RO.b.2).

c) The RQ. c seeks to *capture the users' perspective on the prototype motivation* by designing and evaluating the prototype (RA.c.1). A prototype representation of the user interface of the autonomous learning system for improving users' motivation. Designing evaluation tool (RA.c.2) and collecting quantitative data using the prototype (RA.c.3). The research outcomes were (RO.c.1) prototype system, *QuestionnaireVersion2* (RO.c2), and *ConstructsVersion2* (RO.c.3), which informed the basis for design guidelines.

In Section 1.4, the business environment in which the study has been undertaken was discussed.

1.4 Context of the study in the Business Environment

For the purposes of this study, the research environment is the corporate organisation referred to as ABC Holdings, a state-owned entity. In particular, the entity's health and safety (H&S) course was the targeted system in a digital learning platform. The organisation offers the H&S courses as a statutory requirement that must be adhered to periodically according to the company's H&S, environment, and quality policies. The H&S course contents was accessed online, on the digital learning platform that is part of the digital learning systems (Merdzhanov, 2018).

The preliminary investigation and observations made from within the organisation was the user decline in completion rates of the statutory online learning courses. Amongst other reasons given during these investigations was that the autonomous learning courses on H&S were not sufficiently motivating, resulting decreasing employee completion of autonomous learning courses on the digital learning platform. Similar observations were noted from literature by Kaplarski (2015), namely, the feeling of isolation, lack of technical support, lack of clarity in instructions, and lack of social interactions. A business problem was, thus, created that necessitated some interventions to improve employee motivation for autonomous learning in the digital learning platform. User motivation refers to the user's determination to operate the system to complete the given task (Merdzhanov, 2018). In the context of this study, the latter refers to digital learning tasks. The study was novel in combining the theoretical lenses of PT and UX to motivate users for autonomous learning on online digital learning platforms.

Section 1.5 provided an overview discussion on the research methodology guiding the research study.

1.5 Research methodology

The research study's philosophical paradigm was pragmatism, which was driven by the need to solve problems (Strübing, 2012). The Design Science Research (DSR) methodology guides the research study for producing artefacts (Hevner & Chatterjee, 2010). DSR is described primarily as a problem-solving paradigm that allows researchers to address problems in an environment and to produce effective solutions to creativity and teamwork (Hevner & Chatterjee, 2010). The solutions were continuously evaluated against a set of criteria, through successive iterations, adapted and evolved through implementations and evaluations (Hevner & Chatterjee, 2010). The evaluation applied through DSR determines how well an artefact achieves its expected outcome (Peffers, Tuunanen, & Gengler, 2006). In this study, the solutions were presented as delivered

artefacts, comprising *design guidelines,* an *evaluation questionnaire (*named *QuestionnaireVersion2),* and a *prototype system*. For the DSR process followed in this study, see Chapter 3, Section 3.3.

Research methods used in information systems studies combine qualitative and quantitative research methods to guide the overall research process (Saunders, Lewis, & Thornhill, 2009). In this study, the data, both qualitatively and quantitatively, was collected in three phases of the study: pre-usage, during-usage, and post-usage, by using the data collection tools: recorded and transcript, mouse movement, and survey questionnaire. The qualitative data was captured from the focus group by recording the sessions (pre-usage). Quantitative data was collected (during-usage) by user testing with mouse movement and from the online survey questionnaire (post-usage). Both research methods allowed the researcher to integrate the findings and draw conclusions (Oates, 2006). Furthermore, triangulation was applied to support the findings and strengthen the validity of the results as advocated by Saunders et al. (2009). Triangulation refers to using two or more independent sources of data collection methods to corroborate research findings within a study (Hofstee, 2006).

The research study, driven by DSR (detailed in Section 3.3), delivered the artefacts in stages to allow control of the research outputs, as advocated by Adaji (2017). The DSR was considered appropriate as the research study was driven by a business problem of user motivation in autonomous learning on digital platforms (as detailed in Section 1.2), the need to contribute to theory by design guidelines, and an evaluation questionnaire (*QuestionnaireVersion2*) (as detailed in Section 1.5). Figure 1.1 illustrates the results; Stage 1 delivered outputs of design guidelines and an evaluation questionnaire (*QuestionnaireVersion2*), and Stage 2 produced the prototype system used to evaluate the *ConstructsVersion2* by implementing those constructs to evaluate user motivation improvement.

- The research action was to conduct a systematised review to advance the knowledge and understanding in a combination of PT and UX. A narrative review was performed on related concepts, such as autonomous learning and digital learning, relevant to

the topic in the research study. In Stage 1, the objective was to identify persuasive strategies and UX attributes for improving motivation in autonomous learning. The researcher conducted a systematised review to determine the set of persuasive strategies and UX attributes, defined in the study as a literature-based set of constructs. The analysis of the literature-based set of constructs was reviewed during the first iteration, the commonly used constructs were selected (named *ConstructsVersion1*), and subsequently, during the second iteration, the constructs were validated in focus groups with the subject matter experts. The subject matter experts provided inputs and insights to develop the second version of the constructs (named *ConstructsVersion2*) as research output. The *ConstructsVersion2* were used as the basis for the literature-based design guidelines for developing the prototype prior to it being made available to the users (referred to as pre-usage). The narrative review focused on the sub-themes (autonomous learning, digital learning platforms, and design guidelines), and it assisted in identifying patterns in literature and gaps in the body of knowledge (Saunders et al., 2009).

Furthermore, during a systematised review on PT and UX papers, *QuestionnaireVersion1* was derived from different literature sources as an artefact. *QuestionnaireVersion2* was developed iteratively, with the first iteration of analysis providing a list of questionnaires from PT and UX literature, referred to as the *QuestionnaireVersion1*. The questions were derived from the studies by several authors in the literature in diverse environments (Albert & Tullis, 2013; B. Huang & Hew, 2016; Keller, 2016; F. A. Orji, Vassileva, & Greer, 2018; R. Orji, Reilly, Oyibo, & F.A. Orji, 2019). The sources of the questions used for formulating the questionnaire provided in Table 3.6. The second iteration of the analysis involved selecting the questions relative to the construct in the study. The research output was the final questionnaire (*QuestionnaireVersion2*), which was considered an artefact for usage in Stage 2.

- In Stage 2, the objective was to design a prototype based on the *ConstructsVersion2* design guidelines. The research action was to design a prototype system

representing a user interface of the digital learning platform for evaluation by users (*during-usage*) to improve user motivation for autonomous learning. The development of the digital learning prototype system (as research output) occurred in iterations from low-fidelity wireframe to high-fidelity interactive prototype (detailed in Section 3.4.2). The *QuestionnaireVersion2* was used in the prototype evaluation by end-users (*post-usage*) for assessing employee motivation on the digital platform. The data collected during the evaluation was analysed to produce results supporting the study (detailed in Chapter 6).

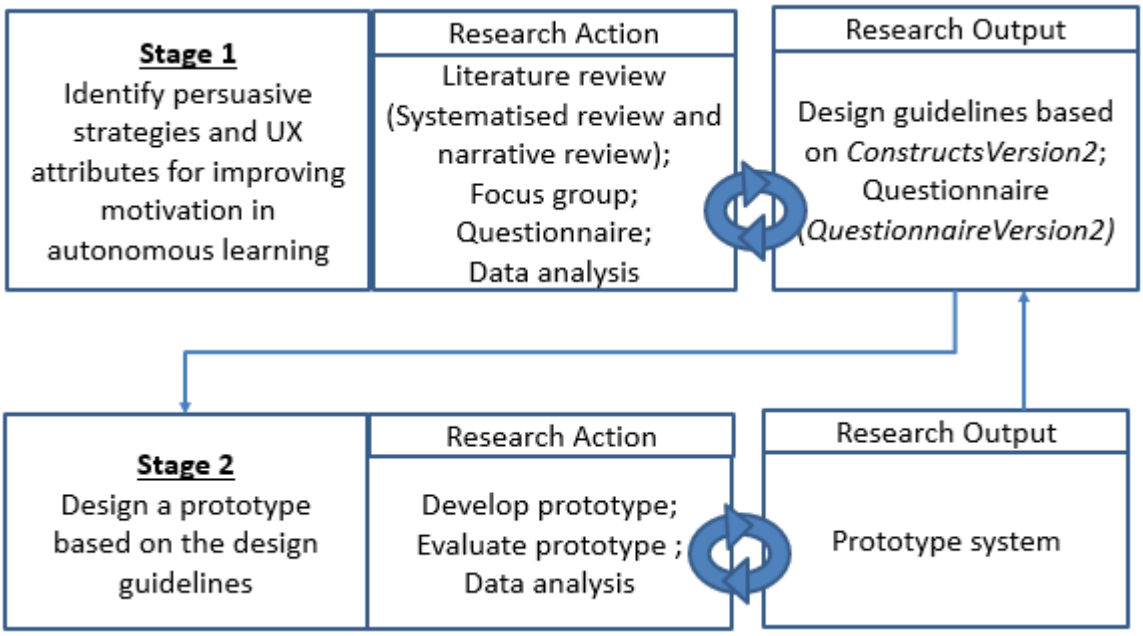

Figure 1.1: Overview of the stages in the research flow

Chapter 3 delivers a detailed discussion of the research process flow.

Section 1.6 discusses the significance and contribution of the research study.

1.6 Significance and contribution

The research study speaks to significance and contribution by making theoretical and practical contributions to the existing literature as expected of a master's study (Hofstee, 2006).

a) This study contributes new knowledge (as theoretical contribution) in terms of the literature-based *design guidelines* based on persuasive strategies and UX constructs for improving the motivation of users in autonomous learning on digital learning platforms in the corporate environment in a South African context. The theoretical contribution refers to how the investigation either offers a new theoretical explanation for something or how it validates an existing theory (Hofstee, 2006). The study also contributes the *questionnaire* that can be used in future studies to evaluate users' motivation. This tool can be used for the evaluation of future studies.
b) Practical contribution refers to what the work does in terms of the real world (Hofstee, 2006). The study contributes a *prototype* representation of the user interface of the autonomous learning system to illustrate the improvements in the user interface to motivate users in autonomous learning on digital learning platforms.

Section 1.7 provides a discussion on the scope and limitations of the research study.

1.7 Scope and limitations of the study

The study was limited to employees' motivation in conducting autonomous learning on the digital learning platform of a South African corporate entity. The research study was limited to one corporate organisation with geographic coverage in South Africa, targeting a sample of employees enrolled on an online autonomous learning course for health and safety.

The research study focused on the motivation to use the digital learning platform; as motivation alone was not the only factor involved in encouraging autonomous learning,

additional strategies will influence learners' sense of control and satisfaction within the learning process (Reynolds, Roberts, & Hauck, 2017). Different courses may require different strategies, but that was not part of this research study.

The theoretical constructs of PT and UX have been identified as relevant to self-motivation on digital platforms. UX involves the user, the system, and the context (Beauregard & Corriveau, 2007). The developed prototype evaluates the combined set of refined PT and UX constructs (i.e., *ConstructsVersion2*, namely: Competition, Cooperation, Satisfaction, Effectiveness, Efficiency, Attention, Relevance, and Confidence), but with limited functionality due to available time and cost constraints.

Section 1.8 provides a discussion on research access and ethics.

1.8 Research access and ethics

Research ethics implies conducting research in a moral and responsible way (Hofstee, 2006; Saunders et al., 2009). The research study complied with the university's code of ethics guidelines. Thus, ensuring that the research study adheres to the university's ethical guidelines. In addition to the participating organisation guidelines where the study took place. Permission to conduct research and collect data was sought, and potential participants were requested to complete consent forms granting access to both the organisation and them as individuals (Hofstee, 2006; Saunders et al., 2009). Therefore, the ethics clearance application submitted to the ethics committee was approved (ERC Reference #: 2020/CSET/SOC/008) and provided in Appendix A and B (comprising the questionnaire, focus group schedules, and access from the organisation).

The details of the ethics clearance and access are outlined in Section 3.7.

Section 1.9 provides details on the research planning.

1.9 Research planning

The research project plan covers the research activities and the timeline provided in Appendix K. The research plan includes the research activities, parties involved, and the timeline indicating the dates when the activities took place. The research plan began with the preliminary activities (i.e., the research topic, research groundwork, the literature review), followed by the research proposal, ethics clearance, questionnaire design, data collection, data analysis, dissertation report writing, and submission.

Section 1.10 provides an overview of the chapters included in this document.

1.10 Research chapter map

The research chapter map provides an overview of the chapters included in this document, as depicted in Figure 1.2. The study comprises seven chapters. Chapter 1 presents the introduction to the research study, Chapter 2 presents the literature review relevant to the research study, and Chapter 3 presents the research design and methodology guiding the research study. Chapters 4, 5 and 6 presents the results from the data collected pre-usage, during usage, and post-usage, respectively. Finally, Chapter 7 presents the discussion and conclusion of the study.

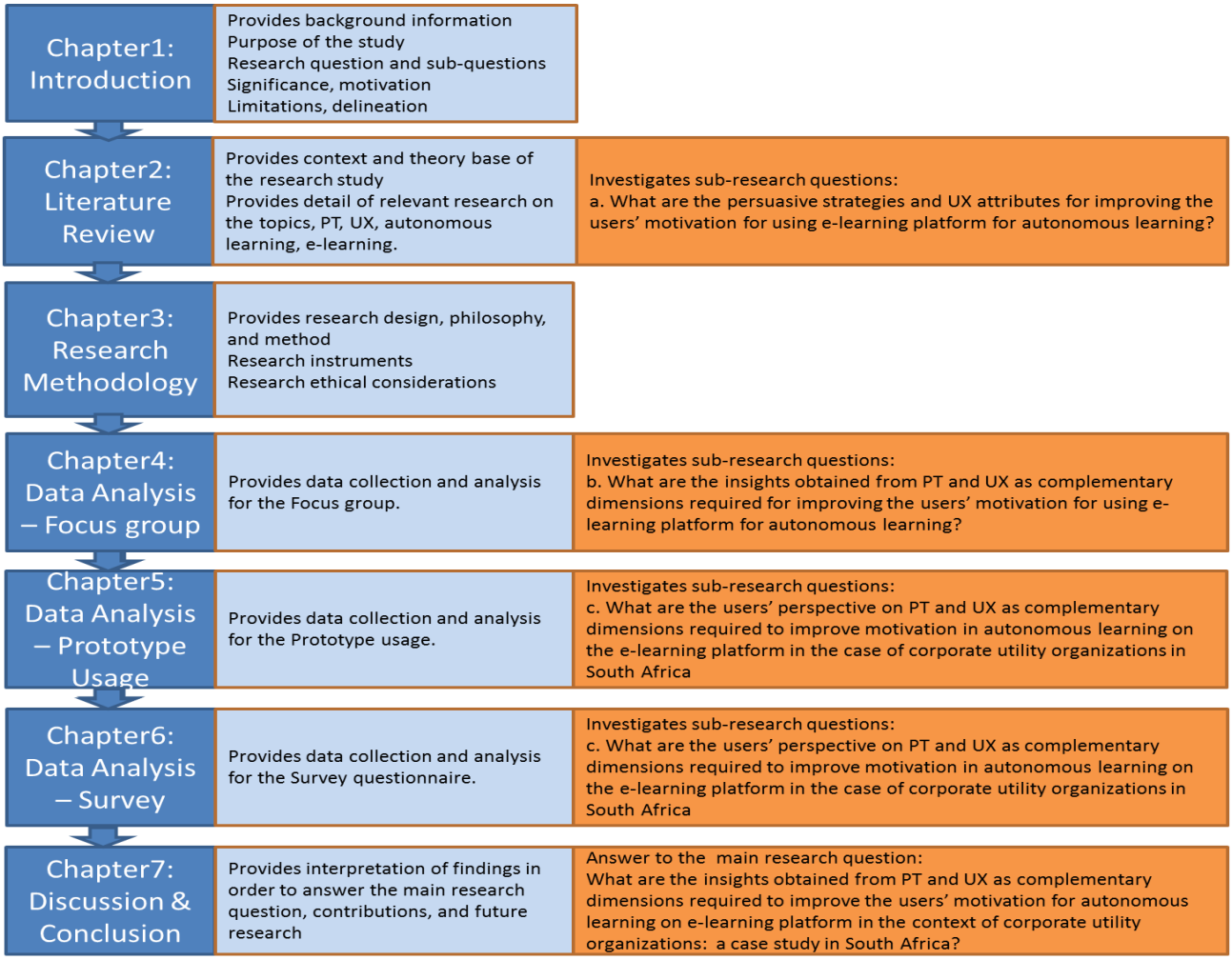

Figure 1.2: Research chapter map.

Chapter 2 provides the literature review relevant to the research study.

2. CHAPTER 2: LITERATURE REVIEW

2.1 Introduction and literature approach

This chapter presented and discussed a literature review on the concepts of PT, UX, digital learning, and autonomous learning. The literature review provided the body of knowledge published by other scholars relevant to the research study (Hofstee, 2006). The literature review was essential to advance the knowledge and understand the breadth of the research on a topic of interest, synthesise the empirical evidence, develop theories or provide a conceptual background for subsequent research, and identify the topics or research domains that require more investigation (Paré, Trudel, Jaana, & Kitsiou, 2015). Grant and Booth's (2009) typology of the fourteen most common types of reviews was, according to their search, appraisal, synthesis, and analysis descriptions. As advocated by (Paré et al., 2015), typology identifies, defines, and contrasts various research syntheses. Using Grant and Booth's (2009) typology, the study adopted a systematised review and a narrative review to advance the knowledge and understanding of the constructs in the study. A systematised review was conducted to advance the knowledge and understanding through a combination of PT and UX. A narrative review was conducted on related concepts such as autonomous learning and digital learning relevant to the topic in the research study. The results presented in Chapter 2 contribute toward addressing the research sub-question (sub-RQ.a) by providing persuasive strategies and UX attributes from the literature.

Figure 2.1 depicts the approach adopted in the study with the systematised review focused on the main themes (PT, UX) and the narrative review focused on the sub-themes (autonomous learning, digital learning platforms, and design guidelines).

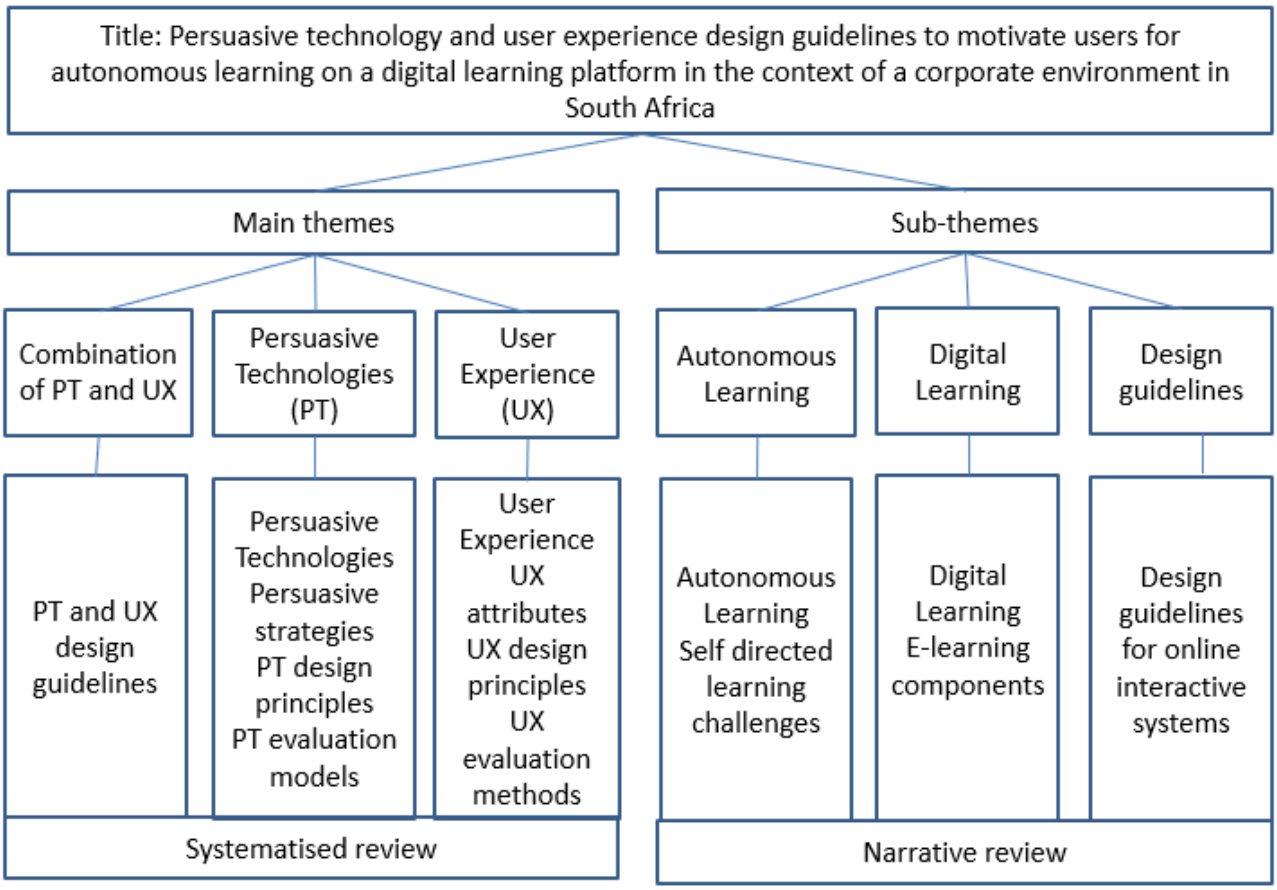

Figure 2.1: Review approach on main themes and sub-themes

The main themes approached the literature review using a systematised review. Included in the systematised review were detailed search, appraisal and synthesis of available research (Grant & Booth, 2009). However, since only one reviewer conducted the review, it cannot be considered a full systematic review. The sub-themes were investigated using a narrative review, as a narrative review attempts to identify research on the subject or topic (Paré et al., 2015).

The sections in this chapter have been organised as follows: Section 2.1 discussed the introduction and literature approach. Section 2.2 discusses the review approaches adopted in this study. Section 2.3 discusses the main constructs in this study by providing the findings

from the systematised review conducted on both PT and UX. However, due to limited results returned at the intersection of PT and UX, the researcher deemed it necessary to conduct additional literature searches on PT and UX individually. The results discussed in Section 2.4 and Section 2.5. The narrative review continued in Section 2.6 for discussion on the design guidelines, and Section 2.7 and Section 2.8 discusses the sub-themes of autonomous learning and digital learning platforms, respectively. Section 2.9 concludes the literature review chapter.

2.2 Literature review approaches adopted in the study

To repeat, the researcher deemed it necessary to adopt systematised and narrative reviews for obtaining additional literature searches on PT and UX individually due to limited results returned at the intersection of PT and UX. The justification for the approaches follows:

Systematised reviews attempt to include one or more elements of the systematic review process while stopping short of claiming that the resultant output was a systematic review transparent in reporting its methods to facilitate others to replicate the process (Grant & Booth, 2009). It allowed, without drawing upon the resources required, for a full systematic review (Okoli & Schabram, 2012). It falls short of being able to claim comprehensiveness, which is fundamental to the systematic review method (Grant & Booth, 2009). See Section 2.2.1 for a detailed discussion on the systematised review applied in the study.

A narrative review or “traditional literature review” attempts to identify writings about the subject or topic by providing a comprehensive, critical and objective analysis of the knowledge on the topic (Paré et al., 2015). It also assists in identifying patterns in literature to identify gaps in the body of knowledge (Saunders et al., 2009).

The systematised review steps are explained in Table 2.1 and include the application of the steps in the study.

2.2.1 Systematised review process

The systematised review process, which included elements of the systematic review steps (Okoli & Schabram, 2012), followed the eight steps in this research study, as provided in Table 2.1. In Table 2.1, column 1 provides the systematic review steps, and column 2 provides the application in the study for systematised review, which included elements relevant to the systematic review process as advocated by Grant and Booth (2009).

Table 2.1: Systematised review steps, descriptions, and application in the study

Steps and Descriptions (Okoli & Schabram, 2012)	**Application in the study for systematised review**
1. Purpose of the literature review: this step requires the reviewer to clearly identify the purpose and intended goals of the review (Okoli & Schabram, 2012).	The purpose of the literature review was to establish the existing literature published in the research study area, and to support the purpose and objectives of the research study as advocated by Saunders et al. (2009).
2. Protocol and training: this step requires a written, detailed protocol document and training for all reviewers to ensure consistency in the execution of the review (Okoli & Schabram, 2012). This was important for any review that employs more than one reviewer (Grant & Booth, 2009), as it is critical that the reviewers are completely clear and in agreement about the detailed procedure to be followed.	As the study adopted the systematised review, the review was conducted by one reviewer, being the researcher, and therefore training was not required. However, to observe protocol for consistency in the execution of the review, the review conducted was documented in a template in Microsoft Excel with headings indicating the parameters of interest consisting of the following headings: year of publication, author, reference, purpose, methodology, key findings, contributions, constraints, country of study and domain sector. The workbook entries found in APPENDIX J.
3. Searching for the literature: this step requires the reviewer to be explicit in describing the details of the literature search and needs to explain and justify how the comprehensiveness	The systematised review was conducted using publications from credible research databases such as SCOPUS, Institute of Electrical and Electronics Engineers (IEEE), and Web of Science (WOS). The articles included in the systematised review were those

of the search was assured (Okoli & Schabram, 2012).	published from 2010 to 2020. The search strings used in the literature search is listed in Section 2.2.2. The parameters relevant to the research study, as indicated in Step 2, were noted from the results.
4. Practical screen or screening for inclusion step: this step was deemed an important part of any literature review. In this step, the reviewer needs to be explicit about the studies that were considered for review and the studies that were eliminated without further examination, along with the reasons for exclusions, so that the resulting review can still be comprehensive given the practical exclusion criteria (Okoli & Schabram, 2012).	The review included articles written in the English language and peer-reviewed journals. The review also included articles employing either or both qualitative and quantitative methodologies. Non-English-related articles were eliminated and therefore excluded based on the relevance to the study from the information provided in the abstract. After removing duplicate articles from the different databases, the remaining articles went into the screening process iteratively. The first iteration used the abstracts and then reviewed the entire article in cases where relevant information was not obtained in the abstract. The process entailed checking and noting the article's purpose, methodology, key findings, contributions, constraints, country of study and domain sector. The relevant articles retained were saved in Mendeley as a repository.
5. Quality appraisal or screening for exclusion: this step requires the reviewer to be explicit about the studies not considered for review by specifying the criteria for judging which articles are of insufficient quality to be included in the review synthesis (Okoli & Schabram, 2012). All included articles had to be scored for quality, depending on the research methodologies employed.	The higher quality selection criteria used: Articles using a similar methodology (DSR) and in similar domains such as corporate organisations. Articles that conducted studies on children/minors have been excluded as part of screening because the research focused on adult employees. The remaining articles after screening for exclusion, were included as they met the quality selection criteria and supported the purpose of this study in PT and UX.
6. Data extraction: the reviewers systematically extract the applicable information from the identified studies (Okoli & Schabram, 2012).	The abstract was used to survey the articles returned in the first iteration of the review, and then during the second iteration, the full article was read. The following information was recorded: year, author, reference,

	purpose, methodology, findings, contributions, constraints, country of study and domain sector. The workbook entries added as APPENDIX J.
7. Synthesis of studies or analysis: in this step, the reviewer extracts the combination of the facts from the studies by using appropriate techniques, such as quantitative, qualitative, or both synthesis (Okoli & Schabram, 2012).	Section 2.3 documents the article analysis. Because of the limited literature available covering PT and UX, the researcher complemented the review by further searching the constructs separately, as detailed in Sections 2.4 and 2.5, respectively, to gain in-depth insights to support the study. Figures 2.2 and 2.3 provides the quantitative analysis of the articles.
8. Writing the review: in this step, the process of a systematic literature review must be reported in sufficient detail so that the review results can be independently reproduced (Okoli & Schabram, 2012).	The writing of the systematised review on the main constructs was recorded in Section 2.3 for PT and UX, together; Section 2.4 for PT, and Section 2.5 for UX, individually.

Based on Table 2.1, the systematised review identified the existing research work published from electronic databases on the main themes, namely PT and UX. This was done in support of the purpose and objectives of the research study. The results returned from the electronic databases search strings were discussed in Section 2.3 for the main themes PT and UX combined. It was repeated on the individual PT theme in Section 2.4 and UX in Section 2.5, respectively, to ensure rigour and process in the review.

The narrative review results on the design guidelines, autonomous learning, and digital learning platforms are discussed in Section 2.6, Section 2.7, and Section 2.8, respectively. A narrative review on autonomous learning on digital learning platforms was conducted, to enhance understanding of the context of the research study. The articles reviewed show that in literature the term digital learning is used interchangeably with electronic-learning or technology-enhanced learning (Mulenga, 2020). Similarly, autonomous learning, as a learning style, was also used interchangeably with self-directed learning, self-education and self-study (Macaskill & Denovan, 2013). This study refers to the terminology of autonomous learning and accessing the learning content on the digital learning platforms in the corporate environment.

This research study seeks to contribute to the limited literature studies covering a combination of PT and UX for improving user motivation in the digital learning platform and fills the gaps as identified in the literature:

Gap 1: There was a need for expanded studies into literature covering both the PT and UX for users' motivation for autonomous learning in the digital learning platform in corporate environments. The literature indicated that few studies cover PT and UX, as presented in the literature by Daud et al. (2013) and Kaplarski (2015), justified by credible sources found in the literature search of the low number of articles covering both PT and UX.

Gap 2: There was a need for further research into other sectors and countries, such as South Arica, covering both PT and UX for users' motivation in autonomous learning on the digital learning platform. This low number of articles found on the African continent from the literature search and credible sources supports this claim (see Section 2.4).

2.2.2 Research databases and search strings

The article search included publications from research databases such as SCOPUS, IEEE, and WOS for articles published between 2010 and 2020, as reported in Table 2.2. Firstly, a search was done with all keywords. Secondly, a search using both PT and UX. Thirdly, a separate search on PT as well as UX in the context of digital learning, and autonomous learning were also conducted.

Table 2.2: Summary of keywords, search strings, and results returned

Keywords	Search Strings	Results
PT and UX and autonomous learning and digital learning	SCOPUS: (TITLE-ABS-KEY ("persuasive technology") AND TITLE-ABS-KEY ("user experience") AND TITLE-ABS-KEY (“autonomous learning”) AND TITLE-ABS-KEY (“digital learning”)) PUBYEAR > 2009 IEEE: (("All Metadata”: “persuasive technology") AND "All Metadata”: “user experience") AND "All Metadata”: “autonomous learning ") AND ("All Metadata”: " digital learning ") Filters Applied: 2010 – 2020 WOS: TOPIC: ("persuasive technology") AND TOPIC: ("user experience") AND TOPIC ("autonomous learning") AND TOPIC ("digital learning") Timespan: 2010-2020.	0 0 0
PT and UX	SCOPUS: (TITLE-ABS-KEY ("persuasive technology") AND TITLE-ABS-KEY ("user experience")) AND PUBYEAR > 2009 IEEE: (("All Metadata”: “persuasive technology") AND "All Metadata”: “user experience") Filters Applied: 2010 – 2020 WOS: TOPIC: ("persuasive technology") AND TOPIC: ("user experience") Timespan: 2010-2020.	46 articles 9 articles 6 articles
PT and autonomous learning	IEEE: (("All Metadata”: “persuasive technology") AND "All Metadata”: “autonomous learning ") Filters Applied: 2010 – 2020	18
PT and digital learning	SCOPUS: (TITLE-ABS-KEY ("persuasive technology") AND TITLE-ABS-KEY ("digital learning")) AND PUBYEAR > 2009	0
Autonomous learning and Digital learning	SCOPUS: (TITLE-ABS-KEY ("autonomous learning") AND TITLE-ABS-KEY (digital learning)) AND PUBYEAR > 2009 IEEE: (("All Metadata": "Autonomous learning") AND "All Metadata": "digital learning") Filters Applied: 2010 - 2020	125 18

According to Table 2.2, the simultaneous search of keywords for articles published between 2010 and 2020 returned zero results from the databases SCOPUS, IEEE, and WOS. The results returned for the remainder of the search strings are discussed in Sections 2.3, 2.4, and 2.5.

2.3 Systematised review on a combination of PT and UX

The purpose and objectives of the research study required support from the systematised review of PT and UX from existing literature. Based on the systematised review process detailed in Section 2.2.1, Step 1 of the systematic review commenced by using PT and UX as theoretical lenses for improving the motivation of users (Daud et al., 2013; Kaplarski, 2015). Step 2 of the systematised review entailed observing protocol for consistency in the execution of the process, contributing to providing the answer to the research sub-question (sub-RQ.a). Step 3 of the systematised review entails searching the literature, as indicated in Table 2.2, providing details of search strings, databases searched (SCOPUS, IEEE, and WOS), and the years (articles between 2010 and 2020). Returned was a total of 61 articles from the search databases.

In executing Step 4 of the systematised review, the following processes occurred; practical screening was implemented, duplicate articles were removed, and articles of insufficient quality excluded (as Step 5). The remaining articles (31 articles) were reviewed for relevance to form the basis for the research study, as documented in the analysis in Figures 2.2 and 2.3. The 31 articles were analysed and categorised into the following categories: industry sectors and countries; studies that were conducted – this action was executed as Step 6 of the systematised review.

Based on the results of the systematised review, where Step 7 shows the analysis, the following two categories identified during the literature review are first, the countries where the research study occurred were *grouped according to continents,* and second, the *industry sectors* in which the studies took place. These two categories are deemed

relevant in the research studies, as they expose opportunities to conduct PT and UX studies on the industry sectors in countries which have been under-researched.

Countries grouped into the continent's analysis: The first iteration of the literature review analysis was conducted on the countries grouped into the continents, as depicted in Figure 2.2. This was done to determine the coverage of studies per continent. This analysis revealed opportunities to conduct studies regarding the status quo in under-researched countries. It was crucial as it may add novel perspectives to the study of South African corporate organisations.

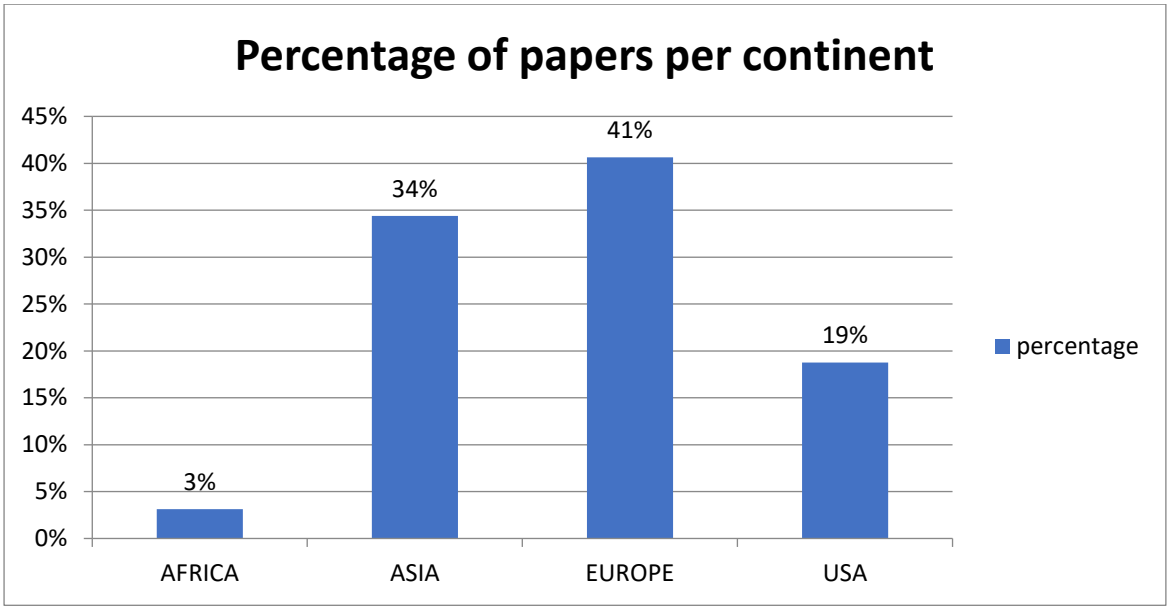

Figure 2.2: PT and UX studies conducted per continent

The analysis shows that the most identified research studies were conducted in the European continent (41%), followed by Asia (34%) and then the USA (19%), the African continent with the lowest (3%), as depicted in Figure 2.2.

The second iteration of the analysis included a review of the industry sector analysis.

Industry sectors analysis: The second iteration in the literature review analysis was conducted to determine the coverage of the combination of PT and UX studies per the industry sector, as depicted in Figure 2.2. This analysis exposed opportunities research on

combination of PT and UX studies in industries that are under-researched and therefore are important as they may add novel perspectives. Furthermore, this analysis could help identify any potential gaps in the industry as a result.

The literature review analysis showed that less than 50% (of the 31 articles) were found on the combination of PT and UX. Supporting the previous argument from the literature that limited studies have been conducted on the combination of PT and UX together as theoretical lenses for users' motivation (Daud et al., 2013; Kaplarski, 2015; Pilloni et al., 2013). The study of PT and UX as theoretical lenses was essential to note the interplay between psychology and information technology when developing interventions to shape human behaviour (Gram-Hansen et al., 2018). Hence, adding novelty to the study in solving the research problem in the South African context.

Notably, most of the studies from the literature were conducted mainly in the Education Sector at 34%, and other sectors (Corporates and the Health Sector) were all below 20% of the literature sample, depicted in Figure 2.3. This finding reveals the need for further studies in these sectors. The General Public (civil society) may be cutting across different sectors, resulting in no further analysis of this category. Therefore, the need to conduct further studies in other sectors supports the observation by Daud et al. (2013) and Kaplarski (2015) that PT and UX were under-researched, especially for digital learning in a corporate organisation (Rana et al., 2016).

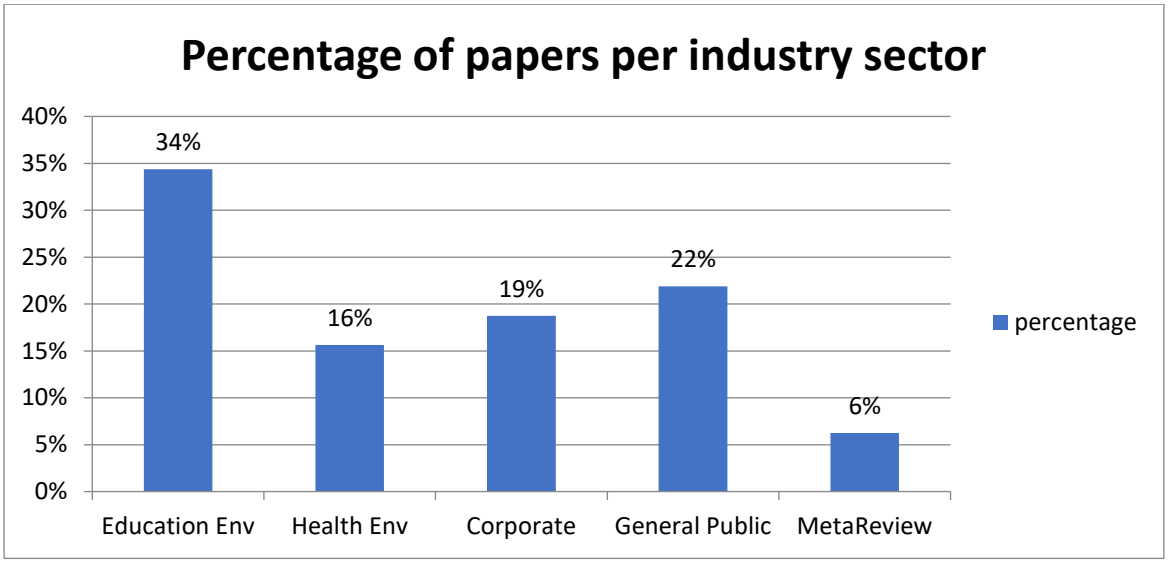

Figure 2.3: PT and UX articles relevance per the sector

MetaReviews revealed the existence of 6% of articles noted in Figure 2.3, which refers to the information provided by the existing reviews. As advocated by Saunders et al. (2009), this shows a beginning of maturity around literature.

As noted, a limited number of articles were returned when searching for studies on the combination of PT and UX. Therefore, the second iteration of the systematised review continued for in-depth studies on the keywords (PT and UX) individually.

The findings from these individual studies revealed the following additional knowledge:

- The common persuasive strategies were deployed to improve users' motivation (F. A. Orji et al., 2018).
- The user perception of satisfaction (attribute of UX) in using the product influence the emotion (improvement in motivation) when using the product (Hassenzahl, Diefenbach, & Göritz, 2010).
- There was an overlap between PT and UX studies; both influence users' emotions, such as motivation (Adaji, 2017; Kaplarski, 2015; Pilloni et al., 2013; Segerståhl et al., 2010).

2.4 Systematised review on Persuasive Technologies (PT)

The literature search for PT was done using specific keywords and search strings from the academic search databases (SCOPUS, IEEE, and WOS) (see Section 2.2). The search resulted in the in-depth content and context on PT, as detailed in Sections 2.4.1 and 2.4.2 for persuasive strategies and evaluation models, respectively. The timeframe was limited to articles published between 2010 to 2020.

Persuasion in PT originates from psychology, which seeks to understand human behaviour; hence when interventions develop to shape human behaviour, it was essential to note the interplay between psychology and information technology (Gram-Hansen et al., 2018). PT employs technologies designed primarily to change users' behaviours, attitudes and thoughts freely and honestly (Fogg, 2009). Using computers as PT alludes to captology (Fogg, 2009). Captology refers to the study of interactive computer applications whose design, research and analysis were created to change behaviours or attitudes (Fogg, 2009). In Figure 2.4, captology in the context of the study depicted the essential items noted to indicate the interplay of the persuasion behaviour (for example, motivation) and computer capabilities (for example, digital learning platform) that were found relevant to the study.

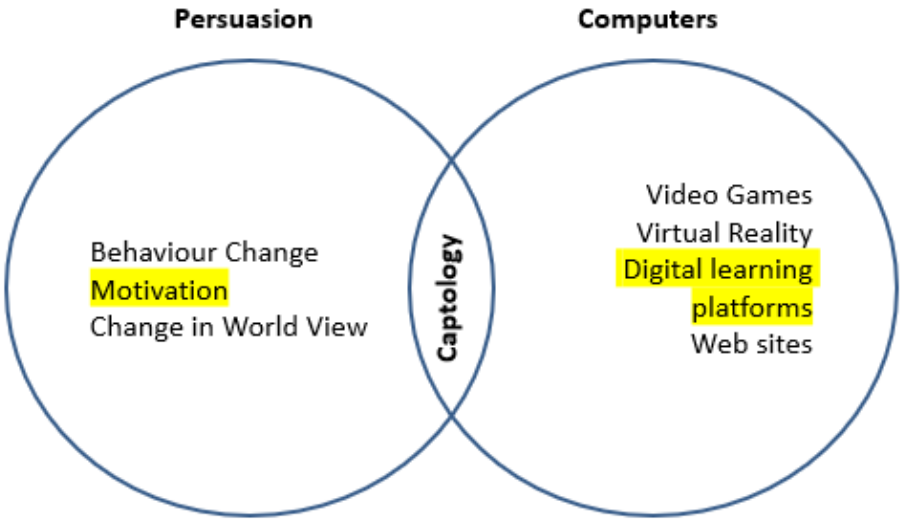

Figure 2.4: Captology - computers and persuasion overlap (adapted from Fogg (2009))

The persuasive strategies used by the PT systems include, among others, competition, self-monitoring and cooperation (F. A. Orji et al., 2018). Daud et al. (2013) provided a valuable model for designing online web-based learning environments. Kaplarski (2015) built on this to provide a basis for combining persuasive design and user experience design in web-based learning environments to motivate students learning.

The literature analysis depicted in Figure 2.2 indicated that limited studies with a combination of PT and UX in the African continent for corporate organisations were available. Only one study in the African continent focusing on PT studies in Africa shows that PT has the potential to persuade learners to develop new study behaviours in the context of schools (Sibanyoni & Alexander, 2017).
In Section 2.4.1, the persuasive strategies of a PT system are discussed.

2.4.1 Persuasive strategies

Persuasive strategies are techniques incorporated into PT to modify or change users' behaviours (Gamberini et al., 2012). The study by Oinas-Kukkonen and Harjumaa (2009) developed 28 design strategies and classified the 28 design strategies into four categories, referring to them as the persuasive system design (PSD) framework. The four categories were based on the type of support the persuasive strategies provided to users of a system and application in the context of usage (Oinas-Kukkonen and Harjumaa, 2009). Essential to the development and evaluation of persuasive systems were the persuasive strategies, which describe the content, software functionality and design principles (Adaji, 2017; Daud et al., 2013). This study adopted the PSD framework for the PT constructs. These persuasive strategies are effective in designing a persuasive system, and it was for this reason that Daud et al. (2013) used the persuasive strategies to formulate a suitable model for web-based learning (WBL), validated in a later study by Kaplarski (2015) in creating a persuasive user interface. See Section 2.6 for a detailed discussion on design principles and guidelines for online interactive systems. It was important for any system design to include both functional and non-functional requirements since a system's persuasiveness is a non-functional requirement or quality (Oinas-Kukkonen & Harjumaa, 2009).

The persuasive strategies were categorised into the four persuasive dimensions (Némery & Brangier, 2014): primary task support, dialogue support, system credibility support and social support, which are referred to as principles by Oinas-Kukkonen and Harjumaa (2009). Each persuasive dimension, the persuasive strategies and their descriptions are depicted in Table 2.3.

Table 2.3: List of 28 persuasive strategies (adapted from Oinas-Kukkonen and Harjumaa (2009))

Persuasive dimensions	Persuasive strategies	Description
Primary task support The primary task support refers to the desired target behaviour in the design, for example, by breaking down the behaviour into smaller steps specific to the task (Oinas-Kukkonen & Harjumaa, 2009).	**Reduction**	This refers to a system that reduces users' effort when performing their target behaviour. It reduces complex behaviour into simple tasks that help users perform the target behaviour and may increase the benefit/cost ratio of behaviour (Oinas-Kukkonen & Harjumaa, 2009).
	Tunnelling	This refers to a system that guides users through attitude change processes by providing the means for action that bring them closer to the target behaviour. It guides users through a process or experience while providing opportunities to persuade along the way (Oinas-Kukkonen & Harjumaa, 2009).
	Tailoring	This refers to the system providing tailored information for user groups. The information provided by the system is more persuasive if tailored to the potential needs, interests, personality, usage context, or other factors of a user group (Oinas-Kukkonen & Harjumaa, 2009).
	Personalisation	This refers to a system that offers personalised content or services more capable of persuasion (Oinas-Kukkonen & Harjumaa, 2009).
	Self-monitoring	This refers to a system that allows users to track their performance or status. It keeps track of a user's performance or status and supports them in achieving goals (Oinas-Kukkonen & Harjumaa, 2009).

	Simulation	Simulation refers to a system that provides the means to observe simulations and persuades by enabling users to immediately observe a link between cause and effect (Oinas-Kukkonen & Harjumaa, 2009).
	Rehearsal	This refers to a system that provides a means to rehearse a target behaviour, enabling people to change their attitudes or behaviour in the real world (Oinas-Kukkonen & Harjumaa, 2009).
	Praise	This refers to expressing approval; a system can make users more open to persuasion; it can praise with words, images, symbols or sounds to provide a user with feedback information based on their behaviours (Oinas-Kukkonen & Harjumaa, 2009).
Dialogue support The dialogue support refers to the dialogue between the user and the system in the design, for example, by incorporating verbal feedback to the user (Oinas-Kukkonen & Harjumaa, 2009).	**Rewards**	This refers to a system that provides users with virtual rewards giving them credit for performing the target behaviour. It provides target behaviours that may have great persuasive powers (Oinas-Kukkonen & Harjumaa, 2009).
	Reminders	This refers to a system that reminds them of their target behaviour when using the system, and they will more likely achieve their goals (Oinas-Kukkonen & Harjumaa, 2009).
	Suggestion	This refers to a system offering fitting suggestions with greater persuasive powers by suggesting that users carry out behaviours while using the system (Oinas-Kukkonen & Harjumaa, 2009).
	Similarity	This refers to using a system reminding people of themselves in some meaningful way. Systems should, thus, imitate their users in a specific way (Oinas-Kukkonen & Harjumaa, 2009).
	Liking	This refers to a visually attractive system that is likely to be more persuasive to users. Therefore, its look and feel should appeal to users (Oinas-Kukkonen & Harjumaa, 2009).
	Social role	This refers to positions in a society like father, mother, employee, and student; users will more likely use it for persuasive purposes. A system should adopt a user's social

		role to be more persuasive (Oinas-Kukkonen & Harjumaa, 2009).
	Trustworthiness	This refers to a system that provides truthful, fair, and unbiased information. The trustworthy information will have increased powers of persuasion (Oinas-Kukkonen & Harjumaa, 2009).
System credibility support The credibility support refers to the design of the system to be more trustworthy for persuasiveness, as an example, by providing trusted sources (Oinas-Kukkonen & Harjumaa, 2009).	**Expertise**	This refers to a system that reflects expertise and will have increased powers of persuasion. Thus, it should offer information which speaks of its knowledge, experience, and competence.
	Surface credibility	This refers to a system with competent look and feel, as people make initial assessments of a system's credibility based on a first-hand inspection (Oinas-Kukkonen & Harjumaa, 2009).
	Real-world feel	This refers to a system providing information on the organisation and/or the people behind its content and services. It gives credibility to the people or organisation behind its content or services (Oinas-Kukkonen & Harjumaa, 2009).
	Authority	This refers to a system that leverages authority roles with enhanced powers of persuasion. Thus, it should refer to people in positions of authority (Oinas-Kukkonen & Harjumaa, 2009).
	Third-party endorsements	Endorsements from well-known and respected sources boost perceptions regarding system credibility. Thus, systems should provide third-party endorsements from respected sources (Oinas-Kukkonen & Harjumaa, 2009).
	Verifiability	This refers to a system's perceptions of enhanced credibility if it is easy to verify the accuracy of site content via outside sources. Therefore, it should provide the means to verify the accuracy of site content via external sources (Oinas-Kukkonen & Harjumaa, 2009).
	Social learning	This refers to a system providing users with the means to observe other users performing target behaviours and see the outcomes of their behaviour. A person will be more motivated to perform a target behaviour if they can use a

		system to observe others performing the behaviour. A person will be more motivated to perform a target behaviour if they can use a system to observe others performing it (Oinas-Kukkonen & Harjumaa, 2009).
Social support The system social support refers to facilitating social influences, such as providing means to interact or compete with peers (Oinas-Kukkonen & Harjumaa, 2009).	**Social comparison**	This refers to a system that provides users with a means to compare their performance with other users. Users will have greater motivation to perform target behaviours if they can compare their performance with that of others (Oinas-Kukkonen & Harjumaa, 2009).
	Normative influence	This refers to a system that can leverage peer pressure to increase the likelihood that a person will adopt a target behaviour. Thus, it should provide the means to bring people together with the same goal and make them feel they share certain norms (Oinas-Kukkonen & Harjumaa, 2009).
	Social facilitation	This refers to a system that provides users with means for discerning other users performing that behaviour. Users are more likely to perform target behaviour if they discern, via the system, that others are performing the behaviour with them (Oinas-Kukkonen & Harjumaa, 2009).
	Cooperation	This refers to a system that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate. The system should, thus, provide a means for cooperation (Oinas-Kukkonen & Harjumaa, 2009).
	Competition	This refers to a system that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete. It should, therefore, provide the means for competing with other users (Oinas-Kukkonen & Harjumaa, 2009).
	Recognition	This refers to a system that publicly recognises users who perform a target behaviour. A system that offers public recognition to an individual/group and increases the likelihood that a person/group will adopt a target behaviour (Oinas-Kukkonen & Harjumaa, 2009).

According to Oinas-Kukkonen and Harjumaa (2009), selecting the relevant persuasive strategies for the research study requires careful analysis of the context of persuasion, as many persuasive strategies cannot be evaluated in a single study, as noted by F. A. Orji et al. (2018). The selection process in the study began with the 28 persuasive strategies (Oinas-Kukkonen & Harjumaa, 2009), further refined to the nine common persuasive strategies (Lehto & Oinas-Kukkonen, 2011; R. Orji, 2017), then into four common persuasive strategies (Bonk & Lee, 2017; F. A. Orji et al., 2018). Finally, they were reduced to three common persuasive strategies since *competition* and *comparison* belong together (R. Orji et al., 2014), as depicted in Table 2.4.

Table 2.4: Selection process of persuasive strategies to be used in this research study

	28 Persuasive strategies (Oinas-Kukkonen and Harjumaa, 2009)	9 common persuasive strategies (Lehto and Oinas-Kukkonen, 2011)	4 common persuasive strategies (Bonk & Lee, 2017; F. A. Orji et al., 2018)	3 common persuasive strategies (R. Orji et al., 2014)
Primary task support	Reduction	-	-	-
	Tunnelling	-	-	-
	Tailoring	-	-	-
	Personalisation	Personalisation	-	-
	Self-monitoring	Self-monitoring	Self-monitoring	Self-monitoring
	Simulation	Simulation	-	-
	Rehearsal	-	-	-
	Praise	-	-	-
Dialogue support	Rewards	-	-	-
	Reminders	Reminders	-	-
	Suggestion	Suggestion	-	-
	Similarity	-	-	-
	Liking	-	-	-
	Social role	-	-	-
	Trustworthiness	-	-	-
System credibility	Expertise	-	-	-
	Surface credibility	-	-	-
	Real-world feel	-	-	-
	Authority	-	-	-
	Verifiability	-	-	-

	3rd party endorsements	-	-	-
	Social learning	-	-	-
Social support	Social comparison	Social comparison	Social comparison	-
	Normative influence	-	-	-
	Social facilitation	-	-	-
	Cooperation	Cooperation	Cooperation	Cooperation
	Competition	Competition	Competition	Competition
	Recognition	Recognition	-	-

Although the persuasive strategies listed for *competition* and *comparison* are two different persuasive strategies (Oinas-Kukkonen and Harjumaa, 2009), they belong together (R. Orji et al., 2014). For example, users tend to perform better in a competition where they compete and compare their performance to their peers. *Competition*, therefore, was a by-product of *comparison* (R. Orji et al., 2014). In the context of the study, as studies on digital learning indicated that over and above motivation, autonomous learning also requires self-monitoring (Bonk & Lee, 2017), as it monitors users' performance (Segerståhl et al., 2010). Therefore, as a result of putting the persuasive strategies in the context of the research study on digital learning, the research study employed the following common persuasive strategies: *competition*, *cooperation*, and *self-monitoring*, as indicated in Table 2.5 for the following reasons:

- These common persuasive strategies have been applied widely in various PT domains because of their perceived effectiveness in motivating behaviour change (R. Orji, 2017) and have been validated in studies by Stibe and Oinas-kukkonen (2014).
- These common persuasive strategies are among the commonly used ones identified (Lehto & Oinas-Kukkonen, 2011; F. A. Orji et al., 2018; R. Orji, 2017).
- The 28 persuasive strategies are too many to practically evaluate in a single study (F. A. Orji et al., 2018); as a result, the research study leverages the power of social influence and primary task support to motivate behaviour change.

The systematised review revealed that different researchers conducted studies on PT for changing user behaviour, and their contribution to literature assisted the study by revealing the design guidelines. Table 2.5 summarises the selected persuasive strategies adopted

and the proposed application in this study that follows the design guidelines found in the various literature resources.

Table 2.5: The selected persuasive strategies adopted in the study and design guidelines

Persuasive strategies	**Proposed application in the study**	**Design guidelines**
Competition	The proposed application of a persuasive strategy leverages the strength of the competition's strategy in that it engages and challenges users to perform towards their goals making the task appear easier to do while keeping it fun and exciting (R. Orji, 2017). An example of a persuasive strategy includes using a scoreboard to share the progress level information, achievements and percentage of other users who have completed the course on the autonomous learning system. This was achieved by comparing performance with peers, hence, the similarity to the social-comparison strategy (R. Orji et al., 2014). This will motivate the users to conduct the autonomous learning courses to catch up with peers on the scoreboard. The system will also assist users with having positive feelings of accomplishment doing the task as they progress through the scoreboard (Zaharias, 2009).	Designers should provide a mechanism for users to compare their performance and compete to break their records and reward them accordingly (R. Orji, 2017). Designers should ensure fair competition and comparison by not comparing dissimilar people and by measuring and comparing only realistic behaviour measures (R. Orji, 2017). The system should provide the means for competing with other users (R. Orji et al., 2014). Online competitions (Daud et al., 2013).
Cooperation	The proposed application of a persuasive strategy leverages the strength of the cooperation strategy in providing opportunities for mutual support, collaboration, and encouragement towards a common goal (R. Orji, 2017).	System should provide the means for co-operation. This requires users to cooperate (work together) to achieve a shared objective and rewards them for achieving their goals collectively (R. Orji, 2017).

	An example of a persuasive strategy application includes users viewing the results of their cooperative efforts through the system (Stibe & Oinas-kukkonen, 2014). The reporting from the system may allow for the grouping of users on the system (e.g., by the departments) to allow for the cooperation of users towards ensuring a common goal of achieving good performance in the department. Therefore, the rating for the whole department will enable users to work together towards the common goal of making the entire department's performance rating look good.	
Self-monitoring	The proposed application of a persuasive strategy allows users to track their progress and performance or status (Segerståhl et al., 2010). Examples of a persuasive strategy application include users viewing their current progress in learning tasks, tracking changes or improvements over time in learning tasks, and displaying user performance or progression (Segerståhl et al., 2010).	The system should provide the means for users to track performance or status (Oinas-Kukkonen and Harjumaa, 2009); (Segerståhl et al., 2010). Designers should provide a mechanism for users to track their performance progress and reward them accordingly (R. Orji, 2017). Measure own performance by using graphs showing time period progress in learning (Daud et al., 2013).

According to F. A. Orji et al. (2018), persuasive technologies motivate behaviour change using various persuasive strategies. The persuasive strategies to be implemented in the research study should leverage the strengths of the strategy for positive behaviour change.

Section 2.4.2 provides a discussion of the tools available for the evaluation of PT.

2.4.2 Evaluating PT

There are various tools available to evaluate PT in different industries, namely, evaluation tools such as PSD were used by Adaji (2017) and Segerståhl et al. (2010). R. Orji et al. (2019) used the ARCS (attention, relevance, confidence, satisfaction) model, while Haque, Isomursu, Kangas, and Jämsä (2018) used the Unified Theory of Acceptance and Use of Technology (UTAUT). This study found PSD and ARCS relevant, as PSD provided persuasive strategies while ARCS measured the motivation behaviour change of the persuasive system. UTAUT was less prevalent in the existing PT literature studies and thus eliminated.

- PSD was identified and discussed in Section 2.4.1 to form a basis for the persuasive strategies. ARCS was discussed as it measures the motivation behaviour change of the persuasive system.
- The ARCS (attention, relevance, confidence, satisfaction) model of motivation identifies system qualities that build or encourage motivation (R. Orji et al., 2019). The acronym ARCS was described as follows:

  Attention – According to Keller (2016), the attention category incorporates research on curiosity and arousal, interest, boredom, and other related areas such as sensation seeking. Therefore, to increase the system's persuasiveness, the design guideline to be adopted was to focus on designing *to capture user attention* (F. A. Orji et al., 2018).

  Relevance - According to Keller (2016), the relevance category refers to learners' perceptions that the instructional requirements are consistent with their goals, compatible with their learning styles, and connected to their past experiences. Therefore, to increase the system's persuasiveness, the design guideline to be adopted was to focus on designing to *increase relevance* (F. A. Orji et al., 2018).

  Confidence - According to Keller (2016), the confidence category refers to the effects of positive expectancies for success, experiences of success, and attributions of success to one's abilities and efforts rather than to luck or to task challenge levels that are too easy or difficult. Therefore, to increase the system's persuasiveness, the

design guideline to be adopted was to focus on designing to *promote confidence* (F. A. Orji et al., 2018).

Satisfaction - According to Keller (2016), satisfaction includes the appropriate mix of intrinsically and extrinsically rewarding outcomes that sustain desirable learning behaviours and discourage undesirable ones. Therefore, to increase the system's persuasiveness, the design guideline to be adopted was to focus on designing to *increase a feeling of satisfaction* (F. A. Orji et al., 2018).

The ARCS components were derived from a synthesis of research on human motivation and are rooted in several popular motivational theories such as the expectancy-value theory, social learning theory, self-efficacy theory, reinforcement theory, and cognitive evaluation theory (F. A. Orji et al., 2018).

The reasons for using the ARCS model were:

• The ARCS model has been widely applied, well-established and validated measurement scales for evaluating persuasive strategies across diverse environments and in many domains (R. Orji et al., 2019).

• The ARCS model was also used successfully in diagnosing improvement in learners' motivational engagement in self-directed learning on online learning platforms (R. Orji, 2017).

• The ARCS model was applied for self-directed online learning and in the web-based course and proved effective in diagnosing learners' motivational problems (B. Huang & Hew, 2016).

• Furthermore, the ARCS model was applied in UX studies to evaluate UX to motivate learning (Zaharias, 2009).

Therefore, the result of the systematised review of the first construct, namely persuasive strategies, identified elements from PSD and ARCS for evaluating PT.

Section 2.5 provides the details of the systematised review of the second construct in the study, namely UX, and identifies the UX attributes relevant to the research study.

2.5 Systematised review on User Experience (UX)

This section details the findings from the systematised review of the second construct in the study, namely UX. The literature search for UX was done from the academic search databases (SCOPUS, IEEE, and WOS) using keywords and search strings (see Section 2.2), and the timeframe was limited to articles published from 2010 to 2020. The results from this search provided in-depth content and context on UX, as detailed in Section 2.5.1 for a definition of UX and UX components, Section 2.5.2 provided the relation between UX and usability, Section 2.5.3 provided evaluation techniques for UX, and Section 2.5.4 provided usability.

This study adopted the definition of UX as defined by ISO9241-210 (2010) due to its simplicity. UX is defined as a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service (ISO9241-210, 2010). UX oversees user interaction with the system, including their resulting emotions, thoughts, feelings, and perceptions (Albert & Tullis, 2013). UX includes all the user responses (emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments) occurring before, during and after use (ISO9241-210, 2010).

2.5.1 UX attributes

In trying to derive UX attributes, the realisation from many authors was that UX was a complex field of study as it involves multiple aspects of user experience - simplicity, effectiveness, emotions, thoughts, attitudes, fun, joy, pleasure, satisfaction, excitement, and aesthetics (Cabestany, Sandoval, Prieto, & Corchado, 2009; Hassenzahl & Tractinsky, 2006; Lallemand, Gronier, & Koenig, 2015). However, effectiveness, efficiency, and satisfaction are the primary factors influencing UX and can be used to accurately portray the

evaluated user experience (Albert & Tullis, 2013). The interaction between a user and a system used in each context gives rise to certain perceptions (emotions, thoughts, and attitudes). These, in turn, influence intentions and interactions with the system over a certain period (Beauregard & Corriveau, 2007), as illustrated in Figure 2.5.

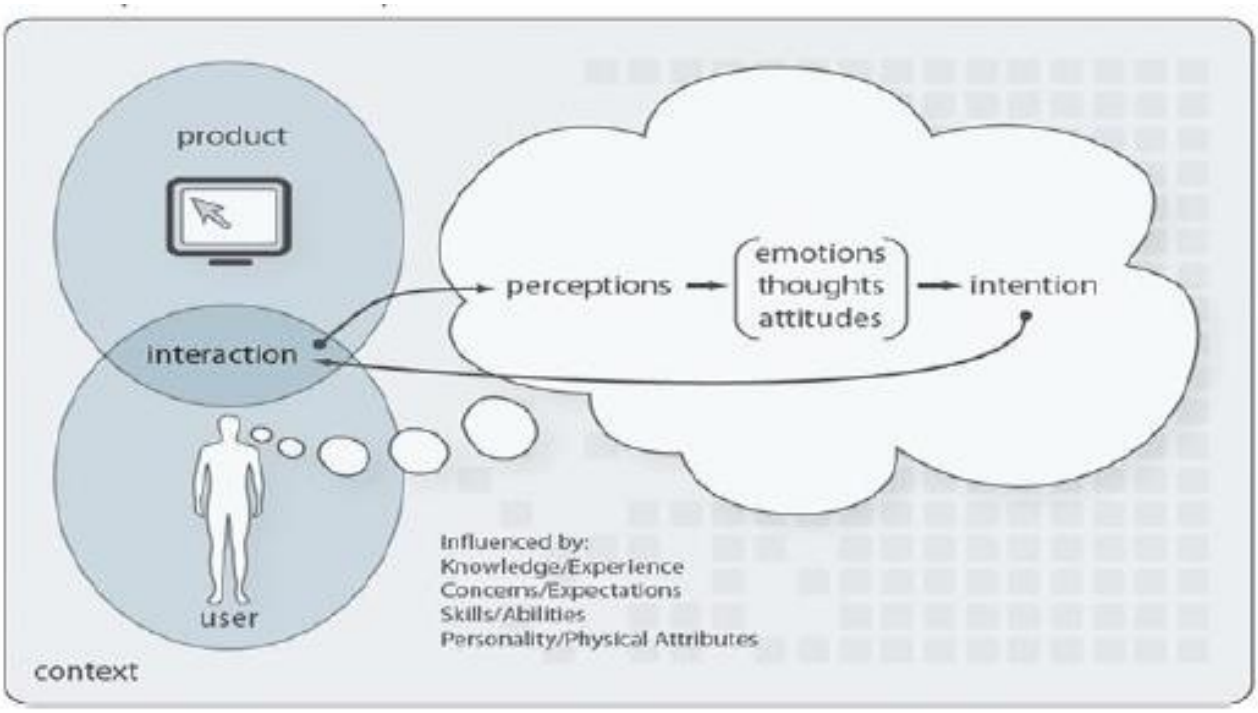

Figure 2.5: Factors influencing user experience (adapted from Beauregard and Corriveau (2007: 327))

Figure 2.5 presents UX components and the relationship between the constructs identified by Beauregard and Corriveau (2007). The view also advocated and shown simplified by Schrepp (2020), as discussed in Figure 2.9. According to Beauregard and Corriveau (2007), UX arises from the interaction between user and product, from which the perception results. The interaction with the product gives rise to emotions, thoughts, and attitudes, which then influence intention and interaction with the product across time (Beauregard & Corriveau, 2007). Factors such as knowledge or experience, concerns or expectations, skills or abilities, personality, and physical attributes influence UX (Beauregard & Corriveau, 2007).

Notably, the use of different terminologies was reviewed, attempting to provide a grouping of the factors influencing UX and classifying them. Thüring and Mahlke (2007) proposed the classification of the UX attributes into the perception of *instrumental qualities* (functionality, usefulness, and then usability - ease of use); emotional user reactions; and the perception of *non-instrumental qualities* (aesthetics, motivation), as depicted in Figure 2.6. A similar classification of UX attributes into instrumental and non-instrumental was also observed in a recent study by van Staden, van Biljon, and Kroeze (2017).

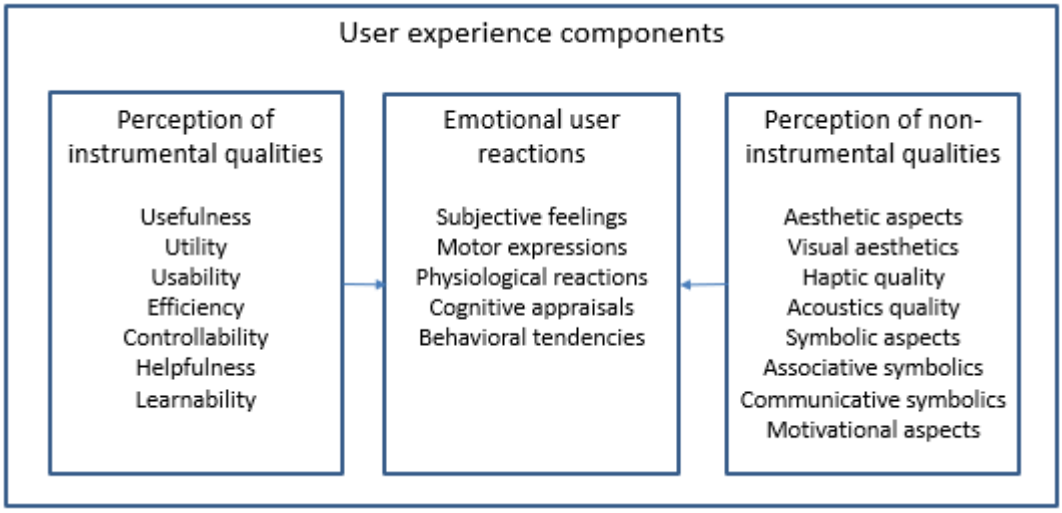

Figure 2.6: UX components (Thüring & Mahlke, 2007)

Another classification proposed by Hassenzahl and Tractinsky (2006) classifies UX attributes into factors, e.g., *pragmatic aspects* and *hedonic aspects* of interaction with a system or product. Hassenzahl and Tractinsky (2006) refer to pragmatic quality as the system's ability to support the achievement of behavioural goals. The hedonic aspects are related to the user, and therefore the users' self-stimulation (e.g., personal growth, an increase of knowledge and skills), identification (e.g., self-expression, interaction with relevant others) and evocation (e.g., self-maintenance, memories) (Hassenzahl & Tractinsky, 2006). The hedonic qualities (e.g., joy, pleasure, satisfaction, excitement) influence the user's emotions and contribute to judgement in the interaction between the user and system (Hassenzahl & Tractinsky, 2006).

Based on the above literature, observed are two different classifications of UX: *instrumental qualities* (functionality, usefulness, and usability) and *pragmatic aspects* (i.e., fit to behaviour goal), which are similar and could fall within the first classification of UX attributes. While *non-instrumental qualities* (aesthetics, motivation) and *hedonic aspects* (joy, pleasure, satisfaction, excitement) sit within the second classification of UX attributes. Therefore, the study adopts the terminologies of classifying UX attributes into *instrumental qualities* collectively referring to functionality, usefulness, and usability. Subsequently, *non-instrumental qualities* refer to collective aesthetics, motivation, satisfaction, and excitement. The grouping follows from the observation of some overlapping attributes of UX from the different literature sources, the *instrumental qualities,* namely, functionality and usability (Thüring & Mahlke, 2007; Albert & Tullis, 2013; ISO9241-210, 2010). Other *non-instrumental qualities* are satisfaction, skills, emotions, feelings of excitement, and perceptions (Albert & Tullis, 2013; de Kock, van Biljon, & Botha, 2016; Hassenzahl & Tractinsky, 2006; ISO9241-210, 2010; van Staden et al., 2017).

Section 2.5.2 provides a brief overview of the relationship between UX and usability. This discussion was vital as it establishes the position the study adopts regarding the relationship between UX and usability.

2.5.2 Relationship between UX and usability

As defined by ISO9241-210 (2010), UX refers to a person's perceptions and responses resultant from the use and/or anticipated use of a product, system or service. Usability is the extent to which a system, product or service can be used by specified users to achieve required goals with *effectiveness, efficiency and satisfaction* in a specified context (ISO9241-210, 2010). User satisfaction was considered in usability; removing the common misconception that usability only refers to making the system easy to use (ISO9241-210, 2010). As depicted in Figure 2.7, UX and usability are related and adapted from previous studies, showing the relationship between usability and UX in the three general viewpoints (Moczamy, de Villiers, & van Biljon, 2012).

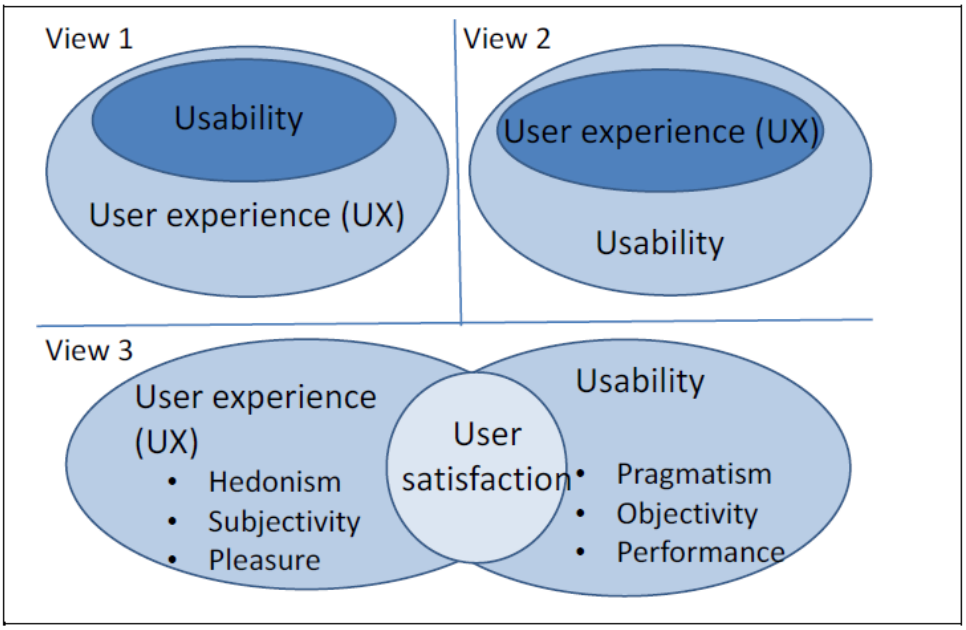

Figure 2.7: Viewpoints showing relationship of UX and usability (adapted from Moczamy et al., 2012: 217)

The three views were described as follows by Moczamy et al. (2012):

- View 1 depicts the relationship between UX and usability, depicting usability as a factor in the UX, therefore, showing usability as included in UX.
- View 2 depicts the relationship between UX and usability, depicting UX as user satisfaction as a subjective component in usability, therefore, showing UX as a factor in usability (Moczamy et al., 2012).
- View 3 depicts UX and usability as separate but closely-related concepts interconnected by common attributes noting that they are both different in their characteristics (Moczamy et al., 2012).

Previous studies by Preece, Rogers, and Sharp (2002) also depicts usability as a subset of UX elegantly, as indicated in Figure 2.8, where the usability goals are a subset of UX goals.

Figure 2.8: Usability and UX goals (Preece et al., 2002:19)

Usability metrics are valuable tools that can be used to successfully evaluate UX (Albert & Tullis, 2013). The position of the view adopted in the research study is View 1 (Figure 2.7), identifying usability as a subset of UX, as previously observed by Preece et al. (2002), depicted in Figure 2.8. This position was maintained considering all usability aspects when evaluating the UX, as proven in previous research studies (de Kock et al., 2016; Preece et al., 2002). Following this discussion, due to the complexity of UX and its attributes, the UX attributes prioritised and selected for consideration in the research study were satisfaction, effectiveness, and efficiency, because these attributes can be easily measured using usability metrics for measuring the influence on users' motivation. Section 2.5.3 provides a discussion on UX measurement metrics.

2.5.3 Measuring UX

Evaluating all the primary factors influencing UX was necessary for an accurate overall picture of UX (Lallemand et al., 2015). The usability evaluation methods are techniques

evaluators use to identify usability problems that need to be addressed through the design of a system (Moczamy et al., 2012). The UX questionnaires measure the impression of a group of users towards using a product (Schrepp, 2020), as depicted in Figure 2.9. The measurement scale requires reliability to obtain relevant results and is discussed further in Section 6.3. Reliable measurement metrics to successfully evaluate UX are referred to as usability metrics (Albert & Tullis, 2013). The measurement metrics are often presented in the form of questionnaires that can be utilised to successfully evaluate UX and show improvement in the user experience in using the product.

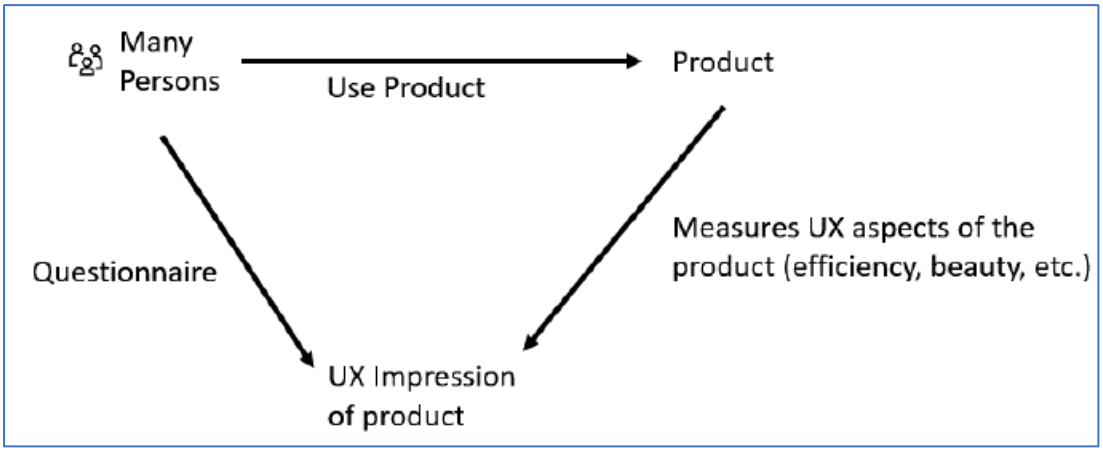

Figure 2.9: UX questionnaire measurement in relation to the use of a product (Schrepp, 2020:251)

The evaluation tools such as the User Experience Questionnaire (UEQ), Questionnaire for User Interaction Satisfaction (QUIS), and System Usability Scale (SUS) are available in the literature, each of them with advantages and disadvantages. Amongst them UEQ allows evaluation of the user experience of a product with little effort (Albert & Tullis, 2013).

The attributes of UX selected for measurement during the user interaction process with the system were *effectiveness, efficiency, and satisfaction*, the core attributes included in usability and UX, as listed in Table 2.6. All the primary factors influencing UX need evaluation to acquire an accurate overall picture of UX (Lallemand et al., 2015) for the design of the digital learning system to be easy to learn, easy to use, and enjoyable to use for the

intended users (Kaplarski, 2015). However, it was necessary to make a selection due to time and resource constraints.

Table 2.6: The UX attributes adopted in the study application and design guidelines

Attribute and Descriptions	Application in the study	Design guidelines
Effectiveness refers to the accuracy and completeness with which users achieve specified goals; and the ability to complete a task successfully (ISO9241-210, 2010).	*Effectiveness* in the context of the research study was measured by the number of tasks users completed successfully, as advocated by Albert and Tullis (2013).	The system's design must support the goals with ease of use (Albert & Tullis, 2013).
Efficiency refers to the amount of effort (Time on task) required to complete the task successfully (Albert & Tullis, 2013).	*Efficiency* in the research study context was measured by the time spent on the task, as advocated by Albert and Tullis (2013).	The system's design must support the efficient use of a system (Albert & Tullis, 2013).
Satisfaction refers to the user's internal state of whether the user was happy with the experience while performing the task (Albert & Tullis, 2013).	*Satisfaction* in the context of the research study was measured by the degree of the user's internal state; for example, was the user happy with the experience while performing the task, as advocated by Albert and Tullis (2013).	The design of the system must provide a satisfactory user experience (Albert & Tullis, 2013).

The selected UX attributes served as a basis for the chosen usability guidelines, as reported in Table 2.6. Notably, the researcher acknowledges that various usability guidelines were available in the literature. See Section 2.6.3 for a detailed discussion of the design guidelines.

As Albert and Tullis (2013) noted, usability metrics are useful tools for successfully evaluating UX. These metrics were adopted, in this study, to measure UX and inform the design guidelines. Literature studies identify lab and online tests as the two most common

usability evaluation methods (Albert & Tullis, 2013; J. Huang & Diriye, 2012). Lab tests require a small number of participants and a usability specialist facilitating the tasks performed (Albert & Tullis, 2013). The online test requires considerable participants, between 50 to 100 using a summative usability study following a well-defined script of tasks with data auto-collected by the data capturing tool (Albert & Tullis, 2013). This study adopted an online test summative study using mouse movement for data collection, as discussed in Section 2.5.4. Section 3.6 provides the data analysis approach to the mouse movement.

2.5.4 User testing studies using mouse movement

The mouse movement demonstrates a participant's eye concentration over a specific area during usage (J. Huang & Diriye, 2012). Research studies have shown a correlation between the position of the mouse movement and the participant's eye gaze (Kirsh, 2020). The term *gaze* refers to a participant's eye intensity over a specific area during usage (Ehmke & Wilson, 2007). The eye fixation intensity was indicated by colour-coded (red, yellow, blue, green) heat maps (Ehmke & Wilson, 2007). Red denotes the most intense fixation, yellow moderate fixation, green less fixation, and blue the least intense fixation (Quant-UX, 2020). In the heat maps, the size of the coloured area and the specific colour indicated a participant's concentration on a specific functionality while performing the task (Ehmke & Wilson, 2007). Nielsen Norman Group (2009) provided helpful guidelines for conducting eye-tracking studies; the mouse movement heat maps from the study were of particular interest. The data collected on types of mouse heat maps are mouse-hover heat maps and mouse-click heat maps (Quant-UX, 2020). The mouse-hover visualisation indicated the movement of the mouse over that area (Kirsh, 2020). Hovering is when the cursor idles over a region on the page (J. Huang & Diriye, 2012). The mouse-clicks visualisation indicated the areas that the user clicked with the mouse (Kirsh, 2020). Eye gaze data can be collected in a small-scale laboratory using sophisticated hardware and software data collection tools (J. Huang & Diriye, 2012). Collecting eye gaze data using mouse movement, data was found (J. Huang & Diriye, 2012) to be prevalent in a large-scale usability study for tracking mouse movement on the web page. Therefore, mouse movement heat maps were a cost-effective option for collecting data during use, as non-specialised equipment is necessary for

collection (e.g., no need for specialised eye-tracking hardware and software). The application of the mouse movement results from the data collected in the study provided in Section 5.5.

As previously noted from the systematised reviews, the existing literature studies on the two terms (PT and UX) originated from different disciplines with different goals (Daud et al., 2013; Kaplarski, 2015). PTs originated from psychology, which seeks to understand human behaviour (Gram-Hansen et al., 2018), while UX studies originates from the inter-discipline of HCI that involves the user, the system, and the contexts (Hassenzahl, Diefenbach, & Göritz, 2010; Hassenzahl & Tractinsky, 2006). Human behaviour remains significant, as advocated by Gram-Hansen et al. (2018), although ultimately mediated by the relation to the system and context. Hence it was essential to note the interplay between psychology and information technology when developing interventions to shape human behaviour.

In section 2.6, the literature review approach was changed to normative review in an attempt to provide existing knowledge on design guidelines, autonomous learning, and digital learning.

2.6 Design guidelines for online interactive systems

There was vast knowledge from software engineering literature for software design approaches. The software development approaches range from the traditional waterfall approach to object-oriented and rapid application development (ISO9241-210, 2010), of which they have well-defined software design principles. The design principles for interactive systems complement the existing software design approaches irrespective of the type of approach (ISO9241-210, 2010). The persuasive design guidelines identified in Sections 2.4 and 2.5 are complemented by these design principles for interactive systems, as detailed in Section 2.6.1.

2.6.1 Design principles for interactive systems

The design principles for interactive systems are necessary to ensure that the interactive systems are well-designed with the user in mind, hence referred to as human centred-design principles (ISO9241-210, 2010). The latter aimed to make the system usable and useful by focusing on the users, their needs and requirements, and applying human factors to improve the quality and system usability (ISO9241-210, 2010). The six design principles for interactive systems were labelled a to f:

a) The design should be based upon an explicit understanding of users, tasks and environments – thus, the systems design should take account of the user's needs, and the context which refers to the goals/tasks of the users in a specified environment (ISO9241-210, 2010). In the study, this principle refers to the goals of learning autonomously in the online-digital learning environment in corporate organisations.

b) The design should involve users throughout the design and development to provide a valuable knowledge source of the context of use and tasks, thereby minimising misalignment and improving user buy-in of the system developed (ISO9241-210, 2010). In the study, this principle was applied by using the prototyping approach, which allows users to get a sense of the user expectations of the system, as it was developed to improve user buy-in.

c) The design was driven and refined by user-centred evaluation which refers to evaluating designs with users, and improved based on their feedback, to minimise the risk of a system not meeting user needs (ISO9241-210, 2010).

d) The design process should be iterative; this principle draws on the strength of repeating a sequence of steps until the desired outcome achieved was to gradually eliminate uncertainty during the development of interactive systems (ISO9241-210, 2010).

e) The design addresses the whole user experience by considering user satisfaction (including emotional and aesthetic appearance) as well as effectiveness and efficiency (ISO9241-210, 2010).

f) The design team includes multidisciplinary skills and perspectives: the design team should be sufficiently diverse to collaborate over design and implementation trade-off decisions at appropriate times (ISO9241-210, 2010).

Other sets of design factors for web-based learning systems are detailed in Section 2.6.2.

2.6.2 Design factors for Web-based learning systems in relation to persuasive strategies

In the context of web-based learning, Daud et al. (2013) formulated a useful list of design factors (23) for consideration in designing Web-based learning systems, and 17 were associated with persuasive strategies. These design factors were adopted in later studies by Kaplarski (2015) as design guidelines. The design factors for a Web-based learning system associated with persuasive strategies are listed in Table 2.7.

Table 2.7: Web-based learning design factors as associated to persuasive strategies

Persuasive strategies and Descriptions (Oinas-Kukkonen and Harjumaa, 2009)	**Web-based learning (WBL) Design factors (Daud et al., 2013)**
Reduction refers to a system that reduces the effort users expend when performing their target behaviour by reducing complex behaviour into simple tasks that help users achieve the target behaviour and may increase the benefit/cost ratio of behaviour (Oinas-Kukkonen & Harjumaa, 2009).	Simplifying in sequence topic (Daud et al., 2013).
Tunnelling refers to a system that guides users through attitude change processes by providing the means for action that bring them closer to the target behaviour while providing opportunities to persuade throughout (Oinas-Kukkonen & Harjumaa, 2009).	Guide learning process {theory, video, question and answer} (Daud et al., 2013).
Tailoring refers to a system providing tailored information for user groups based on potential needs, interests, personality,	Content for adult learners (andragogy) (Daud et al., 2013).

usage context, or other factors of a user group (Oinas-Kukkonen & Harjumaa, 2009).	
Personalisation refers to a system that offers personalised content or services more capable of persuasion (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Self-monitoring refers to a system that provides the means for users to track their performance or status; keeping track of their performance or status supports them in achieving goals (Oinas-Kukkonen & Harjumaa, 2009).	Measure own performance {graph, time period} (Daud et al., 2013).
Simulation refers to a system that provides the means to observe simulations and persuades by enabling users to immediately observe a link between cause and effect (Oinas-Kukkonen & Harjumaa, 2009).	Assessment before and after (Daud et al., 2013).
Rehearsal refers to a system that provides a means for rehearsing a target behaviour that can enable people to change their attitudes or behaviour in the real world (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Praise refers to offering praise; a system can make users more open to persuasion; it can praise with words, images, symbols or sounds to provide a user with feedback information based on their behaviours (Oinas-Kukkonen & Harjumaa, 2009).	Automatic prompts (Daud et al., 2013).
Rewards refer to a system that provides virtual rewards to users, giving them credit for performing the target behaviour, thereby providing great persuasive powers (Oinas-Kukkonen & Harjumaa, 2009).	Using words or sound or symbols or visual (Daud et al., 2013).
Reminder refers to a system that reminds them of their target behaviour when using the system. Users will more likely achieve their goals (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Suggestion refers to a system offering fitting suggestions with greater persuasive powers by suggesting that users carry out behaviours while using the system (Oinas-Kukkonen & Harjumaa, 2009).	Syllabus, learning schedule, learning approach (Daud et al., 2013).
Similarity refers to using a system that reminds people of themselves in some meaningful way. Thus, the system should	No relevant WBL factors were provided.

imitate its users in a specific way (Oinas-Kukkonen & Harjumaa, 2009).	
Liking refers to a system that was visually attractive to users and was likely to be more persuasive. Therefore, its look and feel should appeal to users (Oinas-Kukkonen & Harjumaa, 2009).	Relevant visual (Daud et al., 2013).
Social role refers to positions in a society like father, mother, employee, or student, and users will more likely use it for persuasive purposes. A system should adopt a user's social role to be more persuasive (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Trustworthiness refers to a system that provides truthful, fair, and unbiased information. The trustworthy information will have increased powers of persuasion (Oinas-Kukkonen & Harjumaa, 2009).	Correct, equitable, unbiased (Daud et al., 2013).
Expertise refers to a system that reflects expertise and has increased powers of persuasion. Thus, it should offer information which speaks of its knowledge, experience, and competence (Oinas-Kukkonen & Harjumaa, 2009).	Provide background information, video from experts and communication spaces with experts (Daud et al., 2013).
Surface credibility refers to a system that has a competent look and feel. Users make initial assessments of a system's credibility based on a first-hand inspection (Oinas-Kukkonen & Harjumaa, 2009).	Clear layout, consistent graphics/images/typography, avoid misspelling, grammatical errors, the excessive marketing element (Daud et al., 2013).
Real-world feel refers to a system providing information on the organisation and/or the actual people behind its content and services. It highlights the people or organisation behind its content or services with more credibility (Oinas-Kukkonen & Harjumaa, 2009).	Contact information {name, position, email, telephone, address, web address, photo, biography}, appropriate background (Daud et al., 2013).
Authority refers to a system that leverages authority roles and has enhanced powers of persuasion. Thus, it should refer to people in positions of authority (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Third-party endorsements refer to a system endorsement, especially from well-known and respected sources boosting perceptions regarding system credibility. Thus, such systems	Using related logos (Daud et al., 2013), such as ISO9241-210 certification logo.

should provide endorsements from respected sources (Oinas-Kukkonen & Harjumaa, 2009).	
Verifiability refers to a system's perceptions of enhanced credibility if a system makes it easy to verify the accuracy of site content via outside sources. Thus, it should provide the means to verify the accuracy of site content via external sources (Oinas-Kukkonen & Harjumaa, 2009).	Links to external resources, references to scientific publications, clear expert references, accurate resources (Daud et al., 2013).
Social learning refers to a system providing users with the means to observe other users performing target behaviours and view the outcomes of their behaviour. A person will be more motivated to achieve a target behaviour if they can use a system while observing others' behavioural performances (Oinas-Kukkonen & Harjumaa, 2009).	Interaction method {list of email, chat room, discussion forum and share journals/articles} (Daud et al., 2013).
The social comparison refers to a system that provides users with the means to compare their performance with others. Users will have greater motivation to perform target behaviours if comparisons of their performance with others are available (Oinas-Kukkonen & Harjumaa, 2009).	Comparison method {frequency of learners visit, the most active learners, the highest evaluation/mark} (Daud et al., 2013).
Normative influence refers to a system that can leverage peer pressure to increase the likelihood that a person will adopt a target behaviour (Oinas-Kukkonen & Harjumaa, 2009). Thus, it should provide the means for bringing together people with the same goal and make them feel that they share certain norms.	No relevant WBL factors were provided.
Social facilitation refers to a system that provides users with the means of discerning other users performing that behaviour (Oinas-Kukkonen & Harjumaa, 2009). Users are more likely to perform target behaviour if they discern, via the system, that others are performing the behaviour with them.	Observation method {shows learners who are referring to the same topic, doing a quiz, or discussing a certain topic} (Daud et al., 2013).
Cooperation refers to a system that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate (Oinas-Kukkonen & Harjumaa, 2009).	No relevant WBL factors were provided.
Competition refers to a system that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete (Oinas-Kukkonen & Harjumaa, 2009).	Online competitions (Daud et al., 2013).

Thus, it should provide the means for competing with other users.	
Recognition refers to a system that provides public recognition for users who perform a target behaviour by offering public recognition for an individual/group, and therefore increasing the likelihood that a person/group will adopt a target behaviour (Oinas-Kukkonen & Harjumaa, 2009).	List of top learners, chart of website's success (Daud et al., 2013).

The web-based learning design factors and persuasive strategies presented in Table 2.7 provides useful design factors for consideration in the digital learning system in this research study. Section 2.6.3 discusses the design guidelines for the usability of systems.

2.6.3 Design guidelines for usability of systems

There were various usability guidelines available in the literature. The disadvantage was the volume of guidelines that makes them challenging to use (Renaud & van Biljon, 2017). According to Ormeno et al. (2013), many usability guidelines exist and may confuse software designers who are not usability experts. For example, a report by Nielsen Norman Group (2009) indicated 2394 generic software engineering design guidelines, with 874 usability guidelines specific to UX. ISO9241-210 (2010) provided the seven design principles for consideration for interactive systems for the whole user experience. The human centred-design principles for interactive systems according to ISO9241-210 (2010) include:

a) suitability for the task,
b) self-descriptiveness, which means that the users need to know where they are, which actions to take and how they can perform the action,
c) conformity with user expectations,
d) suitability for learning,
e) controllability,
f) error tolerance,
g) suitability for individualisation.

The interactive system design needs to consider the ergonomics and user interface knowledge and standards to inform the design of hardware and software, including displays, input devices, dialogue principles, menus, presentation of information, user guidance, user interface and accessibility (ISO9241-210, 2010).

Section 2.7 provides the outcomes of a narrative review on autonomous learning to enhance understanding of the context of the research study.

2.7 Autonomous learning in digital learning platforms

Autonomous learning encompasses several other learning concepts that have been studied in the training and development and education domain, including self-directed learning, workplace learning, and informal learning (Ellingson & Noe, 2017; Macaskill & Denovan, 2013). Self-directed learning is ideal for adult education for formal and informal learning (Khiat, 2015; Rana et al., 2016). Autonomous learning in the context of the corporate workplace focuses on employees' efforts toward self-learning to develop their skills and acquire knowledge (Ellingson & Noe, 2017). Corporate organisations are increasingly embracing the use of digital learning technologies such as e-learning, online learning, and mobile learning (Khiat, 2015) due to the following reasons:

- Autonomous learning on digital learning technologies is more cost-effective than on-site training (Rana et al., 2016). Furthermore, autonomous learning increases the emphasis on learner-centred rather than instructor-centred learning (Khiat, 2015).
- The COVID-19 pandemic has accelerated the migration of autonomous learning, especially from non-digital to digital learning platforms accommodating health reasons while facilitating social distancing (Adedoyin & Soykan, 2020).
- Digital learning technologies are easily accessible in corporate organisations. This is due to increased access and availability of devices, such as smartphones and notebook computers and internet access for employees to acquire knowledge and skills by utilising many different learning sources, including YouTube videos, blogs,

wikis, webinars, social media, and Massive Open Online Courses (MOOCs) taught by experts in their field of study (Ellingson & Noe, 2017).

This study focused on autonomous learning for formal training of employees on mandatory courses to improve skills and knowledge. Section 2.8 provides the outcomes of the literature review on digital learning to enhance understanding of the context of the research study.

2.8 Digital learning platforms

Digital learning in the context of the workplace was defined, according to Nachmias and Hubschmid-vierheilig (2021), as the learning supported by digital technology to enhance learning and job performance. Delivering learning content through digital channels has become a trend and is necessary for organisations to build knowledge (Adedoyin & Soykan, 2020). Using online digital learning technologies such as e-learning and mobile learning are increasingly embraced by organisations (Khiat, 2015).

2.8.1 E-Learning

E-Learning was described as technology-mediated methods to support students in the learning process comprising assessment, tutoring, and instruction (Merdzhanov, 2018). The users engaging in e-learning can access the learning content using the digital learning platform as a delivery vehicle (de Kock et al., 2016; Merdzhanov, 2018). The e-learning platform may be on any end-user technology devices, such as personal computers or mobile devices, e.g., mobile phones or smartphones. E-learning may benefit learners using digital learning technologies by offering convenience and flexibility in learning. However, ongoing studies are required on mechanisms to motivate users to continue using digital learning technology for autonomous learning (Khiat, 2015). In addition to balancing the business challenges by reducing costs, providing greater access to information and accountability for learning while increasing employee competence and competitive agility in digital learning environments (Behringer, 2013).

Section 2.8.2 provides a brief discussion on motivation for the digital learning environment.

2.8.2 Motivation in the digital learning environment

Research differentiates between two types of motivation (extrinsic and intrinsic) for stimulating user behaviour (Ryan & Deci, 2000). Intrinsic motivation within the context of learning refers to the performed behaviour driven by user interest, satisfaction, and joy in learning a task. While extrinsic motivation refers to external factors such as rewards, points, awards, or higher marks, both types can stimulate users' behaviour (Ryan & Deci, 2000; von Gillern & Alaswad, 2016). Intrinsic and extrinsic motivators are both significant in autonomous learning on digital platforms (Sibanyoni & Alexander, 2017), although the original designers of digital learning focused more on technology-related issues (applications, systems, and courses) than on users (Zaharias, 2009). The users and their experience require greater attention in emerging studies regarding digital learning. Emerging studies are expanding into digital learning focusing on users' motivation to interact with the digital learning technology in the autonomous learning process (von Gillern & Alaswad, 2016). Motivation stimulates and sustains learning behaviour (Abdessettar, Gardoni, Hotte, & Abdulrazak, 2016; B. Huang & Hew, 2016). Research studies emerged to explore user motivation improvement in autonomous learning on digital technologies (Abdessettar et al., 2016; Haque et al., 2018; F. A. Orji et al., 2018). In another study in a different context, R. Orji (2017) found that physical fitness technology could influence people's attitudes and motivate behavioural change in exercising to a set schedule and using a fitness tracker. For measuring behaviour change, PSD and ARCS are among the tools used for evaluation to obtain inputs from users regarding their interaction with the product (as discussed already in Section 2.4.2).

2.9 Conclusion

The findings from Chapter 2 provided the body of knowledge published by other scholars that were relevant to the research study and contributed to addressing the research sub-question (sub-RQ.a):

What are the persuasive strategies and UX attributes for improving the users' motivation for using digital learning platforms for autonomous learning?

The research study identified the common persuasive strategies, namely competition, cooperation, and self-monitoring (Lehto & Oinas-Kukkonen, 2011; F. A. Orji et al., 2018; R. Orji, 2017). From a UX perspective, the study focused on using usability metrics. As the focal point for the study, the persuasive strategies were derived and provided in Table 2.5, and Table 2.7 provided the UX attributes. The chapter concludes with the literature-based set of PT and UX constructs, named *ConstructsVersion1,* derived from literature. *ConstructsVersion1* includes three persuasive strategies, three user experience attributes, and four ARCS constructs, as depicted in Table 2.8.

Table 2.8: *ConstructsVersion1* - The literature-based set of constructs

Subject Area	**Constructs and Description**
Persuasive strategies	*Competition* refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete. Thus, it should provide the means for competing with other users (Oinas-Kukkonen & Harjumaa, 2009).
	Cooperation refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate. (Oinas-Kukkonen & Harjumaa, 2009).
	Self-monitoring refers to a system attribute that keeps track of a user's performance or status and supports them in achieving goals, tracking their performance or status (Oinas-Kukkonen & Harjumaa, 2009).
User Experience attributes	*Effectiveness* refers to an attribute that gives the ability to complete a task successfully.
	Efficiency refers to an attribute that indicates the amount of effort required to complete the task successfully (Albert & Tullis, 2013).

	Satisfaction refers to an attribute that indicates the degree of the user's internal state, such as indication if the user was happy with the experience while performing the task (Albert & Tullis, 2013).
ARCS	*Attention* refers to an attribute that incorporates curiosity and arousal, interest, boredom, and other related areas such as sensation seeking (Keller, 2016).
	Relevance refers to learners' perceptions that the instructional requirements are consistent with their goals, compatible with their learning styles, and connected to their past experiences (Keller, 2016).
	Confidence refers to the effects of positive expectancies for success, experiences of success, and attributions of success to one's abilities and efforts rather than to luck or to task challenge levels that are too easy or difficult (Keller, 2016).
	Satisfaction refers to the appropriate mix of intrinsically and extrinsically rewarding outcomes that sustain desirable learning behaviours and discourage undesirable ones (Keller, 2016).

Chapter 3 discusses the research methodology applied in this study.

3. CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The purpose of this chapter is to discuss the research design and methodology. All research is conducted within a paradigm, even if not explicitly stated (Hofstee, 2006). The research philosophy or paradigm encompasses important assumptions about the worldview that underpins the chosen research strategy and methods (Hofstee, 2006; Saunders et al., 2009). Table 3.1 provides an overview of the research design adopted in this research study, including the research title, while the philosophy provided was pragmatism. It also included the status of truth, reality, epistemology and the researcher's role in this philosophical view, the research design, and the method.

Table 3.1: Overview of the research design (adapted from UNISA Research scheme, n.d)

<table>
<tr><td colspan="4">Title: Persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa.</td></tr>
<tr><td rowspan="4">Philosophical world view</td><td rowspan="4">Pragmatism</td><td>Status of truth</td><td>Multiple truths</td></tr>
<tr><td>Status of reality</td><td rowspan="2">Subjective reality</td></tr>
<tr><td>Epistemology</td><td>Empiricism</td></tr>
<tr><td>Role of researcher</td><td>Subjective</td></tr>
<tr><td colspan="4">Ethics clearance required. Yes (see details in Section 3.7)</td></tr>
<tr><td>Research design</td><td colspan="3">Empirical research</td></tr>
<tr><td>Research approach</td><td colspan="3">Design Science Research</td></tr>
<tr><td>Context/topic description</td><td colspan="3">Design Science Research (DSR) focuses on the development and performance evaluation of an artefact to understand the research problem in which the artefact was built. Its two main streams are focused on the pragmatic design of the artefact and design theory (see details in Section 3.3).</td></tr>
<tr><td>Specific design property 1</td><td colspan="3">The two main streams of DSR were provided as specific design properties (1 and 2), first focusing on the artefact's pragmatic design.</td></tr>
<tr><td>Specific design property 2</td><td colspan="3">The second specific design property focuses on design theory.</td></tr>
<tr><td>Research method</td><td colspan="3">Hybrid mixed-method approach, namely:
Qualitative method for recorded data that was transcribed for thematic analysis.
Quantitative method for survey data analysed using statistical techniques.</td></tr>
</table>

Data collection process	Purposive sampling was used to select the participants for the focus group, while probability sampling was used for the survey (see details in Section 3.5). Data was collected from a sample of participants (employees). Data was collected from: • Focus groups • Survey questionnaires and mouse movement (See details in Section 3.6)
Data source	Self-reported data was gathered typically from paper-and-pencil or electronic format, or sometimes through interviews. The study data sources were from focus group sessions, electronically in surveys and mouse movement.
Level of control	The researcher had some control over (medium level of control) the conditions under which the research was conducted.
Data format	• Audio data recorded from the focus groups was transcribed into text format. • Text data from questionnaire responses converted into the numeric format. • The mouse movement data was captured using hot spots.
Analysis/validation method	Thematic analysis involves finding patterns of meaning in text by rigorously looking for common themes emerging from the data. An iterative process often requiring a review of the text after being coded to check the initial and later coding themes that emerge. Statistical analysis techniques have been used for analysing the survey data, while the mouse heat maps analysis was used to analyse mouse movement data during the usage of the prototype. (See details in Section 3.6).
Specific method property	• Focus groups, where the schedule of questions was strictly adhered to, and the same questions were asked each time in the same order. • Survey questionnaires and mouse movement.

Based on the research overview structure provided in Table 3.1 of the research schema, the details of the research philosophy, followed by the research method, the sampling technique, and finally, the data collection and analysis were provided and discussed.

3.2 Research philosophy: Pragmatism

The research philosophy adopted was pragmatic, as pragmatism has been driven by the need to solve problems (Strübing, 2012). This study was driven by a problem identified in the business, namely, the challenge of increasing employees' motivation in autonomous learning on digital learning. Ontologically, pragmatists are less interested in the "truth" and more in "what works", while epistemology accepts many different viewpoints and works to reconcile them through pluralistic means (Strübing, 2012). The DSR method focuses on a

real-world problem using the most appropriate methods and works to effect changes in practice (Strübing, 2012; Hevner & Chatterjee, 2010), thus aligning well with pragmatism. Pragmatically speaking, the problem of motivating users in autonomous learning on digital learning platforms drove this research study.

In Section 3.3, the discussion on Design Science Research (DSR) is presented as a research methodology to drive the research study.

3.3 DSR method deployed to drive the study

Design Science Research (DSR) was employed to drive the study as the research methodology with pragmatism as the philosophy. DSR was applicable to this study since it was problem-driven, addressing challenges within organisations and producing innovative artefacts that contribute new knowledge to theory (Drechsler & Hevner, 2016; Hevner & Chatterjee, 2010). According to Gregor and Hevner (2013), the significance of new knowledge was considered noteworthy according to the three types of knowledge areas: *invention, improvement*, and *adaptation. Invention* refers to new knowledge for solutions to solve a new problem; *improvement* refers to developing new knowledge to solve a known problem; and *adaptation* refers to the innovative modification of known knowledge or solutions to solve a new problem (Gregor & Hevner, 2013). The study produced adaptation knowledge to solve the business problem by following the six steps of DSR (Hevner & Chatterjee, 2010), as depicted in Figure 3.1.

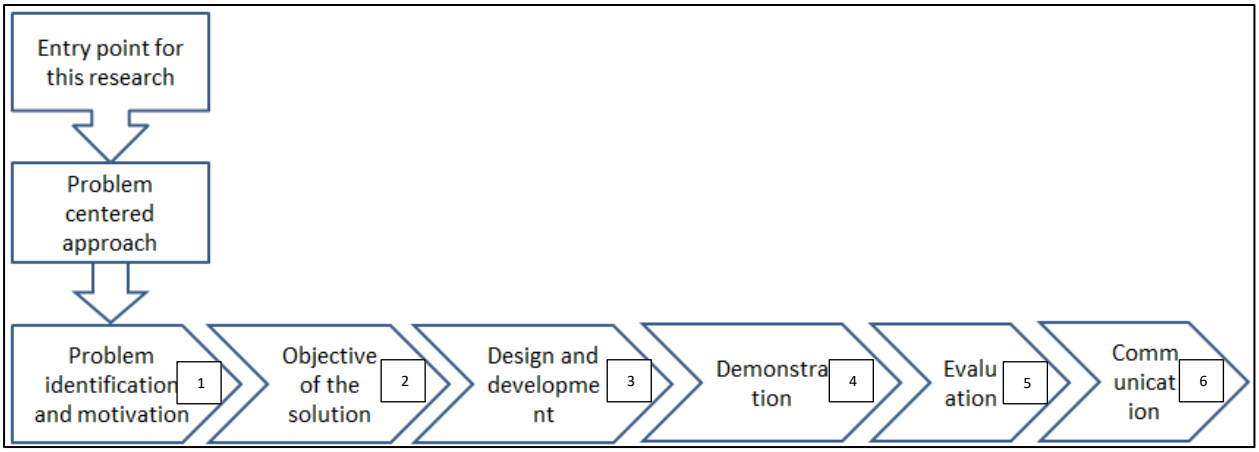

Figure 3.1: DSR process (Hevner & Chatterjee, 2010)

The DSR research entry point for the study was the problem-centred approach, as depicted in Figure 3.1. The research problem was the self-motivation of employees engaging in autonomous learning in digital learning platforms. The DSR process adapted from Hevner and Chatterjee (2010), coupled with the research action and application of DSR in the study, appears in Table 3.2.

Table 3.2: DSR steps, research actions and application in the study

DSR steps and Research action (adapted from Peffers et al., 2006)		**Application in the study**
Step 1: *Problem identification and motivation* – The step defines the research problem and the justification for the solution. This step introduces the research problem.	Research action - Preliminary survey in the business environment to confirm the existence of the business problem and justification of the solution in terms of the importance of the solution to the business (Peffers et al., 2006).	The DSR process has been initiated as necessitated in a business environment by problems in the business with motivating users for autonomous learning in a digital learning environment, as discussed in Section 1.2: Problem statement and Section 1.3: Research question and sub-questions.
Step 2: *Objectives of a solution*. This step provided the objectives of the study.	Literature review to determine the state of the problem in the literature and current solutions (Peffers et al., 2006).	The literature review identified PT and UX as current solutions to the research problem, as detailed in Chapter 2. The proposed solutions, namely PT and UX, and the relevant constructs were used as the basis for the design guidelines (detailed in Section 3.4.1).
Step 3: *Design and development*. This step was the creation stage of the artefacts based on iterative improvements.	Design and development of the solution based on knowledge of theory (Peffers et al., 2006).	Literature-based design guidelines were validated in iterative improvements with the subject matter experts (detailed in Section 3.4.1), and the development of the digital learning prototype system was designed in iterations from low-fidelity

		wireframe to high-fidelity interactive prototype (detailed in Section 3.4.2).
Step 4: *Demonstration*. This step constitutes the demonstration of the artefact.	Demonstration of knowledge of how to use the artefact to solve the problem (Peffers et al., 2006).	Demonstration of the constructs used as a basis for the design guidelines to develop the digital learning prototype system, as detailed in Section 3.6.1. The demonstration of the prototype system was given to end-users for data collection (detailed in Section 3.6.2).
Step 5: *Evaluation*. This step involves the evaluation of the artefacts.	Comparing the objective of a solution to improve the artefact's effectiveness (Peffers et al., 2006).	The constructs with the subject matter experts (the analysis and findings are detailed in Chapter 4) were evaluated before being used as a basis for design guidelines. The end-users evaluated the prototype based on a set of survey questionnaires (detailed in Section 3.6.2). The questionnaires are efficient and widely used for data collection as part of a survey strategy (Hofstee, 2006). The findings were analysed (Chapters 5 and 6) to answer the research question (Section 7.3).
Step 6: Communication. This step involves the communication of the research results in the form of a peer-reviewed publication.	Publication of scholarly publication research paper (Peffers et al., 2006).	Publication of the research study paper in the knowledge area of PT and UX for the contribution of a theory that was limited to a combination of PT and UX studies (Section 7.5).

The study, driven by DSR, was divided into two stages, as advocated by Adaji (2017), to allow the control of research focus and deliverables. To control the research focus, Stage 1 focused on identifying the persuasive strategies and UX attributes that served as a basis for the design guidelines (see Section 3.4.1). Stage 2 focused on developing the prototype and evaluating the questionnaire (see Section 3.4.2). Several artefacts were delivered in this

study, namely, the design guidelines based on PT and UX constructs, the design of the prototype, and the questionnaire for the survey. The three DSR cycles are the relevance cycle, design cycle, and rigour cycle (Hevner & Chatterjee, 2010). The stages were staggered to improve the rigour of the DSR process for the relevant artefacts, as depicted in the DSR cycles in Figure 3.2.

The DSR process, as depicted in Figure 3.2, was initiated in a business environment, as necessitated by problems in the business. Then the relevance cycle connects to DSR containing the design cycle. The rigour cycle follows connecting to the knowledge base.

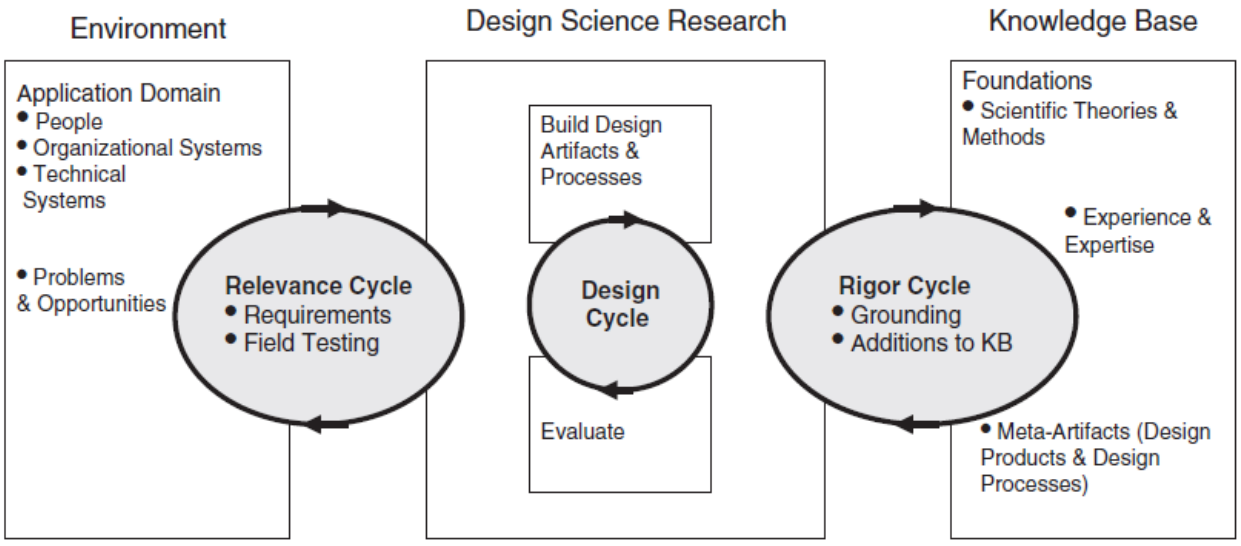

Figure 3.2: Design Science Research cycles (Hevner & Chatterjee, 2010)

3.3.1 Relevance cycle

The *relevance cycle* provided an application context to produce the research requirements and define acceptance criteria (for field testing) for research results (Hevner & Chatterjee, 2010). This relevance cycle process in the research study comprised a problem identified in the business as a requirement to increase employees' motivation in autonomous learning on the digital learning platform. The opportunity for a solution has been identified combining PT and UX constructs as potential solution factors. The focus groups conducted with the

key stakeholders from the business, such as trainers, content developers, and super users, confirmed the relevance of the identified factors as a potential solution to the business problem. The combination of PT and UX literature constructs (*called ConstructsVersion1)* was validated with the subject matter experts in focus group sessions (selection of the subject matter experts detailed in Section 3.5) as a field test of the literature-based constructs for relevance in the study. The validation of the constructs with the subject matter experts underwent iterations, validated using *thematic analysis* (detailed in Chapter 4). To determine if there was a need for additional iterations of the relevance cycle, the field testing results were utilised as advocated by Hevner and Chatterjee (2010). After three iterations with the subject matter experts, the constructs were deemed sufficient (*called ConstructsVersion2)*.

3.3.2 Design cycle

The constructs for PT and UX derived from thematic analysis (*ConstructsVersion2*) were utilised in the design cycle to identify the existing literature's relevant design guidelines. The constructs from PT were derived from the study by F. A. Orji et al. (2018). The proven and widely used strategies are rooted in the persuasive system design principles by Oinas-Kukkonen and Harjumaa (2009). The UX constructs were derived from studies by Hassenzahl et al. (2010) and Lallemand et al. (2015). The design of the prototype adhered to the design guidelines from the constructs (*ConstructsVersion2)*. A prototype refers to a type of design process which goes through various incremental iterations of designing and testing with the users to obtain feedback for improvement (Isa & Liem, 2020). According to ISO9241-210 (2010), a prototype provides a limited system representation usable for analysis, design, and evaluation.

Furthermore, the assessment questionnaire *(QuestionnaireVersion1)* was formulated from the literature on PT and UX and refined into the final questionnaire *(QuestionnaireVersion2)* to evaluate the prototype by the end-users (selection of end-users detailed in Section 3.5). According to Hofstee (2006), the questionnaires are useful and efficient in terms of meeting research objectives in the face of limited resources and are widely used for data collection

as part of a survey strategy. The questionnaire was useful because it could be deployed online to a sample of the population. The study used tools such as Microsoft Forms to design the questionnaire and distribute it online, and the data were collected for analysis. The formulation of the questionnaire is detailed in Section 3.6.2.

The design cycle forms an integral part of DSR as it integrates the relevance and rigour cycles (Hevner & Chatterjee, 2010), as depicted in Figure 3.2. The design cycle obtained inputs (e.g. research problem and the selected constructs) from the *relevance cycle*; the theories for the design of the prototype (literature-based design guidelines); evaluation theories (e.g. evaluation questionnaire); and methods drawn from the knowledge base of the rigour cycle (Hevner & Chatterjee, 2010). The study applied rigorous and thorough testing on the artefacts (such as the design guidelines and prototype) before releasing them into field testing (Hevner & Chatterjee, 2010). Production of the artefact concluded after multiple iterations of the design cycle from low-fidelity prototype to high-fidelity prototype (details in Section 3.4.2). After performing an evaluation, the subsequent feedback refined the design further, and then the output was released into the relevance and rigour cycles (Hevner & Chatterjee, 2010). This study used multiple evaluations for the different participants (given that there were two groups of participants), namely, the subject matter experts and end-users. It conducted a user evaluation of the prototype using the online questionnaire. The benefit of using multiple methods was that they could produce validated findings through triangulation of the results (Saunders et al., 2009).

3.3.3 Rigour cycle

The rigour cycle provided base information from the literature (on PT, UX, autonomous learning, and digital learning platforms), thereby grounding the research project on existing knowledge (Hevner & Chatterjee, 2010). Feedback from the subject matter experts confirmed the rigour of the construct set obtained from the literature (*ConstructsVersion1*). The subject matter experts' feedback from participants was valuable as they work with the digital learning system daily. The feedback proved beneficial and confirmed the constructs used to challenge the initial ideas and assumptions about the use context and to create and

refine the constructs (*ConstructsVersion2)*. The second and subsequent iterations affected improvements based on the feedback received from the subject matter experts. The constructs were improved upon until the final version of the selected constructs was derived (*ConstructsVersion2).* Thus, acting as the basis for design guidelines of the prototype for assessment with the sample of users. The prototype as an artefact was evaluated by end-users using the questionnaire to gather data on the extent of users' motivation.

The outcomes of the evaluation results informed the final design guidelines released and documented as part of the formalisation of learning. The prototype was designed based on the guidelines, illustrating the potential changes to the user interface of the digital learning system. The amendments added to the prototype persuade participants to use online learning activities (Daud et al., 2013; Widyasari, Nugroho, & Permanasari, 2019).

The DSR was used to drive the research study to deliver the artefacts; this has been simplified by the research flow detailed in Section 3.4.

3.4 Research flow overview

The research flow illustrates the activities (along with inputs and outputs) followed to deliver the required artefacts in this study, as guided by DSR, delivered in stages (Stage 1 and Stage 2), allowing control of the research deliverables (Adaji, 2017). Stage 1 was illustrated in Figure 3.3, and Stage 2 was illustrated in Figure 3.4. The DSR process in the research flow was initiated by a problem identified in the business, namely the challenge of increasing employees' motivation in autonomous learning on digital learning. This observation was made from within the organisation, indicating the users' low completion rates of the statutory courses (detailed in Section 1.2 Problem statement).

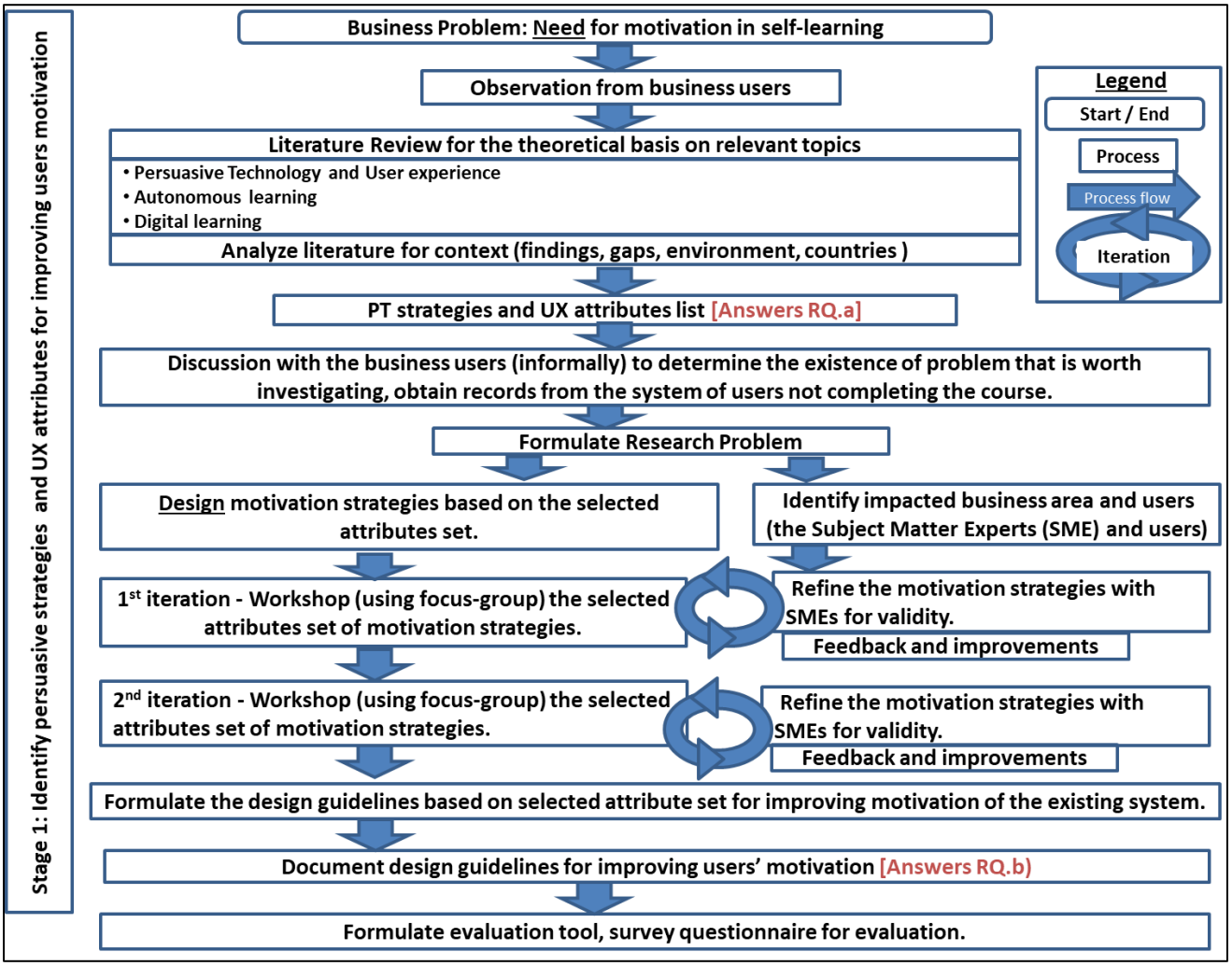

Figure 3.3: Research Flow Diagram (Stage 1)

3.4.1 Stage 1: Identify persuasive strategies and UX attributes

The Stage 1 objective was to *identify the set of suitable persuasive strategies and UX attributes* for improving motivation in autonomous learning. The DSR artefacts delivered in Stage 1 were *design guidelines* (subsequently used for designing the prototype in Stage 2). Furthermore, Stage 1 established the survey questionnaire for evaluating the extent of motivating behaviour change.

In Stage 1, the systematised review conducted established the existing literature published in the research study supporting the purpose and objectives of the research study (Hofstee, 2006; Saunders et al., 2009), as detailed in Sections 2.2.2. The systematised review was

conducted on the main topics of PT and UX, and the narrative review was conducted on digital learning platforms and autonomous learning to obtain context to the study (literature review conducted in Chapter 2, Sections 2.3 to 2.7).

The research problem was identified as *users' motivation toward autonomous learning on a digital learning platform*. Preliminary engagements (informally) with key stakeholders in the business (practitioners who offer training in digital learning courses and develop related content) confirmed the existence of the research problem.

The design guidelines (as artefacts) were derived based on the selected combination of PT and UX constructs derived from literature on persuasive strategies and UX attributes as conducted in the literature review. The constructs were validated with the subject matter experts, comprising trainers, content developers, advisors, and managers in the digital learning department. The data collected from the subject matter experts in the focus groups were recorded and transcribed for thematic analysis. The literature-based constructs from PT and UX *(refer to Table 2.8)* called *ConstructsVersion1* were derived from literature and used to challenge the subject matter experts' initial ideas and assumptions about the use context. The rigour of the selected set of *ConstructsVersion1* was evaluated against the subject matter experts' feedback. The subsequent iterations helped to effect improvements based on the feedback received, which resulted in the final version of the selected set called *ConstructsVersion2* (refer to Table 3.3). *ConstructsVersion2* was used as a basis for the design guidelines prototype development (in Stage 2).

Table 3.3: The 9 final constructs (*ConstructsVersion2*) and design guidelines

Subject Area	**Constructs and Description**	**Design guidelines**
Persuasive strategies	*Competition* refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete, thereby providing the means for competing with other users (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support competition (Oinas-Kukkonen & Harjumaa, 2009).

	Cooperation refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support cooperation (Oinas-Kukkonen & Harjumaa, 2009).
	Self-monitoring refers to a system attribute that keeps track of a user's performance or status and supports them in achieving goals (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support self-monitoring (Oinas-Kukkonen & Harjumaa, 2009).
User Experience (UX) attributes	*Effectiveness* refers to an attribute that gives the ability to complete a task successfully (Albert & Tullis, 2013).	The system should be effective in supporting learning (Albert & Tullis, 2013).
	Efficiency refers to an attribute that indicates the amount of effort required to complete the task successfully (Albert & Tullis, 2013).	The system should be efficient in supporting learning (Albert & Tullis, 2013).
	Satisfaction refers to an attribute that indicates the degree of the user's internal state, was the user happy with the experience while performing the task (Albert & Tullis, 2013).	The users should be satisfied with their interaction experience (Albert & Tullis, 2013).
ARCS	*Attention* is an attribute that incorporates curiosity and arousal, interest, boredom, and other related areas, such as sensation seeking (Keller, 2016).	The interaction design should attract the attention of a user (Keller, 2016).
	Relevance refers to learners' perceptions that the instructional requirements are consistent with their goals, compatible with their learning styles, and connected to their past experiences (Keller, 2016).	The interaction design should support the relevance (Keller, 2016).
	Confidence category refers to the effects of positive expectancies for success, experiences of success, and attributions of success to one's abilities and efforts rather than to luck or to task challenge levels that are too easy or difficult (Keller, 2016).	The interaction design should support confidence (Keller, 2016).

Flexibility	*Flexibility* can refer to allowance for alternative interactions, but it is also considered as allowing digital learning anywhere, anytime for users (Daud et al., 2013). *Derived from Focus groups (See details in Chapter 4, Section 4.4)*	The interaction design platform should be easily accessible anywhere and everywhere (Merdzhanov, 2018).

Furthermore, the survey questionnaire was formulated during a systematised review of PT and UX. The evaluation tool as an artefact, was derived from different literature sources. The questionnaire was developed iteratively, with the first iteration providing a list of questions from PT and UX literature (named *QuestionnaireVersion1)*. The selected questions included in *QuestionnaireVersion1* were derived from the validated and tested studies by different authors in the literature in diverse environments (Albert & Tullis, 2013; B. Huang & Hew, 2016; Keller, 2016; F. A. Orji et al., 2018; R. Orji et al., 2019), as detailed in Chapter 3, Section 3.5. The second iteration involved selecting the questions related to the construct in the study. The outcome was the final questionnaire (*QuestionnaireVersion2*), which was considered an artefact for usage as an evaluation tool in Stage 2.

3.4.2 Stage 2: Design a prototype based on the design guidelines

The Stage 2 objective was to *design a prototype based on the design guidelines* from Stage 1 and make the prototype available to the end-users for evaluation, as depicted in Figure 3.4. The researcher (possessing over 20 years of experience in analysis, design, development, and architecture of software systems) designed the prototype, which was evaluated by the end-users using the questionnaire *(QuestionnaireVersion2)*. The DSR artefact delivered in Stage 2 was the user interface prototype, illustrating the improvement to the user interface based on the selected attributes.

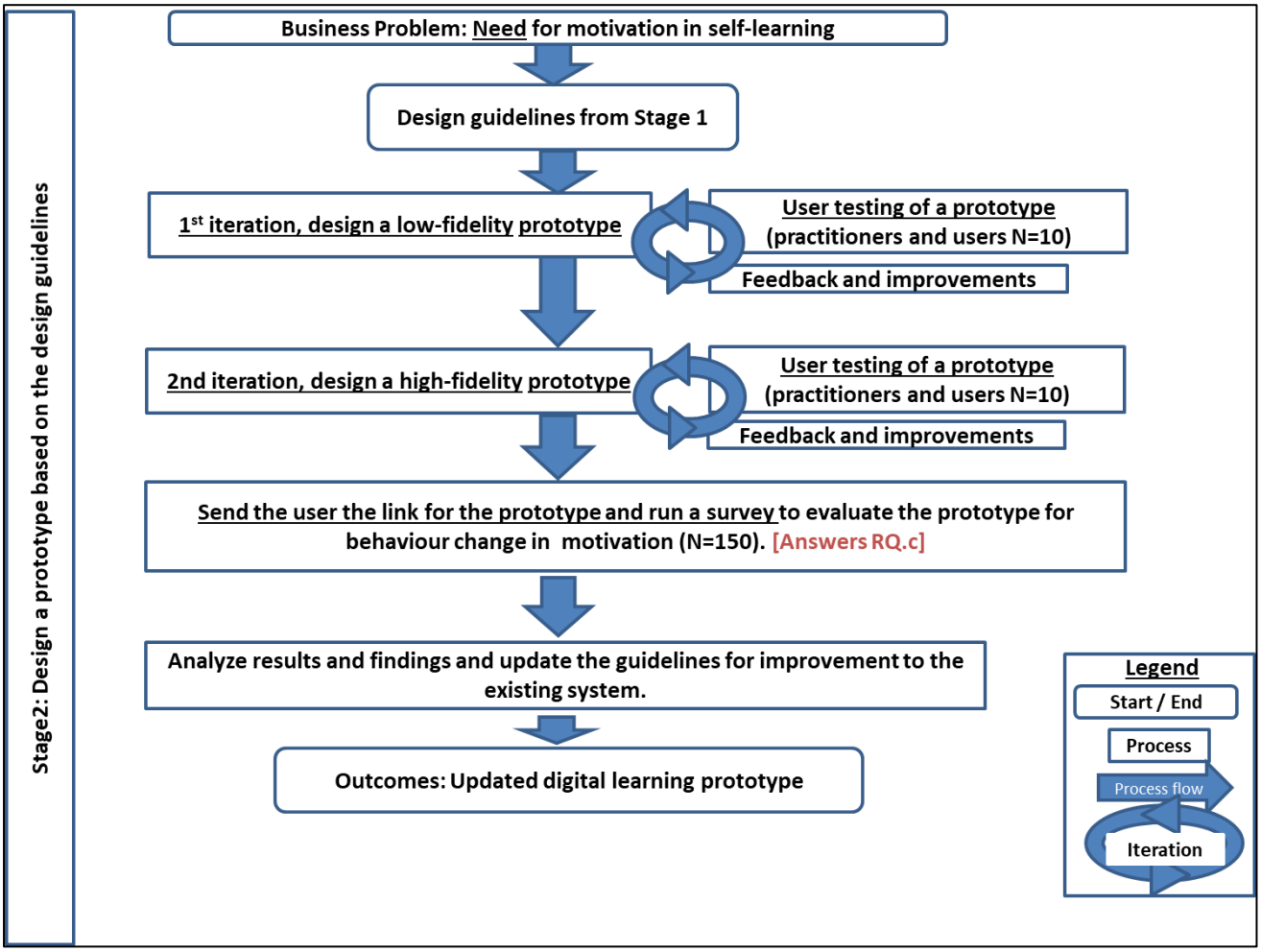

Figure 3.4: Research Flow Diagram (Stage 2)

Stage 2 describes the process followed to produce the prototype demonstrating the changes in the screen layout based on the design guidelines for user evaluation. The inputs for this process were the design guidelines and the business problem. A prototype is a design process that uses various incremental iterations of designing and testing with the users to obtain feedback for improvement (Isa & Liem, 2020). This prototype represented the changes proposed on the user interface of the autonomous learning system.

The prototype was simple, with few interactions performing digital learning tasks to simulate the current learning environment, which is low on user interaction with learning content, arguably changing the design to be more interactive so that it could motivate users. The

focus was on the persuasive strategies and the UX attributes identified. Thus, no additional features were introduced that could interfere with the results.

The prototype helps facilitate conversations on the design and improvements through discussion with the users and stakeholders (Isa & Liem, 2020). Given that, as a design journey, the prototype process includes various iterations of testing with users as it transitions from low-fidelity to high-fidelity prototypes. There are different levels of prototypes (low-fidelity to high-fidelity) depending on the objectives of the business users and the resources available (Isa & Liem, 2020). Low-fidelity prototype refers to a prototyping approach that produces results faster and at a low cost. It may occur rapidly from the earliest iterations, where the idea is expressed via interactive prototypes to test assumptions with the users (Isa & Liem, 2020). It helps provide a clear picture to the users and stakeholders of the functionality and resolve any issues arising.

The prototype design went through various iteration cycles per the DSR process, including improvements and user feedback. In the first iteration of the prototype design, the output was a low-fidelity prototype. Once producing the low-fidelity prototype, testing by selected users to solicit feedback for improvements commenced. Thereafter, based on feedback received, the output was the high-fidelity prototype. An example of a low-fidelity prototype is a monochromatic wireframe. A high-fidelity prototype refers to interactive mock-ups that provided users and stakeholders with the ultimate picture of the result (Isa & Liem, 2020). Wireframes enable the designer to map out screens for user flows without exact details, identifying the high-level structure. Wireframes allow the researcher to quickly map the journey through content as their focus is on information architecture (Isa & Liem, 2020). Some literature indicated that wireframes may also include high-fidelity mock-ups to build interactive prototypes to help users and stakeholders get a feeling for both the visual design and the interaction design (Isa & Liem, 2020). These include the design details such as colour palettes, typographic choices, and animations (Isa & Liem, 2020). In this research study, a high-fidelity interactive prototype of the system produced a deliverable artefact. The

prototype screenshot illustrating the persuasive strategies is depicted in Figure 3.5. Notably, the UX attributes are included in the prototype design for the look and feel of the system.

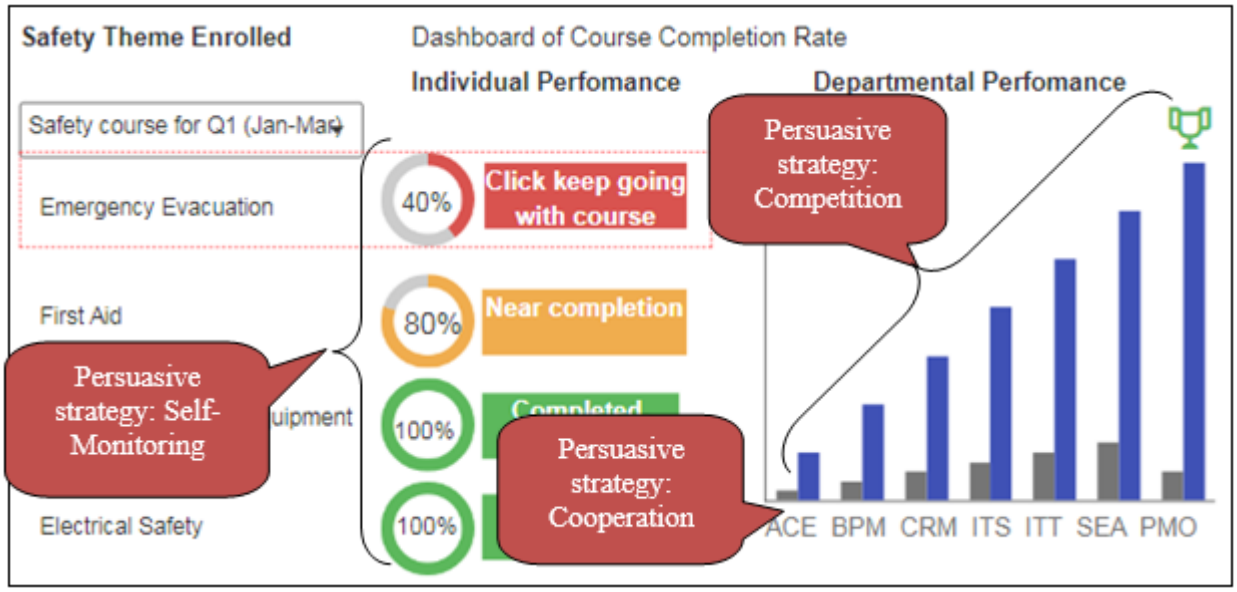

Figure 3.5: Prototype screenshot

The prototype was designed on a cloud-based open-source system, while the front-end user interface was built with Vue.js (Quant-UX, 2020). The prototyping tool is user-friendly and allows easy, fast design of prototypes. It simulates how an application looks and functions before code is written (Quant-UX, 2020). It also had metrics to track mouse activities, referring to a tracking script embedded in all the relevant website pages.

The persuasiveness and the motivational appeal of the selected attributes set elicited feedback by surveying the end-users after using the prototype. The online link of the prototype with instructions of the tasks to be performed was sent to the end-users, and subsequently, post-usage, this was followed by an online survey using *QuestionnaireVersion2*. Instead of post-usage interviews with subject matter experts and end-users (to avoid user fatigue), open-ended questions were included in the survey as a complementary data collection method to enhance the qualitative component of the study (Hofstee, 2006; Saunders et al., 2009).

Finally, with the users and stakeholders satisfied with the improvements on the high-fidelity prototype, the actual building of a product using the development and coding tools of the final product may commence in the future. *NB: development, coding, and implementation were not in the scope of this research project, as the targeted artefact for this research study was the prototype.*

Finally, the communication in the research process followed, referring to the documentation and examination of the reports on the utility of an artefact for the knowledge gained in DSR (Hevner & Chatterjee, 2010). The knowledge gained in this research effort was categorised and documented as either “firm facts” or “loose ends” (Gregor & Hevner, 2013). The firm facts refer to learning that can be repeatedly applied or behaviour that can be repeatedly invoked. The loose ends refer to anomalous behaviour that may be the subject of further research (Gregor & Hevner, 2013). The researcher believes the knowledge from the study may be improved further, hence categorising the knowledge gained in the study as a loose end.

In Section 3.5, the selection of the research sample is discussed.

3.5 Sampling techniques

Sampling refers to a collection of the population included in the study (Oates, 2006). Collecting data from an entire population was impossible due to limited time, funds, and access (Hofstee, 2006). Sampling as a technique allowed for a subset of sample data, enabling research to be covered adequately and completed within the time horizon and with the available resources (Saunders et al., 2009). The study presented took a “snapshot”, taken at a particular time (a *cross-sectional time horizon*) due to constraints such as time and financial resources, as is the case with most academic research projects (Saunders et al., 2009). There were two groups of participants in the study, namely, the subject matter experts and end-users, as detailed in Table 3.4, showing the groups of participants, the population size, and the age category.

Table 3.4: Groups of participants that took part in the study

Participants groups		**Population**	**Age category of groups**	**Time required**
Group 1 (Subject Matter Experts)	Group 1 participants provided the qualitative data. Participants were carefully recruited as a group of people with similar characteristics in functions (Krueger, 2002). This target group was for focus group sessions conducted with the practitioners (stakeholders from the business responsible for digital learning, learning content and development, leaders in the learning department, training, and super users in the learning environment. The participants were invited because they were considered experts in digital learning development in the organisation and possess in-depth knowledge, improving the ongoing development of digital learning initiatives in the organisation.	17	18 years and above	60 min
Group 2 (digital learning end-users)	Group 2 participants provided the quantitative data. This target group was a sample of employees (users of digital learning in the IT division (Group IT)) partaking in autonomous learning for H&S courses. The participating employees already have the ICT skills, computer equipment, and capability and access to the digital learning platforms for autonomous learning of the H&S courses. The research study was conducted on the digital learning platform already implemented in the organisation to enable employees to perform learning tasks on the prototype designed as an artefact based on the selected set of PT and UX attributes.	250	18 years and above	30 min

The study deployed purposive sampling for *Group 1 (subject matter experts)*, wherein the researcher selected the cases that make up the sample (Saunders et al., 2009). For *Group 2 (end-users)*, the study deployed probability (representative), wherein the likelihood of

each case selected from the population was statistically determined at random being equal in all instances, aligning with the survey research strategy (Saunders et al., 2009). Other common sampling techniques (Saunders et al., 2009) found in the literature but not used in the study include random, systematic, cluster, and multi-stage sampling techniques.

The data was collected from a population sample using a different sampling fraction for each stratum (Saunders et al., 2009). To obtain an accurate overall picture of the entire population, the differences in response rates between strata, and the common means of achieving this was to use cases from those strata with lower proportions of responses to represent more than one case in the analysis (Saunders et al., 2009). The sampling was done for the two groups, as provided in Table 3.5, wherein the sample groups, sampling method, sample size, and reason for the sample are detailed.

Table 3.5: Sampling techniques used for selection of participants in the study

Sample groups	**Sampling method**	**Sample size**	**Justification for sample size**
Group 1 (Subject Matter Experts)	Data collection occurred through focus group sessions where open-ended questions were presented to participants. Participant selection for the focus group sessions occurred through purposive sampling. Purposive sampling refers to a non-probability sampling procedure in which the researcher uses their judgment, selecting cases that make up the sample. Based on extreme cases such as heterogeneity (maximum	17	Participants were selected because they have specific shared characteristics relating to the topic of discussion. They were encouraged to discuss and share their points of view without any pressure to reach a consensus (Krueger, 2002). These discussions were conducted several times with similar participants to enable trends and patterns. The participants were invited because they were considered experts in digital learning development in the organisation and have in-depth knowledge of improvement in the ongoing development of organisational digital learning initiatives (e.g. as

	variation), homogeneity (maximum similarity), critical cases, or typical cases (Saunders et al., 2009).		content developer, training, supporting environment, superuser). The participants were information-rich (Krueger, 2002) and considered the go-to person for autonomous learning on the digital learning platform and its benefit to the organisation. Participants were encouraged to discuss and share their points of view without any pressure to reach a consensus (Saunders et al., 2009). Over and above being experts, they were also users in this organisation, using the system frequently for autonomous learning purposes. The participants' contact details were obtained from the organisation's departmental contact list of personnel in the learning area for the focus groups.
Group 2 (digital learning end-users)	Probability (representative) sampling for the questionnaire. The data was collected via a survey questionnaire (Likert-type questions). Probability sampling was used to select the participants for completing the survey. Probability sampling refers to a selection of sampling techniques in which the chance, or probability, of each case selected from the	150	Collecting data from an entire population was impossible due to limited time, funds, and access (Hofstee, 2006). The likelihood of each case selected from the population was statistically determined at random and was equal for all instances aligning with the survey research strategy (Saunders et al., 2009). Meaning 75% of the population responded, and 0.75 being the weight of the population expected to respond. Since the weighting was close to 1, it meant a good proportion of the population was sampled (Saunders et al., 2009).

	population is known and is not zero (Saunders et al., 2009).		

Following Saunders et al. (2009), calculations to weigh the cases for the survey performed as follows:

1) calculate the percentage of the population responding for each stratum in Group 2:

The population of Group IT digital learning staff members undertaking H&S digital learning course = 250

Sample of participants = 150

Therefore % of population responding for the stratum = (150/250) x 100 = 45%

2) the weighting of each stratum:

$$\text{weight} = \frac{\text{highest proportion of population responding for any stratum}}{\text{proportion of population responding in stratum for which calculating weight}}$$

= 150/250
= 0.75

The calculations were interpreted as follows: 75% of the population responded to each stratum, and this was interpreted as 0.75 being the weight of the population that responded. This means an acceptable proportion of the population was sampled, as Saunders et al. (2009) advocated.

Section 3.6 provides the details of the data collection and analysis.

3.6 Data collection, collection tools and analysis

To elicit feedback from the two groups of participants (Group 1: subject matter experts and Group 2: end-users). The data collection began with Group 1 to obtain expert advice from the subject matter experts. The data collection was conducted from pre-usage, during-

usage, and post-usage using the following data collection tools: recorded and transcript, mouse movement, and a survey questionnaire, respectively.

3.6.1 Subject matter experts: Pre-usage

The data was collected in the focus groups from the subject matter experts (Group 1) to obtain expert advice; the data collected in pre-usage was used for qualitative analysis of the study (Hofstee, 2006; Saunders et al., 2009). Participants were selected because they were considered experts in digital learning development in the organisation and have in-depth knowledge in improving the ongoing development of organisational digital learning initiatives. The best practice recommendation was that each focus group should have between six and ten participants, as fewer than six participants may limit the conversation and yield poor data, while more than ten participants can be unwieldy (Krueger, 2002). The invitation was distributed via e-mail to the purposively selected group of subject matter experts to request their participation in the focus groups held online using Microsoft Teams. The data was collected using recording and transcribed for thematic analysis.

3.6.2 End-users: during usage and post usage

Data collection occurred during the usage of the prototype system using mouse movement. The data collected from the end-users (Group 2) and data collection (during usage) took place via the online link with the prototype system. The online link also had the online questionnaire (post-usage). These were administered to the participants using online tools such as Microsoft Forms, easily accessible for administering surveys, as detailed in Stage 2 of the research flow (see Section 3.4).

The survey questionnaire was formulated from constructs from persuasive strategies and UX attributes (refer to Table 3.3 for constructs). The development of the survey questionnaire was informed by combining various empirically tested survey instruments found in other literature (as detailed in Section 3.4.1); the outcome was *QuestionnaireVersion1*. The sources of the questions used for formulating the questionnaire

provided in Table 3.6. The final complete questionnaire (*QuestionnaireVersion2*), including demographic information, in APPENDIX C.

Table 3.6: Measurement tool sources for survey questionnaire (*QuestionnaireVersion1*)

Subject Area	**Construct**	**Statement to be included in the questionnaire**	**Source of question**
Persuasive Technologies (PT) strategies	Competition	It engages and challenges one to be better (R. Orji, 2017).	(R. Orji, 2017)
		It keeps one focused and gives them more reason to push towards the goals (R. Orji, 2017).	(R. Orji, 2017)
		It allows for subtle and empowering peer pressure (R. Orji, 2017).	(R. Orji, 2017)
	Cooperation	It provides opportunities for mutual support and encouragement (R. Orji, 2017).	(R. Orji, 2017)
		It provides opportunities for people to stay responsible and accountable to others which propels them to meet their behaviour goals (R. Orji, 2017).	(R. Orji, 2017)
		It raises users' sensitivity to disappointment and makes them work harder to avoid disappointing others (R. Orji, 2017).	(R. Orji, 2017)
	Self-monitoring	The system allows me to see my current score (R. Orji et al., 2014).	(R. Orji et al., 2014)
		The system allows me to track changes over a period of time (R. Orji et al., 2014).	(R. Orji et al., 2014)
		The system provides monitors for my performance over a period of time (R. Orji et al., 2014).	(R. Orji et al., 2014)
User Experience attributes	Effectiveness	It improves my performance (Ying, 2013).	(Ying, 2013)
		The system would influence my ability to complete the learning tasks (Ying, 2013).	(R. Orji, 2017)
		The system helps me to improve my scores (Ying, 2013).	(Ying, 2013)
	Efficien	The response time is acceptable (Albert & Tullis, 2013).	(Albert & Tullis, 2013)

		It allows me to do the tasks quickly (Albert & Tullis, 2013).	(Albert & Tullis, 2013)
		It does not require a major effort to complete the tasks (Albert & Tullis, 2013).	(Albert & Tullis, 2013)
	Satisfaction	I enjoyed studying on the system (F. A. Orji et al., 2018).	(F. A. Orji et al., 2018)
		It would be a pleasure to work with a system like this (F. A. Orji et al., 2018).	(F. A. Orji et al., 2018)
		It felt good to successfully complete the course on this system (F. A. Orji et al., 2018).	(F. A. Orji et al., 2018)
ARCS	Attention	The system would capture and hold my interest, e.g., diagrams for illustrations are eye-catching (Keller, 2016; R. Orji et al., 2019).	(Keller, 2016; R. Orji et al., 2019)
		The layout of information on the system keeps my attention (Keller, 2016; R. Orji et al., 2019).	(Keller, 2016; R. Orji et al., 2019)
		The system has some contents that stimulate my curiosity (Keller, 2016; R. Orji et al., 2019).	(Keller, 2016; R. Orji et al., 2019)
	Relevance	The content of the system is relevant to me (B. Huang & Hew, 2016; Keller, 2016).	(B. Huang & Hew, 2016; Keller, 2016)
		The training relates to the tasks I need to perform (B. Huang & Hew, 2016; Keller, 2016).	(B. Huang & Hew, 2016; Keller, 2016)
		The system provides explanations or examples of how the knowledge learned can be used (B. Huang & Hew, 2016; Keller, 2016).	(B. Huang & Hew, 2016; Keller, 2016)
	Confidence	The system should help me to complete my courses successfully (Keller, 2016; R. Orji, 2017).	(Keller, 2016; R. Orji, 2017)
		The system would build my confidence to demonstrate the knowledge learned (Keller, 2016; R. Orji, 2017).	(Keller, 2016; R. Orji, 2017)
		After reading the introductory information, I felt confident that I knew what I was supposed to do on the system to learn from this course (Keller, 2016; R. Orji, 2017).	(Keller, 2016; R. Orji, 2017)

As indicated in Table 3.6, the survey measurement tool was derived from different sources. The tool was validated for reliability for usage within the context of the study (refer to Section 6.4) by reliability. According to Boslaugh (2012), reliability, in this context, refers to the consistency of measurements. The reliability of the data or internal consistency of each construct was measured using Cronbach's Alpha value (Boslaugh, 2012). The validation of the tool using statistical analysis techniques detailed in Section 6.4. Table 3.7 provides a list of statistical analysis techniques used in the research study.

Table 3.7: Statistical analysis techniques and application in the study

Statistical analysis technique	**Description**	**Application in the study**
Descriptive statistics	Descriptive statistics refers to the analysis of data that helps describe, show or summarise data in a meaningful way such that, for example, patterns might emerge from the data, such as minimum, maximum, mean, and standard deviation (Saunders et al., 2009).	Section 6.5
Exploratory data analysis (EDA)	EDA refers to an approach that emphasises the use of diagrams to explore and understand the data and emphasises the importance of using data to guide the choices of analysis techniques (Saunders et al., 2009). EDA may also include descriptive analysis.	Section 4,2; 5.4; 6.2
Exploratory Factor Analysis (EFA)	EFA's purpose was used to discover the factor structure of a measure and to examine its internal reliability (Pallant, 2013). Identifies the common factors that explain the order and structure among measured variables (Watkins, 2018).	Section 6.2
Cronbach's alpha (α)	Cronbach's Alpha value provided a measure of reliability or internal consistency (Boslaugh, 2012).	Section 6.2

The quantitative data collected were analysed using statistical procedures. Albert and Tullis (2013) guided the types of statistical data, metrics for collecting data, and statistical procedures for analysis, as depicted in Table 3.8. In this study, interval data collection occurs using a Likert scale. Table 3.8 provides the four data types, matrices, and statistical procedures (Albert & Tullis, 2013).

Table 3.8: Categories of data for statistical analysis, metrics, and procedure (adapted from Albert & Tullis, 2013)

Data Type	Description	Metrics	Statistical Procedures
Nominal (categories)	Nominal data are simply unordered groups or categories (Albert & Tullis, 2013).	Task success (binary), errors (binary), top-2-box scores (Albert & Tullis, 2013).	Frequencies
Ordinal (ranks)	Ordinal data are ordered groups or categories (Albert & Tullis, 2013).	Severity ratings, rankings (designs)	Frequencies, correlation
Interval	Interval data are continuous data where the differences between the measurements are meaningful, but there is no natural zero point (Albert & Tullis, 2013).	Likert scale data (Albert & Tullis, 2013).	Descriptive statistics, correlation
Ratio	Ratio data are the same as interval data, with the addition of an absolute zero (Albert & Tullis, 2013).	Completion time, average task success (aggregated) (Albert & Tullis, 2013).	Descriptive statistics, correlation

Data are commonly collected qualitatively, quantitatively, or using mixed methods (Saunders et al., 2009). Quantitative and quantitative methods were both used in the research study. The study started with the literature review to determine the constructs for informing design guidelines. Followed by the validation with the subject matter experts, wherein the initial data collection occurred in focus groups (Group 1). The data collected in focus groups were analysed qualitatively, as detailed in section 4.4. After this, the design guidelines were used for prototype design, followed by more data collection during the usage of the prototype system. Finally, data were collected post-usage of the prototype from Group 2 using the survey questionnaire, followed by quantitative data analysis to ensure correct data interpretation. Additionally, further understanding of the data was gained by

incorporating open-ended questions. Table 3.9 describes the data collection techniques and tools used in the study.

Table 3.9: Data collection techniques and application in the study

Data collection technique	**Application in the study**	**Tools**	**Refer**
Qualitatively data collection using Focus groups (Group 1)	The data in focus groups were collected then analysed qualitatively using Thematic Analysis.	Atlas.ti 9, and Microsoft Word 2016	Section 4.3
Mixed using mouse movement (Group 2)	More data was collected during usage of the prototype system using mouse movement, then analysed using heat maps on mixed methods.	Microsoft Word 2016 and Microsoft Excel 2016	Section 5.5
Quantitative data collection using a survey questionnaire (Group 2)	The final set of data was collected post-usage of the prototype using the survey questionnaire and then analysing data quantitatively.	SPSS version 27, Microsoft Forms, Microsoft Excel 2016	Chapter 6

The data collected were analysed using software packages; for example, the quantitative data using SPSS version 27, Microsoft Forms, and Microsoft Excel. The qualitative data was analysed using ATLAS.ti 9 and Microsoft Word 2016. The Microsoft software package used in the study comes with Microsoft Office 2016, used on the researcher's personal computer. The SPSS (Statistical Package for Social Science) is the computer software package by IBM used for statistical data analysis. ATLAS.ti is a software package for qualitative data analysis (Atlas.ti, 2020).

Next, the focus was on how to conduct research ethically.

3.7 Research access and ethics

Research ethics implies conducting research morally and responsibly (Saunders et al., 2009). This research was guided by the University of South Africa's code of ethics. Potential participants were requested to complete consent forms to conduct research and collect data, granting access to both the organisation and them as individuals (Saunders et al., 2009).

A consent form was submitted to the organisation under study, and an ethics clearance was obtained from UNISA's ethics department. The approved clearance documents (ERC Reference #: 2020/CSET/SOC/008) were provided in APPENDIX A and B, respectively. Furthermore, in this study, the consent forms from participants were collected electronically for the survey, as indicated in Section 5.4, in line with COVID-19 regulations. The focus group participants provided electronic signatures on the consent forms attached in APPENDIX C.

3.8 Conclusion

The research process was driven by DSR as a pragmatic philosophy, as the study was problem centred. The identified problem to be solved came from an observation in the corporate business environment with users' motivation to learn autonomously using digital learning. Based on DSR, the literature study guided the development of the proposed literature-based design guidelines (as theoretical contribution). Multiple data gathering methods were employed, beginning with a literature review for the constructs validated with the subject matter experts (pre-usage) in iterative focus group sessions (which gathered data in recorded transcripts that were thematically analysed). The design guidelines were deployed in a prototype (as a practical contribution). Data were gathered during the evaluation of the prototype by using mouse movement (during usage) and during the evaluation of the prototype by the end-users, wherein data was gathered using a survey (post-usage). Data-triangulation was deployed based on the qualitative data results (themes from thematic analysis) and quantitative data (statistical constructs) to validate the results and appropriateness of the design guidelines. The DSR has driven the research process to

provide answers to the main research question and sub-questions, as depicted in Table 3.10.

Table 3.10: The research questions, and data analysis techniques

Main research question (RQ): What are the insights obtained from persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa?				
Sub-Research questions (Sub-RQ)	**Research Actions (RA)**	**Data Collection**	**Data Analysis**	**Research output (RO)**
a. What are the persuasive strategies and UX attributes for improving the users' motivation for using digital learning platforms for autonomous learning?	a.1 Literature review on PT and UX. a.2 Literature review for questionnaires for evaluating PT and UX.	Literature review	Qualitative	a.1 The persuasive strategies and UX attributes (see Table 2.8: *ConstructsVersion1* - The literature-based set of constructs). a.2 Produce evaluation questionnaire (see Table 3.6: *QuestionnaireVersion1*).
b. What are the design guidelines on the literature-based set of persuasive strategies and UX attributes required to improve the users' motivation for using digital learning platforms for autonomous learning?	b.1 Focus group sessions with subject matter experts based on *ConstructsVersion1* to validate the suitability of the constructs for users' motivation. b.2 Literature review on PT and UX for design guidelines.	Focus groups	Qualitative	b.1 *ConstructsVersion2* suggested improving the users' motivation for autonomous learning on the digital learning platform. b.2 The validated constructs (see Table 3.3) serve as a basis for the design guidelines of the prototype.
c. What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that need to be evaluated to improve	c.1 Design and develop a prototype based on findings of (RQ. b) design guidelines to gain users' perspectives. c.2 Using the findings of (RQ. b), namely *ConstructsVersion2*, update *QuestionnaireVersion1* by	User testing also captures mouse movement Survey questionnaire	Quantitative	c.1 Prototype systems (see Figure 5.1). Mouse movement results in Section 5.6.1, 5.6.2, 5.6.3) c.2 *QuestionnaireVersion2* was used to evaluate the prototype system by the users (see Appendix C).

motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?	selecting relevant questions and producing an evaluation questionnaire c.3 Prototype evaluation using *QuestionnaireVersion2* to obtain users' perspectives.			c3. Prototype system evaluation results were used to validate *ConstructsVersion2* (see Table 6.4 Rotated Component Matrix).

Chapter 4 discusses the data analysis and findings from the research study.

4. CHAPTER 4: DATA ANALYSIS AND FINDINGS: PRE-USAGE

4.1 Introduction

The objective of the focus groups with the subject matter experts' participants was to validate *ConstructsVersion1* (as seen in Table 2.8) in the digital learning environment. The output was then a validated set of constructs called *ConstructsVersion2* (see Table 3.3) and used as a basis for design guidelines in developing a prototype. For the thematic analysis, the findings from the data collected through focus group sessions with the subject matter experts are discussed in this section. The results presented in Chapter 4 addressed the research sub-question (sub-RQ.b) by analysing the results of the qualitative data captured from the subject matter experts.

Section 4.2 provides the profile distribution of the subject matter expert participation, and Section 4.3 provides the participant expertise based on their roles in the digital learning environment. Section 4.4 provides the details of the thematic analysis of the data collected from the focus groups, and finally, Section 4.5 provides the chapter conclusion.

4.2 Profile of the subject matter experts

The profiles of the 14 subject matter experts that attended the focus group sessions, conducting three sessions over three weeks, were provided in Table 4.1. The first column provided the focus group sessions, followed by the number of participants attending each focus group session. The table also provided the total number of participants invited, the number of those who declined to participate and finally, the non-responses received (the number of non-responses helped determine the number of participants for follow-up sessions in the subsequent focus group). This resulted in follow-up sessions until no more participants responded positively to the invitations sent. The invitation for the 4th

focus group session went out, with no response from the remaining targeted participants, the researcher suspended the focus group sessions.

Table 4.1: The distribution of subject matter experts' attendance in the focus groups.

Focus Group Sessions	Participants attended	Total invited	Participants declined	Non-response
Focus Group1	4	17	8	9
Focus Group2	5	9	2	7
Focus Group3	5	7	2	5
Focus Group4	0	5	2	3
Total	N=14			

Section 4.3 discusses the subject matter expert's demographic data, which consists of expertise and gender.

4.3 Participant's expertise and gender

The subject matter experts that participated in the study, as depicted in Figure 4.1, consisted of 14 selected practitioners from the business and included learning developers (29%), learning trainer coordinators (43%), senior advisors for the digital learning environment (7%), middle managers and senior managers from the academy of learning made up of 14% and 7%, respectively. The gender distribution of the subject matter experts' participation in the focus groups indicated 57% male (8 of 14) and 43% female participants (6 of 14). The observation made from this finding was that a higher

percentage of male than female subject matter experts participated in the focus groups; this observation was consistent with the gender distribution in the organisation.

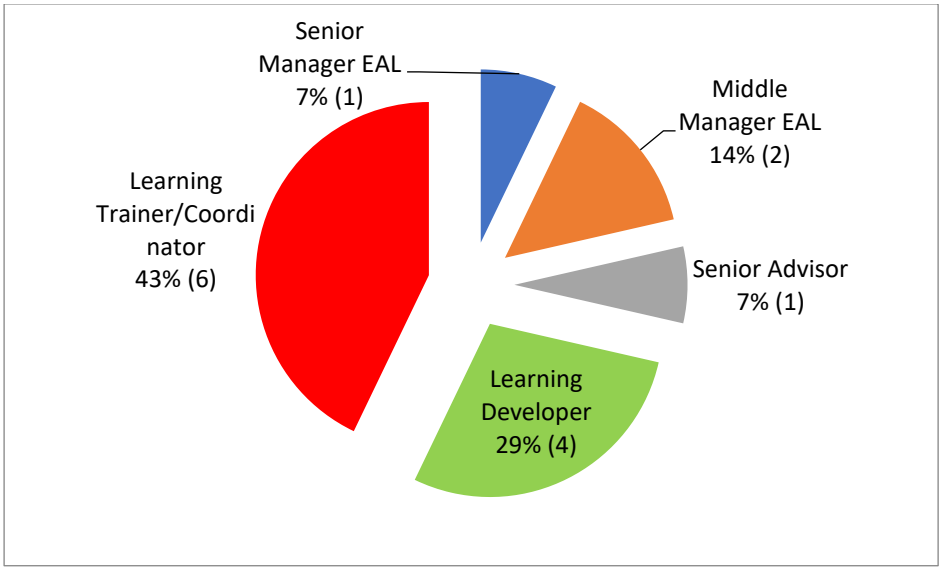

Figure 4.1: Specialisation distribution of the subject matter experts focus group participants

The observation from this finding was that the various subject matter experts involved in the focus groups had vast knowledge (in training, development, advisory, and management) and experience in the digital learning environment.

4.4 Analysis of the focus groups data

The data from the subject matter experts in the focus groups were collected for qualitative analysis following the six-step thematic analysis process (Braun & Clarke, 2020) and transcribed, and summarised in Table 4.2. In Step 1, the researcher studied the recorded data and prepared the transcripts (see APPENDIX H) for thematic analysis. In Step 2, the anonymised data used codes indicating different participants (Saunders et al., 2009), for example, P1, P2, P3, etcetera, whereby the code P1 refers to participant1.

Table 4.2: Thematic analysis process and application in the research study

Thematic analysis steps and Descriptions (adapted from Braun and Clarke (2020))	**Application in a research study**
1. Become familiar with the data - The researcher studied the gathered data to become familiar with them.	Recordings were read and transcribed by the researcher in preparation for the quantitative analysis (Refer to APPENDIX H for the transcript).
2. Generate initial codes - The researcher generated and categorised the data to capture interesting points about the research questions.	The transcripts were grouped by the session number (e.g., session1 = S1) and participant number (participant1 = P1). Therefore, the codes used in session 1 were S1P1, S1P2, S1P3, etcetera. The data categories were deductively derived from theoretical concepts of persuasive system design guidelines. The deductive approach seeks to use existing theory, which links the research to the existing body of knowledge (Saunders et al., 2009). The theoretical concepts that form the constructs in this research study were C*ompetition, Cooperation, Self-monitoring, Attention, Relevance, Confidence, Satisfaction, Effectiveness,* and *Efficiency*. These were the categories of themes generated using the deductive approach for comparison with the transcripts. The transcripts have been uploaded into the software ATLAS.ti and the categories have been captured in ATLAS.ti for ease of management.
3. Search for themes - The researcher searched for the codes and themes in the data paying attention to the significance of the theme.	The researcher used ATLAS.ti to search for the themes on the transcript and use descriptions of the themes for a close match. ATLAS.ti software kept track of the number of occurrences of the theme to determine its significance.
4. Review themes - The researcher looked at the coherence of the data and checked whether the data made sense or supported the themes based on the descriptions of the themes.	The researcher reviewed the transcripts in ATLAS.ti, checking for themes relating to the constructs already identified. These themes have been added to the code distribution report in ATLAS.ti, as depicted in Figure 4.2. The emerging themes from the review were also recorded for constructs occurring more frequently.

5. Define themes - The definition of the finalised themes has been provided.	The deductive approach, which seeks to use existing theory and links the research to the existing body of knowledge (Saunders et al., 2009), was used to define the themes. The themes were compared in the first iteration for similarities to the literature-based constructs, and all the matching themes to the theory has been retained. In the second iteration of refining the themes, frequency counts were used; the higher frequency themes were noted for further analysis. The high-frequency themes have been compared with the theoretical themes. The themes having higher frequency were System Capabilities (8), flexibility (6), change management (3), usage (3), user groups (3), duration (2), and regulatory (2). After analysing the additional themes that emerged, they were re-categorised by comparing the similarities to the literature-based constructs. The deductive approach, which seeks to use existing theory and links the research into the existing body of knowledge, was used to finalise the themes. The constructs were deemed necessary as a basis for design guidelines for developing the prototype.
6. Write-up - The writing-up of the interviews' analysis was performed.	The write-up of the analysis for the focus groups was performed. The constructs were retained as part of the design guidelines. The assumption was that all the primary design factors need to be in place for the persuasive to be effective.

In Step 3, the themes were searched based on significance to the study. The themes have been captured into ATLAS.ti, software, and frequency occurrence reports produced, as depicted in Figure 4.2. The high-frequency themes (any theme occurring more than once) were grouped within a red-dotted rectangle. The outcome action was the frequency report to review the themes as Step 4 of thematic analysis.

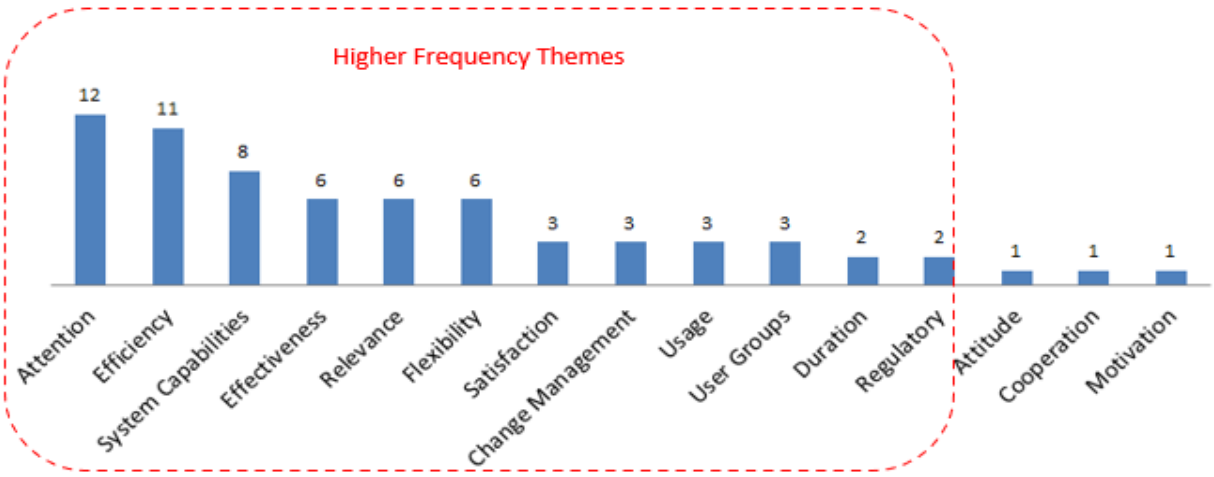

Figure 4.2: Theme frequency report from the thematic analysis in ATLAS.ti

Step 5 of the thematic analysis comprised defining the final themes and comparing them with the theoretical concepts (see Table 2.8: *ConstructsVersion1*) for similarities, then the action was to re-categorise. As the themes were deductively derived from theoretical concepts, the themes that match the theoretical concepts were retained, as depicted in Table 4.3. Themes were sorted in descending order by the frequency, and the justification for the final themes were also provided in the column named “Action”.

Table 4.3: The themes generated after the thematic analysis

#	**Theme** (high-to-low ranking frequency) (emerging themes in bold)	**Action**	**Matching literature-based themes**
1	Attention	Retained, frequency 12	Attention
2	Efficiency	Retained, frequency 11	Efficiency
3	**System Capabilities**	Re-categorised, frequency 8	Effectiveness
4	Effectiveness	Retained, frequency 6	Effectiveness
5	Relevance	Retained, frequency 6	Relevance
6	**Flexibility**	Re-categorised, frequency 6	Efficiency
7	Satisfaction	Retained, frequency 3	Satisfaction
8	**Change Management**	Re-categorised, frequency 3	Cooperation
9	**Usage**	Re-categorised, frequency 3	Effectiveness
10	**User Groups**	Re-categorised, frequency 3	Cooperation
11	**Duration**	Re-categorised, frequency 2	Efficiency
12	Regulatory Courses	Removed, frequency 2, as it was a course type	-
13	Attitude	Removed, low frequency 1	-

14	Cooperation	Retained as deductively derived from theoretical concepts, frequency 1	Cooperation
15	Motivation	Removed, low frequency 1	-

In executing Step 5, the additional themes noted as having higher frequency were: "*System Capabilities*" (8), "*Flexibility*" (6), "*Change Management*" (3), "*Usage*" (3), "*User Groups*" (3), and duration (2). The high-frequency themes were compared with the theoretical themes from *ConstructsVersion1*. New emerging themes with the *ConstructsVersion1* were compared for similarities in the description, and the action was to either remove, re-categorise, or retain. The actions captured in Table 4.3; for example, "*System Capabilities*" and "*Usage*" refer to functions of the system, and "*Effectiveness*" refers to functions to complete the task in the context of the study. "*Flexibility*" can refer to allowance for alternative interactions, but it was also considered as allowing digital learning anywhere, anytime for users (Daud et al., 2013). Since efficiency refers to time as in time-on-task (Albert & Tullis, 2013), this also covers "*Duration*". Therefore, "*Flexibility*" was re-categorised under "*Efficiency*" as they both relate to time in a learning activity. The removed themes were "*Regulatory Courses*", as this was a course type and "*Attitude*" due to low-frequency count. "*Change Management*" as a group activity to embrace change is like cooperation.

Depicted in Table 4.4 were the final themes and descriptions validated by the subject matter experts. Notably, these themes were the same as the validated constructs. Therefore, the validated themes were used as the basis for the design guidelines.

Table 4.4: Final themes considered in the design guidelines

#	**Final themes**	**Description**
1	Attention	*Attention* refers to an attribute that incorporates curiosity and arousal, interest, boredom, and other related areas such as sensation seeking (Keller, 2016).

2	Efficiency	*Efficiency* refers to an attribute that indicates the amount of effort required to complete the task successfully (Albert & Tullis, 2013).
3	Effectiveness	*Effectiveness* refers to an attribute that gives the ability to complete a task successfully (Albert & Tullis, 2013).
4	Relevance	*Relevance* refers to learners' perceptions that the instructional requirements are consistent with their goals, compatible with their learning styles, and connected to their past experiences (Keller, 2016).
5	Satisfaction	*Satisfaction* refers to an attribute indicating the degree of the user's internal state and whether the user was happy with the experience while performing the task (Albert & Tullis, 2013). It includes the appropriate mix of intrinsically and extrinsically rewarding outcomes that sustain desirable learning behaviours and discourage undesirable ones (Keller, 2016).
6	Cooperation	*Cooperation* refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate; thus, it should provide a means for cooperation (Oinas-Kukkonen & Harjumaa, 2009).
7	Competition	*Competition* refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete; thus, it should provide the means for competing with other users (Oinas-Kukkonen & Harjumaa, 2009).
8	Self-monitoring	*Self-monitoring* refers to a system attribute that keeps track of a user's performance, or status and supports him/her in achieving goals; thus, it should provide the means for users to track their performance or status (Oinas-Kukkonen & Harjumaa, 2009).
9	Confidence	*Confidence* category refers to the effects of positive expectancies for success, experiences of success, and attributions of successes to one's abilities and efforts rather than to luck or to task challenge levels that are too easy or difficult (Keller, 2016).

Based on these themes, the relevant design guidelines were obtained from literature to match these themes, as discussed in Section 3.4 and provided in Table 4.5, indicating the subject area, constructs and description (*ConstructsVersion2*) along with the design guidelines, and the source of literature from where the guidelines were obtained.

Table 4.5: *ConstructsVersion2* considered in the design guidelines

Subject Area	Constructs and Description	Design guidelines	Source
Persuasive strategies	*Competition* refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to compete; thus, it should provide the means for competing with other users (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support competition.	(Oinas-Kukkonen & Harjumaa, 2009)
	Cooperation refers to a system attribute that can motivate users to adopt a target attitude or behaviour by leveraging humans' natural drive to cooperate; thus, it should provide a means for cooperation (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support cooperation.	(Oinas-Kukkonen & Harjumaa, 2009)
	Self-monitoring refers to a system attribute that keeps track of a user's own performance, or status and supports them in achieving goals; thus, it should provide the means for users to track their performance or status (Oinas-Kukkonen & Harjumaa, 2009).	The interaction design should support self-monitoring.	(Oinas-Kukkonen & Harjumaa, 2009)
User Experience attributes	*Effectiveness* refers to an attribute that gives the ability to complete a task successfully (Albert & Tullis, 2013).	The system should support the user in getting the learning tasks done.	(Albert & Tullis, 2013)
	Efficiency refers to an attribute that indicates the amount of effort required to complete the task successfully (Albert & Tullis, 2013).	The system should minimise time and effort in supporting learning.	(Albert & Tullis, 2013)
	Satisfaction refers to an attribute that indicates the degree of the user's internal state, was the user happy with the experience while performing the task (Albert & Tullis, 2013).	The users should be satisfied with their interaction experience.	(Albert & Tullis, 2013; Keller, 2016)

ARCS	*Attention* refers to an attribute that incorporates curiosity and arousal, interest, boredom, and other related areas such as sensation seeking (Keller, 2016).	The interaction design should attract the user's attention.	(Keller, 2016)
	Relevance refers to learners' perceptions that the instructional requirements are consistent with their goals, compatible with their learning styles, and connected to their past experiences (Keller, 2016).	The interaction design should be relevant to support learning.	(Keller, 2016)
	Confidence category refers to the effects of positive expectancies for success, experiences of success, and attributions of successes to one's abilities and efforts rather than to luck or to task challenge levels that are too easy or difficult (Keller, 2016).	The interaction design should support confidence.	(Keller, 2016)
Flexibility	*Flexibility* can refer to allowance for alternative interactions, but it was also considered as allowing digital learning anywhere, anytime for users (Daud et al., 2013). *Derived from Focus groups (See details in Chapter 4, Section 4.4)*	The interaction design platform should be easily accessible anywhere and everywhere.	(Merdzhanov , 2018)

4.5 Conclusion

The outcomes of the focus groups based on the thematic analysis of the transcript from the subject matter experts provided the final themes as depicted in Table 4.4. The themes in Table 4.4 were used as a basis for choosing the design guidelines. The themes mapped to the relevant design guidelines are presented in Table 4.5, defined as the validated constructs (*ConstructsVersion2*) included in the selection and inform the relevant design guidelines used to answer research sub-question b (sub-RQ.b):

> *What are the design guidelines on the literature-based set of persuasive strategies and UX attributes required to improve the users' motivation for using digital learning platforms for autonomous learning?*

In answering sub-RQ.b, Table 4.5 provides the design guidelines and the validated constructs (*ConstructsVersion2*, namely, *Competition, Cooperation, Self-monitoring, Effectiveness*, *Efficiency, Satisfaction, Attention, Relevance,* and *Confidence*). The design guidelines have been subsequently used to develop a digital learning platform (prototype).

5. CHAPTER 5: DATA ANALYSIS AND FINDINGS: DURING-USAGE

5.1 Introduction

Another set of data in the study was collected during the usage of the prototype. Note that the data collection was conducted with the second group of users (end-users), which was different from the group used for the focus groups (subject matter experts). The data set was collected from the users during the usage of the prototype. The objective of developing the prototype was to include the validated constructs in the design so that the users' insights on PT and UX attributes could be collected and measured during the usage of the prototype to complete the digital learning tasks. The results presented in Chapter 5 contribute toward addressing the research sub-question (sub-RQ.c) by analysing the results of the quantitative data captured from the users after using the prototype.

> Sub-RQ.c: *What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that needs to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?*

Section 5.2 provides a brief overview of the prototype system used for data collection. Section 5.3 provides the prototype used for data collection from users. Section 5.4 provides the demographic details of the end-user who participated in the prototype evaluation.

5.2 Prototype user interface

The prototype design was simple yet adequate to allow users to perform interactions on the digital learning platform for data collection from users. A detailed discussion on the process of prototype design and development was covered in Section 3.4.2. The landing page of the digital learning prototype, as depicted in Figure 5.1, shows the common persuasive strategies indicated by the callouts to probe the user to take action to start the learning task. The prototype's *self-monitoring* persuasive strategy was applied by displaying the course

progress in the learning task (doughnut cycle) with the persuasive message, encouraging the user to click to start the learning task on the course. The *cooperation* persuasive strategy was applied to the prototype by motivating the users to work collectively in the departments towards improved performance. The *competition* persuasive strategy was applied to the prototype by displaying the scoreboard depicting the highest performer or performing department.

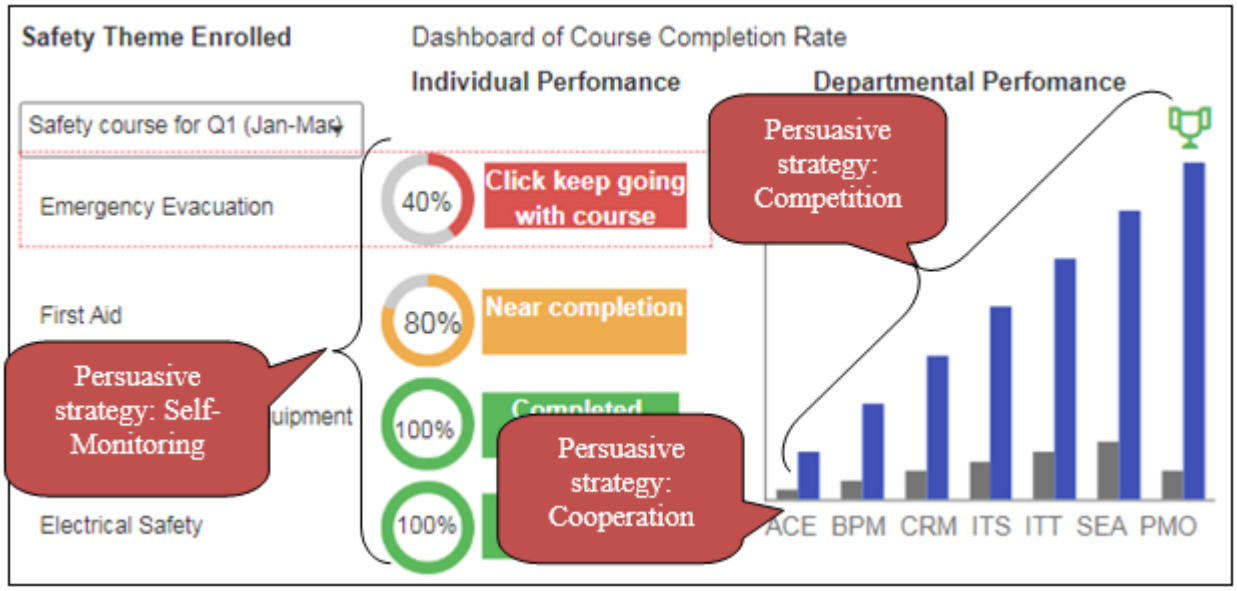

Figure 5.1: Prototype landing screenshot

Section 5.3 discusses the details of the user evaluation of the prototype to obtain user insights for analysis.

5.3 Evaluating the digital learning platform prototype

To obtain user insights, the prototype was presented to end-users via e-mail as a web link (URL) with instructions on the tasks to perform. All the end-users that accepted participation were requested to complete the five learning tasks on the digital platform prototype. If the user clicks “Accept”, the user can continue with the task and if the user clicks “Not accept”, the session would terminate. The data collected comprised both demographic and performance metrics data. Table 5.1 provides the distribution of participant received data.

The total invitations sent (150), and the participants who accepted (N=76), with 1 participant who declined and 73 non-responses.

Table 5.1: Distribution of participant's consent to the prototype usage

Prototype evaluation participation	**Total invited**	**Participants accepted**	**Participants declined**	**Non-responses**
Numbers	150	76	1	73
Percentage	100%	51%	1%	49%

Furthermore, in Table 5.1, 51% of participants consented to participate in the research study, 1% declined, and 49% were non-responses. The demographic profile of participants who accepted and participated in the research study and their demographic data appears in Section 5.4.

5.4 Demographic data of participants during prototype usage

The end-user demographic data collected from the organisation's digital learning system were analysed and interpreted using quantitative analysis techniques. The key aspects to considered were guided by the research question(s) and objectives, they included: specific values; highest and lowest values; trends over time; proportions; and distributions (Saunders et al., 2009).

The results from the participant demographic data were organised according to gender in Section 5.4.1, followed by Section 5.4.2 age, Section 5.4.3 business area, Section 5.4.5 positions, and finally, experience in Section 5.4.6.

5.4.1 Gender of participants

Table 5.2 provided the breakdown of the gender distribution of the end-users who participated in using the prototype system. The results assist the research in identifying the distribution of the participants according to gender. The findings show that from the number

of participants (N=76), 51% were females, 45% were males, and 4% did not disclose their gender.

Table 5.2: Distribution of end-user participants' gender.

Gender	**Quantity**	**Percentage**
Female	39	51%
Male	34	45%
Prefer not to say	3	4%
Total participants	76	100%

Therefore, most of the end-users that participated in the study were females.

5.4.2 Age of participants

Figure 5.2 depicts the findings from the age group of participants to understand the distribution of the participants according to the age groupings.

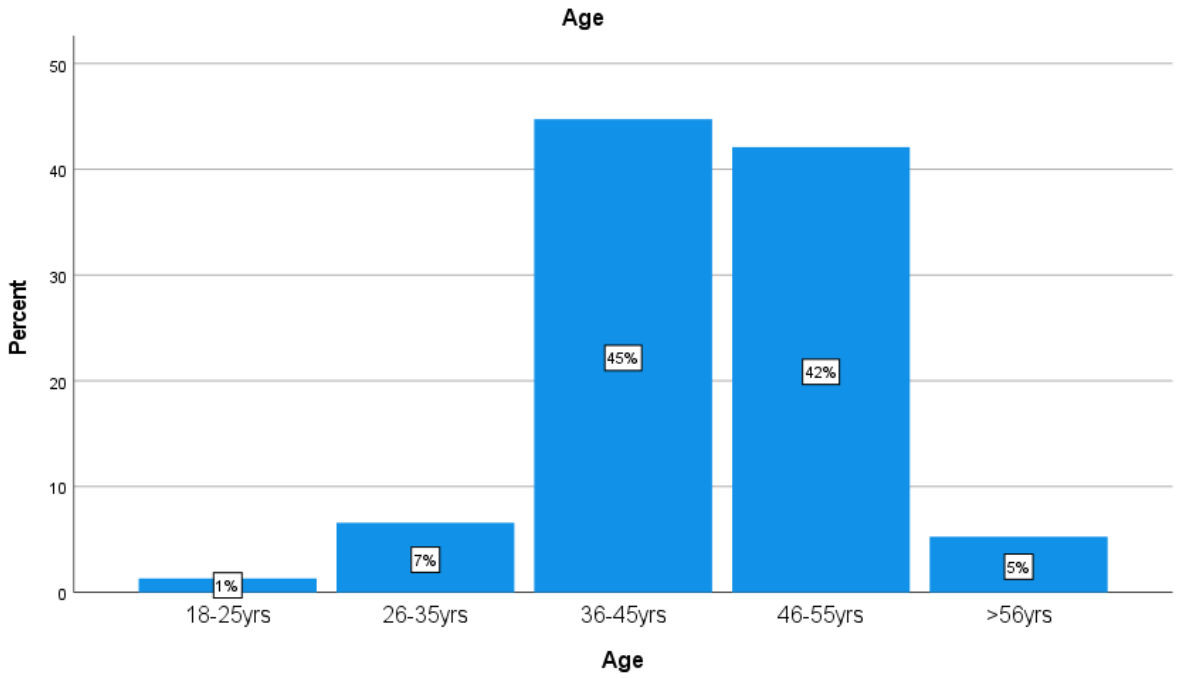

Figure 5.2: Age group of participants

The findings from age analysis indicated that from the total number of participants (N=76), the highest number participants (45%) were in the age group 36-45 years. The lowest number (1%) of participants was from the age group 18-25 years. The data indicated that 87% of the survey population were between 36-55 years. The results show that the participants were mature adults.

5.4.3 Participant per departments

Figure 5.3 represents the number of participants per department.

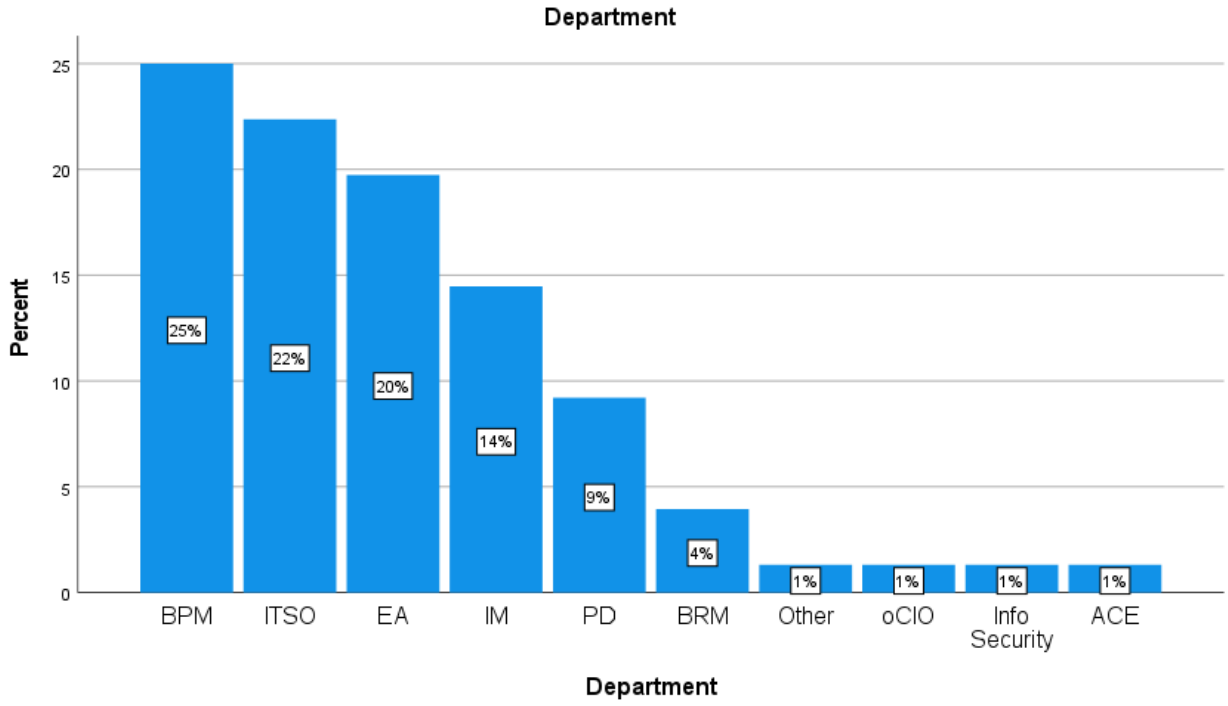

Figure 5.3: Participants per Department in the organisation

The findings in Figure 5.3 provided the number of participants per the departments in the organisation. The observations were ordered from the highest to the lowest number of participants, with Business Process Management (BPM) having the highest number of participants (25%). Information Technology Service Operations (ITSO), at 22%, was followed by Enterprise Architecture (EA) at 20% of participants. Information Management (IM) had 14%, while Project Delivery (PD) had 9% of participants. Business Relationship Management (BRM) at 4%, while the remaining departments each had the contribution of 1% of participants from the office of the Chief Information Officer (oCIO), Information Security (ISec), and Analytics Centre of Excellence (ACE). Others were the participant that could not find the relevant department. The results indicated that the participants were from

an IT background and expected to be familiar with using digital learning platforms to complete the digital learning tasks.

5.4.4 Positions of participants

Figure 5.4 depicts the findings from the grading of positions showing the distribution of the participants' grades. Various employees participated in the study, from managers responsible for different departments, professionals who provided advisory services to varying departments, specialists with knowledge in specialised areas, and bargaining comprising junior employees in the organisation.

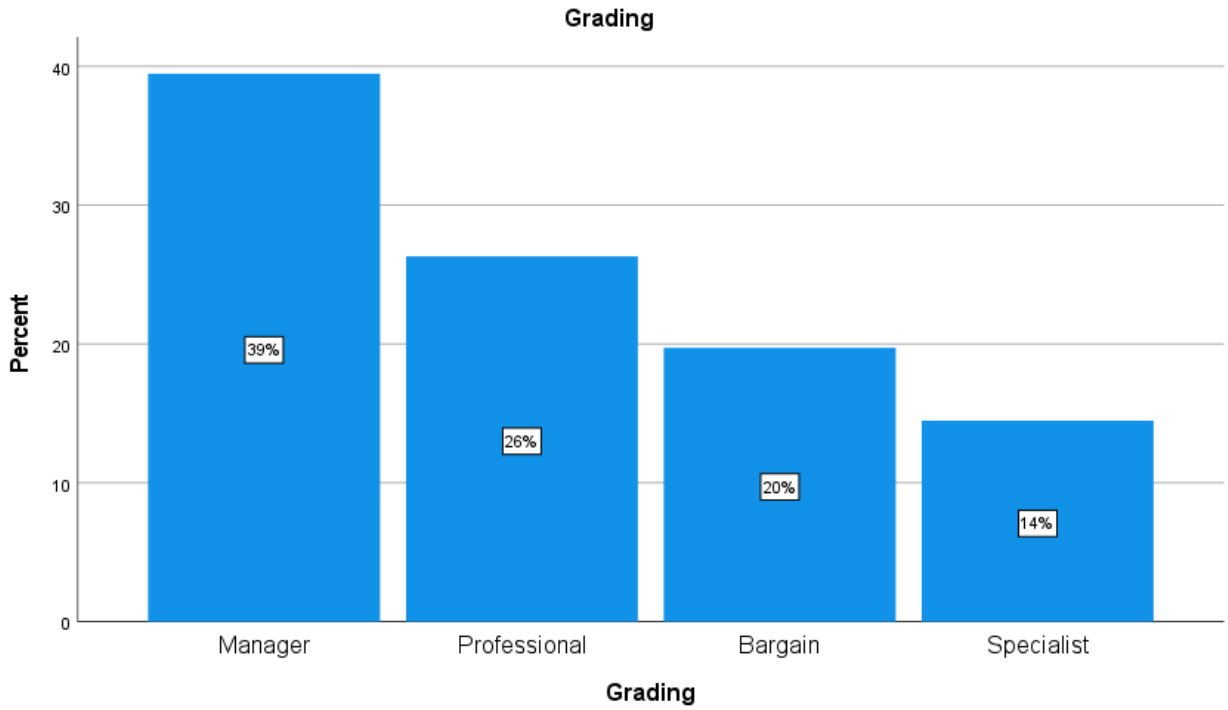

Figure 5.4: Grading positions of participants

The findings from the data collected ordered from highest to lowest show that the highest number of the participants (39%) were managers, followed by professionals (26%), then bargain (20%), and the lowest number of participants were specialists (14%).

Therefore, the results indicated that the participants in the study comprised various positions within IT, from junior employees to managers, displaying a good coverage of the sample of participants across the organisation.

5.4.5 Experience of users on digital learning system

Figure 5.5 depicts the findings from the experience the users have with digital learning usage, showcasing the number of years the participants have in using the digital learning system.

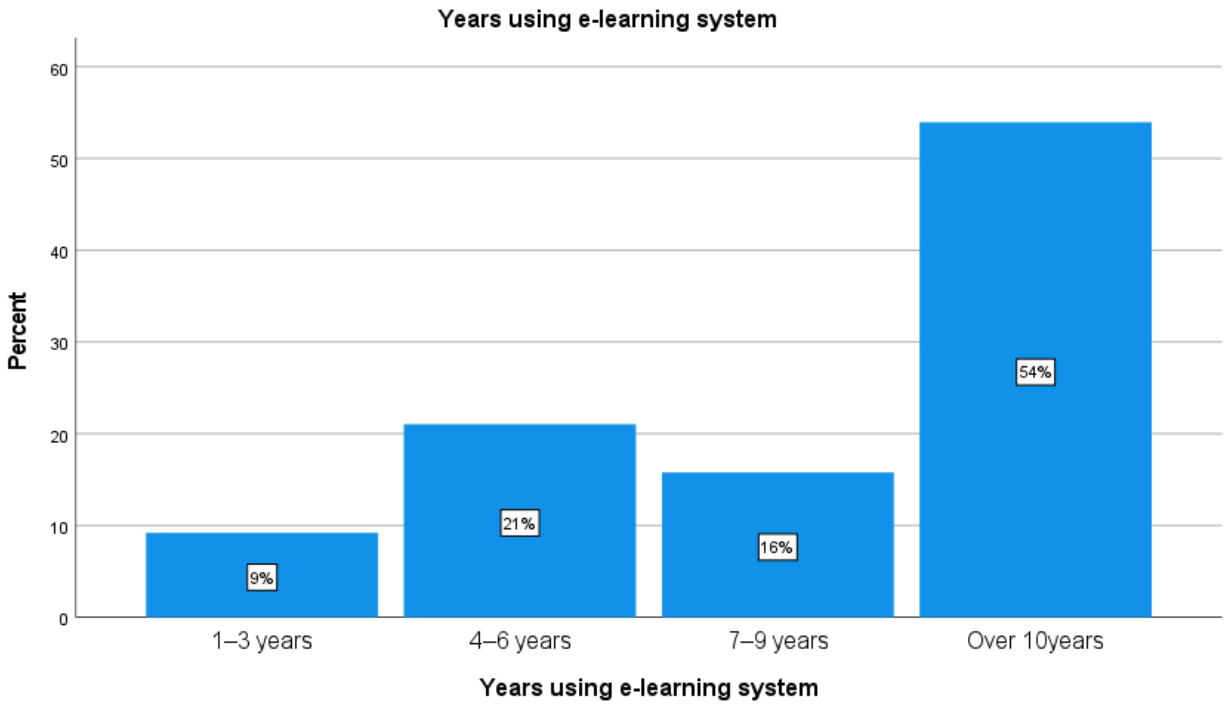

Figure 5.5: Digital learning system usage experience of participants

The findings depicted in Figure 5.5 indicated that from the number of participants, the highest percentage (54%) of participants used the digital learning system for more than ten

years and have extensive experience. The lowest participants percentage (9%) used digital learning for less than four years (1-3 years), 21% had moderate experience (4-6 years), 16% had a good experience (7-9 years) of usage on digital learning system in the organisation.

The results indicated that most participants had extensive experience using digital learning systems. Section 5.5 discusses the findings from the data collected from users testing with mouse movement during usage of the prototype.

5.5 Mouse movement data during the prototype usage

Section 5.5 discusses the analysis of the user testing with mouse movement data while using the prototype for conducting digital learning tasks. As advocated by J. Huang and Diriye (2012), there is a correlation between mouse movement and a participant's eye gaze. The term *gaze* refers to a participant's eye intensity over a specific area during usage (Kirsh, 2020). The prototyping tool (Quant-UX) automatically collects data during user testing of mouse movement while using the prototype, representing them as heat maps. The heat maps were valuable in showing user attention based on the assumption that mouse movements represent eye movements related to user attention (Kirsh, 2020). The heat maps were colour coded (red, yellow, blue, green) to indicate the intensity of the fixation: red denotes the most intense fixation; yellow moderate fixations; green less fixation; and blue the least intense fixations (Quant-UX, 2020). The mouse movement heat maps were a cost-effective option for collecting data during usage since no specialised equipment was necessary for data collection (e.g., no need for specialised eye-tracking hardware and software). It was important to note the limitation of the mouse heat map in that long hover times over a specific area with a mouse can indicate prolonged user interest, but it can also mean that the user simply did not move the mouse (Quant-UX, 2020).

The data collection of the mouse movement data in the study was an aggregate for all users that participated in the research study during the digital learning tasks. The specific types of mouse heat maps used in the research study were *mouse-hover* and *mouse-click* heat maps (Quant-UX, 2020) (Figure 5.6 and Figure 5.7, respectively). These heat maps complement each other in providing beneficial information for design improvement. The data collected during the use of the prototype occurred over four weeks for all the research study participants. The screenshots provided in Chapter 5 are a sample, the range of prototype screenshots and relevant heat maps were provided in APPENDIX D, Figure D2 and Figure D3. While the users were testing the prototype, important performance measures were acquired during the prototype usage, including *test coverage, dwell time, screen views* and *screen clicks* (Quant-UX, 2020).

- The *test coverage* measured the regularity of screen visit to complete the learning task, measuring the percentage of the screens visited by participants. This metric indicated how easy the screen was to find. For example, more than 100% indicated that the screen was visited multiple times.

- *Dwell Time* measured how long the users have spent on average on a screen. A high number might indicate that the users had to perform a lot of interactions or tasks. However, it may also indicate that the users had some problems, for instance, finding the correct elements.

- The *screen views* measured how many times a screen was shown. If this number was much higher than the "Test Coverage", it indicated that the users often returned to this screen.

- The *screen clicks* measured how many times the users have clicked on elements. The number indicated how much "work" the users have performed on a particular screen.

Section 5.5.1 to Section 5.5.4 contain screenshots captured during the tasks performed by the end-users.

5.5.1 Heat map for Welcome screen with Task instructions

Figure 5.6 depicts the “Welcome” screenshot providing participants with the “Task instruction” conducted on the prototype. The participants were requested to read the instructions and then click the Start button.

Task-0: Read instructions and click Start button to progress to the next page.

As depicted in Figure 5.6, the mouse-hover heat map indicated the areas where the mouse hovered, indicating the extent of participant interest (Kirsh, 2020). The size of the coloured area and the specific colour indicated a participant’s concentration on a specific functionality while performing the task. Notably, there is a correlation between mouse movement and eye gaze (J. Huang & Diriye, 2012); the heat maps represented the intensity of the fixation (measured in the time the mouse hovers over an area). The heat maps result from a “reading pattern” (Quant-UX, 2020). The reddish area indicated a strong interest of participants on the “Start button” to start the task, demonstrating the user's *confidence* in completing the tasks. Also, another area of strong interest was in the middle of instruction number 4, suggesting that participants spent time thinking about the task. The concentration of the blue spots on the instructions indicated that the participants noticed the instructions. The concentration of the blue spots (reading pattern) suggests that the participants find the information in that area *relevant*. Notably, the heading “Welcome to PT and UX prototype” attracted little attention, possibly because the abbreviations may be unknown to them.

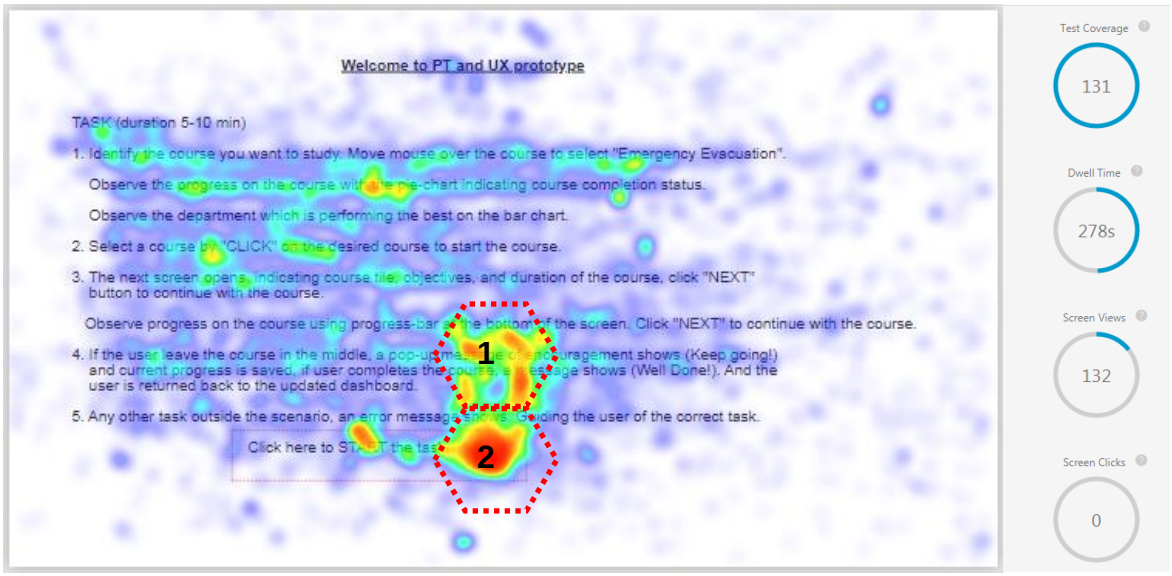

Figure 5.6: Screen1 - Heat map for Task instruction (mouse hovered)

The results indicated red spots on the “Click here to START course” area, annotated as areas of interest with numbers 1 and 2 in dotted lines. The red spots denote the most intense fixation, yellow more moderate fixations, and green the least intense fixations (Djamasbi, Wilson, Strong, & Ruiz, 2016). The blue spots indicated that the area was noticed. The results show that the task instructions were read, as denoted by the blue spots. The results from Figure 5.6 show the task of providing participants with the instructions and clicking the “START button to start” appeared to have posed no significant challenge to the participants.

Section 5.5.2 discusses Screen 2 for the main landing page.

5.5.2 Heat map for Main landing page

Figure 5.7 depicts the screens for the main landing web page of the digital learning environment. This web page displays the courses, while the dashboard shows the status of the specific course (employing self-monitoring, competition strategy) and provides a

scoreboard (employing competition, cooperation strategy) for the participants to see the performance of course completion against other departments, respectively.

Task-1: Identify the course "Emergency Evacuation".
Task-2: Click it to start the course.

Figure 5.7 depicts the mouse-clicks visualisation, indicating the areas where the user had clicked with the mouse (Kirsh, 2020). Orange to red spots denote the intensity of the eye fixation, also referred to as hot spots, and blue spots denote user observation (Djamasbi, Wilson, Strong, & Ruiz, 2016). The heat map intensity suggests that participants successfully located and clicked on the "Emergency Evacuation course", as indicated by the red spot annotated as areas of interest with number 3 in dotted lines. Another significant red spot, noted on the course status block, was where the *self-monitoring* strategy was deployed, annotated as areas of interest with number 4 in dotted lines. Other hot spots are noted on the First Aid course and the status, as well as the dates of the course. The reddish area indicates a strong interest in the object (e.g., "Emergency Evacuation course", "pie-chart", and "course status message") employing the *self-monitoring* strategy. The blue spot denotes the reading pattern of users (Quant-UX, 2020). The blue spots indicates that the participants observed the information on the page, and of interest was the departmental scoreboard where *competition* and *cooperation* strategies were deployed. Furthermore, participants who completed the task found the information in that area *relevant*. Additionally, the key performance measures are also depicted on the right of Figure 5.7; these key performance measures are discussed in Section 5.5.4.

Figure 5.7: Screen 2 - Heat map for the main landing page for course selection task

The results from Figure 5.7 indicated that the task of identifying the course and click-it-to-start appeared to have posed no significant challenge to the participants. Section 5.5.3 discusses the findings for progression screens.

5.5.3 Heat maps for the course progression screens

Figure 5.8 depicts the screenshot for the course progression screen. The course progression screens have common characteristics, allowing participants to read the course contents, click the "Next" button to continue to the next screen, OR click the "Back" button to go back to the previous screen. The course progress bar at the bottom of the screen indicates the status of completion (employing for *self-monitoring* strategy), indicated by blue spots denoting reading patterns.

Task-3: Read course content and click next to progress to the next page.

The findings from Figure 5.8 depicts the heat map for mouse-hover. The blue spots on mouse-hover portray a reading pattern (Quant-UX, 2020). The concentration of blue spots,

denoting reading patterns, indicates that the participants observed the course contents and found information in that area *relevant*. The participants observed the course contents at different intensity levels than others, indicated by the yellow, orange, and red spots at number 6 in dotted lines.

Task-4: Actions available to be performed by users in the course.
Task-5: Actions available in the event users click outside the course area.

The participant's intense fixation on the navigation buttons "Next" button area and "Back" button, annotates areas of interest with number 5 and 7 in dotted lines, respectively. Indicating that the participants did not appear to experience challenges locating the navigation buttons by clicking the "Next" button and "Back" button. Furthermore, the blue spots on the course progress bar that deploy the *self-monitoring strategy* was observed, and the blue spots on the bottom of the page allowed users to end the course.

Figure 5.8: Screen 3 - Heat map for the course progression task

The researcher noticed some blue spots on the menu items on top of the screen and on the left of the screen, indicating that some users clicked outside the course area (Figure 5.8, a similar observation was also made in Figure 5.7, executing Task-5). It follows that users

were curious about using the prototype. The results from Figure 5.8 indicates that the task posed no significant challenge to the participants.

Section 5.5.4 discusses the key performance measures depicted on the right of Figures 5.7 and 5.8, respectively.

5.5.4 Key performance metrics during usage on screens

Table 5.3 details the key performance metrics during the usage of the prototype to conduct the digital learning tasks by the users from screens 1, 2, and 3. The prototyping tool automatically recorded the key performance measures (test coverage, dwell time, screen views, screen clicks), the values recorded and the researcher analysis.

Table 5.3: Key performance metrics during usage

Key performance metrics and descriptions	**Tasks and Screens**							
	Task 0	Task 1, 2	Task 3,4,5					
	Screen 1	Screen 2	Screen 3 (10%)	Screen (40%)	Screen (60%)	Screen (90%)	Screen Knowledge test	Screen Completion
Test coverage – indicates in percentage the screen visits in completing the tasks (Quant-UX, 2020).	131	126	106	90	88	86	84	83
Screen views – indicates the number of times the screen was	132	132	110	96	89	87	84	83

viewed (Quant-UX, 2020).								
Dwell time - indicates the average amount of time (in seconds), spent on the screen (Quant-UX, 2020).	278	35	25	12	10	9	9	130
Screen clicks – indicates the number of clicks that took place during the screen viewing (Quant-UX, 2020).	0	10	4	12	5	3	0	4

The results from the *Test coverage* indicated the given tasks were completed well by all the participants. The acceptable test coverage was greater than 80% (Quant-UX, 2020). This indicates *effectiveness* (task completion) on the system by users against the given tasks.

The results from the *Screen views* indicate that all the screens were viewed by all the users (Quant-UX, 2020). This is indicated by the number of screen views being greater than number of users (76). The results, furthermore, reveal that some of the screens were viewed repeatedly, as all the numbers were above 76.

The results from the *Dwell time* were used to measure the efficiency of the system (Quant-UX, 2020). The dwell time seemed to be the highest on the landing screen compared to the rest of the screens, suggesting that the participants required more effort to understand the instructions. This was also observed by the reading coverage illustrated by the concentration of blue spots, as there was a correlation between mouse movement and eye gaze (J. Huang & Diriye, 2012).

The results from *Screen clicks* indicate the number of clicks that took place during the screen viewing (Quant-UX, 2020). More than 10 clicks were observed on *Screen 2* and

Screen 3 (40%). From *Screen 2*, the higher number of clicks suggests that users were exploring the elements on the screen, especially the persuasive elements on Screen 2. The results were investigated further during the triangulation of results.

5.6 Conclusion

The prototype usage results indicate a significant number of participants (N=76) participating in the study. The minimum number of users required for usability testing is five users to evaluate an interface (Quant-UX, 2020). Usability testing assisted in seeing if the users understood the design and errors made during the usability testing; the results usually stabilise after 40 testers to reduce bias (Quant-UX, 2020). This evaluation captured the user interaction during simple tasks on the digital learning platform prototype with limited functionality. The system interaction was effectively captured using the key performance metrics: test coverage, dwell time, screen views, and screen click; the outcomes were as follows based on the results:

5.6.1 All 76 participants completed tasks

The observation from the results indicated that all 76 participants completed the learning tasks with minimal effort. The findings provided promising results of the prototype design elements that improve users' motivation.

5.6.2 Tasks were executed with minimal effort

There were no significant issues with completing the tasks. The results observed indicate that most of the tasks were executed with minimal effort (evident by the lower dwell time on screens 2 and 3 (at 10%, 40%, 60%, 90%) less than 60 seconds. (i.e., efficiency). Effectiveness (discernible in the screen viewed > 76) number of participants, indicating that all participants used the screens for the given tasks. The results from the perspective of the *effectiveness* and *efficiency* of the prototype system indicate that participants experienced

minor challenges in completing the tasks. The fact that all the users completed the tasks without assistance means that the prototype was effective, i.e., the users could use the system to perform the designated task. In terms of *efficiency*, as measured by dwell time, this measure shows the time participants spent on the task. Thus, the speed with which the participants could complete the task and the dwell time observed from the participant completing within seconds since the prototype deployed simple learning tasks with few interactions allowed them to perform the digital learning tasks. The observation of participants executing the tasks with minimal efforts supports the findings from de Kock et al. (2016) in that in evaluating a digital learning application, an application should allow students to learn the didactic material while expending minimum effort in interacting with the system (de Kock et al., 2016). Thus, the participants could *efficiently* perform the designated tasks on the prototype system. Furthermore, the successful execution of all the tasks, with minimal effort, also shows users' *confidence* which refers to attributions of success to one's abilities and efforts (Keller, 2016).

5.6.3 Mouse movement heat maps provided information for design improvement.

The mouse movement heat maps also assisted the prototype design in providing useful quantitative information for design improvement. Notably, the users noticed the persuasive design elements (Figure 5.8), as indicated by red spots (for *self-monitoring strategy*) and blue spots indicating that the participants observed the scoreboard (*competition* and *cooperation strategies*). The more focus the mouse activity on some course content reflects varying levels of attention. The fixation intensity of the eye gaze can represent user *attention*, as there was a correlation between the mouse position and participant eye gaze (participant's eye intensity) (J. Huang & Diriye, 2012; Quant-UX, 2020). The prototype showed mouse activity to represent user *attention* and gaze. As noted in Figure 5.8, the participants had intense fixation (high *attention*) on the course area, "Emergency Evacuation course", as denoted by the red spots. Another construct was *Relevance*, observed by the blue spots, depicting a reading pattern (Quant-UX, 2020) as the participants viewed the scoreboard, indicating that the participants found the information in that area relevant. There

were hot spots on the scoreboard where persuasive strategies for *Competition* and *Cooperation* were deployed, suggesting that the users found that an area of interest. All the end-users appear to have completed all five learning tasks effectively, with all the screens viewed as indicated by the key performance metrics with minimal effort.

The results from Chapter 5 contributed to answering the research sub-question (sub-RQ.c). To answer this question, the users' performance data was collected *during-usage* of the prototype system by capturing mouse movement data and analysed using heat maps.

The findings of the data collected *post-usage* of the prototype are discussed in Chapter 6, capturing the extent of user satisfaction to contribute insights into user perspective using statistical data from the prototype.

6. CHAPTER 6: DATA ANALYSIS AND FINDINGS: POST-USAGE

6.1 Introduction

This chapter presents the findings from the data collected from the survey completed by 76 users of the prototype system for the mouse movement analysis. The results presented in this chapter contribute toward addressing the research sub-question (sub-RQ.c) by providing the analysis of the results of the quantitative data captured from the users after using the prototype.

> *What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that needs to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?*

The quantitative data collected from the online survey questionnaire (refer to APPENDIX C) provided the participant (digital learning end-users) insights after the usage of the prototype system (post-usage). The online survey questionnaire was sent (via e-mail) to the participants to rate the prototype system's persuasiveness and user experience. The questionnaire included demographics (discussed in Section 5.4), including the rest of the analysis presented in this chapter. Section 6.1 introduces the chapter, Section 6.2 provides the descriptive statistics of the sample, and Section 6.3 discusses reliability for consistency of measurements. Section 6.4 discusses correlation to assess the strength and direction of the linear relationships between pairs of variables using the Pearson correlation coefficient as the validity test. Section 6.5 presents exploratory factor analysis (EFA) to discover the factor structure of a measure and to examine its internal reliability. Section 6.6 discusses the triangulation of results, and Section 6.7 provides the chapter conclusion.

6.2 Descriptive statistics of the sample

Table 6.1 provides the descriptive statistical analysis performed to give an overview of data measured with the parameter's minimum, maximum, mean, and standard deviation values. The nine constructs were provided in the first column, followed by the sample size (denoted

by N), then the minimum and maximum values for the smallest and biggest values collected, respectively (with values 0-Neutral, 1- Strongly agree, 2-Agree, 3-Disagree, 4-Strongly disagree). The mean, as a standard measure of the centre of the data distribution, was rounded up in the next column for ease of interpretation of the results. The standard deviation indicates the measurement of the data dispersion relative to its mean. Based on the findings from Table 6.1, the sample size (N) was 76 participants, and the data ranged from 0 to 4, as indicated by the minimum and maximum values, respectively.

Table 6.1: Descriptive Statistics table

Descriptive Statistics						
Constructs	N	Minimum	Maximum	Mean	Rounded-up mean	Standard Deviation
1. Attention	76	.00	4.00	1.5351	2	.63731
2. Relevance	76	.00	3.00	1.4737	1	.63190
3. Confidence	76	.00	3.33	1.4298	1	.49536
4. Satisfaction	76	.00	4.00	1.4693	1	.65812
5. Competition	76	.00	4.00	1.5329	2	.77604
6. Cooperation	76	.00	3.00	1.5746	2	.70259
7. Self-Monitoring	76	.00	2.67	1.3377	1	.63827
8. Effectiveness	76	.00	4.00	1.5088	2	.70653
9. Efficiency	76	.00	2.33	1.4079	1	.57760

The observation from Table 6.1 for each construct:

1. *Attention* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 2, meaning participants mostly ‘Agree’ with statements in the questionnaire with the standard deviation value of 0.64.

2. *Relevance* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 1, meaning participants ‘Strongly Agree’ with statements in the questionnaire, with a standard deviation value of 0.63.

3. *Confidence* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 1, meaning participants ‘Strongly Agree’ with statements in the questionnaire with the standard deviation value of 0.5.

4. *Satisfaction* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 1, meaning participants ‘Strongly Agree’ with statements in the questionnaire with the standard deviation value of 0.69.

5. *Competition* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 2, meaning participants ‘Agree’ with statements in the questionnaire with a standard deviation value of 0.78.

6. *Cooperation* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 2, meaning participants ‘Agree’ with statements in the questionnaire with the standard deviation value of 0.70.

7. *Self-monitoring* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 1, meaning participants ‘Strongly Agree’ with statements in the questionnaire with the standard deviation value of 0.64.

8. *Effectiveness* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 2, meaning participants ‘Agree’ with statements in the questionnaire with a standard deviation value of 0.71.

9. *Efficiency* construct reported a minimum value of 0, meaning ‘Neutral’, and a maximum value of 4, meaning ‘Strongly disagree’. The mean was rounded to 1, meaning participants ‘Strongly Agree’ with statements in the questionnaire with the standard deviation value of 0.58.

Overall, the observation from the results of the descriptive statistics shows the mean, which measured the centre of the data distribution to be between ‘Agree’ and ‘Strongly disagree’. This shows that most participants ‘Agree’ with the statements (on the questionnaire) that the prototype system motivates them to conduct autonomous learning.

Section 6.3 discusses the reliability of the measurements using Cronbach’s Alpha.

6.3 Reliability

A reliability test was conducted to measure the extent to which the questionnaire results, as testing instruments, can be trusted. Reliability refers to the consistency of measurements (Boslaugh, 2012). The reliability of the data was conducted using Cronbach’s Alpha value (Boslaugh, 2012; Lestari, Hardianto, & Hidayanto, 2014). To measure each construct’s reliability, Cronbach’s Alpha (α) value was used to measure reliability or internal consistency. The significance of the reliability was measured using the scale below (Hinton, McMurray, & Brownlow, 2014):

α > 0.90; shows excellent reliability.

0.70 > α and α <= 0.90; shows high reliability.

0.50 > α <= 0.70; shows moderate reliability.

α <= 0.50; shows low reliability.

The guidelines in this study have been adopted for the reliability test. Furthermore, Cronbach's Alpha calculations were done per the questions grouped under each construct to determine the internal consistency if the individual question was removed from the scale

(the results provided in Table 6.2, including the results of the nine-factor solution). Cronbach's reliability coefficients ranged between 0.543 and 0.779 (see Table 6.2).

Table 6.2: Cronbach's Alpha per construct

Construct **(Cronbach's Alpha value)**	**Questions**	**Cronbach's Alpha if Item Deleted**
1. Attention α = 0.628	Q07.The system would capture and hold my interest.	.495
	Q08. The layout of information on the system keeps my attention.	.550
	Q09. The system has some content that stimulate my curiosity.	.545
2. Relevance α = 0.493 + 0.05 = 0.543* (*Note the addition of tolerance error of +- 0.05)	Q10. The content of the system is relevant to me.	.157
	Q11. The training relates to the tasks I need to perform.	.414
	Q12. The system provides explanations or examples.	.600
3. Confidence α = 0.525	Q13. The system should help me to complete my courses successfully.	.553
	Q14. The system would build my confidence to demonstrate the knowledge learned.	.222
	Q15. After reading the introductory information, I felt confident that I know what to do.	.432
4. Satisfaction α = 0.769	Q16. I enjoyed studying on the system.	.625
	Q17. It would be a pleasure to work with a system like this.	.603
	Q18. It felt good to successfully complete the course on this system.	.818
5. Competition	Q19. It engages and challenges one to be better.	.240

α = 0.530	Q20. It keeps one focused and gives more reason to push towards.	.260
	Q21. It allows for subtle and empowering peer pressure.	.721
6. Cooperation α = 0.629	Q22. It provides opportunities for mutual support and encouragement.	.568
	Q23. It provides opportunities for people to stay responsible and accountable to others.	.585
	Q24. It raises users' sensitivity to disappointment and makes them work harder.	.414
7. Self-Monitoring α = 0.742	Q25. The system allows me to see my current score.	.659
	Q26. The system allows me to track changes over a period of time.	.653
	Q27. The system provides monitors with my performance over a period of time.	.659
8. Effectiveness α = 0.689	Q28. It improves my performance.	.688
	Q29. The system would influence my ability to complete the learning tasks.	.692
	Q30. The system helps me to improve my scores.	.332
9. Efficiency α = 0.779	Q31. The response time is acceptable.	.572
	Q32. It allows me to do the tasks quickly.	.755
	Q33. It does not require a major effort to complete the tasks.	.773

The observation in Table 6.2 was based on the significance scale of the reliability proposed by Hinton et al. (2014). The following constructs were found to be high reliability (α between 0.7 and 0.9): *Satisfaction, Self-monitoring*, and *Efficiency*. The following constructs were found to be moderate reliability (α between 0.5 and 0.7): *Cooperation, Attention, Competition, and Effectiveness*. The *Relevance* construct was initially reported to be low

reliability (α value at 0.493). After considering the tolerance error (0.05) of the measuring tool as proposed by Koo and Li (2016), the revised value for *Relevance* (α value was 0.543). It is important to note that lower reliability does not imply an unacceptable construct; the elements could still be used with the trade-off on slightly lowering the reliability of the results. Since Cronbach's Alpha alone was not sufficient in judging the quality of the scale, the correlation between items in a scale gave much better insight concerning the quality of the scale to indicate consistency (Schrepp, 2020). Furthermore, Cronbach's Alpha depends on the number of items on the scale, meaning α increases with the number of items on a scale (Schrepp, 2020). Therefore, all the constructs were retained based on the significance scale of the reliability proposed by Hinton et al. (2014).

Section 6.4 discusses the correlation for assessing the relationships between the variables using Pearson correlation.

6.4 Correlation

The correlation between items on a scale indicates scale consistency (Schrepp, 2020), meaning all scale items measures the same construct. Correlation coefficients assess the strength and direction of the linear relationships between pairs of variables using the Pearson correlation coefficient as the validity test (Boslaugh, 2012). The Pearson correlation coefficient is the most commonly used measure of linear association between any of the variables (Boslaugh, 2012). The relationship between constructs was investigated using the Pearson correlation coefficient because both variables are normally distributed, and all the questions were mandatory. There were no cases with non-missing values. The strength of the association was measured using the scale formulated by Flavia (2007):

- no association ($| r | < 0.1$).
- weak association ($0.1 < | r | < 0.3$).
- moderate association ($0.3 < | r | < 0.5$).

- strong association (0.5 < | r | < 1).

Preliminary analyses have been performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. The relationship between constructs was investigated using the Pearson correlation coefficient. The observation from the correlation results (refer to APPENDIX E: Table II) shows a positive relationship between most of the constructs.

The observation from the results shows that there was a correlation between most of the constructs in the scale as explained in (i) strong, (ii) moderate, (iii) weak, and (iv) no-correlation.

(i) The observation from the results shows that there was a correlation between all the constructs, especially the constructs that showed a *strong* positive association (0.5 < | r | < 1):

- There was a strong positive correlation between the two variables *Self-Monitoring* and *Confidence*, r= 0.505, n=76, p<0.001

- There was a strong correlation between the two variables *Effectiveness* and *Competition*, r= 0.577, n=76, p<0.001

- There was a strong correlation between the two variables *Efficiency* and *Effectiveness*, r= 0.686, n=76, p<0.001

(ii) The observation from the results shows that there was a correlation between all the constructs, especially the following constructs that shows *moderate* positive association (0.3 < | r | < 0.5):

- There was a moderate positive correlation between the two variables *Attention* and *Confidence*, r= 0.318, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Attention* and *Satisfaction*, r= 0.474, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Attention* and *Competition*, r= 0.301, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Attention* and *Effectiveness*, r= 0.420, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Attention* and *Efficiency*, r= 0.393, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Relevance* and *Efficiency*, r= 0.304, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Confidence* and *Attention*, r= 0.318, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Confidence* and *Satisfaction*, r= 0.300, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Confidence* and *Cooperation*, r= 0.337, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Confidence* and *Effectiveness*, r= 0.336, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Confidence* and *Efficiency*, r= 0.358, n=76, p<0.001

- There was a moderate correlation between the two variables *Satisfaction* and *Confidence*, r= 0.300, n=76, p<0.001

- There was a moderate correlation between the two variables *Satisfaction* and *Competition*, r= 0.487, n=76, p<0.001

- There was a moderate correlation between the two variables *Satisfaction* and *Self-Monitoring*, r= 0.323, n=76, p<0.001

- There was a moderate correlation between the two variables *Satisfaction* and *Effectiveness*, r= 0.483, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Cooperation* and *Self-Monitoring*, r= 0.427, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Cooperation* and *Effectiveness*, r= 0.439, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Cooperation* and *Efficiency*, r= 0.335, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Self-Monitoring* and *Effectiveness*, r= 0.442, n=76, p<0.001

- There was a moderate positive correlation between the two variables *Self-Monitoring* and *Efficiency*, r= 0.485, n=76, p<0.001

(iii) The observation from the results shows that there was a correlation between all the constructs, especially the following constructs that show a *weak* positive association ($0.1 < | r | < 0.3$):

- There was a weak positive correlation between the two variables *Attention* and *Relevance*, r= 0.229, n=76, p<0.001

- There was a weak positive correlation between the two variables *Attention* and *Cooperation*, r= 0.171, n=76, p<0.001

- There was a weak positive correlation between the two variables *Attention* and *Self-Monitoring*, r= 0.296, n=76, p<0.001

- There was a weak positive correlation between the two variables *Relevance* and *Competition*, r= 0.192, n=76, p<0.001

- There was a weak positive correlation between the two variables *Relevance* and *Self-Monitoring*, r= 0.110, n=76, p<0.001

- There was a weak positive correlation between the two variables *Relevance* and *Effectiveness*, r= 0.249, n=76, p<0.001

- There was a weak positive correlation between the two variables *Confidence* and *Competition*, r= 0.206, n=76, p<0.001

- There was a weak correlation between the two variables *Satisfaction* and *Cooperation*, r= 0.226, n=76, p<0.001

- There was a weak correlation between the two variables *Satisfaction* and *Efficiency*, r= 0.246, n=76, p<0.001

- There was a weak positive correlation between the two variables *Competition* and *Cooperation*, r= 0.197, n=76, p<0.001

- There was a weak correlation between the two variables *Competition* and *Self-Monitoring*, r= 0.215, n=76, p<0.001

- There was a weak correlation between the two variables *Competition* and *Efficiency*, r= 0.292, n=76, p<0.001

(iv) The following constructs (*Relevance* and other constructs) show *no* association (r<0.01):

- There was a no-association between the two variables *Relevance* and *Confidence*, r= 0.079, n=76, p<0.05

- There was a no-association between the two variables *Relevance* and *Satisfaction*, r= 0.003, n=76, p<0.05

- There was a no-association between the two variables *Relevance* and *Cooperation*, r= 0.040, n=76, p<0.05

Overall, the correlation results show a positive relationship between the constructs, with the majority of the constructs showing moderate to strong association (with the Pearson correlation coefficient range between 0.001 and 1), except for no-association for the construct *Relevance* and other constructs. This provided an argument for the potential of removing the *Relevance* construct, but it was retained subjecting it to further analysis using Exploratory Factor Analysis. The discussion on Exploratory Factor Analysis is detailed in Section 6.5 to discover the order and structure among measured constructs.

6.5 Exploratory Factor Analysis

Exploratory factor analysis (EFA) was used to discover the factor structure of a measure and examine its internal reliability (Pallant, 2013). It identifies the common factors that explain the order and structure among measured variables (Watkins, 2018). EFA has three basic decision points: decide the number of factors, choosing an extraction method, and choosing a rotation method (Osborne, 2015).

6.5.1 Appropriateness of the data for EFA

Although great care has been exercised in selecting the variables and participants, it was nevertheless important to verify that the measured variables were sufficiently inter-correlated to justify factor analysis (Pallant, 2013). In order to determine the efficiency of factor analysis, the Kaiser-Meyer- Olkin and Bartlett's Test of Sphericity was calculated, as depicted in Table 6.3. KMO values range from 0.00 to 1.00; according to Pallant (2013), a sample was deemed adequate if the value of KMO was equal to or greater than 0.6 or above, and Bartlett's Test of Sphericity value was significant if the value was equal or less than 0.05. Bartlett's Test of Sphericity is an objective test of the factorability of the correlation

matrix test of Sphericity, which statistically tests the hypothesis that the correlation matrix contains ones on the diagonal and zeros on the off diagonals (Watkins, 2018).

Table 6.3: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.665
Bartlett's Test of Sphericity	Approx. Chi-Square	916.907
	df	351
	Sig.	.000

In this study, the observation from Table 6.3 is that the KMO value was 0.665 and Bartlett's test was significant; the value was too small, and it was rounded off to 0.000 ($p < 0.05$) therefore factor analysis was appropriate.

6.5.2 Total Variance Explained

The EFA analysing led to nine factors accounting for 72.5% of the total variance based on the Eigenvalue >= 1, as observed in APPENDIX E: Table I. The strong nine factors extracted from variables accounted for 72.5% of Cumulative variance with Eigenvalues and variance values for the nine factors labelled as follows, respectively, in descending order from highest to lowest Eigenvalues:

Component 1 was regarded as Attention, initial Eigenvalue 6.698; and % of Variance 24.807

Component 2 was regarded as Relevance, initial Eigenvalue 2.285; and % of Variance 10.568

Component 3 was regarded as Confidence, initial Eigenvalue 2.232; and % of Variance 8.265

Component 4 was regarded as Satisfaction, initial Eigenvalue 1.761; and % of Variance 6.523

Component 5 was regarded as Competition, initial Eigenvalue 1.369; and % of Variance 5.070

Component 6 was regarded as Cooperation, initial Eigenvalue 1.308; and % of Variance 4.845

Component 7 was regarded as Self-monitoring, initial Eigenvalue 1.282; and % of Variance 4.749

Component 8 was regarded as Effectiveness, initial Eigenvalue 1.048; and % of Variance 3.883

Component 9 was regarded as Efficiency, initial Eigenvalue 1.023; and % of Variance 3.883

6.5.3 Scree plot of the factors

The scree plot graph depicts the line plot of the Eigenvalues from the analysis (see APPENDIX E, Table I). The scree plot (with Eigenvalue in the y-axis and number of factors in the x-axis) depicts the nine factors retained (see red dotted lines), accounting for 72.5% of the total variance (see Figure 6.1). The observation shows that the nine factors solution was strongly supported by Eigenvalues >=1, as indicated by the red dotted lines.

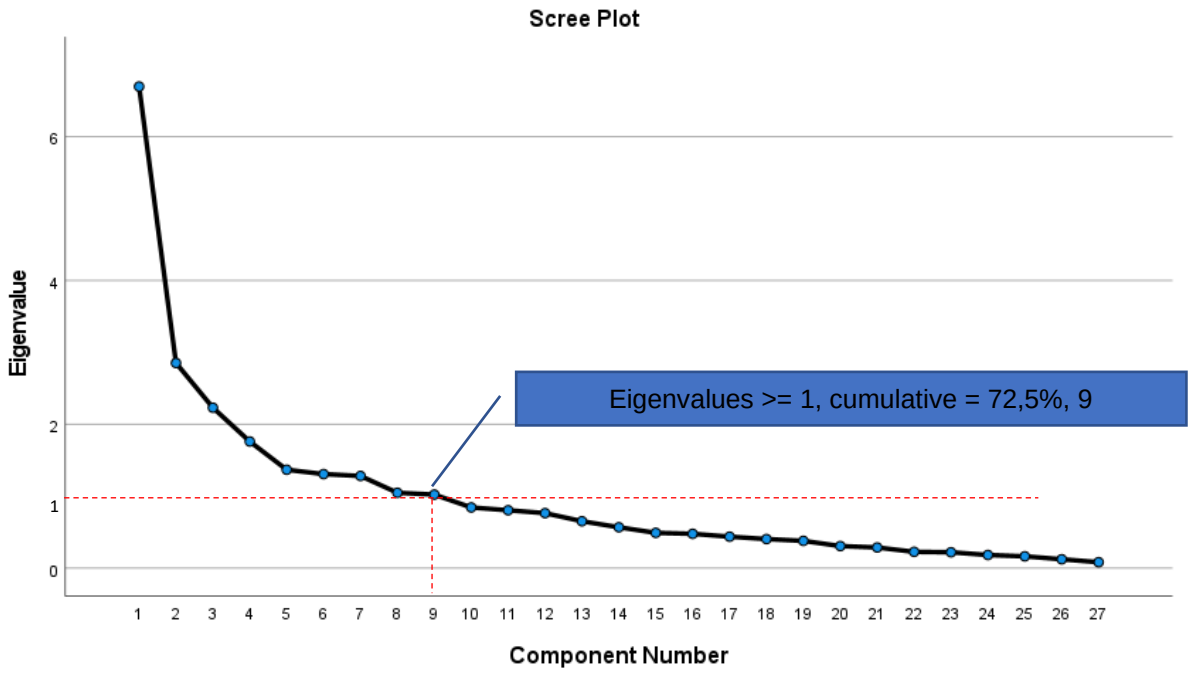

Figure 6.1: Scree Plot

6.5.4 Rotated Component Matrix

Rotation of the component matrix for the nine factors made interpreting the analysis easier. Table 6.4 provides the Pattern Matrix; note that loadings <= 0.10 were suppressed to indicate favourable convergent validity, allowing easy visual confirmation that the EFA with oblique rotation produced the expected result (Osborne, 2015). The objective of rotation

was simplicity and clarity of factor loadings (Watkins, 2018) leading to a clear, easily-interpreted structure of the EFA (Osborne, 2015): 1 was regarded as *Attention*; 2 was regarded as *Relevance*; 3 was regarded as *Confidence*; 4 was regarded as *Satisfaction*; 5 was regarded as *Competition*; 6 was regarded as *Cooperation*; 7 was regarded as *Self-monitoring*; 8 was regarded as *Effectiveness*; 9 was regarded as *Efficiency*.

Table 6.4: Rotated Component Matrix

	Rotated Component Matrix									
		Component								
		1	2	3	4	5	6	7	8	9
(1) Attention	Q07.The system would capture and hold my interest.	.856								
	Q08. The layout of information on the system keeps my attention.	.816								
	Q09. The system has some contents that stimulate my curiosity.	.647								
(2) Relevance	Q10. The content of the system is relevant to me.		.508							
	Q11. The training relates to the tasks I need to perform.		.507							
	Q12. The system provides explanations or examples.		.756							
(3) Confidence	Q13. The system should help me to complete my courses successfully.			.740						
	Q14. The system would build my confidence to demonstrate the knowledge learned.			.663						

	Q15. After reading the introductory information, I felt confident that I know what to do.			.608						
(4) Satisfaction	Q16. I enjoyed studying on the system.				.790					
	Q17. It would be a pleasure to work with a system like this.				.771					
	Q18. It felt good to successfully complete the course on this system.				.529					
(5) Competition	Q19. It engages and challenges one to be better.					.847				
	Q20. It keeps one focused and gives them more reason to push towards.					.823				
	Q21. It allows for subtle and empowering peer pressure.					.798				
(6) Cooperation	Q22. It provides opportunities for mutual support and encouragement.						.733			
	Q23. It provides opportunities for people to stay responsible and accountable to others.						.767			
	Q24. It raises users' sensitivity to disappointment and makes them work harder.						.632			
(7) Self-	Q25. The system allows me to see my current score.							.622		

	Q26. The system allows me to track changes over a period of time.							.851		
	Q27. The system provides monitors for my performance over a period of time.							.590		
(8) Effectiveness	Q28. It improves my performance.								.841	
	Q29. The system would influence my ability to complete the learning tasks.								.865	
	Q30. The system helps me to improve my scores.								.623	
(9) Efficiency	Q31. The response time is acceptable.									.738
	Q32. It allows me to do the tasks quickly.									.513
	Q33. It does not require a major effort to complete the tasks.									.758

Overall, the EFA was performed after conducting the construct reliability and consistency. EFA was used to analyse all nine items of the scale. The results revealed the nine common factors identified in the study that explain the order and structure among measured variables, with Eigenvalue > 1, KMO value = 0.665 and Bartlett's test was significant, revealing that the value was too small, rounded off to 0.000 ($p < 0.05$). The strong nine factors extracted from variables that accounted for 72.5% of Cumulative variance were discovered to be *Attention, Relevance, Confidence, Satisfaction, Competition, Cooperation, Self-monitoring, Effectiveness*, and *Efficiency*. All the factors had factor loading greater than 0.1, indicating favourable convergent validity after oblique rotation. The results of EFA produced the nine factors as the constructs provided in Section 6.5.4.

Section 6.6 discusses the triangulation of the results to validate the findings from different methods.

6.6 Triangulation of findings from pre-usage, during-usage, and post-usage

Triangulation compared and verified the findings from pre-usage, during-usage, and post-usage. Triangulation was applied to support the findings and strengthen the validity of the results (Saunders et al., 2009). The triangulation approach was used to improve rigour by comparing the findings obtained from qualitative (themes from focus groups at pre-usage), during-usage in the user testing with mouse movement data, and post-usage quantitative data (from the survey). The triangulation of results assisted the researcher in providing the answer to the sub-research question (sub-RQ.c).

> *What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that needs to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?*

> Pre-usage: The findings of the thematic analysis of the qualitative data collected from thematic analysis (pre-usage) provided the researcher with the *nine themes*. The nine themes served as the validated constructs (*ConstructsVersion2*, namely, *Competition, Cooperation, Self-monitoring, Effectiveness*, *Efficiency, Satisfaction, Attention, Relevance,* and *Confidence*) that served as the basis for the design guidelines in Table 4.5.

During-usage: To obtain user insights, the prototype was presented to the users as a web link with instructions for the tasks to be performed. The data on user insight was collected during user testing with mouse movement, whereby the persuasive elements and user experience attributes were observed by the users, as indicated by heat maps that were colour-coded to illustrate the intensity of eye fixation, as advocated by Djamasbi et al. (2016). As noted in Figure 5.6, the concentration of the blue spots (reading pattern) suggests that the participants found the information in that area *relevant*. The red spot on the "Start button" to start the task demonstrates user *confidence* in completing the tasks. In Figure 5.7, the participants had intense fixation (indicating *attention*) on the course area "Emergency Evacuation course", as denoted by the red spots. Other hot spots were noted on the scoreboard, wherein persuasive strategies, *competition,* and *cooperation* were deployed, suggesting that the users found it an area of interest. The red spots on the objects, such as the "pie-chart" and "course status indicator") employing a *self-monitoring* strategy. Furthermore, the blue spots on the course progress bar in Figure 5.8 also employed the *self-monitoring* strategy. All the end-users completed the five learning tasks, with all the screens viewed for an average time of 56 seconds. The observation from the results indicates that all users executed tasks effectively and efficiently (with minimal effort) in the prototype during usage. The user testing analysis with mouse movement data shows that all users completed the learning tasks with no significant issues and without needing assistance, indicating satisfaction. All *nine constructs,* namely*, Attention, Relevance, Confidence, Satisfaction, Competition, Cooperation, Self-monitoring, Effectiveness*, and *Efficiency,* were observed during the usage of the prototype.

Post-usage: Considering the quantitative data collected post-usage, the correlation test revealed strong to weak correlations on most of the constructs, except for *Relevance* which showed no association with some of the constructs. However, the findings of the statistical analysis (using EFA output) for the quantitative data collected post-usage of the prototype confirmed the *nine constructs: Attention,*

Relevance, Confidence, Satisfaction, Competition, Cooperation, Self-monitoring, Effectiveness, and *Efficiency,* as presented in Section 6.5.4.

It was decided to retain all *nine constructs* by triangulating the results of both the qualitative data and quantitative data by comparing the findings pre-usage, during-usage, and post-usage. Notably, the *Relevance* construct showed no association with other constructs, but the importance was confirmed in the pre-usage and post-usage findings. Therefore, the *nine constructs* which served as the basis for the design guidelines of the prototype were validated by users during the usage of the prototype.

6.7 Conclusion

The results from statistical analysis found that most participants 'Agree' that the prototype will improve their motivation based on the nine constructs evaluated, explained by the mean value of 1= Agree, and the standard deviation indicated the lower spread of data close to the mean. The results also show that most of the constructs were found to be moderate to high reliability, with the Cronbach α values ranging between 0.493 and 0.779 for all nine constructs. Therefore, the reliability scale proposed by Hinton et al. (2014) with values of $0.50 > \alpha <= 0.90$ indicated that *QuestionnaireVersion2* used as a measurement scale in the research study was reliable. The nine constructs discovered statistically by EFA were *Competition, Cooperation, Self-monitoring, Attention, Relevance, Confidence, Satisfaction, Effectiveness*, and *Efficiency*.

Triangulating the qualitative and quantitative data results by comparing the findings confirmed that all *nine constructs* were retained in the study as the useful basis for the design guidelines.

The results from Chapter 6 contributed to addressing the research sub-question (sub-RQ.c):

What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that needs to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?

The outcomes from the user perspective were obtained from user testing with mouse movement during-usage, completing five learning tasks with all screens viewed, as depicted in Table 5.3 performance metrics. Post-usage outcomes from statistical analysis show mean calculations found that most participants 'Agree' that the prototype improved their motivation based on the nine constructs evaluated (see Table 5.3). These results show that deploying the nine design guidelines on the prototype improved user motivation.

7. CHAPTER 7: DISCUSSION AND CONCLUSION

7.1 Introduction

This chapter presents the outcomes of the study, and the results obtained assisted the researcher in responding to the research question, namely "*What are the design guidelines constructs on the literature-based set of persuasive strategies and UX attributes required for improving the users' motivation for using e-learning platform for autonomous learning*?" The study investigated the design guidelines on PT and UX for improving motivation of employees engaging in autonomous learning using digital learning platforms. In order to achieve the answers to research questions, the study was broken into two stages. Stage 1 of the study extracted the constructs from the literature on PT and UX, from which the literature set of constructs were derived, namely: *Competition, Cooperation, Self-monitoring, Attention, Relevance, Confidence, Satisfaction, Effectiveness,* and *Efficiency*. The constructs were validated and used to guide the researcher to the design guidelines. In Stage 2, the prototype system was designed and developed based on the guidelines, presented to users to obtain user insights during-usage, and evaluation post-usage of the prototype.

The rest of this chapter provides a summary of the context of the study in Section 7.2. Section 7.3 summarises research questions, objectives, findings, and research study contributions. Section 7.4 outlines the study limitations, and Section 7.5 outlines the study contribution. Section 7.6 outlines possible future research. Finally, Section 7.7 provides a reflection on this study.

7.2 Contextualising the research

The discussion in this section highlights recent studies published in the contextualisation of PT and UX for changing user behaviour, as these pertain to the research questions and objectives of the study.

Oyibo and Vassileva (2021) conducted an exploratory study on a prototype of a fitness app on the relationship between perceived UX design attributes and Persuasive features. The purpose was to find the relationship between user-experience (UX) design attributes and user receptiveness to the persuasive features of a persuasive technology aimed at motivating behaviour change. Their findings indicated that designers should prioritise perceived usefulness and aesthetics over perceived usability and credibility. The findings from this study agree with their study in that a good match of PT and UX should be achieved to support the behaviour change. However, the findings from this study does not support their constructs' prioritisation, whereby this study prioritised usability over aesthetics.

Nkwo, Suruliraj, and Orji (2021) systematically evaluated sustainable waste management mobile apps to deconstruct and compared the implementation of persuasive strategies. The purpose was to deconstruct and compare the persuasive strategies employed and their implementations. Overall, the findings uncovered that the most employed category was primary task support, followed by system credibility support, and social support was the least utilised strategy. Specifically, the persuasive strategies employed were reduction, personalisation, real-world feel, surface credibility, reminder, and self-monitoring. The findings from this study support their study on using persuasive strategies. Furthermore, this study offers design implications in a different context to improve their persuasiveness and effectiveness.

Kljun, Krulec, Pucihar, and Solina (2019) investigated PT for usage in corporations for self-paced education on mobile e-learning platforms to retain and keep users engaged. The

purpose was to incite users to regularly use the mobile e-learning platforms in corporations for self-paced education. The findings show that using adaptive triggering in m-learning increases engagement as well as course completion rates. The findings from their study support using persuasive strategies, focusing on triggering, while this study focused on social support due to different contexts.

Ahmad and Ali (2018) investigated UX and PT on two different web applications, namely, health and environmental apps. The purpose was to study emotional experience in the context of persuasive technologies. The findings revealed that a change in UX perception over time might alter persuasion. The study demonstrates the importance of hedonic quality and appeal of a system for greater user experience and successful persuasion. The findings from their study support studying both PT and UX. However, their study was focusing on the hedonic quality and appeal of a system, while this study focused on usability and social support, due to different contexts.

Alqahtani, Orji, Riper, Mccleary, and Witteman (2022) investigated the motivation-based approach for tailoring persuasive mental health applications. Their study explores the relationships between the types of motivation individuals experience and their preferences for various features widely used in persuasive apps for mental and emotional well-being. The purpose was to explore the relationships between types of motivation and perceived persuasiveness. The findings revealed that people's motivation influences perceived persuasiveness. Intrinsically motivated individuals are more motivated by apps that offer relaxation exercises. The findings from this study support their study on a motivation-based approach for tailoring persuasion. Furthermore, their study also offers design guidelines for tailoring persuasive mental health apps based on motivation types in a different context.

In summary, recent studies seem show an appreciation of the interplay between persuasion and user experience and the need for design guidelines as observed in two of the five recent studies reviewed. However, recent studies seem focused on aesthetics and hedonic qualities

over usability. The existing studies were fragmented, and few studies provided the application of design guidelines on a combination of PT and UX for users' motivation. Furthermore, none of these studies addresses the problem in South Africa, confirming the significance and contribution of this study.

7.3 Research questions and objectives

The research questions investigated in the study were answered by following the rigorous research method of DSR. This study culminated in a refined and integrated set of constructs that served as a basis for the design guidelines. Furthermore, this study also provided an evaluation questionnaire that may be useful for evaluation, considering persuasion, user experience and the extent of motivation.

First, the research problem "*lack of motivation for users engaging in autonomous learning on digital learning platforms*" was identified in Section 1.3, which led to the *main research question* as follows:

> *"What are the insights obtained from persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa?"*

In order to answer the main research question, the following sub-research questions were introduced:

7.3.1 Sub-research question (sub-RQ.a)

What are the persuasive strategies and UX attributes for improving the users' motivation for using digital learning platforms for autonomous learning?

The sub-research question was to determine the persuasive strategies and UX attributes by conducting a literature review; the answer to the sub-question was extracting the constructs of PT and UX (see Table 2.8: *ConstructsVersion1* - The literature-based set of constructs). *ConstructsVersion1: Competition, Cooperation, Satisfaction, Effectiveness, Efficiency, Attention, Relevance, and Confidence*.

7.3.2 Sub-research question (sub-RQ.b)

What are the design guidelines on the literature-based set of persuasive strategies and UX attributes required for improving the users' motivation for using digital learning platforms for autonomous learning?

In order to answer this question, the proposed design guidelines were extracted from literature, which was based on *ConstructsVersion2* (see Table 3.3). The guidelines were used in the design of the prototype system.

7.3.3 Sub-research question (sub-RQ.c)

What are the users' perspectives on the literature-based set of persuasive strategies and UX attributes that needs to be evaluated to improve motivation in autonomous learning on the digital learning platform in the case of corporate utility organisations in South Africa?

To answer this question, the prototype was provided to users for autonomous learning and evaluated by users. Different techniques were used to collect and analyse data: mouse movement and survey questionnaire. User perspective and insights were obtained from the

data collected during-usage, and post-usage of the prototype in Chapter 5 (see Section 5.6) and Chapter 6 (see Table 6.4), respectively. The findings indicated that the end-users successfully completed the digital learning task with no significant user interaction problems. Also, most participants 'Agree' that the prototype motivated them to learn autonomously.

7.3.4 Design guidelines (answer to main research question)

Without claiming that the constructs were sufficient or complete, based on the results of the findings in the study, the set of PT and UX constructs served as a useful basis for the design guidelines necessary for improving the users' motivation in autonomous learning on digital platforms. Therefore, the study presented these design guidelines to answer the main research question:

a) The interaction design of the system should provide a mechanism for *competing* with other users on the learning tasks.

b) The interaction design of the system should provide means for users to *cooperate* (work together) to achieve a shared objective collectively on the learning tasks.

c) The interaction design of the system should provide means for users to *monitor their progress* or performance status on the learning tasks.

d) The interaction design of the system should support the learning goals with ease of use (*effective*) in performing the learning task.

e) The interaction design of the system should be *efficient* by minimising time on completing the learning task.

f) The interaction design of the system should provide an increased feeling of *satisfaction with the* user experience.

g) The interaction design of the system should provide visual content to *capture* users' attention.

h) The interaction design of the system should provide users with *relevant* learning tasks.

i) The interaction design of the system should promote *confidence* to users in performing the learning tasks.

7.4 Study limitations

The study was limited to a single corporate environment with a geographic spread in South Africa. The study was limited to three persuasive strategies out of 23 available in the literature and the three usability aspects as a subset of UX. The study was also limited to only one course in one department with a limited number of functions and limited to only the essential functionality for digital learning on a prototype.

7.5 Study contributions

The study was significant as it made a *theoretical contribution* by providing prioritised PT and UX attributes identified in the literature (see Table 3.3). The *theoretical contribution* to the existing knowledge included literature-based design guidelines and an evaluation tool (survey questionnaire). The *knowledge contribution* gained from the study was literature-based design guidelines for improving users' motivation for digital learning technologies in corporate organisations. The study *contributes knowledge* to improve the limited number of studies at the intersection of PT and UX as theoretical lenses for improving users' motivation. Furthermore, the study *contributed knowledge* with an evaluation tool (survey questionnaire) based on PT and UX for usage by corporate organisations.

The *practical contribution* made by the study was the prototype system for the digital learning platform (see Figure 3.5). The prototype was developed using the design guidelines based on the nine constructs from PT and UX together. The prototype was used to collect usability data during-usage (by mouse movement, which correlates to eye gaze) and post-usage (by a survey questionnaire), the analysis provided positive results for improving users' motivation.

7.6 Recommendations for future research

Future studies might involve a more comprehensive prototype with additional functions and other persuasive strategies and UX factors to explore other behaviour changes that could improve the usage of digital learning. Other industries in South Africa might also be involved in future studies for evaluations.

7.7 Reflection on the study

The study allowed the researcher to implement research skills and challenges in the next level of research. It has expanded the researchers' academic research skills, including the importance of embracing surrounding support. The researcher reflected on the study using the SWOT analysis technique, which refers to *Strengths, Weaknesses, Opportunities,* and *Threats* (Hille & Gomer, 2015). SWOT was used to share the experience as a situational analysis for personal growth. The summary of the SWOT analysis appears in Figure 7.1.

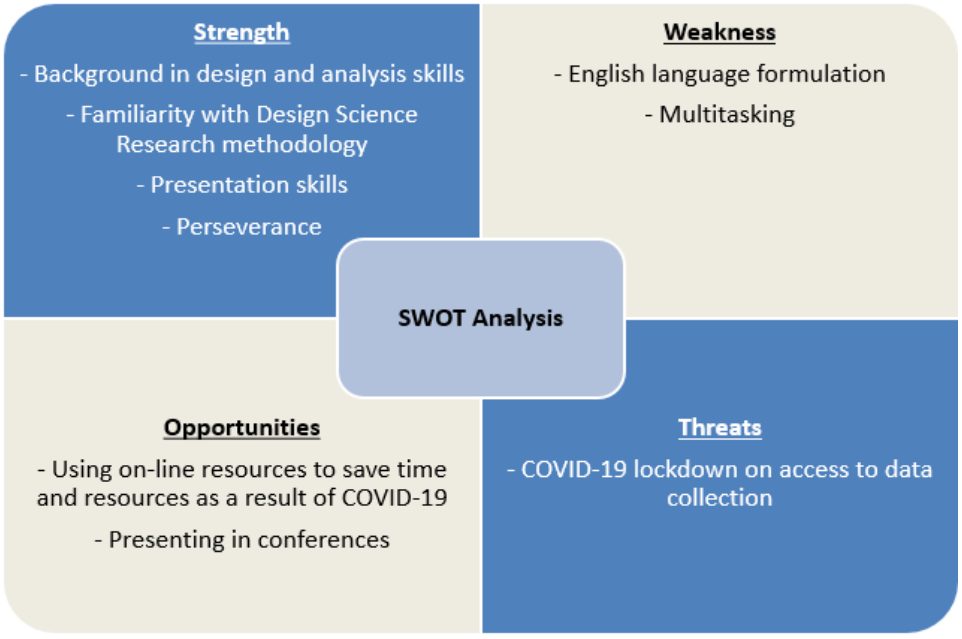

Figure 7.1: SWOT Analysis as basis for study reflection

The research study demanded perseverance and long hours from the researcher. As depicted in Figure 7.1, the *strength* of the researcher was the rich experience in system design and development to solve business problems in information systems, a similar approach used in DSR methodology. The development skills also proved beneficial for the researcher during the prototype development. Presentation skills demonstrated the researcher's ability to facilitate focus group sessions with the subject matter experts.

The *threats* to the study happened with the COVID-19 lockdown concerning data collection. The researcher's courage and motivation declined due to a lack of face-to-face contact and collaboration with other students. The threat to the data collection also needed to be managed by using *opportunities* offered by online resources, resulting in time and costs saved. Using an online survey questionnaire for data collection dispelled COVID-19 effects. Data analysis revealed *weakness* of the researcher in analysing quantitative data collected, mitigated by the assistance of consulting a statistician on techniques used to analyse quantitative data collected. Another *weakness* surfaced when documenting the research study, as English was the researcher's second language, mitigated with the assistance of reviewers and language editors. The researcher explored various collaboration opportunities to supplement any identified skill shortages, ultimately building a network of resources. The researcher acknowledges the support received from the supervisors, reviewers, and language editors for the quality of the research report.

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APPENDIX A: UNISA CSET ETHICS CLERANCE APPROVAL

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

2021/04/08

Dear Mr. Jacob Thabo Mongadi

ERC Reference #: 2020/CSET/SOC/008
Name: Jacob Thabo Mongadi
Student #: 35969830
Staff #:

Decision: Ethics Approval from 2021/04/08 for three years. Humans involved.

Researcher(s): Jacob Thabo Mongadi
35969830@mylife.unisa.ac.za, 082 338 1174

Supervisor (s): Prof Judy Van Biljon
Vbiljja@unisa.ac.za, 011 670 9182
Mrs. Ronell Van Der Merwe
VDMerwer@unisa.ac.za, 011 471 2929

Working title of research:

Persuasive technology and user experience design guidelines to motivate users for autonomous learning on an e-learning platform in the context of a corporate environment in South Africa

Qualification: MSc in Computing

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 3 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2021/04/08 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

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The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date *expiry date*. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
9. *Permission to conduct research involving UNISA employees, students and data should be obtained from the Research Permissions Subcommittee (RPSC) prior to commencing field work.*
10. *Permission to conduct this research should be obtained from the [company, CE organisation, DoE, etc name] prior to commencing field work.*

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Note

The reference number 2020/CSET/SOC/008 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

Dr D Bisschoff
Chair of School of Computing Ethics Review Subcommittee
College of Science, Engineering and Technology (CSET)
E-mail: dbischof@unisa.ac.za
Tel: (011) 471-2109

Prof. E Mnkandla
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APPENDIX B: ETHICS CLEARANCE – ABC HOLDINGS COMPANY APPROVAL

Omitted to preserve anonymity, refer to the link for the approval.

https://drive.google.com/file/d/1eW7sQEIRnfjI8Btp2SjMc8go8WCxAyDh/view

APPENDIX C: SURVEY INSTRUMENT – QuestionnaireVersion2

This questionnaire is part of the study on persuasive technology and user experience towards improving the motivation of users in autonomous learning on the digital learning platform. As part of the research study your inputs are required to evaluate the system in terms of ability to motivate you in conducting the autonomous learning task.

Q1. Consent: You are requested to give consent for participation before you can conduct tasks on the prototype system. If you clicks “Accept”, you will continue with the survey or else if you click “Not accept”, the session terminates.

Please note the following:

- Read and answer each question carefully.
- There are no “wrong” or “right” answers to any of the questions - answers to questions should reflect YOUR opinion.
- All responses are anonymous and are treated in strict confidence.
- Answering this questionnaire should require you about 15 minutes.

Thank you very much for your collaboration. Your input is important for this study.

Section A: Demographic information

Section A of the questionnaire refers to your demographic information, it consists of 5 questions: such as your department, role, gender, age, and grading.

(Please tick the applicable)

Q2. Group IT Department	
1. Business Process Management (BPM)	
2. Business Relationship Management (BRM)	
3. Business Enablement	
4. Enterprise Architecture	
5. Information Management	
6. Information Security and Risk	
7. IT Service Operations (ITSO)	
8. Project Delivery	
9. Other	

Q3. Gender	
1. Male	
2. Female	
3. Other	

Q4. Age	
1. 18–25	
2. 26–35	

3. 36–45	
4. 46–55	
5. Over 55	

Q5. Grading	
1. Manager	
2. Professional	
3. Specialist	
4. Bargain	
5. Other	

Q6. Years using e-learning	
1. 1–3 years	
2. 4-6 years	
3. 7–9 years	
4. Over 10 years	

Section B: Evaluation questionnaire

This Section of the questionnaire seeks to solicit your inputs to evaluate the system extent of the system in terms of ability to motivate you in conducting the autonomous learning task.

The constructs: *Competition, Cooperate, and Self-monitoring* are selected from persuasive technology, the constructs: *Attention*, *Relevance, Confidence, and Satisfaction* are ARCS constructs, and *Effectiveness* and *Efficiency* are selected from UX.

The questions were measured using participant agreement with a 5-point Likert scale ranging from: 0 = Neutral (N), 1 = Strongly agree (SA), 2 = Agree (A), 3 = Disagree (D), 4 = Strongly disagree (SD).

The scale consists of 27 questions:

(Please tick the applicable)

		SA	A	N	D	SD
Attention	Q7. The system would capture and hold my interest, e.g. diagrams for illustrations are eye-catching.					
	Q8. The layout of information on the system keeps my attention.					
	Q9. The system has some contents that stimulate my curiosity.					
Relevance	Q10. The content of the system is relevant to me.					
	Q11. The training relates to the tasks I need to perform.					
	Q12. The system provides explanations or examples of how the knowledge learned can be used.					
Confidence	Q13. The system should help me to complete my courses successfully.					
	Q14. The system would build my confidence to demonstrate the knowledge learned.					
	Q15. After reading the introductory information, I felt confident that I knew what I was supposed to do on the system to learn from this course.					

Satisfaction	Q16. I enjoyed studying on the system.					
	Q17. It would be a pleasure to work with a system like this.					
	Q18. It felt good to successfully complete the course on this system.					
Competition	Q19. It engages and challenges one to be better.					
	Q20. It keeps one focused and gives them more reason to push towards.					
	Q21. It allows for subtle and empowering peer pressure					
Cooperation	Q22. It provides opportunities for mutual support and encouragement					
	Q23. It provides opportunities for people to stay responsible and accountable to others which propels them to meet their behaviour goals					
	Q24. It raises users' sensitivity to disappointment and makes them work harder to avoid disappointing others					
Self-monitoring	Q25. The system allows me to see my current score.					
	Q26. The system allows me track changes over a period of time.					
	Q27. The system provides monitors my performance over a period of time.					
Effectiveness	Q28. It improves my performance (Yong, 2013).					
	Q29. The system would influence my ability to complete the learning tasks (R. Orji, 2017).					
	Q30. The system helps me to improve my scores (Yong, 2013).					
Effici	Q31. The response time is acceptable (Albert & Tullis, 2013).					

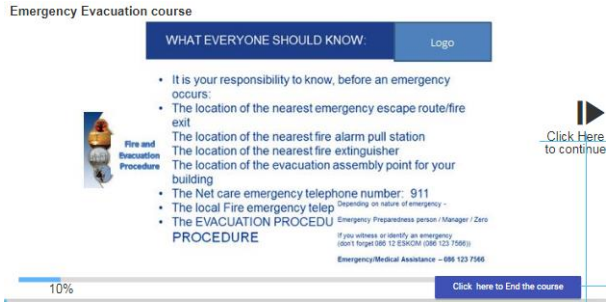
	Q32. It allows me to do the tasks quickly (Albert & Tullis, 2013).					
	Q33. It does not require a major effort to complete the tasks (Albert & Tullis, 2013).					
	Q34. What aspects of the e-learning system were most useful to you?	Type your answer here.				
	Q35. What improvements would you recommend for the system?	Type your answer here.				

APPENDIX D: SURVEY DATA RESPONSES

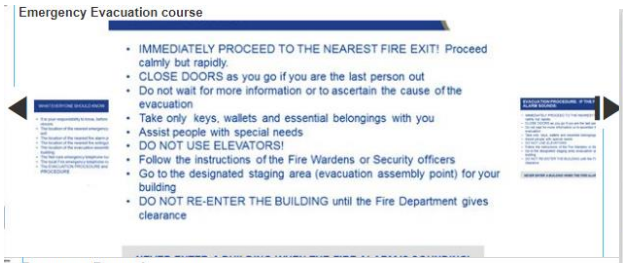
Figure D1. SPSS data file, refer to the link for the SPSS data file.

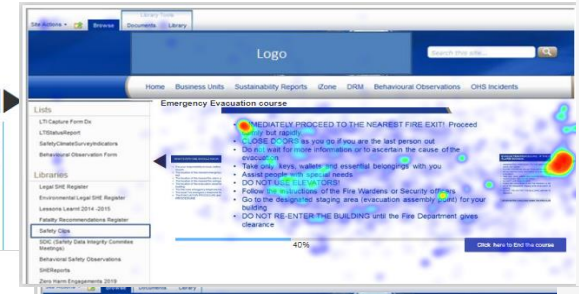
https://drive.google.com/file/d/1V54iMkN1Kvyq1is_K8xDM42CrJ9oZPNt/view?usp=sharing

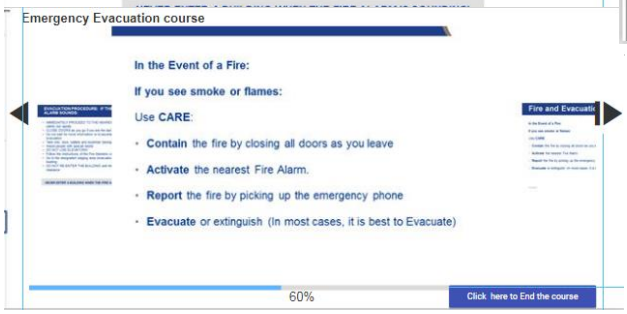
Figure D2. Prototype screenshots (all) vs. Figure D3. User testing with mouse movement data screenshots.


Emergency Evacuation course
WHAT EVERYONE SHOULD KNOW:
Logo
It is your responsibility to know, before an emergency occurs:
The location of the nearest emergency escape route/fire exit
The location of the nearest fire alarm pull station
The location of the nearest fire extinguisher
The location of the evacuation assembly point for your building
The Net care emergency telephone number: 911
The local Fire emergency telep
The EVACUATION PROCEDU
PROCEDURE
Fire and Evacuation Procedure
Click Here to continue
10%
Click here to End the course

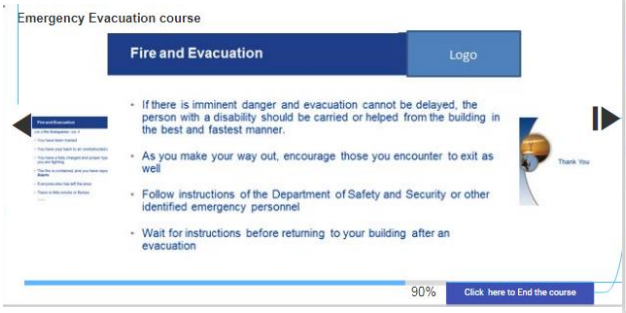

Logo
Emergency Evacuation course
WHAT EVERYONE SHOULD KNOW:
10%

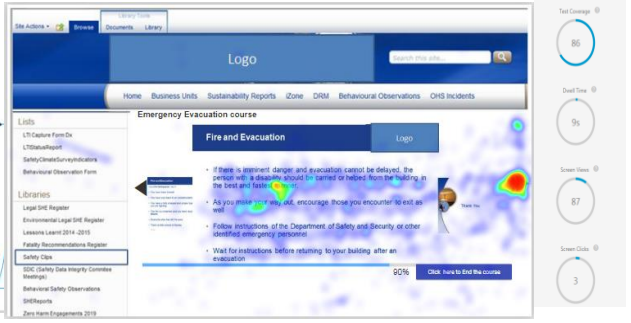

Emergency Evacuation course
IMMEDIATELY PROCEED TO THE NEAREST FIRE EXIT! Proceed calmly but rapidly.
CLOSE DOORS as you go if you are the last person out
Do not wait for more information or to ascertain the cause of the evacuation
Take only keys, wallets and essential belongings with you
Assist people with special needs
DO NOT USE ELEVATORS!
Follow the instructions of the Fire Wardens or Security officers
Go to the designated staging area (evacuation assembly point) for your building
DO NOT RE-ENTER THE BUILDING until the Fire Department gives clearance

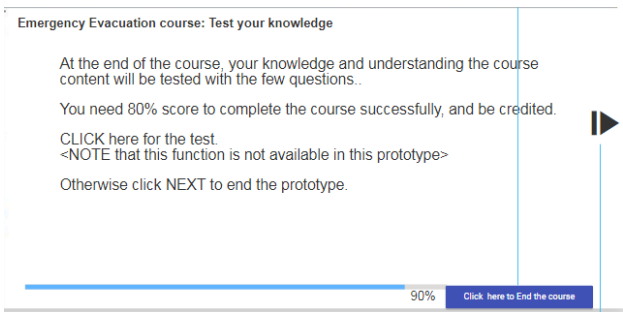

Logo
Emergency Evacuation course
40%

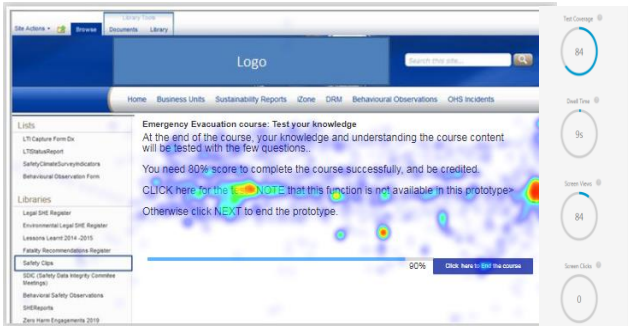

Emergency Evacuation course
In the Event of a Fire:
If you see smoke or flames:
Use CARE:
Contain the fire by closing all doors as you leave
Activate the nearest Fire Alarm.
Report the fire by picking up the emergency phone
Evacuate or extinguish (In most cases, it is best to Evacuate)
60%
Click here to End the course

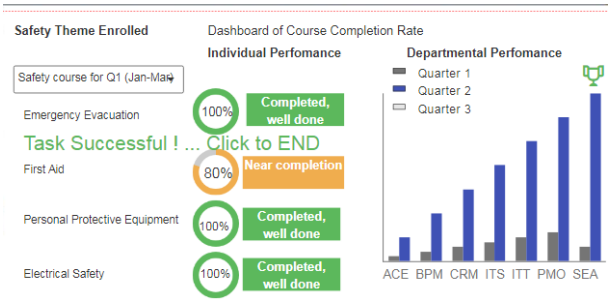

Logo
Emergency Evacuation course
In the Event of a Fire:
If you see smoke or flames:
Use CARE:
Contain the fire by closing all doors as you leave
Activate the nearest Fire Alarm.
Report the fire by picking up the emergency phone
Evacuate or extinguish (In most cases, it is best to Evacuate)
60%
Click here to End the course


Emergency Evacuation course
Fire and Evacuation
Logo
If there is imminent danger and evacuation cannot be delayed, the person with a disability should be carried or helped from the building in the best and fastest manner.
As you make your way out, encourage those you encounter to exit as well
Follow instructions of the Department of Safety and Security or other identified emergency personnel
Wait for instructions before returning to your building after an evacuation
Thank You
90%
Click here to End the course


Logo
Emergency Evacuation course
Fire and Evacuation
Logo
90%
Click here to End the course


Emergency Evacuation course: Test your knowledge
At the end of the course, your knowledge and understanding the course content will be tested with the few questions..
You need 80% score to complete the course successfully, and be credited.
CLICK here for the test.
<NOTE that this function is not available in this prototype>
Otherwise click NEXT to end the prototype.
90%
Click here to End the course


Logo
Emergency Evacuation course: Test your knowledge
At the end of the course, your knowledge and understanding the course content will be tested with the few questions..
You need 80% score to complete the course successfully, and be credited.
Otherwise click NEXT to end the prototype.
90%



APPENDIX E: STATISTICAL ANALYSIS QUANTITATIVE DATA

Table E1: Total Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.698	24.807	24.807	6.698	24.807	24.807	2.984	11.051	11.051
2	2.853	10.568	35.375	2.853	10.568	35.375	2.766	10.246	21.297
3	2.232	8.265	43.640	2.232	8.265	43.640	2.612	9.674	30.971
4	1.761	6.523	50.163	1.761	6.523	50.163	2.327	8.620	39.591
5	1.369	5.070	55.234	1.369	5.070	55.234	2.186	8.098	47.689
6	1.308	4.845	60.079	1.308	4.845	60.079	1.848	6.845	54.533
7	1.282	4.749	64.828	1.282	4.749	64.828	1.746	6.468	61.002
8	1.048	3.883	68.711	1.048	3.883	68.711	1.677	6.212	67.214
9	1.023	3.789	72.500	1.023	3.789	72.500	1.427	5.286	72.500

10	.844	3.127	75.627						
11	.805	2.983	78.610						
12	.765	2.834	81.444						
13	.653	2.417	83.861						
14	.569	2.106	85.968						
15	.491	1.820	87.787						
16	.478	1.769	89.556						
17	.438	1.622	91.179						
18	.405	1.499	92.677						
19	.380	1.406	94.084						
20	.307	1.138	95.221						
21	.288	1.065	96.287						
22	.227	.841	97.127						
23	.221	.819	97.947						
24	.183	.678	98.625						
25	.165	.609	99.234						
26	.124	.458	99.692						
27	.083	.308	100.000						
Extraction Method: Principal Component Analysis.									

Table E2: Correlations Table

Constructs		1. Attention	2.Relevance	3.Confidence	4.Satisfaction	5.Competition	6.Cooperation	7.Self-Monitoring	8.Effectiveness	9.Efficiency
1. Attention	| r |	1	**.229***	**.318****	**.474****	**.301****	**.171**	**.296****	**.420****	**.393****
	Sig. (2-tailed)		.047	.005	.000	.008	.139	.009	.000	.000
	N	76	76	76	76	76	76	76	76	76
2. Relevance	| r |	.229*	1	.079	.003	.192	.040	.110	**.249***	**.304****
	Sig. (2-tailed)	.047		.496	.977	.096	.735	.342	.030	.008
	N	76	76	76	76	76	76	76	76	76
3. Confidence	| r |	.318**	.079	1	.300**	.206	.337**	.505**	.336**	.358**
	Sig. (2-tailed)	.005	.496		.008	.075	.003	.000	.003	.002
	N	76	76	76	76	76	76	76	76	76
4. Satisfaction	| r |	.474**	.003	.300**	1	.487**	.226*	.323**	.483**	.246*
	Sig. (2-tailed)	.000	.977	.008		.000	.050	.004	.000	.032
	N	76	76	76	76	76	76	76	76	76
	| r |	.301**	.192	.206	.487**	1	.197	.215	.577**	.292*

5. Competition	Sig. (2-tailed)	.008	.096	.075	.000		.088	.062	.000	.011
	N	76	76	76	76	76	76	76	76	76
6. Cooperation	| r |	.171	.040	.337**	.226*	.197	1	.427**	.439**	.335**
	Sig. (2-tailed)	.139	.735	.003	.050	.088		.000	.000	.003
	N	76	76	76	76	76	76	76	76	76
7. Self-Monitoring	| r |	.296**	.110	.505**	.323**	.215	.427**	1	.442**	.485**
	Sig. (2-tailed)	.009	.342	.000	.004	.062	.000		.000	.000
	N	76	76	76	76	76	76	76	76	76
8. Effectiveness	| r |	.420**	.249*	.336**	.483**	.577**	.439**	.442**	1	.686**
	Sig. (2-tailed)	.000	.030	.003	.000	.000	.000	.000		.000
	N	76	76	76	76	76	76	76	76	76
9. Efficiency	| r |	.393**	.304**	.358**	.246*	.292*	.335**	.485**	.686**	1
	Sig. (2-tailed)	.000	.008	.002	.032	.011	.003	.000	.000	
	N	76	76	76	76	76	76	76	76	76

APPENDIX F: FOCUS GROUPS CONSENT FORM

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits, and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the focus group.

I have received a signed copy of the informed consent agreement.

Participant Name and Surname…… (please print)

Participant Signature……..Date……

Researcher's Name and Surname…Thabo Mongadi…… (please print)

Researcher's signature……..Date……

APPENDIX G: FOCUS GROUPS PROTOCOL AND QUESTIONNAIRE

Agenda

1. Welcome

2. Overview of topic and why am I here?

3. Ground rules

4. Questions to be discussed

5. Closure

1. Welcome and objectives

Good evening and welcome to the session. Thanks for taking the time to join us.

My name is Thabo Mongadi; I am an employee in the organisation, currently pursuing the Masters' study with the University of South Africa (UNISA). I am conducting the research to explore and obtain some information from the staff about your perceptions of the digital learning usage and efforts towards improving usage of the digital learning in the organisation.

The reason being that organisations are increasingly embracing digital learning technologies to improve their employees' skills and knowledge (Rana et al., 2016). Digital learning platforms are amongst the innovations which make organisational learning and development more cost-effective than on-site training (Khiat, 2015; Rana et al., 2016). However, one of the challenges in learning on the digital learning platform is self-motivation by adult learners (Khiat, 2015, Rana et al., 2016). This research comes from the observation I made in the organisation that some users are not completing the eLearning courses (as per eLearning reports, indicating low user completion rate). Research shows that this problem is not unique to this organisation; researchers have indicated similar challenges in other organisations (Khiat, 2015, Rana et al., 2016) as per the findings in the literature review.

Since digital learning is conducted by users on their own on digital platforms, we refer to this method of learning as autonomous learning on digital platforms (Rana et al., 2016, Khiat, 2015). We identified users' motivation as one of the factors that we could investigate towards improving usage of the eLearning in the environment.

In this study we explore the contribution of persuasive technologies (PT) and user experience (UX) towards improving the users' motivation in autonomous learning on the digital learning platforms. PT refers to the use of technologies designed for the primary purpose of changing users' behaviours, attitudes, and thoughts, without using coercion or deception (Fogg, 2009). UX is defined as a person's perceptions and responses that result from the use and/or

anticipated use of a product, system or service (ISO9241-210, 2010). Persuasion inspires motivation for behaviour change (Oinas-Kukkonen and Harjumaa, 2009).

2. Overview of topic, and your involvement

As part of the academic research study under the topic:

“Persuasive technology and user experience design guidelines to motivate users for autonomous learning on digital learning platform in the context of a corporate environment in South Africa”.

The objective of this session is to collect data / some information from employees in the organisation about your perceptions of the usage of the eLearning by employees and interventions focusing on users’ motivation that may be explored for improving the usage of the system.

You were invited because you have in-depth knowledge and involvement usage of the digital learning, therefore you are rich in information (Saunders et al., 2009), that could be valuable in improvement the ongoing development of digital learning program in the organisation (amongst you some are either subject matter experts, content developers, training instructors, supporting digital learning environment, super users). You have certain characteristics in common that relate to the topic being discussed (Saunders et al., 2009) so you're familiar as users and experts with digital learning and you understand the full benefits in the organisation, and finally you are all employees in this organisation.

3. Ground rules

a) Please submit the completed consent forms (if not already done so prior joining the session).

b) There is no right or wrong answers, only differing points of view.

c) You don't need to agree with others, but you must listen respectfully as others share their views.

d) You are encouraged to discuss and share points of view without any pressure to reach a consensus (Saunders et al., 2009).

e) The rules for cellular phones: We ask that your turn off your phones or if you cannot and must respond to a call, please do so as quietly as possible and re-join us as quickly as you can.

f) My role as moderator will be to guide the discussion.

g) We're recording the session, one person speaking at a time.

4. Questions to be discussed.

Sequence the questions from general to specific, five types of questions (Krueger, 2002).

a) Opening Question

Tell us briefly about the department where you work and about the experience you have using digital learning in the organisation?

(Probes: name of department where you work, your role, usage purpose of digital learning, number of years using digital learning system (expert, intermediate, novice), and number of years using the digital learning system.

b) Introductory Question

"You are using the digital learning system for learning. What do you find motivating with the digital learning system to get the learning task completed successfully?"

(Probes: look of the user interface (layout, skin, buttons), content (short learning steps), easy to find information looking for (number of clicks, scrolling), number of years using the system, knowing where you are and how long to go (self-monitoring/progress), knowing how peers are doing (comparison), overall department performance (co-operation). Note the UX or PT aspects.

c) Transition Questions

How do you feel about the status of the digital learning system?"

(Probes: focusing on / considering satisfaction, effectiveness, efficiency).

- “What causes this”
- "Would you explain further?"
- "Would you give an example?"

d) Key Questions

What aspects/features of the digital learning system motivate you?

(Probes: Note the UX or PT aspects. look of the user interface (layout, skin, buttons), content (short learning steps), easy to find information looking for (number of clicks, scrolling), number of years using the system, knowing where you are and how long to go (self-monitoring/progress), knowing how peers are doing (comparison), overall department performance (co-operation).

- “What is the feature(s) motivating you”
- "Would you explain further?"
- "Would you give an example?"

e) Ending Questions

What features of the digital learning system would you like to see improved (or new introduced) to improve motivation of users?

(Probes: Note the UX or PT aspects. look of the user interface (layout, skin, buttons - satisfaction), content (short learning steps - effectiveness), easy to find information looking for (number of clicks, scrolling - efficiency), knowing where you are and how long to go (self-monitoring/progress bar), knowing how peers are doing (comparison), overall department performance (co-operation).

5. Closure

Thanks participants, give them contact information for further follow up if requested and dismissal.

APPENDIX H: FOCUS GROUPS TRANSCRIPTS

FOCUS GROUP1 : The codes used, S=Session number, P = participant number, e.g S1P1 = In session number1, participant number1. As well as the time stamp of the recording in min:sec.

S1P1: Digital learning is referred mainly in ABC Holdings to e-learning, it is **not interactive**, very **static**, **rigid**.26:59

S1P2: 27:53 Restriction in the digital learning, as it limited to infrastructure within ABC Holdings. Consider opening the learning environment to open source platforms, cloud based platforms. Our **learning platform is so outdated**. ABC Holdings is trailing in adopting cloud opportunities, this is limitation. **Make learning flexible**, wherever the user is, on mobile, on social, etc. **Ease of use of the platform**. Organisation needs to change. **Change the mindse**t of the users in the organisation. **Culture shift in the organisation**, for the value of digital learning to be beneficial, in this tight budget constraint. UNISA is advanced in digital learning, what learning can ABC Holdings get form UNISA44:09.

S1P3: 35:02 Lots of content being pushed into the learning environment. Consider storyboarding. Lack of analysis on the learning content. Limit of the learning tool, rigidness.

S1P4: 39:32 Most of the completed courses are **compliance base**d. Because they are being forced to do training. We need to identify opportunities that will motivate learning in the organisation, e.g . The EAL Digital learning strategy (framework) can be shared.

FOCUS GROUP2 : The codes used, S=Session number, P = participant number, e.g S1P1 = In session number1, participant number1. As well as the time stamp of the recording in min:sec.

S2P1: 04:57 Attendance in training has improved since digital learning due to COVID-19.

Training has been minimised to **within an hour**, that way users are able to accommodate training in their time. (similar to microlearning)

Flexibility to the end users, schedule different schedules, allowing the participants to attend the sessions that are suitable for them. Keep learning shorter, and flexible. Especially in awareness.

09:28 **Facilitators need to activate their videos**, for the focus and be in touch with the trainer. Makes the training more personal and in touch.

S2P2: Indeed uptake on e-learning has improved since COVID-19. Traditionally there has been resistance to move away from class room training, this has changed the culture and behaviour of learning in the organisation. The **content of the learning material must be precise and to the poin**t, to allow the concentration span if users, don't make the learning content long. Keep sessions interactive, e.g. switching videos during introductions, not making the sessions monotonous.

15:39 Enabling learning on mobile cell phones for learning task, **mobilise learning**, because users always have their cell phones. This will also add to **flexibility** in learning.

Include **videos and simulations** in the training pertaining to the topic will make it interesting.

S2P3: 20:44 Offer **learner/user centric learning**, anytime, and on the go, related to **flexibility**. Using **different platform**, e.g. on cell phones, and laptops. Make the learning content shorter, to afford concentration. Maybe cut the learning into chapters to **keep in short**. Learning must be interactive. Challenges form use perspective, is the data to encourage users to participate in learning, e.g, using dial in, where users don't carry the cost of data. Interruptions of electricity, learning can continue on the cell phones as they run batteries. Limitation of 3G cards due to interruptions and speed. Fibre links are more reliable and faster. Limited data may be discouraging people to show videos, therefore limiting the visibility of gesture of the users. **Engage with users, by calling their names in the training sessions**, it encourages users to feel active in the learning process. Digital learning advantage is that it is cost effective, it cuts on travelling and lodging. Infrastructure aspects contribute to the challenges. 30:21 Gamification and simulations are also important especially for practicals, because they make the practicals shorter and interesting. Allowing for learning and playing. During learning on games, the items that are **consumed are less**, because they are not using the actual materials, e.g. during welding, you learn on simulation, without spending the actual material.

Digital leaning framework allows for changes and improvements, as opposed to strategy that is constant for a period of time. The research study will enhance the digital learning initiative in the organisation.

S2P4: There are valuable insights gained, inputs appreciated.

FOCUS GROUP3 : The codes used, S=Session number, P = participant number, e.g S1P1 = In session number1, participant number1. As well as the time stamp of the recording in min:sec.

S3P1: **Change management** in implementation of the e-learning system is important. This will ensure that users are aware what is coming, if not conducted discourages users.

The e-learning system is not **integrated**, needs to be integrated with other systems in the organisation contributing towards learning. This will reduce frustration of the learners, e.g LMS, sharepoint, hyperwave, this will discourage users in learning as they seek information from different sources. Ease of **access for information** can be achieved by integrating the backend systems, and present a single environment to the user. 22:36 Change management. Getting to know what the users are expecting form the new learning system, leading to learners frustrated and discouraged.

S3P2: 23:25 System integration are challenges within the organisation, over and above change management. Prior knowledge of IT background, as **aging users** (old users) with experience will be a challenge on the uptake on digital learning platform.

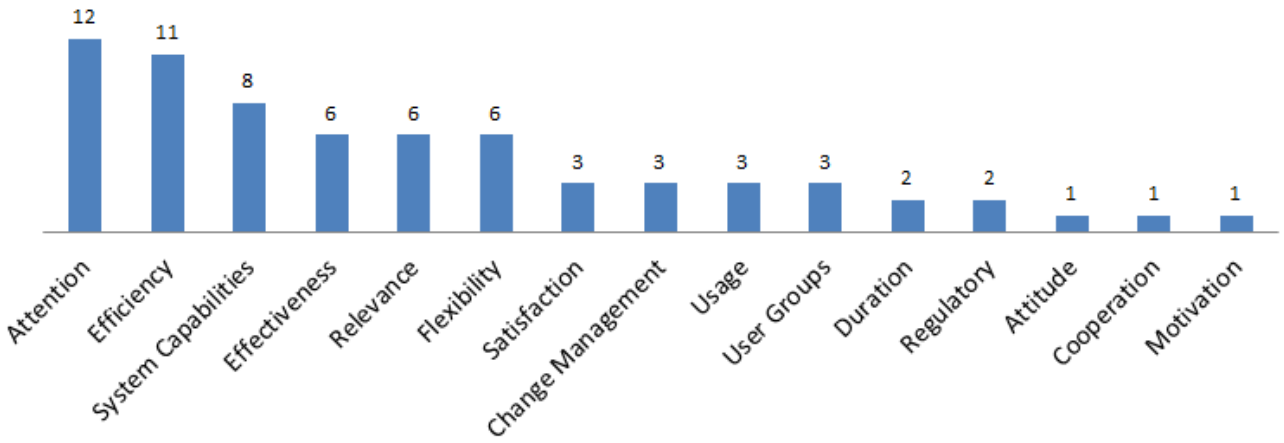
S3P3: 26:14 Kids learn best with videos on movies, it helps them remember the learning content easier. This makes learning enjoyable. As indicated age makes difference. **Liking entertainment** to learning is key. Social learning also is another method of making learning easier. 28:47 Looking at new easier ways of learning to make learning funny, e.g. short learning. Focus on perspective of the learners, put the learner in the centre. Involve the learners in preparing the learning. Attention span of users is a challenge for longer learning material, make the learning shorter.

S3P4: 32:03 Ageing users is a challenge in digital learning. But COVID-19 forced the move to digital learning. Long bulky information is not easy to consume. Try adding **images, animation, short videos, reduce wording/writing** to make learning exciting. Make **learning practica**l, include games for excitement for learning. Keep learners engaged, entice them. Find video clips easier to follow, a practical example used in UNISA.

S3P5: 37:11 Change management, which includes upskilling users. Overlooking the skills of the facilitators, and tools/platform needs to be available, e.g. need to 2 screens one for projecting the other for seeing the attendees. 38:51 **User interface** is important to make digital learning engaging. Change needs to be managed, sometimes the user interface of the older system is better than the user interface of the new systems, make the user interface appealing.

S3P6: 43:01 **Compliance courses** seems to be on the leading with regard to update of users, fraud and ethics courses. Less participation is seen on elective courses from users. Good thing is retain reporting on the courses uptake for visibility. 48:37 Adding **movies** on learning is also important, as it helps to remember the contents in a short space, typically 45sec-60sec.

APPENDIX I: FOCUS GROUPS THEMATIC ANALYSIS



Theme frequency report from the thematic analysis in Atlas.ti

APPENDIX J: SYSTEMATIC LITERATURE REVIEW WORKSHEET

Author	Year	Counti	Sector (Env	Research methodology or research design	Studies covering PT and I	mixe	Quan	Qual	exper	surve	PSD	ARCS	UTAU	AR	DSR	proto	case st
2019, Bootsmann, Wearable technology for posture monitoring at the workplace	2019	USA	Health	For the field study, a triangulated mixed methods (Creswell et al., 2007) approach was followed, which combines quantitative and		1	1	1									
Orji, R., Reilly, D., Oyibo, K. and Orji, F.A. (2019) 'Deconstructing persuasiveness of strategies in behaviour change systems using the ARCS model of motivation', Behaviour and Information Technology. Taylor & Francis, 38(4), pp. 319–335. doi: 10.1080/0144929X.2018.1520302.	2019	USA	General public	we conducted a large-scale study with 543 participants to investigate the relation between Attention, Relevance, Confidence, and Satisfaction constructs from the ARCS model of motivation and 10 strategies that are commonly used in persuasive systems design (PSD).								1					
Widyasari, Y. D. L., Nugroho, L. E. and Permanasari, A. E. (2019) 'Persuasive technology for enhanced learning behavior in higher education', International Journal of Educational Technology in Higher Education, Springer Netherlands, 16(1).	2019	Asia	Education	Data were collected by conducting questionnaires (=survey)to test participants.						1							
Czaja, S.J., 2019, Usability of Technology for Older Adults: Where Are We and Where Do We Need to Be, *Journal of Usability Studies* , vol 14 (2), pp. 61 - 64.	2019	USA	General public	The first step is to recognize that, in fact, older people are willing to use technology, can learn to interact with technology systems, need to interact with technology to function independently, and are an important user group. Second, is the understanding of the implications													
2019, Thatch, Persuasive Design Principles in Mental Health Apps: A Qualitative Analysis of User Reviews '	2019	Asia	Health	The study is conducted by conducting qualitative analysis of user reviews.		1		1									
2019, Kljun, Persuasive Technologies in m-Learning for Training Professionals: How to Keep Learners	2019	Asia	Corporate	The method adopted was action research [58]. We conducted two experiments (E1 and E2) in three phases (Phase 1, 2 and 3) each lasting					1					1			
Ahmad, W., Nooraishya, W., & Ali, M., 2018, A Study on Persuasive Technologies: The Relationship between User Emotions, Trust and Persuasion, International Journal of Interactive Multimedia and Artificial Intelligence, inPress. 1.10.9781/ijimai.2018.02.010, pp. 57–61.	2018	Asia	Education	Experimental design approaches were used to measure different aspect of evaluation. User emotions were measured at three stages of interaction; pre, during and post, while user's trust were measured in pre-post interaction stages, whereas, persuasion were measured in post-interaction stages. Quantitative measurement scales for each aspects			1		1								
Makuochi Nkwo and Rita Orji. 2018. Persuasive Technology in African Context: Deconstructing Persuasive Techniques in an African Online Marketplace. In Proceedings of 2nd African Computer Human Interaction Conference (AfriCHI'18), Windhoek, Namibia, 10 pages. https://doi.org/10.1145/3283458.3283479	2018	Africa	General public	We used multiple perspective methodology (a mixture of expert evaluation and quantitative approaches) to carry out this study (=mixed). This method was used because it is more comprehensive and yields more broad findings. Secondly, we conducted a study of 112 users to determine their awareness of the use of PT techniques in Jumia. Our questions were measured using participants' agreement with a 4-		1	1	1									
Orji, F.A., Vassileva, J., & Greer, J., 2018, Personalized Persuasion for Promoting Students' Engagement and Learning, Proceedings of the Personalization in Persuasive Technology Workshop, Persuasive Technology, Waterloo, Canada, 17-04-2018, published at http://ceur-ws.org, pp. 75-85	2018	USA	Education	This paper draws from persuasive system design (PSD) and best practices to design a persuasive system for evaluating the effectiveness of personalizing three social influences strategies (social comparison, social learning, and competition) in motivating students to engage in online learning activities and hence promote deeper learning. Near the beginning of the semester, students were surveyed using a questionnaire based on Busch et al.'s persuadability						1							

Haque, M.S., Isomursu, M., Kangas, M., and Jamsa, T., 2018, Measuring the Influence of a Persuasive Application to Promote Physical Activity,	2018	Europe	Corporate	We designed a persuasive application iGO to encourage workers to exercise and walk more often during working hours. To evaluate user acceptance, we collected end-user data in relation to						1			1				
Adaji, I., 2017, Towards Improving E-commerce Users Experience Using Personalization & Persuasive Technology, UMAP'17, July 9-12, 2017, Bratislava, Slovakia	2017	USA	General public	I plan to carry out my research in 3 main stages: Stage 1: Identifying and evaluating e-commerce persuasive strategies. We initially evaluated Amazon as a persuasive system using the PSD	1						1					1	
Zachary Fitz-Walter, Daniel Johnson, Peta Wyeth, Dian Tjondronegoro, and Bridie Scott-Parker. 2017. Driven to drive? Investigating the effect of gamification on learner driver behavior, perceived motivation and user experience. Comput. Hum. Behav. 71, C (June 2017), 586–595. DOI:https://doi.org/10.1016/j.chb.2016.08.050	2017	Asia	General public	Participants were recruited via a Facebook event page created for the study and by snowball-sampling techniques. Participants had to meet two criteria for recruitment: (1) the participant had to be currently learning to drive in Queensland, Australia, and (2) they had to own and use an iOS mobile device (iPhone, iPod touch or iPad) on which to use the application.						1								
Orji R. (2017) Why Are Persuasive Strategies Effective? Exploring the Strengths and Weaknesses of Socially-Oriented Persuasive Strategies. In: de Vries P., Oinas-Kukkonen H., Siemons L., Beerlage-de Jong N., van Gemert-	2017	USA	Health	we conduct a large-scale qualitative and quantitative study (mixed)of 1768 participants to investigate the strengths and weaknesses of these strategies and their comparative effectiveness at motivating healthy behaviors. We represented each persuasive		1	1	1		1							
V. F. Emets and J. Rogowski, "Using persuasive technologies in computer systems," 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT),	2017	Europe	Education	Development of mobile application. The application is implemented in a client-server architecture. The client is implemented as a mobile application running on the Android platform. The Android SDK, Java programming language, SQLite database and ORMLite library were												1	

Harris, A., Islam, S., & Khan, U.A., (2017), Persuasive Technology for Human Development: Review and Case Study, DOI: 10.4108/eai.8-12-2017.153401, EAI Endorsed Transactions on Serious Games, vol.4 (12), pp. 1-11.	2017	Asia	General public	started by literature review on common applications of persuasive technology for helping modify human behaviour towards positive social outcomes in developing countries. Then we present a case study outlining how persuasive technology can be used for human													1
Göschlberger, B., and Bruck, P.A., 2017, Gamification in Mobile and Workplace Integrated MicroLearning. In iiWAS '17: The 19th International Conference on Information Integration andWeb-based Applications & Services,	2017	Europe	Corporate	In this case study, we report and analyze the learning behavior of 175 employees using gamified MicroLearning over the course of seven months. The study setup allows observing behaviour with and without the extrinsic motivation of an employee competition.													1
Kaplarski, K. (2015) 'Mobile Learning Technology : Using Persuasive Mobile Ux Design To Change Learning Behavior', The Sixth International Conference on e-Learning (eLearning-2015), (September), pp. 24–25.	2015	Europe	Education	We used a human centred design approach to evaluate existing e-learning infrastructure and to implement new requirements based upon users' feedback. Participants of the BMU survey were students of the Faculty of Information Technologies (FIT) and Faculty of Digital	1					1						1	
Bakar,An investigation of user engagement factors in E-learning for working adult learners	2015	Asia	Corporate	Interviews were carried out with 30 participants; all of who are in the learning process of using an e-learning system provided by their						1							
Agnis Stibe and Harri Oinas-Kukkonen, 2014, "DESIGNING PERSUASIVE SYSTEMS FOR USER ENGAGEMENT IN COLLABORATIVE INTERACTION", Proceedings of the	2014	Europe	Education	Based on a theory driven research model, a persuasive information system comprising social influence design principles of cooperation, social learning, and social facilitation was implemented and						1							
Hamari, J., Koivisto, J., & Pakkanen, T. (2014). Do Persuasive Technologies Persuade? - A Review of	2014	Europe	Miscellaneous	The review process began with selection of the sources to be used for the literature searches. We chose the Scopus database.						1							

Lockton, D., Nicholson, L., Cain, R., and Harrison, D., 2014, Persuasive Technology for Sustainable Workplaces, FORUM SUSTAINABILITY IN (INTER)ACTION, www.INTERACTIONS. ACM.ORG, DOI: 10.1145/2544170, pp58-	2014	Europe	Corporate	a range of low-cost HCI led interventions designed and iterated through a pilot study at DECC's offices (about 1,000 staff). We adopted elements from different approaches for engagement and influencing behavior through											1		
Némery, A., and Brangier, E., 2014, Set of Guidelines for Persuasive Interfaces: Organization and Validation of the Criteria, *Journal of Usability Studies* , vol 9 (3), pp. 105-128.	2014	Europ	Education	To present and validate a checklist to assess persuasion in interfaces, we start by describing the theoretical basis of our set of guidelines. Then, we classify persuasive criteria into eight categories (credibility,					1									
2014, Adna, Comparison of Adaptive E-learning Mobile and Web-Based Software Applications Effectiveness	2014	Asia	Education	We have developed an e-learning software system that assists students to improve their study behavior from two different perspectives.						1								
2013, Pilloni, Assessing the User Experience Design as a Persuasive Methodology in a Real World Sport Application,	2013	Europe	Health	This work describes an experimentation conducted on Ev-erywhere Run! (EWRun). The new design of Everywhere Run! caused a statistically significant user base growth. As a result, we decided to compare the two designs	1				1									
Busch M., Schrammel J., Tscheligi M. (2013) Personalized Persuasive Technology – Development and Validation of Scales for Measuring Persuadability. In: Berkovsky S., Freyne J. (eds) Persuasive Technology. PERSUASIVE 2013.	2013	Europe	Education	For scale development, we follow selected steps from a process that is proposed for construct measurement and validation procedures in management information systems: Definition of the construct, the generation of items to assess the construct (in section: 3.1 First														
Daud, N. A., Sahari@Ashaari, N. and Muda, Z. (2013) 'An Initial Model of Persuasive Design in Web based Learning Environment', Procedia Technology. Elsevier B.V., 11(Iceei), pp. 895–902. doi: 10.1016/j.protcy.2013.12.273.	2013	Asia	Corporate	Construction of the model is adapting design science in IS Research Framework [28], whereby the first step starts with the identification of components that appropriate to be included in the persuasive WBL. In developing the model that describes the persuasive components of										1				
Daud, N. A., Sahari@Ashaari, N. and Muda, Z. (2013) 'An Initial Model of Persuasive Design in Web based Learning Environment', Procedia Technology. Elsevier B.V., 11(Iceei), pp. 895–902. doi: 10.1016/j.protcy.2013.12.273.	2013	Asia	Corporate	Construction of the model is adapting design science in IS Research Framework [28], whereby the first step starts with the identification of components that appropriate to be included in the persuasive WBL. In developing the model that describes the persuasive components of										1				
2013, Meng, Towards Design of Technologies Persuading more Physical Activity	2013	Asia	Health	We develop a set of persuasive principles (PSD): goal-setting, personal awareness, social influence, rewards, reminders, and entertainment.							1							
2012, Partala, Understanding the most satisfying and unsatisfying user experiences: Emotions, psychological needs, and context	2012	Europe	Education	The questionnaire method by Sheldon et al. (2001) is used in the current study with minor amendments to study the psychological needs related to the reported most satisfying and unsatisfying user					1	1								
2011, Jawdat, Towards User Experience Based Persuasive Systems	2011	Asia	General Public	surveys some recently developed persuasive systems.						1								
Crilly, N. 2011. Do Users Know What Designers Are Up To? Product Experience and the Inference of Persuasive Intentions. International Journal of Design [Online] 5:3.	2011	Europe	Miscellaneous	For guidance in this we can look to methodological precedent in the PKM literature stream and other fields that study the use of knowledge, the acquisition of literacy and the effects of														
Segerståhl K., Kotro T., Väänänen-Vainio-Mattila K. (2010) Pitfalls in Persuasion: How Do Users Experience Persuasive Techniques in a Web Service?. In: Ploug T., Hasle P., Oinas-Kukkonen H. (eds) Persuasive Technology.	2010	Europe	Education	A qualitative online questionnaire was distributed through the web service and a total of 291 responses were extracted for interpretative analysis. The Persuasive Systems Design model (PSD) was used for supporting				1		1	1							

APPENDIX K: RESEARCH PLANNING

The research planning comprises the research activities, parties involved, instruments used and timelines.

Research Activities	**Parties involved**	**Jan-Dec2019**	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Preliminary: Formulate research study title	Researcher, Supervisor-review																									
Decide on topic and area of interest	Researcher, Supervisor-review																									
Preliminary research	Researcher																									
Identify research problem	Researcher																									
Do detailed secondary research (systematic literature review)	Researcher																									
Develop research design	Researcher																									
Prepare research proposal	Researcher, Supervisor-review																									

Organise notes for literature review	Researcher																									
Write body of the literature review	Researcher																									
Write conclusion to the literature review	Researcher																									
Write introduction to the literature review	Researcher																									
Introduce Proposed research design	Researcher																									
Describe and Justify method, research instruments	Researcher																									
Discuss data and analysis techniques	Researcher																									

Discuss ethical constraints	Researcher																									
Finalise Draft Proposal	Researcher																									
Generate bibliography	Researcher																									
Edit proposal	Researcher																									
Submit Final proposal	Researcher, Supervisor-review																									
Ethical Clearance	Researcher, Supervisor-review																									
Write Chapter 1-3 revisions (Intro, Literature Review, Method)	Researcher																									
Questionnaire Design	Researcher, Supervisor-review																									
Focus groups schedule	Researcher																									
Design Focus groups schedule	Researcher, Supervisor-review																									

Focus group sessions	Researcher																									
Prototype design and development	Researcher																									
Prototype Design	Researcher																									
Prototype development	Researcher																									
Data collection	Researcher																									
Sample selection for questionnaire	Researcher																									
Send the prototype to users for testing and evaluation	Researcher																									
Data Analysis instruments	Researcher, Supervisor-review																									
Finalise Chapter 1-3, report writing	Researcher, Supervisor-review																									
Finalise Chapter 4, report writing	Researcher, Supervisor-review																									

on data analysis																										
Finalise Chapter 5, report writing on findings	Researcher, Supervisor-review																									
Finalise Chapter 6, report writing on conclusion	Researcher, Supervisor-review																									
Generate bibliography	Researcher, Supervisor-review																									
Edit Thesis Report	Researcher																									
Submit Final Thesis report and printing	Researcher, Supervisor-review																									

APPENDIX L: PUBLICATION RESULTING FROM THIS STUDY

2022 Conference on Information Communications Technology and Society

Persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa

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***Abstract*—Persuasive technologies (PT) improve motivation for autonomous learning across digital learning platforms. Despite the potential for supporting learning, the application of PT in the South African corporate organizations' context remains limited. The research problem identified is the lack of users' motivation to self-learn on digital learning platforms. The study is novel in integrating the theoretical lenses of PT and user experience (UX) to investigate the improvement of autonomous learning in a corporate power utility in South Africa. The study reports on the persuasive strategies and UX attributes to be prioritised for motivation in digital learning. The study is guided by design science research (DSR) methodology. The theoretical contribution is the literature-based design guidelines validated by the subject matter experts (SMEs) in focus-groups for motivating users to self-learn on digital learning platforms. The study makes a practical contribution by developing a prototype that incorporates the PT strategies and strives towards meeting usability criteria.**

Keywords— persuasive technology; user experience; autonomous learning; digital learning; design science research

I. INTRODUCTION

Organisations are increasingly using digital learning technologies as platforms for autonomous learning to improve employees' skills and knowledge [1]. Whereby, autonomous learning can be seen as a learning style that encourages employees to own the learning initiatives [1; 2]. However, self-motivation is one of the challenges faced by employees when conducting autonomous learning on digital platforms [1; 2]. Usability is another factor impacting the use of digital platforms [14]. Therefore, this research investigates the use of Persuasive technologies (PT) strategies and user experience (UX) attributes to improve the users' self-motivation when conducting autonomous learning on digital platforms in the context of a corporate organization in South Africa. The study is novel in integrating the theoretical lenses of PT and UX to investigate the improvement of autonomous learning in a corporate utility. This study is guided by the design science research (DSR) methodology to answer the research question: *What are the design guidelines constructs on the literature-based set of persuasive strategies and UX attributes required for improving the users' motivation for using e-learning platform for autonomous learning*? The theoretical contribution is the literature-based design guidelines validated by the subject matter experts (SMEs), for designing the prototype (practical contribution).

subject matter experts (SMEs), for designing the prototype (practical contribution).

II. BACKGROUND LITERATURE

This section defines the three theoretical constructs that underpin the study. The first is persuasive technologies (PT), which refers to the use of technologies designed for the primary purpose of changing users' behaviours, attitudes, and thoughts, without using coercion or deception [3]. The study includes PT, because persuasion inspires motivation for behaviour change [3] and includes the common persuasive strategies of competition, social comparison, cooperation, and self-monitoring [4; 5]. Where competition and social comparison belong together, in that competition is a by-product of comparison [6]. As it was not feasible to investigate all 28 persuasive strategies [7], the selected set of common strategies, namely, competition, cooperation, and self-monitoring, were prioritised and added to Table 1.

The second is User Experience (UX), which is defined as a person's perceptions and responses that result from the use or anticipated use of a product, system or service [8; 9]. Furthermore, research studies indicate that UX also may positively influence users' motivation [8]. From this perspective, the measures of UX can encompass effectiveness, efficiency and user satisfaction as the component model of usability [10]. These constructs are summarised and added to Table 1.

Finally, the third construct is ARCS, an acronym for attention, relevance, confidence, and satisfaction; this motivation model has been proven and validated for use in promoting and sustaining the motivation of users in the learning process [11]. In this context, autonomous learning refers to a learning style that permits employees to own the learning initiatives [1; 2]; and digital learning or technology-enhanced learning are used interchangeably to refer to e-learning. Table 1 shows the Alpha and Beta versions of the set of constructs.

Table 1. Literature based constructs for improving user motivation in autonomous learning (* refers to an additional construct added as part of the beta version)

Subject Area	***Constructs***	***Application of the construct in the study***	***Design guide-lines***
Common PT strategies	Competition	It engages and challenges users to perform while keeping the learning exciting, e.g., it includes a scoreboard.	[5;7]
	Cooperation	It provides opportunities for mutual support, and encouragement towards a common goal, e.g., it includes Results of cooperative efforts.	[5;7]
	Self-monitoring	It provides the capability for users to track their progress, e.g., includes performance status.	[5;8]
UX attributes	Effectiveness	It refers to the ability to complete a task successfully.	[12;13]
	Efficiency	It refers to the amount of effort (time) required to complete the task successfully.	[12;13]
	Satisfaction	It refers to the degree of the user internal state, was the user happy with the experience while performing the task.	[12;13]
ARCS	Attention	It incorporates aesthetics (graphics, art), curiosity, interest and other related areas such as sensation seeking.	[14;15]
	Relevance	It refers to perceptions that the instructional requirements are consistent with their goals.	[16]
	Confidence	It refers to the effects of positive expectancies and attributions of successes	[16]

Subject Area	*Constructs*	*Application of the construct in the study*	*Design guide-lines*
		to one's own abilities and efforts.	
Added construct	Flexibility*	It refers to allowing digital learning anywhere, anytime; for improving the autonomous learning motivation of users.	[17]

III. RESEARCH DESIGN

The study was guided by the set of DSR guidelines [18] with pragmatism as philosophy. This study is divided into three stages to allow the control of research focus and deliverables. The DSR steps [19] were applied as follows: Step 1 was applied to identify the problem, step 2 was to define the solution, step 3 and 4 were applied to design and develop the prototype, as the artefact, for evaluation in step 5. Step 6, communication through intended publication, completed the DSR steps.

The literature review to identify literature-based PT strategies, UX attributes, and ARCS constructs for improving the motivation of users in autonomous learning on digital learning platforms is summarised in Table 1. The selected set (alpha version) of nine constructs was validated in a focus group with 14 subject matter experts (SME) and is reported in section IV. The validated set of constructs that includes flexibility, (beta version) was used as the basis for informing a digital platform as an artefact, and is described in section V. The digital platform was evaluated with 75 participants. Due to space limitations, the presentation of the comprehensive evaluation is beyond the scope of this paper. We present only the mouse movement heat map as an evaluation metric.

IV. VALIDATION OF THE CONSTRUCTS

The alpha version of the set of constructs (as seen in Table 1), was evaluated with the SMEs in a focus group. The SME participants, depicted in Fig. 1, consisted of 14 selected practitioners from the business digital learning department: learning developers, learning coordinators, senior advisors, middle and senior manager. The gender distribution was 57% Male and 43% Female.

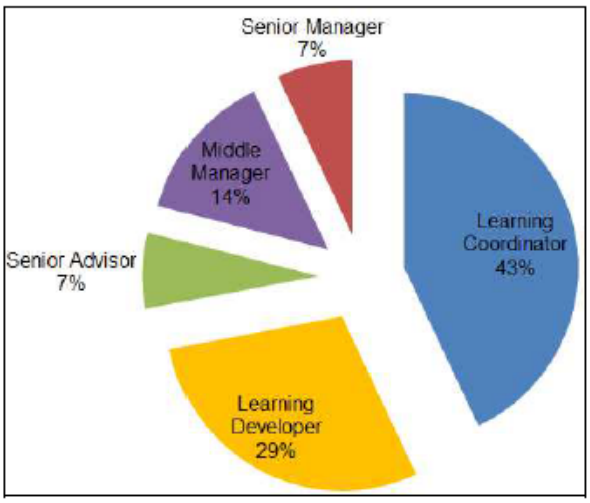

Fig. 1. Specialization distribution of the focus group participants

The discussion in the SME focus group was guided by a predefined set of questions that were based on the constructs identified in the alpha version as seen in Table 1. The discussions were recorded and transcribed for thematic analysis, indicating the high frequency themes as depicted in Fig. 2. The themes with frequency of more than 1 were shortlisted for iteration by reviewing, rationalised and re-categorised to remove duplications as part of thematic analysis [20]. The result was the beta version with the validated set of constructs.

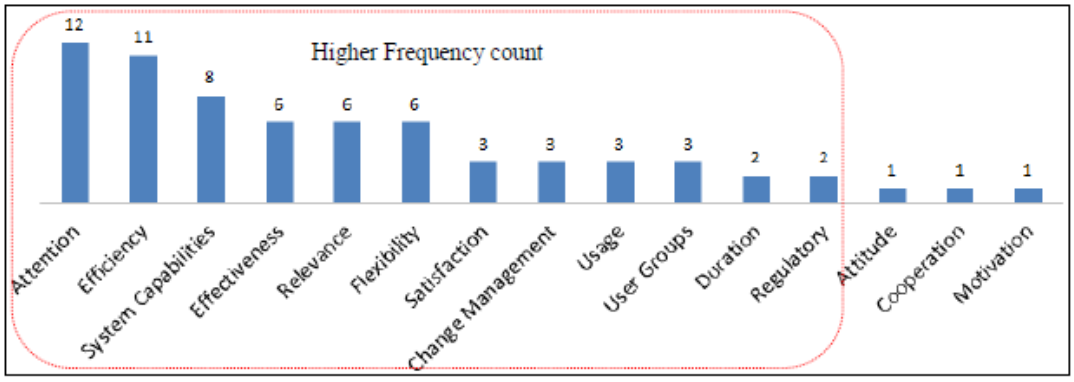

Fig. 2. Theme frequency from the thematic analysis of the SMEs in the focus group

The beta version includes the constructs: competition, cooperation, self-monitoring, effectiveness, efficiency, satisfaction, attention, relevance, confidence, and flexibility. Flexibility was identified as an additional construct and added as a construct, as seen in Table 1. Using the constructs identified in the beta version, a digital platform, as an artefact, was developed and presented to end-users to obtain user insights. This is discussed in section V.

V. OBTAINING USER INSIGHTS BY EVALUATION OF THE DIGITAL PLATFORM

The prototype was designed on a cloud-based open-source system with the front-end user interface build with Vue.js [21]. The prototype screenshot illustrating the persuasive strategies is depicted in Fig. 3.

To obtain user insights, the prototype was presented to 75 end-users as a web-link (URL) in an e-mail, with instructions of the tasks to be performed. All the end-users completed the 5 learning tasks, with an average of 91% of the screens viewed, and average time of 56 seconds.

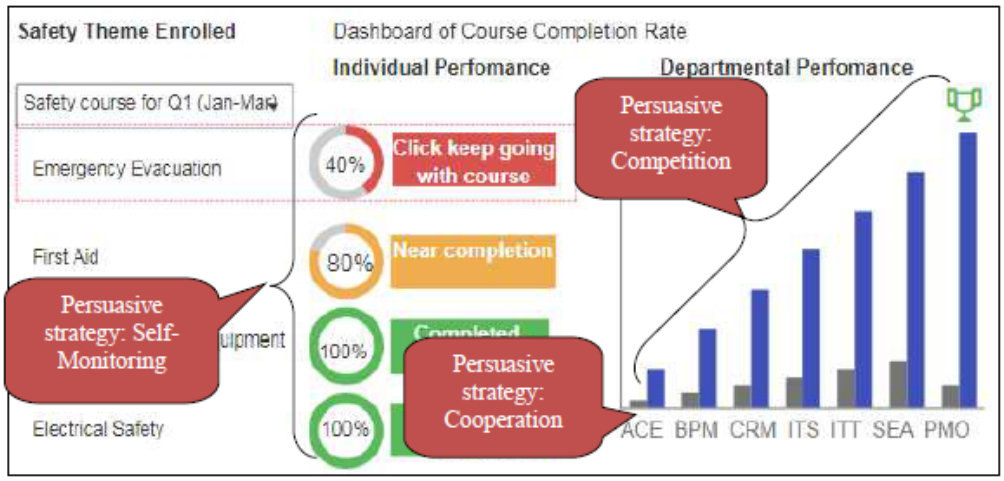

Fig. 3. Prototype screenshot

Fig. 4 depicts the mouse movement heat-map, which is useful because movement heat-maps correlate to eye gaze demonstrating a participant's eye concentration over a specific area during usage [22]. The results indicate red-spots on the "emergency evacuation course" area, annotated as areas of interest with numbers 1 and 2 in dotted lines. The red-spots denote the most intense fixation, yellow more moderate fixations, and green the least intense fixations [23]. The blue-spots indicate that the area was noticed. The results indicate that a large part of the page was read; of particular interest were area number 3, the self-monitoring strategy, and area number 4 which provides the "Departmental Scoreboard".

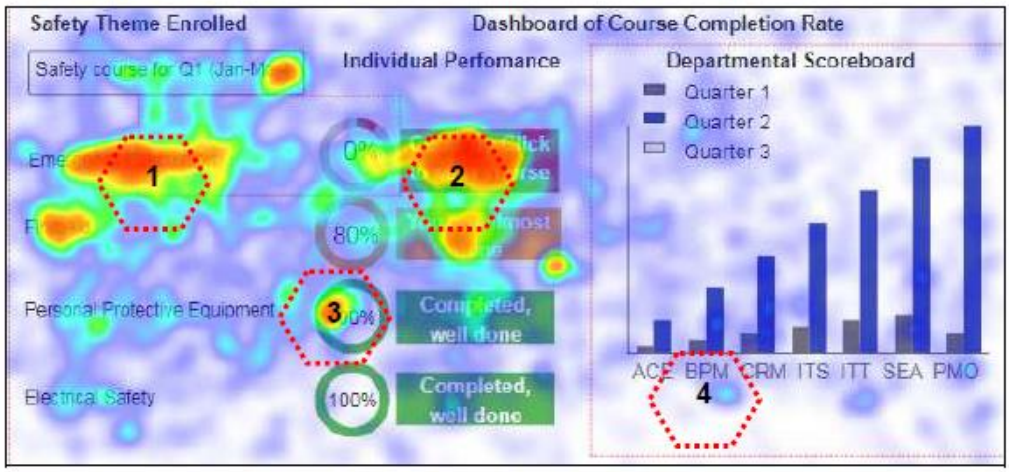

Fig. 4. Mouse movement heat-maps

VI. DISCUSSION AND CONCLUSION

The paper presents the outcomes of the study, and the results assisted the researcher in responding to the research question, namely "*What are the design guidelines constructs on the literature-based set of persuasive strategies and UX attributes required for improving the users' motivation for using e-learning platform for autonomous learning?*"

Based on the outcome of the focus group held with the SME, the constructs in Table 1 were validated and used as 10 design guidelines in the development of a working prototype for improving user motivation in autonomous learning. The prototype was developed and the usage thereof by end-users was evaluated and the mouse movements were captured as heat-maps. The results indicated the end-users completed the digital learning task successfully with no significant user interaction problems. Without claiming that the constructs are sufficient or complete, we suggest this set of constructs as a useful basis for improving the users' motivation in autonomous learning on digital platforms. Based on the results from the study, the validated constructs (nine from literature and one from our results as presented in Table 1) can be used in evaluating prototypes for improving the users' motivation in autonomous learning on digital platforms and presented as the following guidelines:

1. The interaction design should support competition
2. The interaction design should support cooperation.
3. The interaction design should support self-monitoring
4. The system should be effective in supporting learning.
5. The system should be efficient in supporting learning.
6. The users should be satisfied with their interaction experience.
7. The interaction design should support attention.

8. The learning support should be relevant to the instructional requirements.
9. The interaction design should support confidence.
10. The interaction design should support flexibility.

Future work is required for evaluating the in-depth analysis of post-usage data on the prototype and replicate the study in other corporate organizations to validate the guidelines.

ACKNOWLEDGEMENTS

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APPENDIX M: BEST RUNNER-UP CONFERENCE PAPER

DUT

INFORMATION COMMUNICATION TECHNOLOGY & SOCIETY

THE ICTAS 2022 CONFERENCE COMMITTEE HEREBY CERTIFIES THAT

JACOB THABO MONGADI, PROF JUDY VAN BILJON AND RONELL VAN DER MERWE

are awarded

The Runner-up to Best Conference Paper

Paper Title:

Persuasive technology and user experience design guidelines to motivate users for autonomous learning on a digital learning platform in the context of a corporate environment in South Africa

Criteria for award: Relevance to ICTAS themes, originality of the work, currency of the work and quality of the presentation.

March 2022

Presented by

Richard L Millham

Prof Richard Millham
ICTAS 2022 Conference Chair

DUT

INFORMATION COMMUNICATION TECHNOLOGY & SOCIETY CONFERENCE MARCH 2022