A FRAMEWORK FOR AD HOC MOBILE TECHNOLOGY-ENHANCED LEARNING IN A HIGHER EDUCATION CONTEXT

by

Patricia-Ann Harpur

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Supervisor: Professor Johannes C. Cronjé

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Declaration

I, **Patricia-Ann Harpur,** declare that the contents of this thesis represents my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

10 November 2018

Signed **Date**

Abstract

Although the use of mobile technology features prominently in all walks of life, learning and teaching supported by its ad hoc use in higher education contexts is an under-researched topic. Moreover, elements constituting best practices for quality improvement and aimed at informing decision-making stakeholders, are spread across disparate frameworks, reported in literature.

The study aimed to meet the following objectives:

- O1: To identify the elements that inform strategic decisions for ad hoc mobile technology-enhanced learning.
- O2: To inform the structure of the framework, defined by its constituent components.

These objectives were associated with two main research questions, addressed via five secondary research questions that guided the exploration of elements associated with the ad hoc use of mobile technology-enhanced learning in a specific higher education environment. The study consequently proposed a consolidated and synthesised set of theoretically based and empirically determined elements, leading to a framework of interrelated guidelines.

A moderate constructionist approach adapted from Järvensivu and Törnroos (2010) underpins the dual-purpose research design. At first, a systematic literature review explored existing frameworks applicable to e-learning, m-learning, technology-enhanced learning and blended-learning modalities. The review was subsequently expanded to include additional sources that addressed diverse aspects of mobile technology-enhanced learning. I undertook an extensive qualitative data analysis of the 55 articles resulting from the systematic literature review. Analysis techniques incorporated open, axial and selective coding, memoing, thematic analysis and the construction of network maps using ATLAS.ti V8.0, a CAQDAS tool. Outcomes of the analysis established an initial set of theoretically grounded elements, comprising a hierarchy of 11 constructs, five categories, 16 sub-categories and 60 items. Network maps demonstrated the interlinking of elements for each of the five categories titled: A. Enablement, B. Environment, C. Interactivity, D. Dynamics and E. Mobility. A final network map consolidated these individual maps, presenting the foundations for a framework for the ad hoc use of mobile technology-enhanced learning in higher education contexts.

The theoretically based elements established foundations for the empirical portion of the study – a single exploratory case study defined by an architectural technology domain. The case study supported the inclusion of multiple perspectives and complex, natural contexts where mobile technology usage by stakeholders was the focus of the study. Empirical data was collected during six studies from purposively selected faculty respondents. Qualitative data analysis of collected data yielded additional empirically determined elements, namely: eight constructs, eight sub-categories and 35 items. These empirically determined elements augmented findings of the systematic literature review. Additional categories did not emerge; however support for theoretically based elements was demonstrated via network maps.

The thesis contributed methodologically, substantively and scientifically to the body of knowledge. Methodologically, it assembled guidelines from diverse disciplines to produce systematic literature reviews, extending the application of the methodology to incorporate technology-enhanced studies using mobile technologies. The thesis offered substantive and categorised guidelines for all institutional decision makers – strategic, tactical and operational, regarding best practices for the ad hoc use of mobile technology. Finally, the scientific contribution of the thesis vested in the assemblage and juxtapositioning of theoretically based and empirically determined elements. These elements contributed to the concretisation of a single yet multi-purpose framework, synthesised from disparate literature sources.

Recommendations suggest higher education stakeholders should address needs for quality improvement, orient their decisions towards benefits associated with mobile productivity, address digital differences, provide support for informed leadership, integrate constantly changing social technologies, harness the valued attributes of champions and explore mobile personal learning environments.

The study was limited by its small sample size, where the collection of empirical data was characterised by an inability to observe directly the personal use of mobile technology in natural contexts. Qualitative data was collected in one case study context within a large population of faculties, departments and domains. This approach precluded generalisation.

The thesis highlighted the following foci, deemed to be of notable interest and worthy of future research: the potential role of social technologies, mobile differences and divides of stakeholders; productivity associated with mobile personal learning environments; influential habits and behaviour patterns of on-the-move champions; the evolution of mobile usage patterns in higher education environments over time; and the nature of mobile technology-enhanced learning in private compared with public higher education institutions.

Keywords: Best practices, Case study research, Change management, Cloud-based facilities, Digital differences and divides, Evolutionary mobile usage habits, Mobile champions, Mobile personal learning environments, mobile technology-enhanced learning, Qualitative data analysis, Social learning and technologies, Systematic literature review.

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- Michael Bernard Schrönen – for challenging me and setting the bar high.

Dedication

Dear Little Oscar Doveston, Granny's Boy, this one is for you. I am sorry for all the time I spent behind my laptop during your first seven planet years. I missed you every day.

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Terminology

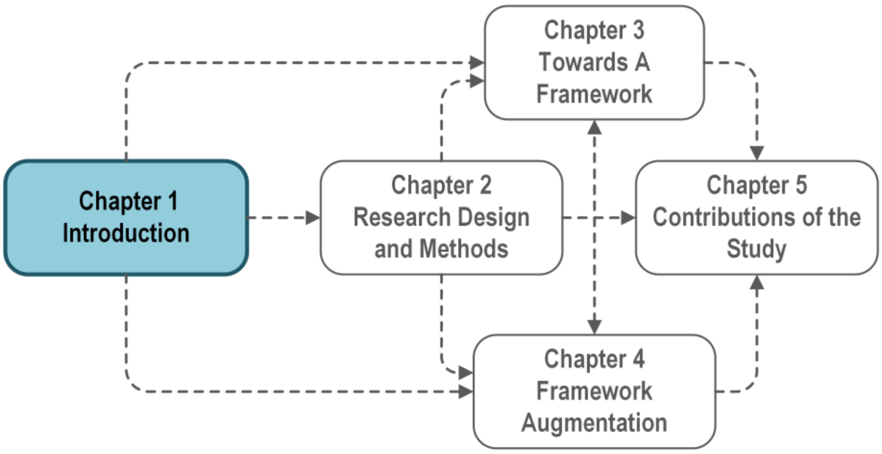
Term	Notation
AS	Additional source
BL	Blended learning
BYOD	Bring your own device
CAQDAS	Computer-Assisted Qualitative Data AnalysiS software
CCN	Construction Communication Network
DE	Domain expert
EL, e-learning	Electronic learning
FA	Faculty academic
FH	Faculty head
FW	Framework source
HEI	Higher education institution
ICT	Information and communication technologies
ID	Index
IR	Institutional repository
IS	Information systems
ISO	International Organization for Standardization
LM	Learning modality
LMS	Learning-management system
ML, m-learning	Mobile learning
MPLE	Mobile personal learning environment
MQ	Main question
MTEL	Mobile technology-enhanced learning
OA	OpenArchitecture
PC	Personal computer
PDA	Personal digital assistant
PDF	Portable document format
PLE	Personal learning environment
PMD	Personal mobile device
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QAC	Quality assessment criteria
SACAP	South African Council for the Architectural Profession
SAIA	South African Institute of Architects
SLR	Systematic literature review
SNS	Social networking software

Term	Notation
SQ	Secondary question
TEL	Technology-enhanced learning
URL	Universal resource locator
UX	User experience
VLE	Virtual learning environment

A term and its notation may be used interchangeably throughout the thesis.

Chapter 1 Introduction

There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy
William Shakespeare: Hamlet, Act 1, Scene 5



This thesis explores the informal use of mobile technology capable of scaffolding teaching and learning in higher education contexts. In this chapter, I delineate an identified, real-world problem emanating from first-hand experience of the influence of mobile technology in all spheres of life. The problem statement determines the purpose, objectives and research questions of the thesis. Then, I establish the architectural technology context of the study. The chapter briefly outlines the research strategy adopted for the study. I briefly review enabling requirements, complex environmental considerations, stakeholder interactivity and the dynamics of teaching and learning in a mobile-centric world. This initial literature review grounds the study and validates the posed research questions. Finally, Chapter 1 highlights strategic, tactical and operational guidelines for higher education stakeholders, demonstrating the significance of best practices and the value of maintained quality assurance decisions.

There is a growing body of knowledge concerning mobility. The student's universe is mobile (Traxler, 2010a) and is described as "a fragmented and rapidly changing picture" (Traxler, 2010b:17). The student rather than technology is regarded as ubiquitously mobile, being situated in ever-shifting contexts of use (El-Hussein & Cronjé, 2010).

Use of mobile technology to enhance teaching and learning occurs "across different settings" (Pimmer, 2016:2). Unplanned and ad hoc personal learning environments (PLEs) have evolved where "the mobile device has transformed the … ways in which students interact with their surroundings" (Aladjem & Nachmias, 2014:167). Lecturers and students select and use "… all the different tools we use in our everyday life for learning …" (Attwell, 2007:4) incidentally, idiosyncratically and anecdotally. Usage spaces are viewed as personal, mediated by mobile technologies yet related to lifelong learning (Ramos et al., 2014).

This study focuses on ad hoc mobile technology-enhanced learning that comprises technology-enhanced learning (TEL), facilitated by the ad hoc use of mobile devices and technologies. In addition, ad hoc mobile technology-enhanced learning encompasses attributes of e-learning, m-learning and blended learning. Furthermore, the ad hoc mobile technology-enhanced learning phenomenon is explored in a natural context of use rather than as part of a formalised teaching and learning modality.

1.1 Problem statement

My first-hand involvement in a formal, tablet-based initiative highlighted several issues associated with the advent of mobile technology and its influence on higher education contexts. Based on personal perceptions and informed by my participation within a relatively unsuccessful and haphazard implementation in a higher education context, I was inspired to undertake my current research work, exploring a different South African public university context.

I questioned choices of institutional decision-makers who should have enabled the process but who hampered it instead. Experienced issues included a lack of effective planning and integration mechanisms, the adverse impact of tablet technology on teaching and learning and subsequent chaotic fixes resulting from a lack of best practice guidelines.

I became aware of contextual factors that seemed to have ignored the need to proactively address negativity and resistance to adoption of emerging educational technologies among educators and students. Whereas students demonstrated a keenness to communicate and collaborate using social media, many stakeholders resisted acknowledging this user experience evidence. However, students who responded positively to the potential of access to social media were disgruntled and disappointed when institutional policy-makers throttled access to many social platforms such as Facebook and LinkedIn.

Education in a mobile milieu is dynamic – evolving and differentiating rapidly. The speed of adjustment exacerbated a digital divide based on digital skills rather than determined by poverty levels. This observation underlined the call by many publications to heed the call for dynamic educational processes. Finally, students in an emerging and mobile world demanded instant responses, called out for digital resources rather than books presented as scanned images. They cried out for on-campus power sources, subsidized data and Internet access which guaranteed fast and friendly response times. In addition, adequate power supply and wireless facilities had been overlooked, leading to unusable devices and non-available connectivity. These personal observations inspired and link directly to the five secondary research questions posed in Section 1.2.2, Table 1.1.

In summary, these real-world experiences pinpointed the need for a consolidated set of guidelines, supporting quality-oriented higher education experiences, enabling the satisfactory and informal use of mobile technology. Issues manifested on three levels: inappropriate institutional decision making; academic shortcomings regarding content design and context delivery; emergent digital divides and differences and technological shortcomings of the established infrastructure.

1.2 Research purpose, objectives and questions, and rationale

This section defines the purpose of the study, introduces the research objectives and questions and explains the rationale for the study.

1.2.1 Research purpose

The study comprised a dual-purpose strategy (Robson & Mccartan, 2016). Firstly, it described theoretically based elements for mobile technology-enhanced learning, gathered from existing literature sources during a systematic literature review. The outcomes of this review are the focus of Chapter 3. Secondly, the findings of the systematic literature review underpin the design of an exploratory case study defined by a higher education context. The subsequent empirically determined findings, reported in Chapter 4, served to support and augment theoretical outcomes.

Both theoretically based and empirically determined components aimed to inform considerations for on-the-move and *ad hoc* use of mobile technology by higher education stakeholders. The juxtaposition and interrelationship of theoretically based and empirically determined components delineate the purpose of the study.

1.2.2 Research objectives and questions

In this study, I sought to achieve two objectives. The first objective concerns the identification of elements that inform strategic decisions governing the ad hoc use of mobile technology in a higher education context. The second objective determines the structure of a framework that defines relationships between the identified elements. To meet these objectives, I designed two main and five secondary research questions. The first main question is associated with the first objective. Similarly, the second main question links to the second objective. Five secondary questions support the answering of the main questions and hence the achievement of the objectives of the study. The secondary questions are validated by literature sources in Sections 1.5.1 to 1.5.5.

Table 1.1 aligns research objectives (O1 and O2) with the two tentative main questions (MQ1 and MQ2). Outcomes of secondary research questions (SQ1.1 to SQ1.5) address the first main question and provide support for the second main question. The final column maps objectives and research questions to chapter sections, providing links to supportive content.

Table 1.1: Mapping research objectives and questions, relative to chapter sections

Research objectives, main and secondary questions	Chapter sections
O1: To identify the elements that inform strategic decisions for ad hoc mobile technology-enhanced learning **MQ1:** What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?	3.8.1, 4.9.1, 5.4.1
SQ1.1: What elements inform institutional decision making?	3.3.1 – 3.3.4, 4.4.1 – 4.4.6, 5.3.1
SQ1.2: What elements reflect contextual influences?	3.4.1 – 3.4.4, 4.5.1 – 4.5.5, 5.3.2
SQ1.3: What is the nature of relationships mediated by social technology?	3.5.1 – 3.5.4, 4.6.1 – 4.6.5, 5.3.3
SQ1.4: What are the implications of teaching and learning in a mobile milieu?	3.6.1 – 3.6.4, 4.7.1 – 4.7.6, 5.3.4
SQ1.5: What aspects emanate from being mobile?	3.7.1 – 3.7.5, 4.8.1 – 4.8.7, 5.3.5
O2: To inform the structure of the framework, defined by its constituent components **MQ2:** How are the elements, identified in MQ1, related?	3.8.2, 4.9.2, 5.4.2

1.2.3 The rationale for the study

The study was undertaken for both theoretical and pragmatic reasons.

Theoretical rationale

A preliminary scan of literature sources in search of a set of guidelines for successful and ad hoc use of mobile technology to enhance teaching and learning was conducted. It highlighted several disparate frameworks addressing technological puzzles experienced in higher education contexts. In addition to the diverse nature of their foci, I observed gaps in theoretically based frameworks.

This study addresses these gaps and heeds the call by Oldfield and Herrington (2012:724), who comment: "investigating new technologies in education contexts is frequently conducted a-theoretically, resulting in a focus on the technology itself, rather than as a pedagogical support". Park (2014:31) suggests "the most serious issue faced by mLearning is the lack of a solid theoretical framework that can guide effective instructional design and evaluate the quality of programmes that rely significantly on mobile technologies". In addition, the study extends the research undertaken by Marshall and Mitchell (2002) and Marshall (2006) who propose a process-centric model guiding capability and maturity of e-learning initiatives.

Finally, a paucity of literature that specifically proposes guidelines for the ad hoc use of mobile technology used to improve quality-oriented teaching and learning experiences was noted.

Pragmatic rationale

The study lends support to educational stakeholders – institutional leaders, administrators, academics, lecturers and students – in their professional and personal quests to appreciate the educational challenges and opportunities of their idiosyncratic mobile worlds. The study communicates a consolidated and holistic view, presenting categorised elements that delineate guidelines for the ad hoc use of mobile technology. It informs proactive rather than reactive strategies that are effectively planned and organised rather than chaotic mechanisms evolving in response to crisis management.

A structured set of elements has the potential to scaffold requirements for quality evaluation, address mobile capability and maturity levels of the institution and its faculties and departments, and boost readiness for teaching and learning by the integration of mobile technology. A synthesised set of components may contribute value as a multi-dimensional yet single point of departure for practitioners and policy makers. Its constructs, categories, sub-categories and elements are generic, and thus may be beneficial to different educational contexts – domains, faculties, departments and stakeholders.

Emergent components may be applied in totality or decision makers may selectively implement an assemblage of components, serving several pragmatic purposes. Firstly, the framework aims to support institutional decision making, enabling appropriate strategic infrastructure and policy decisions, with the integration of support for ad hoc mobile technology-enhanced learning. Secondly, the framework establishes awareness of constantly shifting contextual influences that supersede erstwhile preoccupations with acceptance and adoption of educational technology. It also highlights that, contrary to opinions in some academic circles, social technology plays a critical role in information sharing, interconnectivity of stakeholders and interpersonal contact.

Features of mobile personal learning environments are worthy of inclusion into an academic toolbox, albeit in an informal manner, and are indicative of ongoing and dynamic change. Regarding a social media presence, it is of value to provide clear "regulations regarding its use (private life, protecting intellectual property, etc.)" in higher education environments (Holotescu & Grosseck, 2012:173). The capabilities of digital technology are influencing pedagogy and affecting the way students want to learn and lecturers need to teach (Cochrane & Bateman, 2010). While being cognisant of its limitations, pedagogical decisions that integrate the practical affordances of mobile technology could improve the quality of educational experiences. A consolidated perspective of the role mobile technology could play in a mobile world, impinges on perceived efficiency and effectiveness characterised by moving boundaries. Finally, concepts associated with being mobile provoke reflection on guidelines for best practices such as the improvement of digital skills and the reduction of digital differences.

1.3 Research context – a higher education focus

This section situates the study in a higher education faculty. The faculty has a people-centric focus, is inclusive of appropriate digital technologies, prides itself in the support of excellence in teaching and learning, and engenders a culture of trans-disciplinary scholarship and research. It comprises several departments that provide tertiary education programmes: Architectural Technology and Interior Design, Design, Information Technology, Media, and Town and Regional Planning.

An amalgamation of concepts suggests mobility manifests in particular contexts (Hildreth & Boiros, 2013; Garcia-Cabot et al., 2015) where the stakeholders rather than the technology is mobile (Vavoula & Sharples, 2009). A multi-dimensional association of technology, learners, and learning (El-Hussein & Cronjé, 2010) impacts the evolution of mobile knowledge workers, influencing educational expectations and behaviour (Traxler, 2007). Mobile realities include the connectedness of people (Traxler, 2010a), benefits of mobile productivity (Park, 2014) and applicable, rhizomatic, and workable mobile preferences (Cronjé, 2016).

1.3.1 Architectural technology as an ill-defined domain

The concept 'ill-definedness' is viewed by Lynch et al. (2009) in many ways. Problems are characterised by a set of "…concepts, relations, or solution criteria [that] are un- or under-specified, open-textured, or intractable, requiring a solver to frame or recharacterize it. …" demonstrating a "… lack a single strong domain theory uniquely specifying the essential concepts, relationships, and procedures for the domain and providing a means to validate problem solutions or cases …" (p. 258). They refer to architectural problems as being ill-defined as "…no amount of expertise can provide *the* indisputable answer …" (p. 261).

Figure 1.1 illustrates the digital context of an innovative architectural technology programme represented as a virtual design studio. Contrary to traditional design studio contexts, students and lecturers collaborate, do online crits and assessments and deliver practical design artifacts digitally. The process is facilitated via a hub - a bespoke customisation of *Microsoft SharePoint* which supports webinar sessions, conference calling and document sharing. This figure is repeated for convenience later as Figure 2.8 in Section 2.6.1.

Mobile personal learning environments are social and encompass informal, personalised and ad hoc use of mobile technology.

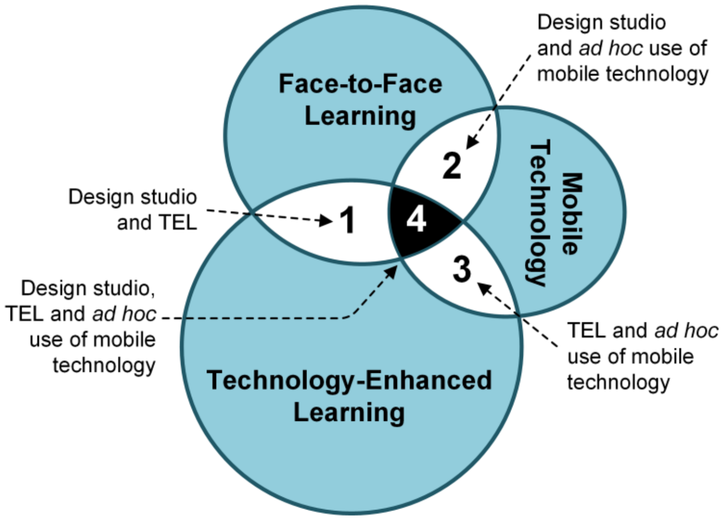


Figure 1.1: Architectural technology in the context of the study

A novel third-year architectural technology programme defines the primary context of the study. The hybrid initiative is offered by the South African Institute of Architects (SAIA), vetted by OpenArchitecture (OpenArchitecture Education, 2014) and delivered by a higher education institution in South Africa. This programme differs from traditional SAIA approved programmes which are design-studio oriented. Distance-learning students are enrolled in the part-time degree model, must be employed in architectural settings prior to being admitted to the programme, and achieve on-the-job practice while assimilating course content (Morkel, 2012). An online blend offers a virtual studio environment which simulates the traditional studio space. Face-to-face block sessions complement online critiques, digital course content, and web-based interactivity such as webinars delivered by lecturers via a customised *Microsoft SharePoint* learning portal. Emerging technologies support off-campus teaching and learning, augmented via *TED-Ed* lessons and *YouTube* videos.

Architectural technology, an ill-defined domain, is characterised by an ongoing personal dialogue, conversations involving fellow students and communication between students and lecturers (Morkel, 2012). Interactivity extends beyond campus confines into the world of work and incorporates digital tools such as Facebook groups and blogs for educational purposes (Ivala & Gachago, 2012; Morkel, 2012). While the build of a model is informed by an architectural brief, evaluation of competence is a difficult mechanism, since assessment is based largely on the application of taught principles rather than the principles in and of themselves. Assessment is determined by the ability to produce drawings, formulate projections, display creativity and apply self-expression (Lynch et al., 2009).

The innovative application of emerging technologies in ill-defined domains such as architectural technology is well documented. Morkel (2012) reports the successful use of Facebook in virtual architecture studios as a facilitating medium that promotes interactivity, communication and architectural conversation. Similarly, Ivala and Gachago (2012) suggest social media have the potential to improve student engagement, calling for lecturer involvement with the integration of new technologies into teaching and learning but acknowledging the role of student stakeholders whose valued participation and voice should be noted.

Table 1.2: Emerging technologies

Emerging technology	Purpose
Blackboard	Institutional LMS
GoToMeeting	Web-based seminars, i.e. webinars
SharePoint	Content delivery and critique submission
Skype	Communication, assessment, feedback
TED-Ed	Customised digital lessons
YouTube	Video enhancement of lessons

Table 1.1 summarises the main emerging educational technologies relevant to the higher education context of the study.

1.3.2 Stakeholders

Key educational stakeholders include institutional decision makers, faculty and departmental managers, designers and developers of instructional resources and delivery mechanisms, responsible lecturers, and enrolled students. Success of digital learning environments is dependent on meeting expectations and satisfying concerns of stakeholders (Wagner et al., 2008). The study incorporates attitudes and opinions of the stakeholders from one faculty, namely, the dean – an executive and strategic faculty leader, a champion of emerging technologies viewed as an expert in the architecture domain, a selection of tactical-level faculty academics, a cohort of part-time architectural technology students and dedicated architectural technology lecturers.

1.3.3 Affordances of mobile technology

Students may benefit from the affordances of mobile Web 2.0 technologies that support "connectivity, mobility, geolocation, social networking, personal podcasting and vodcasting" (Cochrane & Bateman, 2010:2). Lecturers are assured the inclusion of mobile technologies in their teaching regimes remains relevant (Herrington & Herrington, 2007:8). Educational benefits of mobile technologies incorporate the delivery of content irrespective of time and space, instantaneous support for seamless learning in differing environments (Lai et al., 2007:327) and educational engagement via social media, for example, Facebook (Ng'ambi et al., 2016).

The affordances of ubiquitous Internet-enabled mobile devices such as smart phones, laptops, tablets and netbooks encourage the integration of emerging technologies into educational contexts and facilitate digital interactivity (Fischer et al., 2013; Barry et al., 2015). Mobile technologies may extend and augment learning practices (MacCallum & Kinshuk, 2008) and afford mobile lecturers and students opportunities to enhance informal teaching and learning via online platforms that house digital artefacts (Ng, 2015).

1.3.4 Mobile personal learning environments (MPLEs)

Personal learning environments (PLEs) may comprise a set of cloud-based technologies that support holistic learning (Martindale & Dowdy, 2010) and student efforts to collect and share resources (Dabbagh & Kitsantas, 2012). PLEs constitute technology-enhanced learning (TEL) contexts (Rahimi et al., 2015). In addition, they provide a milieu for interactivity, communication and collaboration with a people-centric focus on informal learning. Besides highlighting the student-driven value of social technologies, learning experiences are ongoing and personally motivated (Attwell et al., 2009). The incorporation of specifically designed and developed social media that support educational activities has the potential to improve learning (Kožuh et al., 2015).

A mobile personal learning environment (MPLE) is essentially a PLE that scaffolds learning via mobile devices and applications (García-Peñalvo & Conde, 2015:376). Attwell et al. (2009:10) suggest "the key to the mobile environment is in facilitating the use of context". Additionally, MPLEs are seen as "…new learning scenarios that integrate the PLE approach with mobile technology …" (Ramos et al., 2014:678).

1.3.5 The researcher as a primary data source

I am an IS lecturer in a higher education environment where a formalised tablet technology implementation aimed to enhance teaching and learning. I identify with Rogers' view that "change agents may increase the predictability of the rate of adoption of innovations" (Rogers, 2003, cited in Sahin, 2006:17). Consequently, I prefer to fill the role of champion (Cronjé, 2016), promoting the benefits of mobile technology used for educational purposes among academic colleagues and students.

1.4 Research strategy: design and methods

The dual-perspective approach of this study pragmatically accommodates a theoretically based description of a framework for ad hoc mobile technology-enhanced learning (Chapter 3) augmented by an empirically determined exploration in Chapter 4.

The moderate constructionist strategy of the study summarised as Figure 1.2 was adapted from Järvensivu and Törnroos (2010) and is detailed further in Section 2.3.1 as part of Chapter 2. It demonstrates in Chapter 2 that the study is underpinned firstly by a radical structuralist paradigm where I aim to provide a situated and exact description (Cronjé, 2016). In Chapter 3, a systematic literature review delivers descriptions of the framework gleaned from literature sources, providing secondary theoretical data from which the initial set of framework guidelines emerged during qualitative analysis.

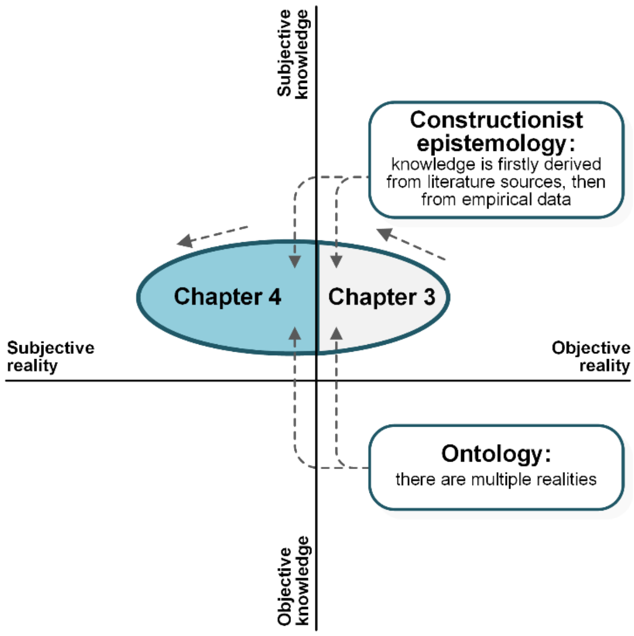


Figure 1.2: Moderate constructionism (adapted from Järvensivu & Törnroos, 2010:102)

Mishra and Koehler (2006:1017) observe "…research in the area of educational technology has often been critiqued for a lack of theoretical grounding …". The design of this study takes cognisance of this comment as it offers an initial theoretical foundation (Chapter 3), later augmented by empirical findings (Chapter 4).

The research methods listed here are detailed in Chapter 2.

1.4.1 Theoretical perspectives – a systematic literature review

A systematic literature review was conducted as it offered the opportunity to provide a rigorous, structured and multi-dimensional artefact that would provide a sound theoretical platform for the study (Moher et al., 2009; Okoli & Schabram, 2010; Alrasheedi et al., 2015; Wong et al., 2015). It comprised journal and peer-reviewed conference papers, books and e-articles published between 2009 and 2016. Chapter 3 outlines the findings of the review.

1.4.2 Empirical perspectives – an exploratory case study

The systematic literature review reported in Section 1.6.1 was supplemented by a cross-sectional empirical data-collection design comprising three focused stages with a total of six separate studies conducted between 2014 and 2015. Chapter 4 reports findings of an exploratory, single-case design with a single unit of analysis, namely the case itself. This chapter adopts a radical humanist perspective where I explore options and possibilities as an anti-positivist explorer (Cronjé, 2016). This approach overcomes the issue highlighted by the 4-quadrant matrix proposed by Roode (1993) who suggests research may not simultaneously involve more than one of the four quadrants of research defined as: Q I to describe, Q II to develop, Q III to interpret and Q IV to explore.

The case study provided the strategy for a 'slice-in-time' platform and opportunity for the gathering of sufficient rich and thick data (Creswell, 2014) to address the research questions of the study. The qualitative research design sought to understand educational phenomena in an architectural technology discipline, mediated socially and informally by emerging mobile technologies. In accordance with a case study strategy, a case study protocol was developed (Yin, 2014) and served to guide the empirical component of the research design.

The study focused neither on communities of practice nor the establishment of a controlled m-learning project, implemented in higher education contexts. Contrarily, the study was conducted in a natural context of use and aligns with the view of Dahlbom and Mathiassen (1993:225) who advise the approach will:

> …help us understand the complex interplay of people, methods and technology, and the important role of interpretation, personal interests, and values involved in the use of these techniques…

For the purposes of this study, a combination of views outlined the concept 'case study' as a multi-method approach to data collection (Robson & McCartan, 2016) delineating the empirical aspect of the thesis. It provided an opportunity to explore the ad hoc use of mobile technologies in a specific higher education context (Yin, 2014), characterised as a complex and contemporary phenomenon (Runeson & Höst, 2009) with shifting and indistinct boundaries. A small and focused group of higher education stakeholders drawn from a single faculty in a natural context of use (Benbasat et al., 1987) constituted a non-probabilistic sample of convenience (Oates, 2006).

Empirical data was collected during interviews and from the administration of customised questionnaires among a group of stakeholders, including the following:

- Faculty head – the dean responsible for departments constituting the faculty;
- Faculty academics – a select group of departmental educators;
- Domain expert – a senior academic with expertise in both architecture education and emerging technologies domains;
- Architecture lecturers – all academics responsible for a part-time, distance-learning programme delivered as a blended-learning model; and
- Architecture students – an entire cohort of enrolees in the part-time architectural technology programme.

The questionnaire instruments comprised Likert-type, matrix-like and open-ended questions. Qualitative analysis via ATLAS.ti V8.0 of literature sources and empirically determined feedback led to a theoretically based codebook.

Table 1.3 illustrates the multi-method data-collection approach designed for the study, encompassing purposefully selected data sources.

Table 1.3: Summary of the research design

Phase	Study and method	Focus
1: Preamble	1.1: Domain expert – unstructured interview	Rapport
	1.2: Institutional repository – document analysis	Context
	1.3: Faculty academics – questionnaire surveys	Exploration
2: Cohort	2.1: Architecture students – questionnaire surveys	Collection
3: Faculty	3.1: Architecture lecturers – questionnaire surveys	Investigation
	3.2: Faculty head – semi-structured interview	Enrichment

The research strategy was conducted in a natural context of use, resonating with Wright and Parchoma (2011:255-256) who recommend:

> …studying mobile learning in authentic, situated practice rather than in settings and with technologies selected and controlled by the researcher … rather than seeking to set up and control for the device, situations and practices and connect them via 'affordances'.

Methodological issues associated with case study research include quality and trustworthiness (Lincoln & Guba, 1985), rigour (Yin, 2014), and unwieldy volumes of data and implementation difficulties (Robson & McCartan, 2016). To counter these issues, the strategy incorporated triangulation (Cohen et al., 2007), ensured rich and thick descriptions, demonstrated reflexivity (Creswell, 2014) and crystallisation (Ellingson, 2009). The synthesis of emergent themes emphasised resonance in preference to statistical generalisation (Lincoln & Guba, 2002). M-learning interventions were not implemented. Rather, the study explored a natural context of use of mobile technology.

1.4.3 Data collection

Besides the systematic literature review undertaken to collect secondary data, the research design incorporated multiple data-collection methods such as interviews with faculty stakeholders, document analysis and questionnaire surveys. These empirical methods aimed to gather rich and thick primary data in digital format (Oates, 2006:37).

Custom-designed questionnaires were administered digitally among academics, lecturers and students. Questionnaire content comprised six logically structured sections of questions determined by preliminary and systematic literature reviews (Cohen et al., 2007). Sections included: 1 Context, 2 Usage, 3 Experiences, 4 Expectations, 5 Networks, 6 Technology and Education. Instruments comprised demographic, Likert-type and matrix-like questions and open-ended questions. Anonymity, confidentiality and the right to withdraw at any time was guaranteed (Oates, 2006). Ethical consent granted permission to collect data, assuring institutional ethical clearance prerequisites were met.

A non-probabilistic and purposive sample of convenience incorporated the faculty head, faculty academics, a domain expert, a cohort of part-time architecture students and all architecture lecturers associated with the programme. Suppliers of the customised institutional learning portal, administrators and employers of student respondents were excluded.

Direct interface with unavailable lecturers and geographically dispersed, distance-learning students was infeasible. Furthermore, students attending occasional campus-based, block sessions were not personally contactable. Additionally, in accordance with ethical clearance conditions, links to online questionnaires were distributed by the domain expert. These logistical complexities obviated data collection by interview.

In accordance with Lincoln and Guba (1985), qualitative research may incorporate quantitative methods such as survey questionnaires classically allocated to quantitative studies. It was thus deemed expedient to collect data digitally via customised, Internet-based questionnaires, designed to emulate semi-structured interviews. Analysis of digital documents stored in an institutional repository[1] provided opportunities for familiarisation with the architectural technology programme.

1.4.4 Researcher as a primary data source

Malterud (2001:483-484) indicates:

> A researcher's background and position will affect what they choose to investigate, the angle of investigation, the methods judged most adequate for this purpose, the findings considered most appropriate, and the framing and communication of conclusions.

The researcher's voice and presence have the potential to influence research design and methods, analysis techniques, reported findings, and proposal of emergent themes. In the qualitative study, I contributed to the study as a primary data source. For these reasons, bias is possible owing to subjective involvement. Each chapter closes with a section titled 'crystallisation' that serves as a reflection space.

1.4.5 Analysis and interpretation of results

Recorded and transcribed interview conversations provided snippets in readiness for qualitative data analysis. Questionnaire data was collected digitally, downloaded in Microsoft Excel format and anonymised to maintain confidentiality. Qualitative data from interviews and questionnaire sources was cleaned and open-coded in readiness for analysis using ATLAS.ti V8.0. Data was retained in Google Drive folders and files enabling thematic analysis, basic descriptive statistics and chart preparation.

1.4.6 Trustworthiness

Steps to ensure trustworthiness (Lincoln & Guba, 1985) are informed by the inclusion of techniques, described in Chapter 2, to improve credibility (Section 2.8.1), transferability (Section 2.8.2), dependability (Section 2.8.3)

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[1] http://digitalknowledge.cput.ac.za/xmlui/handle/11189/3090

and confirmability (Section 2.8.4). Applied techniques such as triangulation, member-checking, thick descriptions, an external audit, reflection and crystallisation contributed to trustworthiness.

1.4.7 Ethical considerations

Requisite institutional ethical clearance permitted data collection while ethical consent documentation administered among respondents assured anonymity, confidentiality, and the right to withdraw.

1.5 Ad hoc mobile technology-enhanced learning

Mobile technology-enhanced learning is viewed simplistically as technology-enhanced learning that is supported by mobile technology defined in various ways as: personal mobile devices and applications where mobile devices include either desktop or handheld devices such as laptops, personal digital assistants (PDAs) and mobile phones (Sung et al., 2016), institutionally supplied mobile equipment, for example, MacBook Pro laptops and iPads, and applications (Farah et al., 2016) and bring-your-own-device (BYOD) initiatives (Flavin, 2016). M-learning may be viewed as a formalised set of processes which are basically e-learning mechanisms which use mobile devices and technologies by on-the-move users. However, in this study the term '*ad hoc*' refers to casual and informal use of an array of mobile devices and technologies. Users demonstrate personal preferences, diverse practices and idiosyncratic usage patterns. Usage patterns are characterised as convenient, immediate, impromptu, makeshift and expedient.

Theoretically based elements that facilitate informed and multi-perspective decision making would leverage the ways students use mobile technology, providing lecturers with useful insight, and facilitating alignment of mobile strategies. This study aligns with the views of Wright and Parchoma (2011:256) who draw attention to a techno-centric approach to the use of mobile devices in education. They suggest:

> … studies of people who have chosen to use mobile devices in their learning and practice are not in evidence in the literature to date, despite the calls for just such a focus. Instead it is dominated by the top-down imposition of technologies, locales and tools to complete pre-defined tasks….

Sections 1.5.1 to 1.5.5 establish a solid conceptual foundation for the study.

1.5.1 Enablement – institutional decision making

Enablement encapsulates the concepts 'design and development', 'implementation', 'inclusiveness', and 'strategy'.

Design and development

Farah et al. address m-learning design and development. They propose a predictive model that recognises relationships between "technological facilities … pedagogy … curriculum and learning" (Farah et al., 2016:1205). Their study demonstrates "the integration of mobile technology into the learning environment has a positive effect on the learning outcome".

Implementation

Success factors for quality-oriented stakeholder experiences for e-learning (Inglis, 2005) and technology-enhanced learning (Mhlanga et al., 2013) depend on up-to-date implementation decisions (Bennett et al., 2012; Khaddage et al., 2015).

In a higher education context in the UK, Walker et al. (2016:438) comment:

> While the drivers for technology-enhanced learning development have consistently focused on enhancing teaching and learning over the years, the subject of this investment has been directed to the implementation of enterprise-wide systems to manage and control learning processes, delivering efficiencies of scale and standardised learning experiences through centrally managed solutions, rather than support for student-controlled tools.

However, this study does not undertake any form of implementation. Rather it seeks to provide guidelines worth considering *prior to* any implementations, suggesting elements that constitute part of planning steps and that may aid the implementation process.

Inclusiveness

Educational stakeholders need to be seamlessly mobile and are required to be adaptable and versatile with device- and context-independent capability of being on the move. Seamlessness is inclusive of social communication, demonstrates the importance of design of learning tasks, implies timely support requirements, depends on effective inspiration and calls for active involvement (Lan & Lin, 2016). According to Chiang et al. (2016:10), current mobile trends cover seamless learning support, "multipresentation", improved learner diversity and awareness of need for context-aware requirements. They advocate cloud-based platforms as a mechanism for students to access learning resources.

While Kaganer et al. (2013) recognise that organisations need a long-term roadmap, Andersen et al. (2013) call for additional research into a best practices approach, integration requirements and models developed by lecturers. In addition, they propose institutions should formulate a specific implementation plan, providing for the integration of mobile technology into curricula, incorporating a student-centred approach that investigates the influence of acceptance by lecturers. If this approach is not adopted, efforts to introduce educational technology such as 'flipping the classroom', might fail and be discontinued.

Strategy

A review by Schmidt and Ho (2013:966) recognises "…complexities, potential roadblocks, and constraints…" associated with large and strategic deployments of educational technology.

Researchers highlight the significance of integrating traditional pedagogy and student-centred, digital education (Mayisela, 2013; Oh & Reeves, 2014) into ad hoc mobile technology-enhanced learning initiatives. Studies suggest institutional strategy should be underpinned by established m-learning design and development principles (Laurillard, 2007; Harpur & De Villiers, 2014), aimed at effective change and focused improvement. Benchmarks for the evaluation of technology-enhanced learning environments should be based on sound theoretical foundations (Tedre et al., 2011) and inform strategic institutional decisions, targeting capability and maturity levels (Marshall, 2010).

With reference to emergent and inclusive learning technologies, Lytras et al. (2014:1404) call for further research into institutional strategy, in the light of the "limited adoption of the proposed methodologies, designs and infrastructures from the 'relevant markets', for example academic institutions, universities … it is obvious that there is a key performance gap, derived from the absence of fast response of academic organisations to this 'thrilling revolution' of social networks". They pinpoint inflexibility and traditional and change-resistant approaches to curriculum design and recognise change as the propensity of students to use their mobile devices for all activities.

Academic strategies should consider deep, student-focused learning that is relevant, flexible and occurs anywhere and at any time, such as in face-to-face and in industry situations (Samaka & Ally, 2016).

Literature reviewed in this section indicates the topic's design and development of the topic, inclusiveness and strategy are worthy of research, supporting the inclusion of the secondary research question, *SQ1.1: What elements inform institutional decision making?*

1.5.2 Environment – contextual influences

Context is constantly changing (Traxler, 2010a) and mobile reality implies connectedness of people irrespective of time, place or experience. Mobile pedagogy must continually adapt to change in a complex and challenging environment owing to authentic, situated learning occurring in particular contexts (Koole, 2009; Oldfield &

Herrington, 2012). These observations suggest ad hoc mobile technology-enhanced learning is complex, requiring awareness of the critical success factors necessary for effective outcomes.

Factors such as adoption, impact, innovation and personal learning environments impinge on teaching and learning environments.

Adoption

This study extends the blended-learning research of Graham et al. (2013) who contend the potential value of mobile technology used for educational purposes depends on the adoption of mobile ICT by a spectrum of stakeholders. Alrasheedi and Capretz (2015) emphasise institutional support as a key ingredient for motivation of acceptance by all stakeholders of mobile learning. Personal mobile devices (PMDs) are used in both working worlds and campus spaces. Trede et al. (2016:250) indicate that adoption of mobile technology in working worlds varies and that "perceptions of the value of PMDs range from strong advocacy to resistance … to ban in some workplaces …". This observation is significant to the working worlds of institutional educational stakeholders whether they are on campus or on the move.

Impact

Hwang and Wu (2014:92) refer to the success of mobile technology-enhanced learning, mentioning a range of classroom limitations. They add:

> It is also important to investigate the factors that might affect students' mobile learning performance, such as the lack of self-regulation in using mobile devices, the attraction of gaming or social network software and improper learning design…

Sung et al. call for further, in-depth research into how teachers reconcile mobile hardware and software, lesson content, teaching methods, and educational goals. The impact of three foci are identified as: "leveraging the pedagogical effects of mobile devices", "enhancing the quality of the experimental design for mobile intervention", and "empowering educational practitioners through orchestration of mobile devices, software, and pedagogical design" (Sung et al., 2016:265-266).

Innovation

Innovative technology-enhanced learning implemented in higher education spaces may be disruptive. Students are linked to concept 'demarcation' where they use "different technologies to support their learning lives and their social lives" (Flavin, 2016:632). This observation presents design challenges, with the implementation of emerging technologies and practices such as Bring-Your-Own-Device (BYOD).

Personal learning environments (PLEs)

Academics and students personalise their devices and technologies for myriads of purposes. Mobile devices and applications pervade all aspects of educational life, influencing the way lecturers like to teach and students want to learn. Yet, in many academic circles, powerful mobile capabilities materialise mostly in an ad hoc, 'whichever-way-you-like' fashion rather than in response to an effective and formal m-learning strategy.

While one study of personal learning environments offers guidelines for the personalisation of technology-enhanced learning (FitzGerald et al., 2017, in press), another explores linkages between institutional learning-management systems and mobile personal learning environments (García-Peñalvo & Conde, 2015). García-Peñalvo and Conde suggest research should "…consider different contexts away from the world of the university, with people with less knowledge about the use of mobiles, in different countries, and to apply other … qualitative techniques" (2015:385). This comment supports the natural context of use associated with this qualitative research study.

The review of literature in this section reflects the value of the inclusion of the following secondary research question: *SQ1.2: What elements reflect contextual influences?*

1.5.3 Interactivity – social technologies

In this study, the concept 'interactivity' indicates technology-enhanced learning is mediated by social media and extended by mobile technology providing web-based opportunities for lecturers and students to interact and share information. Perspectives discussed in this section comprise collaboration, learning portal and social networking (Tedre et al., 2011; Lai et al., 2013; Cochrane et al., 2015; Harpur & De Villiers, 2015b).

Collaboration

The concept 'collaboration' encompasses impact, attitudes, engagement, and learning. Heflin et al. (2017:91) comment that "collaborative learning environments" manifest differences, adding that mobile technology is ascribed blame for student disengagement during classes.

Learning portal

Learning portals should be seamlessly integrated, improving interactivity and the quality of teaching and learning. They function as platforms – virtual learning environments that support the delivery of course content for technology-enhanced learning (McGill et al., 2014) and are used especially for distance education. They should support the quest of students to pursue their own personal learning avenues (Wild et al., 2013).

Institutional virtual learning environments must be suited to and compatible with mobile devices and apps (Kukulska-Hulme, 2012).

Social networking

Kivunja (2015:23) advises "… much further research is needed to shed more light on the potential of social media technologies to support pedagogical practice…".

Sugimoto et al. indicate that both informal and formal activities occur during online interactivity. There is a merging of personal and professional images contributing to challenges associated with social networking (Sugimoto et al., 2015:1).

They comment:

> "Despite the prevalence of Facebook in contemporary society and the predominance of this platform in academia and adoption by both students and faculty, very little is known about how (or even whether) students and faculty informally interact in this space" (Sugimoto et al., 2015:1).

The educational use of Facebook incorporates the "…formal use in formal learning settings … informal use in formal learning settings … and use in informal learning settings…" (Manca & Ranieri, 2016:503). From this perspective, Facebook is defined as a technology-enhanced learning environment. Manca and Ranieri pinpoint three affordances of Facebook: "mixing information and learning resources, hybridisation of expertise, and widening context of learning".

Kitsantas et al. (2016:237) comment: "future research should strive to keep up with students' social networking use [such] as the adoption of new platforms (e.g. Snapchat) and new generation learning environments (e.g., Personal Learning Environments or PLEs)". This research may provide insight into student use and perception of social networking capabilities. Additional research into the effectiveness of social tools as interactive and support mechanisms is required, exploring device and social media usage patterns of university students (Gikas & Grant, 2013).

The literature in this section reinforces the relevance of the following secondary research question: *SQ1.3: What is the nature of relationships mediated by social technology?*

1.5.4 Dynamics – education in a mobile milieu

In general, m-learning may be viewed as ubiquitous e-learning that is achieved via some, non-specified form of handheld digital device, such as a smartphones, tablet devices, ultrabooks, laptops or even a smart wearable devices by an on-the-move learner. This thesis suggests m-learning incorporates and goes beyond traditional e-learning to include the affordances of technology-enhanced learning.

Technology-enhanced learning is challenged by dynamic educational patterns and processes in response to evolutionary changes invoked by digital trends. Whereas literature sources define m-learning as a distinct concept, characterized as: spontaneous; situated; informal; and context-aware (Traxler, 2005). Traxler hinted at a shifting digital learning vista, suggesting that m-learning would come to infer attributes, such as connected and interactive, personalised learning. For the purpose of this study, it is not necessary to synthesize detailed definitions of technology-enhanced learning, e-learning or m-learning as the premise of the study was to review existing models and frameworks and to synthesise an all-encompassing artifact.

Alrasheedi and Capretz (2015:49), who reviewed factors critical for the success of m-learning, call for additional research into mobile perspectives such as "technical competence of lecturers". Although their literature analysis portrays the student perspective, the article accepts other perspectives are worthy of future research. Ally (2013:1) comments: "… more research is needed to determine how mobile technology impacts education so that mobile learning initiatives can follow proper practice in their implementation…". Teaching with technology is an under-researched topic (Ifenthaler & Schweinbenz, 2013).

This section reviews a range of modalities pertinent to the context of the study: technology-enhanced learning, mobile learning, blended learning, and social learning.

Technology-enhanced learning (TEL)

Duval et al. (2017:1) define technology-enhanced learning as: "…the study of how we learn and teach with interactive technologies, and how to design and evaluate effective technologies for learning". For technology-enhanced learning (TEL) initiatives to be successful, they need to engage students effectively, be underpinned by sound planning and supported by digital expertise (Mang & Wardley, 2012). TEL, seen as a means of extending the classroom, should be supported by committed lecturers (Stickel & Hum, 2008) and based on sound principles and practices (Oldfield & Herrington, 2012; Bozalek et al., 2013). Additionally, authentic, digital activities are built into classroom exercises (Oldfield & Herrington, 2012). However, paper-based course material requires adjustment to suit device limitations (Stickel & Hum, 2008; Fischer et al., 2013) whilst integrating appeal and novelty (Gikas & Grant, 2013). Value may be added to higher education experiences where innovative use of technology-enhanced learning such as social networking technologies is made (Charlesworth & Sarrasin, 2016).

Technology-enhanced learning is changing, becoming more informal but "…this does not mean, however, that learning will be less formal, and research scenarios will change to reflect this. The models of what's formal will change and maybe research will shift to assess key factors in the shift from transforming today's informal learning and making it an essential part of tomorrow's formal learning…" (Wild et al., 2013:28).

M-learning

M-learning initiatives are characterised by a lack of familiarity with best practices, critical success factors and user expectations; the exclusion of theoretically sound educational principles; ad hoc, chaotic, technological and device-centric decision making; and efforts of individuals to champion the cause rather than institution-wide strategies. M-learning research concerning perception of iPad use and mobile technology applied in problem-based learning environments highlights a need for additional research concerning the sharing of resources in groups. This approach has the potential to inform the design of cohort groups (Wood et al., 2016:12). Bannan et al. (2016:948) refer to "new perspectives on learning with transformative mobile devices", calling this research perspective a "wicked" and critical endeavour.

Blended learning

Literature sources report many blended-learning variants. In the broadest sense, blended learning represents complex combinations of face-to-face and online learning (Halverson et al., 2014). However, for the purposes of this study, blended learning is viewed as "…a strategic and systematic approach to combining times and modes of learning, integrating the best aspects of face-to-face and online interactions … using appropriate ICTs …" (Saliba et al., 2013:4). In a higher education context, a blended approach to digital delivery benefits both faculty and students. It reduces the demand for physical space while accommodating the realities of hands-on participation of students entrenched in the world of work.

Blended-learning research in a higher education context in Tanzania calls for long-term planning to stimulate "new hopes among university communities and cases that eLearning can change not only composition of the student body but works beyond boundary offering equitable access to and quality of education to those who would otherwise never get the chance to study at our campus" (Mtebe & Raphael, 2017:112).

Social learning

South African universities have a history of poor institutionally funded ICT infrastructure. Ng'ambi et al. (2016) indicate the need for strategic change that incorporates benefits of a cloud-based infrastructure. However, although teaching and learning has not changed, mobile and social technologies are instrumentally effecting change.

The review of literature in this section supports the inclusion of the following secondary research question: *SQ1.4: What are the implications of teaching and learning in a mobile milieu?*

1.5.5 Mobility – mobile stakeholders

An in-depth literature survey highlighted a plethora of research material addressing 'mobility'. However, I noted limited resources addressed the nature of a perceived gap between educational mobility patterns of lecturers and those of students. Hence, this study addresses the alignment of mobile capabilities of both lecturers and students, contributes to the body of knowledge regarding mobile technology usage, and advances work in Australia by Farley et al. (2015).

Despite the ubiquity of mobile devices and applications, mystery surrounds the personalised usage by academics and students of mobile technology as a mediating tool in ill-defined domains. Furthermore, the perceptions and attitudes of differing stakeholders – institutional and administrative, contextual, socio-cultural, educational, and technological – contribute to a complex set of lenses. As such, teaching and learning in the mobile era may not be supported effectively by ad hoc mobile technology. The focus of research has moved away from technological mobility towards learner mobility. In addition "…issues arise as students move across multiple, quickly dating devices, both personal and public, possibly over short time periods in multiple locations …" (Vavoula & Sharples, 2009:58).

Section 1.4.6 reviews literature sources that reflect concepts such as attitude, device types, digital preferences, and motivation. These elements contribute to mobile stakeholder perception.

Attitude

The attitude of higher education institutions and the application of emerging technologies are questioned by Mileva et al. (2008:49), who indicate higher education institutions "seem relatively cautious about exploiting wireless and mobile technologies in teaching, learning, assessment and administration and [their] champions must recognise and explore the issues".

Kounaves et al. (2016:365) challenge the belief that informal learning is enhanced by the use of digital media, suggesting a need to "re-visit claims of mobile devices facilitating learning". In addition, a call is made to "re-evaluate the ways in which mobile technologies might best be utilised to improve engagement".

Device types

Attitudes to bring-your-own-device (BYOD) initiatives are reported to be positive for several reasons: familiarity, acceptable cost and ubiquitous integration into personal life. Contrarily, positive attitudes to the use of institutionally supplied, prescribed devices arise from acceptably low costs, perceived equity, consistent learning experiences, security, and institutional control over patterns of use. However, it remains important to consider student preferences, device choices mapped to educational experiences and compatibility with learning-management systems (Reid & Pechenkina, 2016).

Digital preferences

Grant and Eynon (2017:157) emphasise digital inequalities and strategies, mentioning the need for researchers to address technology-enhanced learning efforts along these lines of a "broader programme of policy and practice that commits to tackling inequalities at every level of society".

Motivation

Yüksel et al. (2017:240) explore 'motivation to learn' juxtaposed with seamless learning, technology-enhanced learning contexts, mobility, self-regulation in "technology-rich classrooms" and institutionally supplied tablet devices. Technological champions are recognised as motivational forces but this topic is under-researched (Tedre et al., 2011). Harpur and De Villiers (2015b:8) note the emergence of expert evaluators who are students. They comment that paradoxically, "mobile student users may be more 'expert' than experts".

Cober et al. (2015:225) believe it is important to engage teachers, who fill motivational roles and who inform teaching and learning requirements and design processes. The authors call for more work in this direction.

The review of literature in this section supports the inclusion of the following secondary research question: *SQ1.5: What aspects emanate from being mobile?*

1.5.6 Conceptual model

The emergent conceptual model (Figure 1.3) represents "the current version of the researcher's map of the territory being investigated" (Miles & Huberman, 1984:33). It establishes a platform for pertinent theoretical components of the study (Chapter 3) and is a summary of key concepts from the preceding, preliminary literature sources. This selection of literature sources is expanded and then detailed in the systematic literature review reported in Chapter 3.

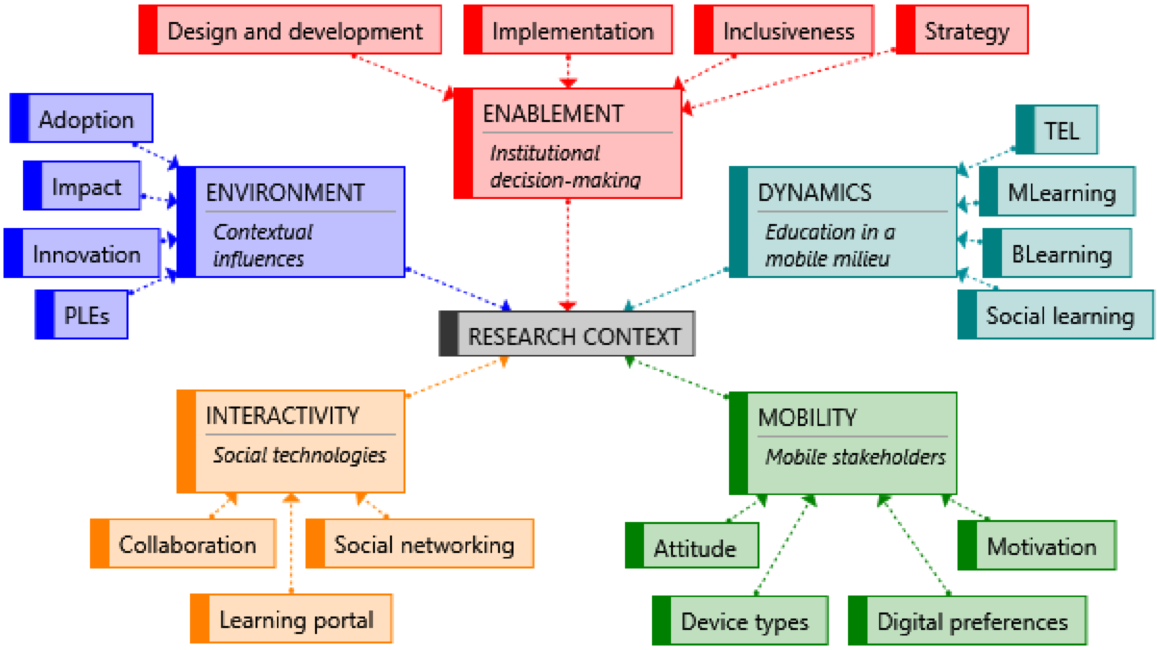


Figure 1.3: Emergent conceptual model

The emergent conceptual model in Figure 1.3 outlines five hubs associated with the higher education context of the study:

- Enablement – institutional decision making (Section 1.5.1);
- Environment – contextual influences (Section 1.5.2);
- Interactivity – social technologies (Section 1.5.3);
- Dynamics – education in a mobile milieu (Section 1.5.4); and
- Mobility – mobile stakeholders (Section 1.5.5).

This section confirms the validity of the secondary research questions SQ1.1 to SQ1.5, supporting the main research questions MQ1 and MQ2, proposed in Section 1.3.2.

1.6 Framework synthesis – towards the two main questions

Whereas Section 1.5 provided preliminary literature culminating in a conceptual model for the study (Figure 1.3), this section considers concepts based on literature sources, associated with the structuring of a framework that links eventually to Chapter 3 and to Chapter 4. The final set of elements is presented in Section 5.4.1 as Figure 5.4.1 and detailed in tabular format in Appendices F.1, F.2, F.3, F.4 and F.5. The visualised framework is presented as a network map as Figure 5.2 in Section 5.4.2.

Several researchers advocate the synthesis of frameworks, calling for:

- Refinement by institutional course developers of existing quality assurance frameworks to improve technology-enhanced learning programmes (Mhlanga et al., 2013);
- Deeper investigation of practical guidelines from a systemic perspective, serving needs of educational technology specialists in developing countries (Tedre et al., 2011);
- Theoretical frameworks enabling quality evaluation of programmes with a specific dependency on mobile technologies (Park, 2014); and
- Investigation and classification of critical success factors for m-learning, addressing differing stakeholder perspectives such as students, academics, and institutional leaders (Alrasheedi & Capretz, 2015).

The terms 'model' and 'framework' are often applied synonymously and interchangeably in research studies with authors referring to similar concepts, but in differing ways (Merriam, 2009; Maxwell, 2013). However, while a model is viewed as a descriptive tool, emerging from the framework, a framework provides conceptual guidelines for an exploration from a specific perspective. A framework is characterised as a lens, guiding the research study (Craig et al., 1994), and determined primarily by embedded contextual criteria. Inglis (2005:4) suggests the framework should align with specific purposes, such as:

- Structure, format and inflexibility;
- Support for enhancement of quality-focused processes; and
- An emphasis on best practices.

Table 1.4 tabulates a generic view of the multi-faceted and complex nature of frameworks – summarised in seven dimensions that are linked to various concepts. Based on this perspective, the framework synthesised in the study comprises: a structured set of categories, a focused set of challenges, the establishment of guidelines, considerations appropriate for higher education contexts, an objective of holistic integration, efforts to establish and improve capability levels, and a roadmap for quality orientation.

Table 1.4: Dimensions and concepts defining the term 'framework'

Dimensions	Concepts	Sources
Benefits	*Approach*, *blueprint*, *capability*, clarity, decisions, emphasis, gap analysis, inferences, *lenses*, norms, reusability, rules, sense making, *support*, *tools* and *vehicle*.	(Inglis, 2005; Mishra & Koehler, 2006; Vavoula & Sharples, 2009; Marshall, 2010; Graham et al., 2013)
Characteristics	*Analytical orientation*, *bottom-up approach*, challenges, *concepts*, questions, theories and top-down strategy.	(Marshall, 2010; Graham et al., 2013; Preece et al., 2015)
Goals	*Comprehensibility*, ease of use, *inclusiveness*, influence, *integration*, system orientation, usability, utility and unification.	(Vavoula & Sharples, 2009; Botha et al., 2012; Dolan et al., 2013; Wong et al., 2015)
Purpose	*Best practices*, design issues, *guidelines*, impact, *planning*, *reflection*, regulation and *relationships*.	(Craig et al., 1994; Inglis, 2005; Marshall, 2010)
Roadmap	Basics, core, *foundations*, hub, paradigms, *perspectives*, *quality*, *platform* and template.	(Marshall, 2010; Casanova et al., 2011; Wong et al., 2015)
Scope	*Audience*, *context*, domain, *levels of abstraction*, overview and representation.	(Vavoula & Sharples, 2009; Botha et al., 2012; Dolan et al., 2013; Preece et al., 2015)
Structure	*Constructs*, *categories*, classification, combinations, components, connections, criteria, dimensions, *elements*, factors, *hierarchy*, life cycle, links, matrix, modules, principles, quadrant, sections, stages, taxonomy and tiers.	(Inglis, 2005; Salmon, 2005; Mileva et al., 2008; Botha et al., 2012; Graham et al., 2013; Wong et al., 2015)

Italicised concepts are associated with alphabetically ordered dimensions in Table 1.4 and emphasise the purpose of and rationale for establishing a single holistic framework for ad hoc mobile technology-enhanced learning. These concepts permeate the study.

Various authors apply categorical division to organise items that inform success of learning modalities. For example, Squires and Preece (1999) provide categorised guidelines for the prediction of quality of e-learning initiatives, while Khaddage et al. (2016) propose a structured understanding of technological and educational shifts where gaps exist between formal and informal educational settings. Categories for the evaluation of usability and UX (Ssemugabi & De Villiers, 2007; Harpur & De Villiers, 2015a) and for critical success factors (Alrasheedi & Capretz, 2015) apply to m-learning.

This study differentiates between foci of existing frameworks and draws attention to constructs, categories, sub-categories and elements, and ultimately to gaps in literature sources.

1.7 Limitations

Methodological, practical, contextual and technological limitations discussed here are pertinent to the study.

1.7.1 Methodological limitations

The interpretive nature of the study implies the application of analysis techniques aimed at resonance rather than generalisation of results, limiting the applicability and transferability of findings to other faculties and departments. At best, literature sources reporting previous research could be linked with synergy, augmentation and divergence to the empirical outcomes of the study. The analysis phase using qualitative data is subjective, based on my own researcher lens. The emergent codebook (Appendices D.1 to D.5) and synthesised set of elements (Figure 5.2) represent this perspective.

Although the findings were grounded in theoretical foundations, the study did not adopt a formal grounded theory strategy. Analysis processes comprised an initial theoretically based analysis of secondary data from literature sources followed by subsequent analysis of empirical data.

1.7.2 Practical limitations

The conducting of interviews with architectural technology students and lecturers was not permitted, so interpretation of the findings was limited by quality and trustworthiness of feedback from online questionnaire surveys. As responses are based on opinions and attitudes, absolute truth of findings could not be claimed. The case study design led to a small sample size. I was unable to claim reliability and validity, typically associated with quantitative studies.

1.7.3 Contextual limitations

Mobile experiences may occur in diverse contexts. For example, respondents filled roles in work environments, were often off campus, interacted either from home or in a formal classroom space, and were often mobile. Consequently, the same activity may elicit different responses. For this reason, findings may have limited generalisability. Additionally, it was not feasible to observe the ad hoc use of mobile devices and applications in personal learning environments. Collected data could only be interpreted based on received responses. This observation pressured me to ask the 'right' questions concerning usage patterns leading to some uncertainty.

1.7.4 Technological limitations

Opinions and attitudes of academics, students and lecturers to educational technology may differ, reflecting personal preferences and experiences. Expressed perceptions may be influenced by capabilities of the mobile devices and applications, and other factors such as budget. In addition to these affective factors, the study was also limited by my technological capabilities as I was required to develop qualitative data analysis skills, accommodating the technical aspects of the CAQDAS tool, ATLAS.ti V8.0.

1.8 Delimitation

The study sought responses from one entire cohort of architectural technology students, enrolled in a 2014–2015 part-time, distance-learning programme. The programme comprised a single domain – an undergraduate architectural technology programme focusing on blended-learning students within a single department. It neither sought to ascertain the effectiveness of the part-time blend, nor did it undertake a practical assessment of its capability level.

Informal and ad hoc use of mobile technology rather than formal m-learning rollouts was investigated. Respondents were all working 'apprentices' who used their own devices, rather than as part of controlled or experimental interventions. Thus, the study did not explore educational effectiveness associated with mobile technology use.

This was not a comparative study as there was no intention to differentiate between any of the respondent groups.

Whereas the study focused on ad hoc mobile technology-enhanced learning, its constituent learning models – e-learning, m-learning and technology-enhanced learning – were not addressed as isolated modalities, but were viewed rather as parts of the 'big picture'. No learning activities were designed and delivered as part of the research. In addition, laboratory-style interventions were not implemented.

1.9 Significance of the study

The research resulted in a single holistic framework of multi-dimensional guidelines. The study is significant to the field of mobile educational technology as it adds to the body of knowledge concerned with the ad hoc use of mobile devices and applications in higher education contexts. In addition, the study is relevant as formal digital strategies implemented by higher education institutions and mediated by the informal application of mobile technologies, are purported to scaffold teaching and learning environments (McLoughlin & Luca, 2002; De Villiers & Harpur, 2013; Park, 2014).

It offered quality assurance elements with multi-purpose benefits. It additionally informed understanding of mobile quality in educational environments to support three levels of decision making:

- Strategic level – by institutional leadership for strategic decision making;
- Tactical level – by faculty and departmental stakeholders for empowerment of tactical functionality; and
- Operational level – by students for operationalisation of learning enhanced by mobile technology.

Theoretical concepts were elicited from existing yet disparate frameworks and models, severally associated with educational technology. Thereafter, consolidation and aggregation of theoretical concepts and empirical findings led to a finalised framework.

1.9.1 Institutional leadership – best practices for strategic decision making

An emergent framework for the use of mobile technology comprising theoretically based and empirically determined guidelines informed strategic institutional decisions. The framework aimed to enhance higher education experiences by contributing to the understanding of requirements for improved capability and maturity of mobile initiatives. Outcomes of the study highlighted leadership insight for effective infrastructural implementation ensuring satisfactory interactivity of mobile stakeholders and support for dynamic educational patterns.

1.9.2 Faculty and departmental stakeholders – empowerment of tactical functionality

The study oriented academic faculty and departments towards sharing of practical outcomes to empower trans-disciplinary decisions in blended-learning environments. Additionally, it highlighted contextual aspects that could contribute to either remediation or misalignment of teaching and learning processes. The comprehensive framework provided an evaluation map, with the potential to sanction the implementation of quality assurance measures for ad hoc mobile technology-enhanced learning in higher education contexts.

1.9.3 Students – operationalisation of learning enhanced by mobile technology

Findings of the study supported hands-on student engagement with evolving and emerging mobile technologies. The study reinforced the understanding that lecturers and students represent mobile diversities. Consequently, the perception of the affordances and limitations of mobile technology via comparable lenses highlighted a need to resolve digital differences. The study recognised student centricity as a barometer of successful ad hoc mobile technology-enhanced learning. Thus, it additionally emphasised a need to garner the support of student champions and mitigate the negativity of saboteurs. Finally, it gathered student-based considerations for the achievement of seamless integration of informal social learning.

1.10 Summary of thesis chapters

The thesis comprises five chapters. Each chapter begins with a brief introduction and ends with a section titled 'Crystallisation'. These holding points reflect on the contents of the chapter. Besides this chapter, the thesis is structured around four additional chapters.

Chapter 2: Research Design and Methods – an exploratory case study strategy revisits the research problem, purpose and questions, followed by a discussion of the theoretical perspectives that underpin the strategy. The theoretical design of the study incorporated a systematic literature review of existing literature, reported in Chapter 3. An empirical review of data (Chapter 4) was undertaken via research instruments and methods. The research process defined by three phases – preamble, cohort and faculty – is presented. The approach to data analysis and interpretation of results includes the findings, a review of ethical issues, and trustworthiness. Finally, methodological limitations and delimiters are addressed.

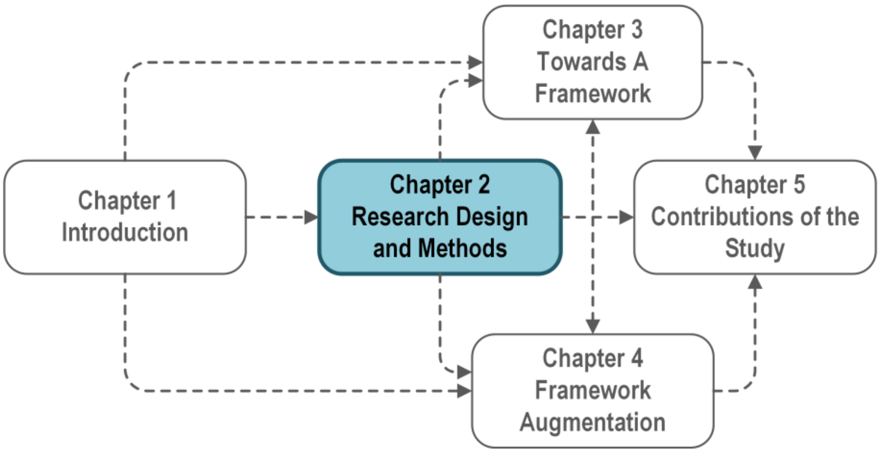
Chapter 3: Towards a Framework: Theoretical Perspectives – a systematic review of literature sources grounds the structure and components of an initial, theoretically based framework for ad hoc mobile technology-enhanced learning, partially answering the two main questions, MQ1 and MQ2. The literature highlights five secondary questions that are vehicles for the answering of the first main question. The chapter delivers an initial framework of elements, tabulating and visualising constructs, categories, sub-categories and elements.

Chapter 4: Framework Augmentation: Empirical Findings – the secondary questions emerging from Chapter 1 and answered theoretically in Chapter 3 are revisited during analysis of data gathered from the empirical studies outlined in Chapter 2. Thematic analysis of qualitative data is achieved using ATLAS.ti V8.0, while the quantitative data collected from survey questionnaires contributed basic descriptive statistics. Findings are reported both textually and diagrammatically, focusing on SQ1.1 to SQ1.5 as for the theoretical component in Chapter 3. At the end of the chapter, additional elemental contributions to the framework based on empirically determined premises are proposed via the main research questions (MQ1 and MQ2).

Chapter 5: Contributions of the study – the research study culminates in a reflective chapter with the inclusion of methodological, substantive and scientific contributions of the study. Directions for future research were delineated followed by recommendations for higher education policy makers and practitioners. A consolidated and final crystallisation closed the study.

Chapter 2 Research Design and Methods

What light through yonder window breaks
William Shakespeare: Romeo and Juliet, Act 2, Scene 2



2.1 Introduction

This chapter communicates a dual-purpose research strategy that juxtaposed two evidence collection methods to address the research objectives and questions of the thesis. Theoretically based data emanated from a systematic literature review while an exploratory case study gathered empirically determined data. The research strategy ensured that interrelated sources of evidence contributed synergistically to the resolution of research objectives and questions. Additionally, the research strategy aimed to strengthen and augment outcomes of this qualitative study.

Mobile technology-enhanced learning was defined in Chapter 1 as a combination of the features of technology-enhanced learning (TEL), e-learning, m-learning and blended learning, facilitated by the ad hoc use of mobile devices and technologies. The study investigated mobile technology-enhanced learning, used in a natural way by on-the-move stakeholders.

This chapter introduces dual research worlds reported respectively in Chapter 3 and Chapter 4, leading to a two-fold methodology. Firstly, a systematic literature review defines the theoretical component. Thereafter, an exploratory case study strategy constitutes a second methodological section, underlying the empirical part of the thesis. The layout of this chapter is adapted from Lincoln and Guba (1985) and applies the features of the interpretivist paradigm that guides the study.

Firstly, Chapter 2 pays attention to the rationale and methods applicable to the four-phase systematic literature review described in Chapter 3. Secondly, it focuses on the case study strategy underpinning the study. It describes the case, methods, instruments and respondents pertinent to the research process where data was collected in three phases and six studies and analysed in Chapter 4. Section 2.2 revisits the identified problem and purpose of the study and research questions introduced in Chapter 1. The discussion that follows In Section 2.3 sets out the philosophical perspectives that underpin the research. Research tools applicable to the theoretical and empirical portions of the study are outlined in Section 2.4. Section 2.5 presents the theoretical design aimed at collecting secondary data from literature sources. Thereafter, Section 2.6 reviews the empirical design by introducing the exploratory case study research – the vehicle for data collection adopted for the study. Data collection is defined in terms of methods and instruments. The research process underlying the phased empirical part of the thesis totals six studies. Section 2.7 sketches analysis and interpretation approaches, including decisions associated with reported findings. Thereafter, trustworthiness is addressed (Section 2.8), followed by a summary of the practical limitations and delimiters of the research design and methods (Section 2.9). Finally, my researcher voice forms part of a chapter section titled 'crystallisation'.

2.2 Research problem, purpose, objectives, questions

This section revisits the research problem, the purpose of the study and the associated objectives and research questions, introduced in Chapter 1.

In Chapter 1, I reviewed many frameworks concerning diverse aspects of educational technology. I observed that published literature shows scant consideration for the consolidation of these frameworks for the effective and quality-centric incorporation of mobile technology-enhanced learning into higher education environments. This noted gap in the body of knowledge regarding the nature and structure of a framework informing the ad hoc use of mobile technology to enhance learning in ill-defined domains in higher education contexts is the focus of this study.

The study aimed to:

- Expand the understanding of the potential of mobile technology as an informal and supportive educational mechanism;
- Improve quality of the managed incorporation of ad hoc mobile technology;
- Cohesively support institutional decision making; and
- Demonstrate the relevance for all educational stakeholders of being educationally mobile.

Two main questions drove the study. The first main question, MQ1, was refined by five secondary questions – SQ1.1 to SQ1.5. The questions were introduced in Chapter 1 and are:

MQ1: What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?

SQ1.1: What elements inform institutional decision making?

SQ1.2: What elements reflect contextual influences?

SQ1.3: What is the nature of relationships mediated by social technology?

SQ1.4: What are the implications of teaching and learning in a mobile milieu?

SQ1.5: What aspects emanate from being mobile?

MQ2: How are the elements, identified in MQ1, related?

The secondary questions (SQ1.1 to SQ1.5) are the focus of both the theoretical and the empirical components of the study, addressed respectively in Chapters 3 and 4. The answering of secondary research questions contributes to the resolution of the main research questions (MQ1 and MQ2).

2.3 Philosophical perspectives

Crotty (1998) refers to a theoretical perspective as the stance informing the chosen methods, providing context for the research process and grounding the logic and criteria of the study. Figure 2.1 reflects an adaption of the hierarchical, theoretical framework, proposed by Crotty (1998:4) and guides the research design and methods framework of the study.

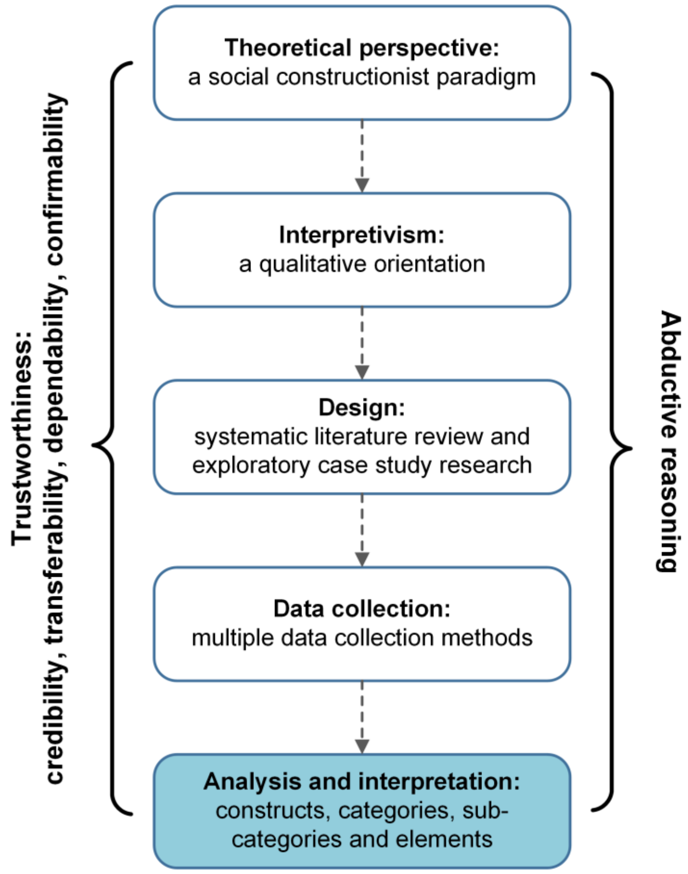


Figure 2.1: Research design and methods, informed by Crotty (1988:4)

The qualitative study does not relate to formally implemented mobile technology-enhanced learning. Rather, it explores how respondents construct their own mobile technology-enhanced learning reality, examines what they do in a natural context of use and reviews the way a social construction process emerges. Consequently, I adopted an interpretivist and subjective stance, underpinned by a socially constructed reality. There exists an interlinking and subjective relationship between myself as the researcher and the concepts explored. The findings of the study emerge or "are created" during and as part of the exploration of the topics linked to the study.

Section 2.3 reviews ontological and epistemological considerations by delineating the social constructionist paradigm associated with the study. It touches on the subjective and interpretive stance influencing data-collection and interpretation processes and indicates a qualitative orientation. Finally, it addresses abductive reasoning (Section 2.3.4).

2.3.1 A socially-constructed reality

The metatheory 'social constructionism' (constructionism) provides a "broad analytical framework" (Talja et al., 2005:80) and resonates to a large extent with my worldview, influencing the methodological designs and approaches outlined in Sections 2.5, 2.6 and 2.7.

The philosophical approach of this thesis is influenced by Cronjé (2016) who suggests the four-quadrant model proposed by Burrell and Morgan (1979) is able to accommodate differing yet mutually exclusive research paradigms in one study. Two sequential quadrants applicable to this study are illustrated in Figure 2.2 that is repeated from Chapter 1, Section 1.6. It depicts the moderate constructionist paradigm underlying the study.

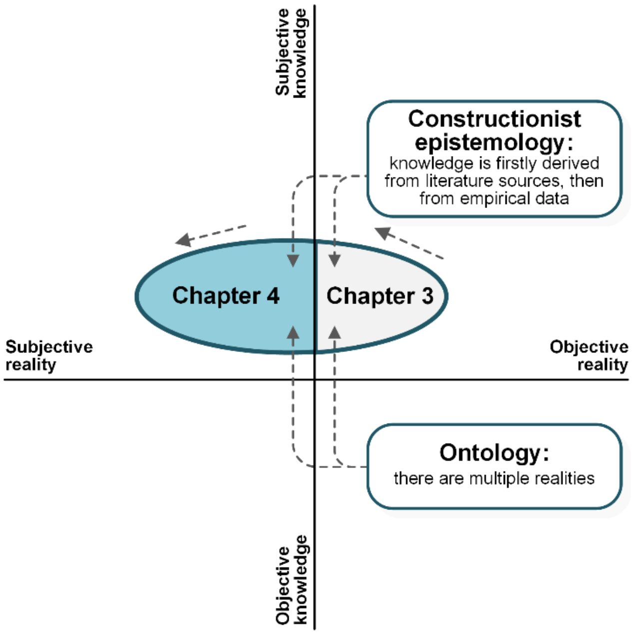


Figure 2.2: Moderate constructionism (adapted from Järvensivu & Törnroos, 2010:102)

Figure 2.2 communicates the ontological premises underpinning the study, relative to multiple and sequential realities. These realities are described objectively at first (Chapter 3) and subsequently explored subjectively (Chapter 4). In addition, epistemological links exist between theoretical and empirical sources of evidence. The epistemology associated with moderate constructionism acknowledges rational and socially derived knowledge collected both empirically and interactively within communities. Järvensivu and Törnroos (2010:101) indicate "research should proceed towards finding local, community-bounded, interacting forms of truth that are created and validated through dialogue in different communities". Knowledge is mostly subjective – community oriented, but is also objective, where knowledge is derived during empirical observation.

This study resonates moderately with voluntarist and socially constructed reality where collaboration with respondents occurs (Yin, 2014). Social reality constitutes a mosaic of personal constructs where sense is made of technology-enhanced learning in mobile worlds by viewing reality as a natural social setting. It is constructed from real-world interactions between mobile technologies, higher education decision makers such as the domain expert and faculty head, faculty academics, architecture students and architecture lecturers. Experimental laboratory situations are excluded. Mobile reality is characterised by personal attitudes, experiences, perceptions and preferences. When respondents construct and share their stories, the unravelling of respondent actions occurs, influencing outcomes of the study.

Guba and Lincoln (1994:108) indicate that the traditional distinction between ontology and epistemology disappears – they are intertwined, implying constructions are relatively informed or sophisticated but not absolutely true – fitting the expression “it depends”, changeable and changing and formatted by those who construct them.

Constructionism, as advocated by Papert and Harel (1991), builds on the theory of constructivist learning (Cakir, 2008). Social constructionism is defined by Leeds-Hurwitz (2009) as linked to sociological and communication theory and inclusive of a worldview that is constructed and informed by shared conceptual realities. The moderate constructionist perspective underpinning this study embraces the following concepts: ontology and epistemology, stakeholder centricity, context, a real-world environment, understanding before construction, situated learning, subjectivity, synthesis, my researcher role, and society.

Table 2.1 summarises and applies social constructionist concepts to the case study context of the study.

Table 2.1: Applied tenets of social constructionism

Tenets	Concepts	Contextual application
Ontology and epistemology	Diverse opinions inform reality and knowledge (Järvensivu & Törnroos, 2010) rather than a single "absolute truth" (Hibberd, 2005:30).	The research design constituted the collection of both theoretical and empirical data from multiple, socially situated sources.
Stakeholder centricity	The "concerns of gatekeepers and respondents affect … construction" (Charmaz, 2008:408).	Questionnaire design focused on stakeholder attitudes concerning ad hoc use of mobile technology.
Context	Historically-situated circumstances emphasise an evolving context (Hibberd, 2005). The contextual building of structures facilitates learning-by-making associated with innovative "microworlds" (Harel & Papert, 1990:3).	The study explored an established higher education context that applies educational technology to deliver a blended, part-time architectural technology programme. Empirical data was collected from differing stakeholders.
A real-world, case study environment	Moderate constructionism considers "the multiple constructed, community-bounded realities that all case studies inevitably deal with" (Järvensivu & Törnroos, 2010:100)	The case study strategy explored attitudes to mobile technology used informally for educational purposes in a natural context of use – a blended architectural technology programme.
Communication	Knowledge production occurs during conversations establishing societal categories where phenomena are visible (Talja et al., 2005).	The study communicated a structured framework of constructs, categories, sub-categories and elements based on analysis of stakeholder feedback.
Social, situated learning	Multi-faceted, situated learning concerns a social milieu and is "socially-constructed" with a human activity focus (Hibberd, 2005:2).	Selected methods supported the exploration of a complex and socially relevant, on-the-move education environment.
Subjectivity	Respondents' attitudes and opinions create personal realities in the research context (Charmaz, 2008) with a subjective reliance "…upon definitional concepts and categories established by researchers" (Jacobs & Manzi, 2000:37).	Rigorous, in-depth qualitative data analysis elicited subjectively interpreted findings, resulting in: a codebook of categorised theoretically based and empirically determined codes, and themes and sub-themes inferred from analysed data.
Synthesis	The research "approach of social constructionists tends towards synthesis rather than analysis" (Hibberd, 2005:2).	Framework components emerged from theoretical and empirical sources, integrated holistically into a single, structured end result.
Researcher's role	A rigorous inspection of theoretical evidence was undertaken (Charmaz, 2008). Proponents reflect on the impermanence of society, challenge the status quo and contribute to knowledge construction for change (Jacobs & Manzi, 2000).	The study recognised the central researcher role I filled, improving trustworthiness of the study by the inclusion of reflexivity and crystallisation. Outcomes potentially benefited institutional decision making.

From a moderately constructionist viewpoint, truth is viewed from many perspectives, rather than as one worldview. Knowledge emerges iteratively and interactively between the researcher and respondents (Guba & Lincoln, 1994:111). Similarly, Järvensivu & Törnroos suggest constructionism comprises "multiple constructed, community-bounded realities" (2010:100). Ontologically, reality is mostly subjective and characterised by a dynamically evolving and moderately constructionist educational environment. They add that “there may be a reality; specific local, contingent truth claims apply” (2010:102, Figure 2).

2.3.2 A subjective, interpretivist stance

From my perspective, dealing with reality means both interpretation and understanding that develops and is not a given. It is linked to meanings and experiences that are dynamic and constantly and socially constructed during interactivity. I considered the following two philosophical questions: “What is the form and nature of reality and, therefore, what is there that can be known about it?" and “What is the nature of the relationship between the knower … and what can be known?”. Consequently, I adopted an interpretivist and subjective stance supported by a socially constructed reality (Guba & Lincoln, 1994:112).

In this interpretive study, respondents filled various roles. I filled the role of interviewer and “primary data collection instrument”, gathering background information, transcribing where verbal communication becomes textual data and sharing research insight as part of researcher reflexivity. McLellan et al. (2003:84) indicate “the transcript is a tool that helps qualitative researchers make sense of and understand interviewees’ experiences and perceptions”. Transcription processes are interpretive and applied iteratively. They involve listening and flexible activities and are guided by protocols (Creswell, 2009). During interviews and the design of survey questionnaires, respondents are treated as experts in their own lifeworlds and regarded in a different way for each diverse respondent role (Cohen et al., 2007).

The research incorporates iterative processes that support the understanding of sections of collected text (Boell & Cecez-Kecmanovic, 2014). A review of literature sources established an initial theoretical lens and codebook (Chapter 3). During the sequential analysis of collected theoretical and empirical data, included respectively in Chapters 3 and 4, a mapping and classification process occurred, facilitating the search for and understanding of emerging themes (Chan et al., 2015). Findings were interpreted, compared and discussed using conventional hermeneutic techniques (Guba & Lincoln, 1994), deemed a ‘plausible’ analysis strategy. The approach made the creation of descriptions a possibility (Harris & Park, 2008), while establishing meaning by the conversion from text to meaning associated with the text (Pachler & Daly, 2009).

2.3.3 A qualitative orientation

This study adopted a qualitative orientation where I developed a relationship between understanding, meaning and experiences. In the process, I filled a primary role as researcher during data collection, analysis and interpretation involving a set of processes aimed at achieving a rich description of the end product (Merriam, 2009). I realised that through experiences and interactivity, active educational stakeholders became co-

constructors of the context of the study enabling the discovery of socially oriented, contextually dependent phenomena. Furthermore, I interconnected with respondent stakeholders in a subjective process of observing, asking, answering, sharing, recording and interpretation. Consequently, I addressed the relationship between the knower and what can be known (Guba & Lincoln, 1994).

2.3.4 Abductive, deductive and inductive analysis processes

This section outlines the concepts 'abductive, deductive and inductive analysis processes' in readiness for its application in Section 2.7 that discusses methods for the analysis and interpretation of research findings. Figure 2.3 demonstrates the approach I implemented. It illustrates evidence of abductive, deductive and inductive analysis processes (Järvensivu & Törnroos, 2010:102).

At first, I extracted theoretically-based evidence from literature sources, applying both inductive and abductive processes. In the absence of an existing theory, these sources provided differing theoretically based elements pertinent to building of theoretical foundations for ad hoc mobile technology-enhanced learning. This data produced a set of theoretically-based codes in support of the theoretical elements arising from literature sources. The initial codebook formed the starting point for the analysis of empirical data from the exploratory case study.

Thereafter, I gathered and analysed empirical data during an exploratory case study. Both deductive and inductive processes occurred as, at first the theoretically-based codes were applied to the empirically-determined items. Analysis of the empirical data augmented the set of theoretically based codes.

Consequently, codes emerged that had not previously been recorded when theoretical sources were analysed. I regard this phase as additional inductive processing. The resultant codebook was achieved by the synergy and augmentation of theoretically-based and empirically-determined analysis processes which were at times abductive but also deductive and inductive.

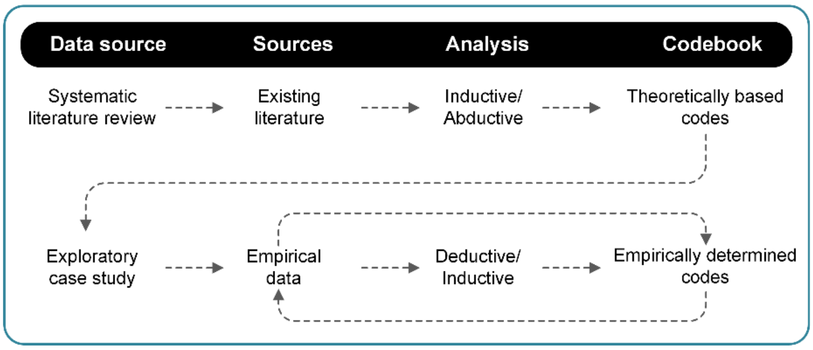


Figure 2.3: Sequential and iterative analysis

Järvensivu and Törnroos speak of abductive reasoning as being situated between inductive and deductive reasoning, suggesting:

> Unlike induction, abduction accepts existing theory, which might improve the theoretical strength of case analysis. Abduction also allows for a less theory-driven research process than deduction, thereby enabling data-driven theory generation (Järvensivu and Törnroos, 2010:102).

They propose differential phase- and study-dependence reasoning during the research process where the researcher may apply abduction at one point but then hover towards deductive or inductive reasoning at others. The application of abductive reasoning is not necessarily based on "existing theory" or bound to the establishment of new theory; it could also be determined by theoretical sources.

Dubois and Gadde share the following insight:

> One major difference, as compared with both deductive and inductive studies, is the role of the framework. In studies relying on abduction, the original framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process. This approach creates fruitful cross-fertilisation where new combinations are developed through a mixture of established theoretical models and new concepts derived from the confrontation with reality (Dubois and Gadde, 2002:559).

The view of Dubois and Gadde is pertinent to this study that aims to synthesise a framework for mobile technology-enhanced learning – established at first on the basis of literature sources (Chapter 3). The framework is dynamic and evolves in response to findings emerging during empirical iterations (Chapter 4). Abductive reasoning is part of analysis and interpretation of findings, associated with case study research (Dubois & Gadde, 2002; Locke, 2010). Plowright (2011:110) says an "inferential process" occurs.

2.4 Research tools

Table 2.2 tabulates research tools that were incorporated in the study and that served specific purposes, reflected research requirements and benefited mobile research activities. The tools were selectively used for theoretical and empirical designs (Sections 2.5 and 2.6).

Table 2.2: Research tools used for theoretical and empirical data collection and analysis

Research tool	Purpose	Usage
ATLAS.ti V8.0 http://atlasti.com/	A qualitative data analysis tool used for hermeneutic tasks, elicitation of codes, construction of network diagrams, formulation of the framework and thematic analysis.	Analysis of literature sources and empirical data in both Windows and Android contexts. Application: "T&E"
EndNote http://EndNote.com/	An online reference management tool for searching, organising, and writing, publishing and sharing of literature sources.	The building and formatting of anywhere and any-time reference lists, served as a citation manager. Application: "T&E"
Evernote https://Evernote.com/	A cloud-based tool for the capture and management of a valuable diary for case study research, increased research productivity – sync capabilities.	Retrieval of diary items via multiple device. Items characterised by recordings of thoughts: images, audio and text. Application: "T&E"
Google Drive https://www.google.com/drive/	Cloud storage for backup and safekeeping of research material.	Support for on-the-move access to files. Application: "T&E"
Google Forms https://www.google.com/forms/	Questionnaire design, customisation and distribution.	Distribution of questionnaires and collected online respondent feedback. Application: "E"
Microsoft® Office Suite: Word, Excel, Visio https://www.office.com/	Productivity tools for production of template-based research artefacts.	Completion of data cleansing and manipulation, charts, diagrams, final thesis report. Application: "T&E"
RecordMyCall (RMC) https://play.google.com/	Free mobile app for Android devices downloadable from Google Play.	Digital recording of both ingoing and outgoing mobile interview content via smartphone. Application: "E"

Note: In the third column, "E" implies tool was only applied in an empirical capacity, while "T&E" indicates the tool was used for both theoretical and empirical research tasks.

2.5 Theoretical design: a systematic literature review

Section 2.5.1 compares traditional and systematic literature reviews, justifying the structured approach adopted in the study. This strategy is outlined in Section 2.5.2. Guidelines from experts establish a structure that guides the implementation of a systematic literature review (Section 2.5.3). The resultant four-phase strategy is delineated in Section 2.5.4.

2.5.1 Traditional vs systematic literature reviews

Although I decided to implement a systematic literature review to gather secondary data based on sound theoretical sources, I wanted firstly to distinguish between traditional and systematic reviews to establish my position and to justify my choices. Traditional reviews synthesise findings from previously written primary research (Demeyin, 2016). These reviews address emergent gaps and new perspectives, communicating the context of the study and establishing the relevance of the study (Hart ,1998, cited in Randolph, 2009). Despite producing overall coverage of concepts associated with the research topic, traditional reviews do not deliver a set of clear methodological guidelines (Rother, 2007).

Systematic reviews illustrate the benefits of a methodical approach incorporating: increased specificity, aggregation of data from a range of databases, the possibility of replicability, consideration of bias, the ability to work in teams, and the production of measurable outcomes (Perry & Hammond, 2002). Traditional reviews may manifest the following shortcomings:

- Lack of a focused question;
- Missed yet important publications;
- Inclusion of biased publications; and
- Limited possibility of generalisability of review outcomes (Nasseri-Moghaddam & Malekzadeh, 2006:196).

These issues justify the use of a systematic literature review strategy.

I conducted a systematic literature review as the method offered sought-after guidelines for my study, such as structure, reproducibility, synthesis, evidential support and superior quality. A theoretical premise is applied to the context of the study and supported by relevant citations for each of the following guidelines:

- The delivery of a literature review determined by a detailed and structured search strategy as analysis of the literature sources would provide secondary data (Demeyin, 2016);
- The enhanced reproducibility of extracted selection of sources by listing inclusion and exclusion criteria, contributing to the rigour of my study (Inayat et al., 2014);
- The incorporation and synthesis of diverse literature sources that are of central relevance to mobile technology-enhanced learning, focusing on a specific domain – architectural technology in a higher education context (Armitage & Keeble-Allen, 2008; Goulding & Kyriacou, 2008);
- The production of theoretical guidelines that are determined by evidence and that support educational practitioners (Kitchenham et al., 2009); and
- The demonstration of the production of superior quality theoretical outputs leading to publication (Pickering et al., 2015).

Table 2.3 summarises the salient features of traditional and systematic reviews with respect to six dimensions, differentiating between the two strategies and justifying the decision in this study to design a systematic rather than a traditional literature review in the final column.

Table 2.3: Traditional vs systematic reviews (Perry & Hammond, 2002:33)

Dimensions	Traditional reviews	Systematic reviews	Why did I select a systematic review strategy?
Search strategy	Not a specific approach	Specific strategy	I conducted a thorough search of literature sources for specific elements informing the ad hoc use of mobile technology-enhanced learning.
Database use	Seldom systematic and structured	Defined by several databases	I systematically collected secondary data via purposively and conveniently selected databases.
Replication	Not replicable	May be replicated by other researchers	To establish trustworthiness of the qualitative study, I believed a systematic and replicable review would contribute to rigour of the study.
Bias	Potentially biased	Minimally biased	My subjective responses to secondary data might negatively impact outcomes of the interpretive nature of the study. A systematic review mitigated this bias.
Researcher role	Individual researchers	Team-based research activities	I contributed individually to the study in my researcher role. A systematic review emulated the benefits of team-based research, gathering structured input from diverse sources.
Conclusions	Based on findings of studied material	Determined by measurable outcomes	Importantly, the defined objectives of the study enabled me to produce measurable elements and an associated framework that aimed primarily to support reliably institutional decision making.

Having included a rationale for its incorporation in the study, the next sub-sections offer a definition of a systematic review, provide brief background information regarding its current use and present considerations regarding its use.

Definition

I regard a systematic review as "…a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review…" (The Cochrane Collection, 2005, cited in Moher et al., 2009). In keeping with this definition, the literature review in this study is systematic and uses precise methods to gather and evaluate pertinent, sourced articles according to a set of criteria. Reported data is qualitatively analysed, contributing to a set of elements for the ad hoc use of mobile technology-enhanced learning in higher education contexts.

Background

The systematic literature review methodology was initially applied in medical domains such as public health (South et al., 2010) and postgraduate nursing education (Ten Ham-Baloyi & Jordan, 2016). It is currently supported in other research disciplines such as research methodology (Zheng, 2015), software engineering (Kitchenham et al., 2009; Inayat et al., 2014), information technology (Okoli & Schabram, 2010; Bandara et al., 2011) and social sciences (Brendel, 2011). However, recent literature illustrates the application of the systematic literature review methodology to mobile technology use in education.

Various studies have been conducted in mobile contexts, demonstrating the application of the systematic review approach. Examples include the following:

- Mobile computer-supported learning (Amara et al., 2016);
- M-learning within African HE institutions (Kaliisa & Picard, 2017);
- The use of iPads in higher education (Nguyen et al., 2015);
- M-learning directions in Malaysia (Mahalingam et al., 2013); and
- Critical success factors for m-learning (Alrasheedi & Capretz, 2015).

This study makes a methodological contribution to the body of knowledge by providing both a method for and an example of a systematic literature review for the ad hoc use of mobile technology-enhanced learning. Thus, it extends and enriches existing systematic review work.

Considerations

Despite the positives, my approach resonates with that of Daigneault et al. (2014) who provide lessons learned and encouragement for doctoral students to reflect on the use of systematic literature reviews. On reflection, I noted that the structured approach led to a loss of curiosity and creativity issues. The review process was time consuming, and required effort and patience. It called for an extensive period of immersion in the techniques, processes, application and reports associated with the strategy. In agreement with Ten Ham-Baloyi and Jordan (2016), I observed that the approach demanded the acquiring of technical competencies and tool sets. Although the quality of reviews executed in this way is sometimes questioned when the number of reviewed articles is low (Bandara et al., 2011), my study collected many articles worthy of inclusion in the review.

On reflection, the adoption of a systematic review strategy implied the following requirements:

- Justification of decisions and choices informed by expert opinions (Section 2.5.3);
- Comprehensive planning as part of an overall strategy (Section 2.5.4);
- Maintenance of a manageable scope, limited to the ad hoc use of mobile technology in an educational capacity (Section 2.2);
- Pre-review development of expertise such as a preliminary review of literature (Sections 1.1 and 1.4) and the exploration of guidelines on conducting systematic literature reviews (Section 2.5.3); and
- Clear demarcation of selection criteria (Section 2.5.4).

These factors underpin the adopted approach that is characterised by a detailed account of findings associated with the four phases implemented in the systematic literature review strategy in Section 2.5.4.

2.5.2 Preamble – systematic literature review

Section 2.5.1 provided a brief comparison justifying the application of a systematic literature review rather than a traditional literature review. Section 2.5.3 delineates guidelines provided by experts for the conducting of the systematic literature review. Section 2.5.4 outlines the four-phase strategy used in the study to review pertinent literature sources systematically to elicit secondary data from existing literature sources. The success of this decision was dependent on a systematic approach (Johnston, 2014). It offered me the benefit of theoretical insight and alternative perspectives, while simultaneously adding to the body of knowledge.

I developed the systematic literature review process defined by Figure 2.4 as a methodological contribution to the study. It depicts the synthesised four-phase, systematic literature review strategy adopted for the study and represents a more detailed version of a PRISMA flowchart (Liberati et al., 2009; Moher et al., 2009). It reflects the iterative and sequential activities detailed in Section 2.5.4. Furthermore, it delineates a four-phase strategy comprising Phase 1 – Planning, Phase 2 – Selection, Phase 3 – Extraction, and Phase 4 – Execution.

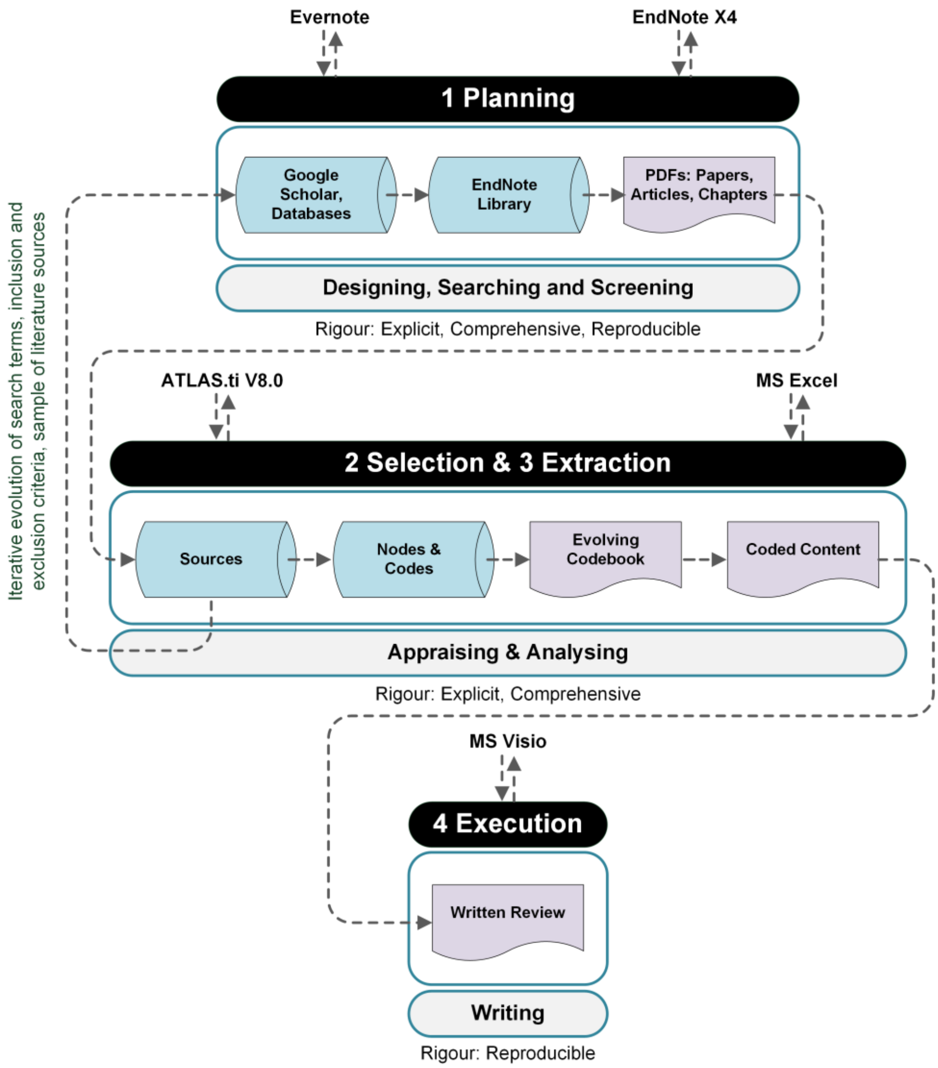


Figure 2.4: My systematic literature review strategy, synthesised from Alrasheedi et al. (2015), Bandara et al. (2011) and Okoli and Schabram (2010)

Whereas this chapter defines the four phases of the strategy and preliminary findings associated with the review method, Chapter 3 discusses the findings of Phase 4 – Execution. Section 2.5.4 addresses the four phases: Phase 1 – Planning, Phase 2 – Selection, Phase 3 – Extraction and Phase 4 – Execution.

Chapter 3 incorporates the writing of the review and the reporting of its findings.

Although this review is not a stand-alone artefact, the adopted approach is nevertheless guided by and adapted from the eight-step procedural approach proposed by Okoli and Schabram (2010:8). Furthermore, methodological design was informed by a simpler approach proposed by Bandara et al. (2011) and applied to IS projects. Finally, the endeavour by Alrasheedi et al. (2015), designed to understand m-learning success factors in higher education contexts, supported the inclusion of an iterative strategy.

I took cognisance of the four principles of methodological rigour for systematic reviews advocated by Fink (2005) by ensuring my approach was systematic where explicit, pre-defined selection criteria were applied. Furthermore, I endeavoured to report the way I conducted the review to render the approach comprehensible and reproducible. The first three phases demonstrate an iterative evolution of search terms, inclusion and exclusion criteria, and selected literature sources. Section 2.4 suggests several research tools that I used to support the management of resources (Bandara et al., 2011).

The methodological strategy depicted earlier as Figure 2.4 comprised two major iterations. The first iteration comprised a review of existing frameworks, while the second sought to fill gaps in literature sources and reviewed additional non-framework sources. Minor iterations were undertaken to remedy noticeable shortcomings of sourced literature.

Additionally, these deliberate forays were supplemented by the incidental inclusion of:

- 'Guru-sources' shared by research colleagues;
- Additional literature gleaned from bibliographies; and
- Topic-specific articles accidentally uncovered during journal browsing.

Researcher reflexivity and sensitivity are highlighted by Ten Ham-Baloyi and Jordan (2016) and Newton et al. (2011:15) who suggest: "…done with sensitivity, adequate reflexivity and within a constructivist framework, the interpretation of a single researcher should be considered an acceptable qualitative approach…".

2.5.3 Guidelines from experts for execution of a systematic literature review

The systematic literature review process is scaffolded by key guidelines, including: structure with researcher creativity (Boell & Cecez-Kecmanovic, 2014), scope defined by requirements (Fink, 2005), a flow diagram (Liberati et al., 2009; Moher et al., 2009), a checklist for a systematically phased approach (Kitchenham et al., 2009; Moher et al., 2009; Okoli & Schabram, 2010; Bandara et al., 2011; Alrasheedi et al., 2015), inclusion and exclusion criteria (Inayat et al., 2014), iteration – searching, sampling and extrication (Emery, 2012; Booth et al., 2013; Halverson et al., 2014), rigour (Fink, 2005; Levy & Ellis, 2006; Okoli & Schabram, 2010), analysis and synthesis (Wu, 2010; Emery, 2012; Halverson et al., 2014) and reporting (Liberati et al., 2009; Manca & Ranieri, 2013; Halverson et al., 2014).

Inspiration

The decision to design and implement a systematic literature review was inspired and justified by the following journal publications:

- A rigorous systematic review was undertaken in the software engineering domain to build "evidence-based guidelines for practitioners" from aggregated findings (Kitchenham et al., 2009:8);
- Khoo et al. (2011) conducted a systematic review to explore a review of literature reviews and observed differences between descriptive reviews that produce summaries with some detail on each study and integrative reviews that are more conceptual with structural complexity;
- Manca and Ranieri (2013) performed a critical analysis of literature sources to determine the pedagogical potential of Facebook. The outcomes of the analysis phase of their systematic literature review suggest many factors formulate the Facebook experience. It revealed interconnected concepts comprising collections of old issues side-by-side with new challenges;
- Inayat et al. (2014) reviewed agile requirements engineering by conducting a phased systematic literature review, emulating the strategy applied by Kitchenham et al. (2009); and
- Alrasheedi et al. (2015) applied a phased systematic literature review methodology to explore factors critical to the success of m-learning in higher education.

Section 2.5.4 sets out the four-phase strategy adapted to suit the domain and context of this study.

Features

I experienced the development of my systematic review as a gradual process with dependence on personal engagement. It incorporated a set of structured characteristics linked to reproducibility, signifying the features of the review were:

- Systematic – a specific method was defined and adopted as in any methodology;
- Explicit – all procedures followed in the review were clearly set out;
- Comprehensive – scope was a broad cover inclusive of all relevant literature; and
- Reproducible – other researchers could emulate the approach and repeat the exercise (Fink, 2005).

Understanding and insight with knowledge creation emerge as deliverables (Boell & Cecez-Kecmanovic, 2014).

Flow diagram and checklist

A flow diagram illustrates a phased strategy (Kitchenham, 2004). The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[2] Statement offers template-based guidelines for the flow of information through a review (Moher et al., 2009). Liberati et al. (2009) list the 27-item PRISMA checklist that is available at www.annals.org. The checklist serves to evaluate the credibility of the systematic literature review, and is an additional recommendation. An eight-step procedural approach is proposed by Okoli and Schabram (2010). It is built around phases proposed by Bandara et al. (2011), given as: the establishment of purpose, design of a protocol, iterative searching for sources, screening of selected sources, appraisal of quality, data extraction, analysis of the studies, and the writing of the review.

Iteration: searching, sampling and extrication

Emery (2012) explored categorised factors associated with bring-your-own-device (BYOD) initiatives in higher education by evaluating literature published between 2007 and 2012 and selected to extricate information. Cluster searching was implemented to gather a sample of pertinent documents to review a single topic (Booth et al., 2013). Halverson et al. (2014) used phrases to search Google Scholar for the most-cited literature sources pertinent to blended-learning research prior to conducting a thematic analysis.

Rigour, analysis and synthesis

A systematic review achieves rigour by including several verification techniques in the course of the research process (Morse et al., 2002). Rigour equates to quality of both synthesis and scholarly critique, is applied throughout the review and cannot be neglected (Fink, 2005; Okoli & Schabram, 2010). The iterative analysis process incorporates various forms of coding where relevant concepts are evaluated and grouped (Wu, 2010; Emery, 2012; Halverson et al., 2014). Synthesis encompasses knowledge creation, improved understanding, and compartmentalisation into constructs, models, frameworks, application insight and critical evaluation (Levy & Ellis, 2006).

Reporting

While the PRISMA Statement offers an explanatory document that guides the reporting of a systematic literature review (Liberati et al., 2009), Halverson et al. (2014) proffer the sequence of the report sections.

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[2] www.prisma-statement.org

2.5.4 A four-phase strategy

This section defines the four phases of the strategy applied during the systematic literature review, included in Chapter 3.

Phase 1 Planning: designing, searching and screening

This review aimed to synthesise an initial set of theoretically based elements for a mobile technology-enhanced learning framework, aligning with one of the purposes for conducting a systematic literature review proposed by Okoli and Schabram (2010), namely, the construction of models and frameworks.

Research logic, context and questions determined the focus of the planning phase. It comprised a choice of search criteria such as keywords and phrases for the search. Screened articles were captured in EndNote, a cloud-enabled software package (Thomson Reuters, 2016) for the management of in-text citations and bibliographical content. Figure 2.5 shows how articles were powerfully catalogued and grouped as custom-defined topics, inclusive of index sortation, attachments, author(s), year, title, source type and research notes.

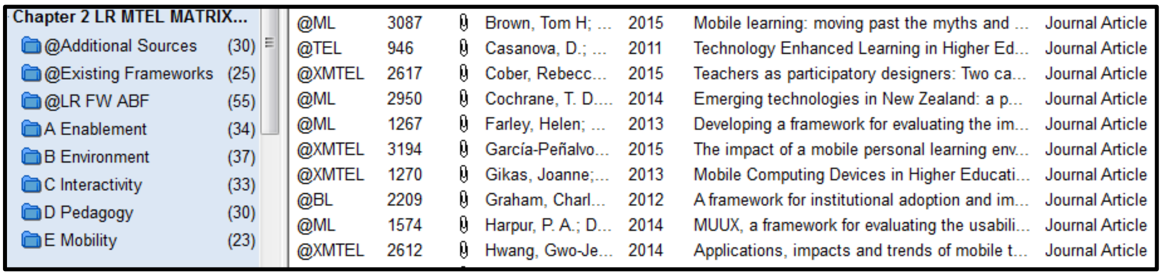

Figure 2.5: A selection of references stored in EndNote

In addition to the customisation of EndNote and the establishment of a library of pertinent references, a set of folders that stored downloaded conference papers, journal articles and e-book chapters as PDF documents was named accordingly for easy cross-referencing purposes. For example, Figure 2.5 illustrates the group titled @LR FW ABF that provided structured access to the selection of articles used for the systematic literature review. This EndNote group mapped to an identically named folder of PDF documents.

A comprehensive search elicited literature sources published between 2005 and 2016 underpinning a single holistic and comprehensive framework for the ad hoc use of mobile technology in a higher education context. The search addressed the main and secondary research questions, noting the guidelines of Pearson et al. (2011) who propose a qualitative search strategy should be intuitive, creative and iterative. Furthermore, it considered the advice of Booth et al. (2013) who suggest qualitative searches call for evidence of four specific qualities: robustness, rigour to ensure credibility of the review, iteration, and intuition.

A scan of Google Scholar applied a focused search for literature sources reflecting existing frameworks pertinent to mobile technology-enhanced learning. Table 2.4 lists an excerpt of pertinent search filters. However, Appendix A.1 offers a full set of search terms.

Table 2.4: Sample to search terms used to elicit the selection of review articles

Academic administration	Education curriculum	Internet access	Professional development
Academic relations on Facebook	Educational content	Interoperability	Quality assurance
Academic staff development	Educational software	iPad	Quality enhancement
Education 2.0	Instructional tasks	Potential of distance learning	Web 2.0, Web 3.0

Although types of sources such as blogs, chapters, books, conference papers, electronic articles, journal publications, reports, theses and websites were screened at the outset, the review is based only on published chapters, conference papers, e-resources and journal articles.

Figure 2.6 reflects my planning of the collection of literature sources. The process stemmed from the topic associated with the context of the study, the research problem I identified and the resultant research questions I posed to address the problem. The process led to a narrowed selection of specific literature sources.

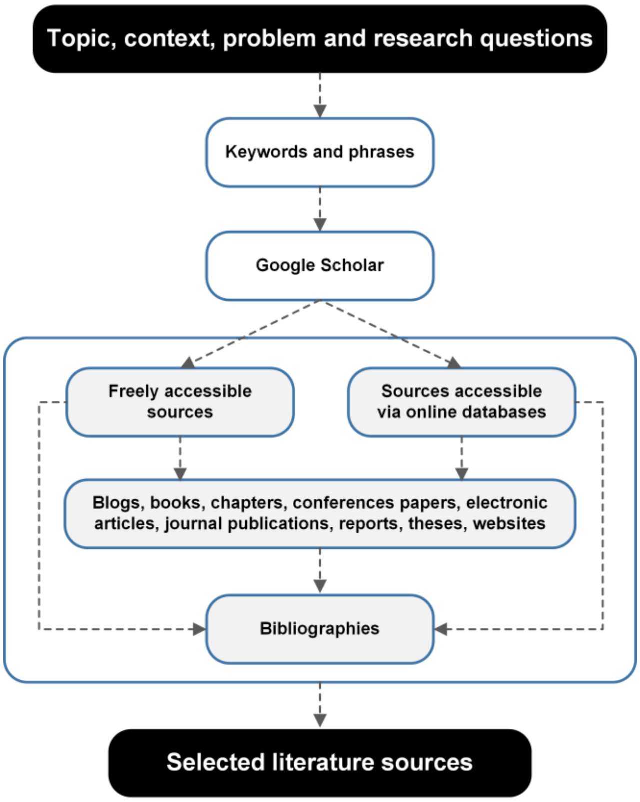

Figure 2.6: Planning the collection process

The initial search used search terms listed in Appendix A.1 and led to a broad collection of blogs and websites, electronic articles and books – all freely available – and online database sources, theses and reports. Thereafter, a 'snowballing exploration' of specific bibliographies produced additional sources (Inayat et al., 2014). Iterative cluster searching defined as an: "…explicit methodology for the identification of conceptually rich or contextually thick 'clusters' of data …, to help explore … theoretical underpinnings…" (Booth et al., 2013:3) allowed the gathering of an extensive assortment of linked sources. Thereafter specific digital libraries were consulted to gather pertinent articles (Appendix A.2). Search items that focused solely on higher education environments led to deeper and detailed exploration of specific online database search engines, including ACM, Citeseer, Elsevier, ERIC, IEEE, IGI Global, Sage Publications, ScienceDirect, Springer, and Taylor & Francis. However, a scarcity of sources specifically addressing elements of ad hoc mobile technology-enhanced learning and associated frameworks was noted.

Mobile technology-enhanced learning was defined in Chapter 1 as a combination of mobile devices, m-learning, technology-enhanced learning and blended learning. This definition was inspired by the work of El-Hussein and Cronjé (2010) who propose the compartmentalisation of key constituents of m-learning. Concurring with this view, mobile technology-enhanced learning is seen to embrace many dimensions of educational technology. In the context of this study, mobile technology-enhanced learning touches aspects of e-learning, m-learning, technology-enhanced learning and blended learning, with additional conceptual attributes of its own. This observation justifies the inclusion of source material from other learning modalities.

Iteration 1 led to an initial set of 175 articles from 'Phase 1 – Planning'. 'Phase 2 – Selection' reflects the further refinement of the article selection process. Planning consisted of a 'preparing for analysis' phase that covers the setting up of ATLAS.ti V8.0 (Bandara et al., 2011), in readiness for 'Phase 3 – Extraction'. Thereafter, 'Phase 4 – Execution' made provision for the reporting of outcomes of the systematic literature review.

Phase 2 Selection: appraising

The resultant sources after the screening in 'Phase 1 – Planning', served as input to this phase. The explicitly defined literature sources were appraised for relevance, limiting the scope of the review (Fink, 2005). This led to a focused selection process comprising a further four iterations, determined by inclusion and exclusion criteria. The inclusion (I1 to I6) and exclusion (E1 to E6) criteria were applied to the 175 articles selected at the end of Phase 1.

The inclusion criteria were defined by the following search terms:

- I1: Addresses the use of digital technologies for educational purposes;
- I2: Suggests factors – in framework format or otherwise – for the success of educational technology.
- I3a: Incorporates articles published between 2005 and 2016;
- I3b: May include articles authored by experts, published prior to 2005;
- I4: Pertains to higher education contexts;
- I5: Has peer-reviewed journal articles and conference proceedings, e-resources, chapters; and
- I6: Focuses on one of five learning modalities, namely e-learning or m-learning or technology-enhanced learning or blended learning or ad hoc mobile technology-enhanced learning.

The study investigated a specific higher education context. It focused on learning modalities that used digital technology to enhance teaching and learning aided by mobile technology. Recent academic publications that addressed frameworks and success factors were sought.

For these reasons, the following exclusion criteria were applied:

- E1: Does not address educational use of digital technology;
- E2: Does not contribute to an understanding of frameworks or critical success factors;
- E3: Is not a suitably current publication; more recent articles exist;
- E4: Does not research HE contexts;
- E5: Is not a designated academic publication;
- E6: Does not relate to specified learning modalities associated with the study; and
- E7: Allows refinements due to deeper analysis.

Iteration 1 consisted of multiple scans of available literature sources. Various processes were followed, including snowball searching where one excellent source led to another, the deliberate review of recommended ‘guru’ articles, and the investigation of previously conducted literature reviews. These processes established an early selection defined in ‘Phase 1 – Planning’, comprising a total of 175 articles. During Iteration 2, the application of exclusion criteria reduced the resource count to 25 articles. Iteration 3 addressed noted gaps linked mainly to the mobile technology-enhanced learning modality and led to the addition of 47 articles, increasing the number of publications to 72.

Finally, Iteration 4 necessitated minor refinements (E7) when deeper analysis was undertaken resulting in the exclusion of three m-learning, four TEL, seven blended learning, and three mobile technology-enhanced learning articles. The minor refinements occurred owing to the location and substitution of stronger and newer article versions, removal of non-academic papers and articles not suited to digital education, and a topic focus of educational outcomes associated with teaching and learning rather than criteria pertinent to the study. This step required the exclusion of 17 articles, reducing the selection total from 72 to 55 articles. Table 2.5 sets out the steps to the final set of publications that comprised these 55 articles.

Four iterations (1 to 4) with exclusions and additions are summarised in Table 2.5. While iterations 1, 3 and 4 comprised singular activities, iteration 2 consisted of six exclusion criteria, each of which was applied where appropriate.

Table 2.5: Summary of iterations

Iteration	Descriptor	EL	ML	TEL	BL	MTEL	Total
1	Result of first iteration: initial screen	23	66	73	13	0	175
2	E1: does not address educational use of digital technology	0	3	5	1	0	9
	E2: does not contribute to an understanding of frameworks or critical success factors	11	35	44	9	0	99
	E3: is not a suitably current publication; more recent articles exist	4	8	2	0	0	14
	E4: does not research HE contexts	2	1	7	0	0	10
	E5: is not a designated academic publication	3	6	5	0	0	14
	E6: does not relate to specified learning modalities associated with the study	0	0	4	0	0	4
	Result of second iteration: reduction	3	13	6	3	0	25
3	Additional articles sourced to fill noted gap	3	7	10	7	20	47
	Result of third iteration: addition	6	20	16	10	20	72
4	E7: refinement during deeper analysis	0	3	4	7	3	17
	Result of fourth iteration: reduction	6	17	12	3	17	55

Note: EL = e-learning, ML = m-learning, TEL = technology-enhanced learning, BL = blended learning and MTEL = mobile technology-enhanced learning

The review of methodological quality of the selected articles was informed by (Agoritsas et al., 2015). The quality evaluation process reviews whether the final search results have been satisfactory and provides support for the scope of the review.

The four quality assessment criteria (QAC) proposed by Inayat et al. (2014) were customised to suit the nature of the study and are defined as:

- QAC1: Are aims of the article suitably aligned to this study?
- QAC2: Does the article focus on issues in HE contexts?
- QAC3: Is there an easily identified framework or set of criteria?
- QAC4: Are the findings of value for the synthesis of a framework for ad hoc mobile technology-enhanced learning?

In alignment with Kitchenham et al. (2009), I evaluated each of the selected articles using the four listed criteria. An ordinal scale was applied where Yes = 1, Nominally = 0.5 and No = 0. Ratings resulted in an aggregated index for each article with the possibility of minimum and maximum values of 0 and 4 respectively (Alrasheedi et al., 2015). Table 2.6 represents an illustrative sample of the finalised evaluation outcomes reported in Appendix A.3: Quality Assessment Details.

Table 2.6: Quality evaluation outcomes

ID	Author(s)	Abbreviated Title	QAC1	QAC2	QAC3	QAC4	Index
P01	Inglis (2005)	Quality improvement, quality assurance, and benchmarking	1	1	0.5	1	3.5
P02	Marshall (2010)	Change, technology and higher education	1	1	0.5	0.5	3
P03	Schoonenboom (2014)	Using an adapted task-level technology acceptance model to explain	1	1	1	1	4
P04	Alrasheedi & Capretz (2015)	Determination of critical success factors affecting mobile learning	1	1	1	1	4
P05	Botha et al. (2012)	Towards a mobile learning curriculum framework	1	1	1	1	4
P06	Cochrane et al. (2015)	Emerging technologies in New Zealand	1	1	1	1	4
P07	Farley & Murphy (2013)	Developing a framework for evaluating the impact and sustainability of mobile learning initiatives in HE	1	1	1	0.5	3.5
P08	Fetaji & Fetaji (2011)	Devising m-learning usability framework	1	1	1	0.5	3.5
P09	Harpur & De Villiers (2015b)	MUUX-E, a framework for evaluating the usability, user experience and learning features of m-learning environments	1	1	1	1	4
P55	Webb (2014)	Pedagogy with information communications technologies in transition	1	0.5	0.5	0.5	2.5
Overall aggregated indices			**1**	**0.9**	**0.7**	**0.7**	**3.3**
			100%	**89.1%**	**73.6%**	**66.4%**	**82.3%**

Note: QAC1 = Are aims of the article suitably aligned to this study? QAC2 = Does the article focus on issues in HE contexts? QAC3 = Is there an easily identified framework or set of criteria? QAC4 = Are the findings of value for the synthesis of a framework for mobile technology-enhanced learning?

In keeping with the evaluation method and reporting strategy adopted by Kitchenham et al. (2009), an overall quality index for each of the four criteria was calculated. These values are reflected in the final row of Table 2.6. An overall aggregated index for all selected articles of 82.3% indicates that from these values it can be concluded that the quality of the systematic literature review was satisfactory. The quality evaluation outcomes ground the analysis included in Chapter 3.

Figure 2.7 reflects an analysis of search engines and databases consulted during the review process. It illustrates the percentage contributions of Google Scholar (38%), Springer LINK (16%) and Elsevier (13%). In addition, it demonstrates the use of a broad spectrum of search engines and databases.

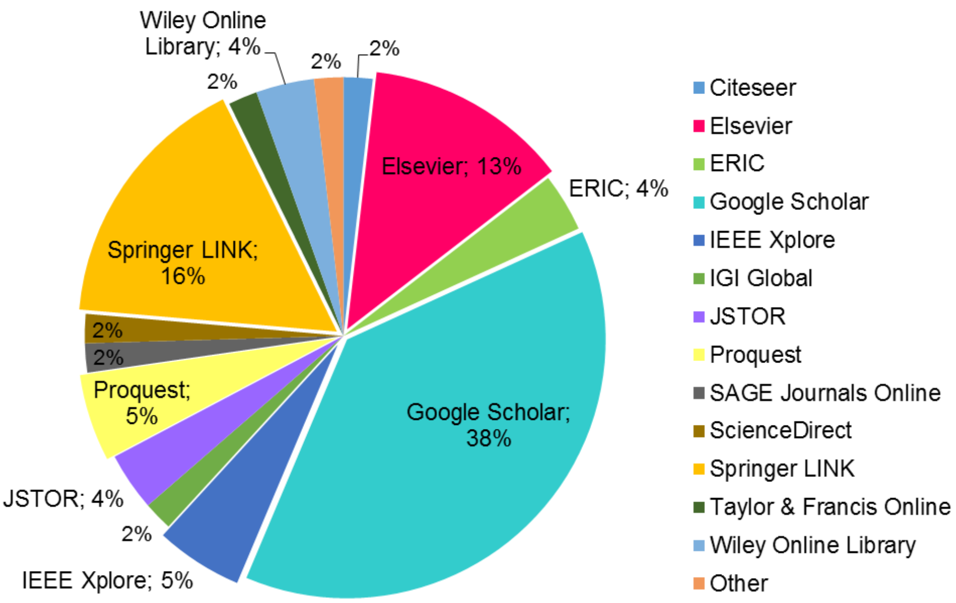

Figure 2.7: Search engine and database analysis

Table 2.7 delivers a selection of the final 55 articles that constitute the foundation of the systematic literature review. It presents the outcome of 'Phase 2 – Selection' and simultaneously provides a starting point for 'Phase 3 – Extraction'. The full list is included as Appendix A.4. Sources are indexed (ID) and described textually in columns two, three, four and five, respectively defined as Author, Abbreviated Title, Article Type and Strategy. Tabular data is sorted according to learning modalities (LMs) in column six as e-learning (EL), m-learning (ML), technology-enhanced learning, blended learning (BL) and mobile technology-enhanced learning. Furthermore, column seven designates items as either a framework source (FW) or additional source (AS). Supplementary information – labelled as Methodology, Participants and Analysis – establishes the theoretical context for the review in keeping with a well-structured, systematic literature review.

Table 2.7: An excerpt of the refined selection of 55 articles

ID	Author(s)	Abbreviated Title	Article Type	Strategy	LM	Source	Methodology	Participants	Analysis
P01	Inglis (2005)	Quality Improvement, Quality Assurance, and Benchmarking	Journal Article	Theoretical	EL	FW	Comparative review	-	Content
P02	Marshall (2010)	Change, technology and HE	Journal Article	Theoretical	EL	FW	Position paper	-	Benchmarking
P03	Schoonenboom (2014)	Using an adapted task-level technology acceptance model to explain	Journal Article	Empirical	EL	FW	Survey research	Practitioners	Exploratory
P04	Alrasheedi & Capretz (2015)	Determination of Critical Success Factors Affecting Mobile Learning	Journal Article	Theoretical	ML	FW	Systematic literature review	-	Content
P05	Botha *et al.* (2012)	Towards a Mobile Learning Curriculum Framework	Conference Proceedings	Theoretical	ML	FW	Design-based research	-	Iterative
P06	Cochrane *et al.* (2014)	Emerging Technologies in New Zealand	Chapter	Empirical	ML	FW	Case Study	Students, Lecturers, Researchers	Discourse
P07	Farley & Murphy (2013)	Developing a framework for evaluating the impact and sustainability of mobile learning initiatives in HE	Conference Proceedings	Theoretical	ML	FW	Systematic literature review	-	Study
P08	Fetaji & Fetaji (2011)	Devising MLearning Usability Framework	Conference Proceedings	Empirical	ML	FW	Case study	Students	Case-based
P09	Harpur & de Villiers (2014)	MUUX, a framework for evaluating the usability, user experience and learning features of MLearning environments	Journal Article	Empirical	ML	FW	Design-based research	Students, Experts	Evaluation

Note: LM = Learning Modality, FW = Framework source, AS = Additional source

Phase 3 Extraction: analysing

The final selection of articles for the systematic literature review was imported into ATLAS.ti V8.0, a Computer-Assisted Qualitative Data AnalysiS software (CAQDAS) tool discussed in Section 2.7.2. An *a priori* codebook was not utilised. However, initial coding in 'Phase 2 – Selection' intuitively incorporated concepts that emanated from the research topic, problem, questions and objectives prior to reviewing the literature.

During 'Phase 3 – Extraction', words and phrases – quotations from selected articles – were extracted and open-coded in readiness for the synthesis to be performed and reported in Chapter 3 (Okoli & Schabram, 2010). This step divided data into manageable pieces to support understanding and categorisation (Dey, 2003). The extraction process was iterative and applied to "…systematically capture, code, and analyse the literature within one single repository…" (Bandara et al., 2011:3).

Further iterative development of a theoretically based and customised codebook evolved in parallel. Axial coding of extracted content comprised a refinement of initial codes leading to a focused emergence of patterns and connections between encoded snippets. This process aimed to establish framework elements – constructs, categories, sub-categories and items (Seidel, 2008). Nodes provided locations for encoded segments, enabling the labelling and organisation of text sections.

Query functionality and the construction of memo snippets supported pattern searching. Writing of memos recorded research anecdotes and created opportunities for reflection, analysis, integration and interpretation. In addition, memo content supported interpretive synthesis achieved in 'Phase 4 – Execution'.

Finally, selective coding (Strauss & Corbin, 1994) sought to identify core categories, providing a central hierarchy rather than a peripheral framework structure. The five network maps, Figure 3.2 to Figure 3.6, represent analytical linkages between codes and quotations, codes and codes, quotations and quotations and memos, providing a visual understanding of framework connections and associations. Results of multi-dimensional thematic analysis of extracted concepts are discussed in Chapter 5, where theoretical and empirical patterns are integrated.

The findings of 'Phase 3 – Extraction' are found in Chapter 3, Section 3.2.

Phase 4 Execution: writing

A qualitative synthesis was undertaken owing to the methodological diversity of sourced articles. This phase interpreted and synthesised information gleaned from selected literature sources (Okoli & Schabram, 2010), developing the systematic literature review (Chapter 3). Additionally, it provided thematically organised content

(Khoo et al., 2011) where linkages and patterns were sought between constructs, categories, sub-categories and framework elements in the reviewed studies. Tabulated and graphical presentations alongside a clearly understandable write-up contributed to the proposal of a theoretically based mobile technology-enhanced learning framework at the end of Chapter 3. The subdivision of conceptually arranged sections and sub-sections facilitated flow and coherence.

The systematic literature review reported a synthesis, a hierarchical summary of identified yet disparate concepts relevant to this study. The review established boundaries for the study. In Chapter 3, the methodologically reported analysis culminated in two noteworthy contributions. Firstly, Table 3.14 and Table 3.15 collectively detailed the constituents of the framework. Consequently, a partial answer emerged for the first main question, MQ1: *What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?*

Secondly, Figure 3.7 proposes a framework for ad hoc mobile technology-enhanced learning. This diagram constructs a succinct view of the theoretically based elements of the framework, addressing the second research question, *MQ2: How are the elements of the framework related?*

Phase 4 reviewed literature sources identified and coded in preceding phases, highlighted the varying foci of the selected frameworks and additional sources, and suggested constructs, categories, sub-categories and items associated with a framework for mobile technology-enhanced learning. This analysis is reported in Chapter 3, where the method of "constant comparison" (Glaser & Strauss, 1967:105) was applied, incorporating immersion (Borkan, 1999), data reduction (Miles & Huberman, 1994) and crystallisation (Ellingson, 2009). Further review of the extracted selection of 55 theoretical sources resulted in the synthesis of a theoretically based framework for mobile technology-enhanced learning, addressing aspects of the research questions.

The review served several purposes. It established a vehicle for me to address a gap identified in Chapter 1 concerning a framework of elements that inform mobile technology-enhanced learning. It responded to Okoli and Schabram (2010:38), who comment:

> … if there is a shortage of studies in an area, the scoping study … would highlight this dearth, and would guide the researchers in designing a primary study that fills the identified gap…

In the process, it consolidated the body of literature concerning quality-oriented, educational technology initiatives where the ad hoc use of mobile technology has the propensity to enhance teaching and learning. Finally, it presented the potential to inform institutional policies and practices, grounded in sound theoretical premises.

2.6 Empirical design: an exploratory case study research

A single exploratory case study set in a higher education context in South Africa constituted the empirical portion of the research. The case was delineated by a stakeholder group associated with a part-time distance-learning architectural technology programme, delivered to distance-learning students. Stakeholder-respondents encompassed a domain expert, the faculty head, faculty academics, architecture students and architecture lecturers.

2.6.1 Introduction to the empirical section

Institutional ethical clearance granted permission to collect data from potential respondents via gatekeepers. This constraint did not apply to the domain expert and the faculty head as they filled the role of gatekeeper. However, I was unable to access the main respondents directly, namely, faculty academics, architecture students and architecture lecturers. Faculty and architecture lecturers indicated they were too busy for interviews but were prepared to complete survey questionnaires. Students only attended campus twice a year for busy block sessions. The gatekeepers indicated time could thus not be allocated to interviews precluding the possibility of traditional qualitative data- collection methods such as observation and face-to-face interviews. Consequently, the administration of online, self-completed questionnaire surveys that incorporated several open-ended questions aimed to emulate structured interviews. For this reason, a brief summary of survey research is followed by justification for a case study strategy. Thereafter, the design of the case, data-collection processes and instruments, (Section 2.6.2) and empirical methods comprising a three-phase strategy are discussed (Section 2.6.3).

Outline of survey research

Robson and McCartan (2016:246) suggest surveys have “a fixed design”, and involve “the collection of a small amount of data in standardized form” from “representative samples of individuals from known populations”. Survey research is traditionally associated with data collection reported in quantitative research studies. Surveys supply an inexpensive and effective way of collecting large volumes of replicable data in short periods of time, with lower costs, and the possibility of generalisation of findings to other contexts (Haron et al., 2012; Lai et al., 2012; Walker et al., 2012). Consequently, I designed survey questionnaires to collect data from students and lecturers as surveys are:

> … particularly useful in describing the characteristics of a large population … especially self-administered ones make large samples feasible … are flexible … allow you to ask many questions on a given topic … standardized questionnaires have an important strength in regard to measurement ... by having to ask exactly the same questions of all subjects and having to impute the same intent to all respondents giving a particular response … (Babbie, 2008:303).

I used Internet-based digital data collection via web-based mechanisms, providing immediate feedback and safe and secure online storage of data and emailed questionnaires. Emails were used to invite responses by directing recipients to a website. Digital approaches suited to mobile device compatibility were favoured for the administration of paperless data-collection instruments. The administration of self-completed, digital surveys led to lowered cost and increased speed of data collection (Robson & McCartan, 2016).

However, while survey research allowed access to geographically diverse participants, the approach focused mostly on the collection of slice-in-time, multiple data types (Oates, 2006). I heeded Babbie’s warning (2008:304) concerning issues associated with survey research:

- A lack of appropriateness for all respondents;
- Superficiality of findings associated with complex topics;
- Poor development of a feel for social contexts connected to thinking, acting respondents; and
- An initial yet unchanging study design throughout the project.

Ultimately, the analysis process demonstrated that none of these problems materialised. Additionally, the best of the survey research methodology, namely data collection via custom-designed questionnaires, was adopted without the design and implementation of a formal survey research strategy.

Domain and case study as a choice

Despite the appropriateness of survey research, the architectural technology domain underpinning the study offered a unique and contained research opportunity. Consequently, I decided preferably to design a typical and convenient case as a data-collection tool. Boundaries between institutional use of technology to enhance educational experiences and the informal and personalised use of mobile technology by lecturers and by students appeared to be blurred. Thus, having considered survey research as a feasible data-collection option, a case study strategy seemed a more suitable approach (Creswell, 2014).

A case study strategy was adopted as it:

- Aided the investigation of a "contemporary phenomenon in depth and in its real-world context" (Yin, 2014:235);
- Uncovered issues, possibly common to other situations via a single, revelatory case that may be almost anything such as a "group of people" (Runeson & Höst, 2009:139);
- Provided opportunities to gather rich and thick data directly from a real-world higher education context (Yin, 2014);
- Applied multiple episodes of evidence collection among diverse respondents as part of an empirical inquiry (Yin, 2014; Robson & McCartan, 2016);
- Supported a "search for meaning and understanding" (Merriam, 2009:39);
- Facilitated in-depth and holistic exploration of phenomena in natural settings, addressing the complexities and messiness of everyday life (Yin, 2014); and
- Embraced the flexibility of multiple data-collection methods, aimed at producing rich insight with the potential to investigate new theoretical perspectives (Oates, 2006).

The approach supported the exploration of mobile interactivity and experiences of higher education stakeholders in a single context of use. In order to grasp the complexity of the context, several differing data sources were selected to support triangulation (Stake, 1995; Robson & McCartan, 2016). Natural and ad hoc usage of mobile technology is personal and idiosyncratic, and is difficult to study. This study investigated contemporary issues such as changing digital trends and diverse stakeholder attitudes that permeate the use of mobile technology for educational purposes and traverse boundaries between social and educational spheres. A bounded and complex mobile setting involves social learning where boundaries between phenomenon and context are not easy to discern (Runeson & Höst, 2009; Yin, 2014). A case study strategy allowed the direct collection of rich and thick data in a real-world, higher education context. Furthermore, information was gathered from relatively few respondents, where I was unable to control data-collection conditions directly (Benbasat et al., 1987). While the research was *not* undertaken as a laboratory experiment or as a purposive intervention, a holistic view was adopted (Lincoln & Guba, 1985; Merriam, 1988).

Two illustrative studies that address facets of mobile technology in higher education environments highlight the pertinence of case study research using questionnaires as data-collection instruments. Pérez-Sanagustín et al.

(2012) applied a case study strategy to explore a blended-learning scenario in a specific undergraduate environment. The study administered questionnaires among student respondents, collecting both qualitative and quantitative data. Farley et al. (2015) incorporated online surveys and face-to-face focus groups, designed to examine student perceptions of mobile learning.

Despite the applicability and benefits of case study research, Yin (2014) highlights limitations of a case-study approach as: a lack of statistical generalisability, the possibility of biased reporting, unwieldy amounts of data, and implementation difficulties calling for consultation with experts and literature sources to build skills and acumen.

In accordance with Merriam (2009) and Yin (2014), a single-case, exploratory case study provided textual data between September 2014 and January 2015, providing the opportunity to explore the ad hoc use of mobile technology. The design was guided by the research problem and questions outlined in Section 2.2, facilitating the meeting of the objectives of the study. Furthermore, the empirical design aligned with an initial theory-building investigation (Chapter 3). Analysis of empirically collected data (Chapter 4) contributed to the theoretical perspectives emerging during the systematic literature review.

The case study supported the inclusion of multiple perspectives and complex, natural contexts where mobile technology usage by stakeholders was the focus of the study. The research design consisted of "different groups such as from the perspectives of students, instructors, and university management" (Alrasheedi & Capretz, 2015:49).

The approach aligns with that of Bozalek et al. who address the role played by champions of educational technology, indicating:

> opinion leaders need to purposefully create an enabling environment by giving recognition to and communicating with change agents, and developing policies that will encourage institutional-wide engagement with emerging technologies (Bozalek et al., 2013:1).

Lecturer feedback was incorporated in the design in agreement with Nguyen et al. who comment:

> There has been little concern about engaging academics, motivating them and discussing with them possible changes to their teaching and research processes, or taking into account various social and human factors, such as cultural outlook, preferences and sensitivities of innovators and adopters (Nguyen et al., 2015:9).

The case study research process comprised several steps (Runeson & Höst, 2009:137-138), namely:

- Multiple evidence collection methods and instruments (Section 2.6.2);
- Preparation of data-collection instruments, procedures and protocols (Section 2.6.2);
- A phased approach (Section 2.6.3);
- Analysis and interpretation (Section 2.7.3); and
- Reporting (Section 2.7.4).

Case study context and protocol

Figure 1.1 from Chapter 1 is repeated here for convenience as Figure 2.8. The zone marked "4" marks the combination of on-campus, face-to-face learning experienced during biannual block sessions; the causal and informal way stakeholders use mobile technology in their own idiosyncratic ways to support their learning mechanisms; and the role of an institutionalised blend of technology-enhanced learning in support of virtual design studio activities. It:

- Depicts the architectural technology context of the study;
- Illustrates the components of a blended-learning programme; and
- Incorporates the ad hoc, informal and social use of mobile technology to enhance learning.

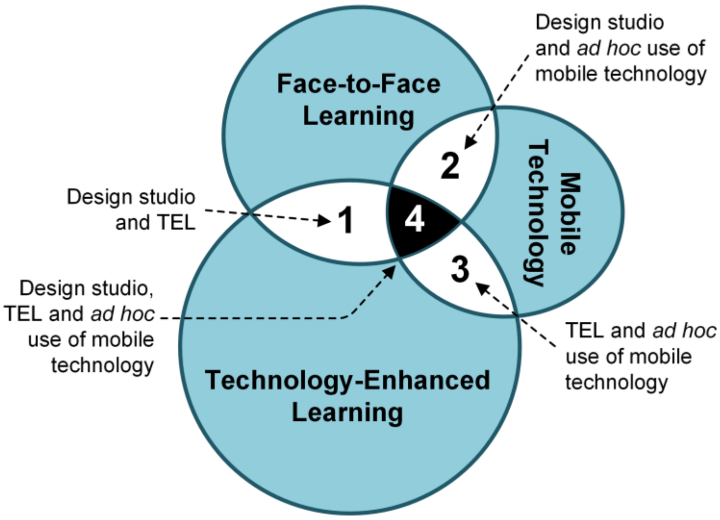

Figure 2.8: Architectural technology in the context of the study

Educational components such as social networking technologies were used in addition to face-to-face block sessions. Respondents incorporated ad hoc mobile technology to manifest personal productivity preferences informally. An institutionally implemented technology-enhanced learning initiative supported the delivery of a curriculum customised for an ill-defined, higher education domain in a South African undergraduate architectural technology programme. Stakeholders comprised institutional leadership, faculty experts, departmental lecturers and architectural technology students. The blended-learning environment comprised a mix of face-to-face, studio-based block sessions and online, distance-learning processes. This cross-sectional study focused on a contemporary subject of investigation, namely, an existing educational situation where mobile technology had the potential to improve teaching and learning. A case study strategy established a 'slice-of-time' platform for the gathering of sufficient rich and thick data to address the research questions of the study.

A case study protocol (Appendix B.2) served several purposes. It supported a case study checklist (Runeson & Höst, 2009), suggested research guidelines (Maimbo & Pervan, 2005), planning (Brereton et al., 2008) and defined data-collection procedures, question definition and quality measures (Yin, 2014).

The case

In keeping with guidelines for case study research (Yin, 2014), a purposive and convenient sampling strategy defined the case as a small and specifically selected subset of a larger population (Oates, 2006; Creswell, 2009). This method was adopted as it is "…a type of nonprobability sampling in which the units to be observed are selected on the basis of the researcher's judgment about which ones will be the most useful or representative…" (Babbie, 2008:204). Taylor and Newton justify the inclusion of "academic staff who were either 'early adopters' or 'early majority' categories … meaning that they were very interested in change but were not lone technology pioneers and so appreciated significant university support" (Taylor & Newton, 2013:55). The case excluded suppliers of a customised learning portal, university administrators and employers of student respondents.

I purposively selected a suitable case that sought sufficient data to attain data saturation (Padgett, 2017). The case comprised a small, bounded community of respondents and aimed to gather quality-oriented feedback rather than a maximal set of data. Whereas the sampling frame comprised a set of higher education faculties and associated departments, a conveniently selected case embraced a subset of a single faculty that offered an architectural technology programme. This programme implemented a technologically rich and evolving environment, under guidance of a few 'champions', and delivered the innovative, blended-learning model to a part-time, final-year undergraduate cohort. Besides its convenience, the case was purposively selected for educational innovativeness, boundedness and a genuine curiosity regarding the potential of the design for other faculties and departments.

The case comprised a respondent group consisting of the faculty head, a domain expert, a convenient and purposive sample of faculty academics (n=5). Additionally, it consisted of all architecture lecturers (n=3) and the cohort of distance-learning architecture students (n=14) associated with the initial rollout of a part-time, blended-learning programme. Section 2.6.3 provides respondent information associated with the three-phase method that totalled six studies, presented as Table 2.11, Table 2.12, Table 2.13 and Table 2.14.

Throughout the chapter, the following naming convention interchangeably describes case respondents as: faculty head [FH], domain expert [DE], faculty academics [A1 to A5], architecture students [S1 to S14] and architecture lecturers [L1 to L3].

2.6.2 Data-collection procedures

The case outlined in Section 2.6.1 served as the vehicle for multiple data-collection methods, including interviews and questionnaire surveys. This section discusses the methods used and defines the design of data-collection instruments.

Multiple data-collection methods

The study's context, illustrated earlier as Figure 2.8, dictated methodological choices suited to an exploratory case study strategy. The selected methods considered social constructions and were thus dependent on interactivity between and among myself and respondents. Interpretation of findings applied conventional hermeneutical techniques (Guba & Lincoln, 1994) whereby data collection and analysis decisions are made based on the application of my own interpretive perceptions, personal intuition and experiential understanding of the meanings of encoded snippets (Pries-Heje, Baskerville and Venable, 2008).

The data-collection methods underlying the single holistic case study strategy of this research aimed to elicit attitudes to the ad hoc use of mobile technology-enhanced learning for education purposes. The study adopted data-collection methods typically associated with qualitative research such as unstructured and semi-structured interviews and document analysis. However, qualitative research may incorporate quantitative methods such as questionnaires classically allocated to quantitative studies (Lincoln & Guba, 1985). Merriam (2009:42) comments:

> Unlike experimental, survey, or historical research, case study does not claim any particular methods for data collection or data analysis. Any and all methods of gathering data, from testing to interviewing, can be used in a case study, although certain techniques are used more than others.

Although quantitative methods traditionally include survey designs, qualitative methods may also incorporate interview and questionnaires surveys, aimed at capturing descriptive data – both textual and numerical, and portraying trends and opinions of a sample from a population (Creswell, 2009).

Following Saunders and Tosey (2013:59), who comment that a multimethod design may "…use more than one qualitative data collection technique … with associated analysis procedures", different data-collection methods were used. Data-collection methods collected mostly qualitative and some quantitative data (Creswell, 2009) via unstructured and semi-structured interviews and custom-designed questionnaire surveys, contributing multiple sources of evidence. Multiple sources of data resulting from deep probing afford the opportunity to explore a range of issues, whether they be attitudinal or behavioural (Yin, 2014).

Direct interface with unavailable lecturers and geographically dispersed, distance-learning students was not feasible. Furthermore, students attending occasional campus-based, block sessions were not personally contactable. Additionally, in accordance with ethical clearance conditions, links to online questionnaires were circulated via the domain expert. These logistical complexities obviated data collection by interview. It was thus deemed expedient to collect data digitally via customised, Internet-based questionnaires, designed to emulate semi-structured interviews. Questionnaires comprised a mix of open-ended and closed questions, gathering opinions, experiences, attitudes and beliefs, expressed in the respondent's own words. In addition, domain knowledge and content linked to the case study was gathered during analysis of documentation, stored in an online institutional repository. The review of course-related documentation (Study 1.2) gave contextual background to the study. Sources of data are outlined in Section 2.6.3, where 'Phase 1 – Preamble' is discussed.

Instrumentation

Data-collection instruments consisted of three survey questionnaires custom designed respectively for: Study 1.3 – faculty academics, Study 2.1 – architecture students (Appendix B.6) and Study 3.1 – architecture lecturers (Appendix B.7). Table 2.8 lists questionnaire sections and related foci.

Table 2.8: Structure of questionnaire instruments

Division	Focus
Section 1: Context (Studies 1.3, 2.1, 3.1)	Survey questions collected demographic and contextual data via multiple choice, matrix, Likert and open-ended questions. Focus of the questions addressed connection, communication and collaboration patterns associated with education contexts.
Section 2: Usage (Studies 1.3, 2.1, 3.1)	Multiple choice, matrix, Likert and open-ended questions investigated the use of mobile technology – devices and applications – to support teaching and learning activities.
Section 3: Experiences (Studies 1.3, 2.1, 3.1)	Likert-type and open-ended questions gathered feedback describing teaching and learning experiences, institutional strategy, tablet technology and suitability of course material for a mobile context.
Section 4: Expectations (Studies 1.3, 2.1, 3.1)	Likert-type and open-ended questions elicited opinions and attitudes regarding motivation, affordability, potential success and mobile technology preferences.
Section 5: Networks (Studies 1.3, 2.1, 3.1)	Questionnaire item types involved multiple choice, matrix, Likert and open-ended questions and concerned applications affording interactivity between students and lecturers together with influential and ongoing changes in teaching and learning.
Section 6: Technology and Education (Studies 2.1 and 3.1 only)	Likert-type and open-ended questions explored opinions and attitudes regarding mobile technology choices, potential educational outcomes, the blended-learning context, and the architectural technology programme.

Convenient collection of data in digital format relative to a single context (Oates, 2006:37) was conducted by structured and custom-designed Google Forms questionnaires from faculty academics, architecture students and architecture lecturers. Literature sources informed the inclusion of instrument content, specifically pertinent to the needs of the study, enabling the answering of the research questions (Cohen et al., 2007). The design of an initial draft version of the instrument was influenced by pertinent literature sources encountered during the systematic review (Section 2.5), feedback gathered during the unstructured interview with the domain expert (Study 1.1) and the analysis of documentation stored in the institutional repository (Study 1.2).

After preparation of an initial draft version, the domain expert reviewed the instrument advising adjustments to improve logical flow, readability and clarity of the questions. Suggested modifications resulting from this feedback led to rectification of experienced confusion, a call for the separation of communication and social networking questions, and the inclusion of an additional section addressing educational aspects associated with mobility and technology, thus improving both the quality and focus of collected data. While instrument content was retained, wording of questions was improved to suit a student audience in readiness for Study 2.1 (architecture students). After some adjustments, the initial instrument was administered among faculty academics (Study 1.3). The body of this instrument comprised five categories of related questions grouped as: Section 1: Context, Section 2: Usage, Section 3: Experiences, Section 4: Expectations and Section 5: Networks.

The two subsequent survey instruments – Studies 2.1 (architecture students) and 3.1 (architecture lecturers) did not differ substantially from the initial instrument. The focus of several questions in the data-collection instruments administered during these studies reviewed aspects of architectural education. However, an additional category – Section 6: Technology and Education – concluded instruments for Studies 2.1 (architecture students) and 3.1 (architecture lecturers). All questionnaires explained the nature of the study, guaranteed anonymity, confidentiality and the right to withdraw at any time together with my contact details.

.Table 2.9: Examples of closed-ended question types

Question-type	Example
List	In response to the statement *"I connect and collaborate wirelessly with other OpenArchitecture students when I am ..."*. Select EACH relevant option: *On the bus; train or taxi; Watching TV; At home; Relaxing…*
Category	Answer the question *"Do you consistently use the same approach to establish lines of communication and collaboration with other students?"* by selecting ONE option from the list provided that resonates with you: *Yes; No; It depends…*
Rating	Rate the statement "Mobile technology skills are valuable in my work environment" by selecting ONE response: *Strongly agree, Agree, Disagree, Strongly disagree*
Matrix	For EACH educational activity: *Library access; Learning portal; Admin…* select the MOST LIKELY mobile device*: Smartphone; Tablet; Netbook…*

Closed-ended questions consisted of list, category, rating and matrix-like items (Table 2.9). Figure 2.9 demonstrates that instruments incorporated open-ended questions such as Q76 "…for which the respondent is asked to provide his or her own answers…" (Babbie, 2008:272). It additionally shows the inclusion of Q77 – a matrix-like question – and incorporates Q78, reflecting a four-point, Likert-type rating questions.

Q76 What have you noticed about the way students use mobile devices and applications to work on projects with each other?

Offer a few BRIEF suggestions in the space below:

Q77 The future of education is changing to a more mobile, flexible, boundary-free conversation between students

Select the MOST relevant option

- ☐ The rapidly changing nature of mobile technology causes chaos and confusion
- ☐ No single student influences the mobile usage patterns of the group
- ☐ There are endless ways that networked students can access course content
- ☐ Students are constantly creating innovative ways of using technology
- ☐ A break in the thread of an online discussion does not mean the conversation is over

Q78 The mobile phone, originally a means of communication, has become a tool for the enhancement of learning

Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Figure 2.9: An illustration of both open- and closed-ended questions

Instrument design aimed to ensure consistency while limiting respondent confusion (Saunders & Lewis, 2012:436). Responses indicated which option best reflected contextual information, opinions and attitudes. Highest scores designated strongest responses (McIver & Carmines, 1981). Aggregated response values led to the determination of basic descriptive statistics such as means, medians and overall measures of scatter, determined during analysis (Section 2.7). These values are incorporated, where applicable, in Chapter 4 and detailed in Appendices E.1 to E.3.

In addition to questionnaire content, the following detail was incorporated:

- Ethical consent considerations that assured respondents of a commitment to anonymity, confidentiality and the right to withdraw at any time;
- An explanation of purpose for the research study underpinning data collection by questionnaires;
- My contact details; and
- A note of thanks for participation.

An Internet-mediated questionnaire administration strategy supported access to questionnaire respondents via a gatekeeper who motivated participation. This necessary process formed part of ethical consent requirements and accommodated distance-learning students situated around the country and non-contactable lecturers. A covering email included a URL link to online Google Forms questionnaires.

After examining the number of respondents, I sent out follow-up emails to encourage the completion of questionnaires. Respondent data was automatically saved to a cloud-based repository prior to being downloaded in Excel format.

While the unstructured interview (Study 1.1) explored several topics in a free and flowing manner, an interview protocol guided the conversation, covering eleven main foci (Appendix B.4). The semi-structured interview (Study 3.2) addressed four central themes (Appendix B.5).

Finally, Table 2.10 indicates the six foci of the empirical data-collection strategy: establishing rapport, determining the research context, implementing an initial exploration, collecting student data, investigating lecturer attitudes and opinions, and achieving enrichment by chatting to the faculty head.

I conducted the hermeneutical study in a natural context of use, aligning with the view of Dahlbom and Mathiassen (1993:225) who comment:

> … hermeneutics will help us understand the complex interplay of people, methods and technology, and the important role of interpretation, personal interests, and values involved in the use of these techniques.

I designed Figure 2.10 to communicate the data-collection framework of the study. The design comprised ‘Phase 1 – Preamble’ with Studies 1.1, 1.2, and 1.3, ‘Phase 2 – Cohort’ with only Study 2.1, and ‘Phase 3 – Faculty’’ with Studies 3.1 and 3.2. Input to the framework emanated from the initial theoretical framework of elements, reported in Chapter 3. The analysis of data collected during the studies ultimately contributed towards the final synthesised framework of elements presented as Figure 5.2 in Chapter 5. In addition, the diagram indicates the final framework emerged from a synthesis of both theoretical origins (Chapter 3) and empirical influences (Chapter 4).

The research process was personal, subjective, interpretive, interactive, and iterative. I sought resonance and analytical generalisation rather than statistical generalisation, and determined qualitative themes and recommendations rather than quantitative outcomes and solutions.

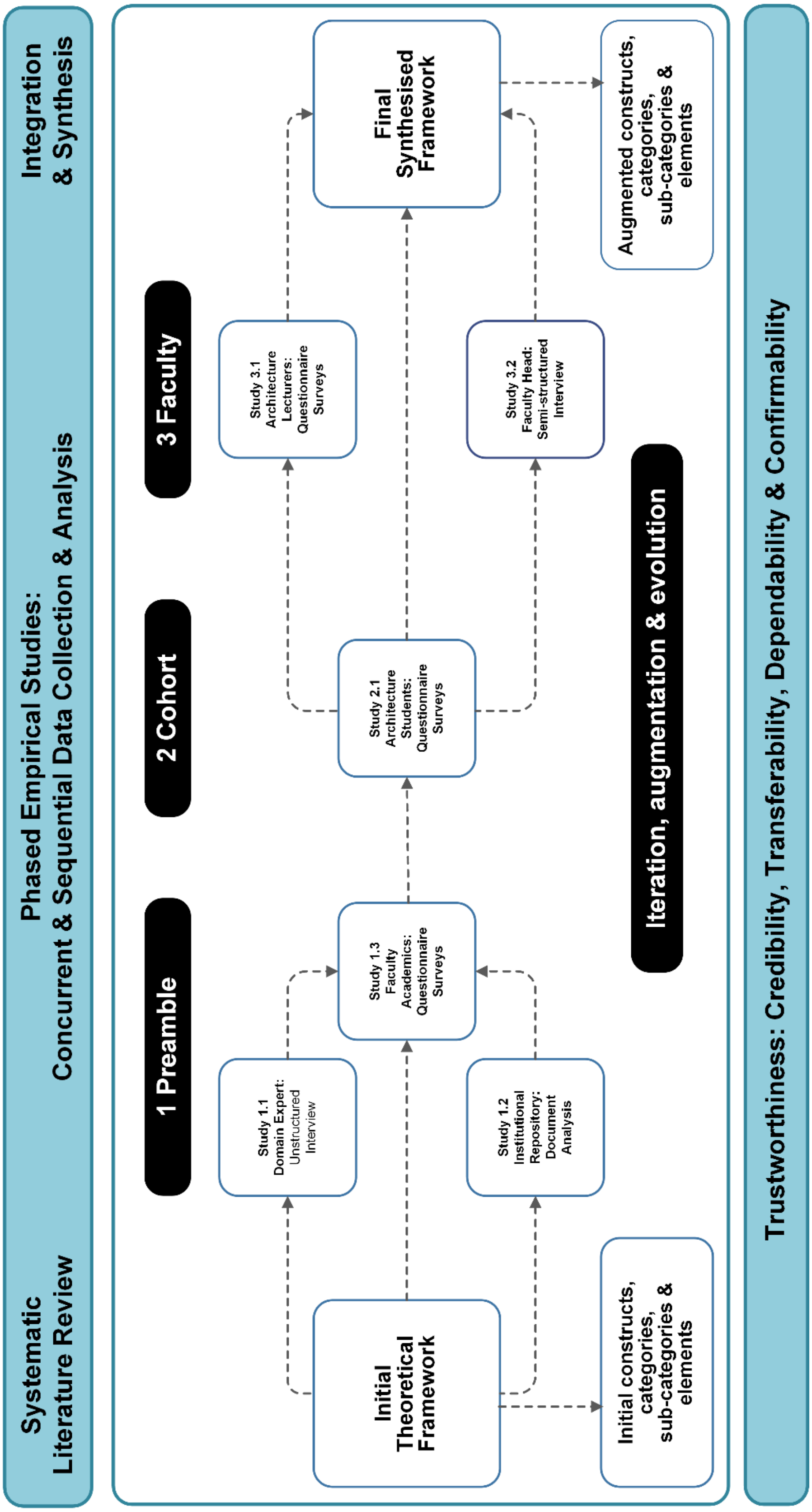

Figure 2.10: My three-phase method comprising six empirical studies

2.6.3 *Empirical methods: three phases and six studies*

The research design incorporated three methods – unstructured and semi-structured interviews, document analysis and questionnaire surveys applied in the phased studies as set out in Figure 2.10 and Table 2.10. Secondary questions map to phases, studies, data sources, methods and research foci.

Table 2.10 illustrates a multi-method research design encompassing purposefully selected data sources. The empirical component of the study explored educational phenomena associated with an architectural technology discipline, mediated socially and informally by emerging mobile technologies. The single, exploratory case study strategy outlined in Section 2.6.2 was designed to collect rich and thick data (Creswell, 2014). The cross-sectional design comprised three focused phases with a total of six separate studies conducted between 2014 and 2015 (Figure 2.10).

Table 2.10: Research design – secondary questions mapped to phases, studies and foci

Phase	Study, data source, method	SQ1.1	SQ1.2	SQ1.3	SQ1.4	SQ1.5	Focus
1. Preamble	1.1: Domain expert Unstructured interview	-	-	■	■	-	Rapport
	1.2: Institutional repository Document analysis	-	-	■	■	-	Context
	1.3: Faculty academics Questionnaire surveys	■	■	■	■	■	Exploration
2. Cohort	2.1: Architecture students Questionnaire surveys	■	■	■	■	■	Collection
3. Faculty	3.1: Architecture lecturers Questionnaire surveys	■	■	■	■	■	Investigation
	3.2: Faculty head Semi-structured interview	■	■	■	■	■	Enrichment

Table 2.10 illustrates a three-phase research design defined by 1. Preamble, 2. Cohort and 3. Faculty. It maps the three phases, six studies, six data sources and four research methods to the five secondary questions, SQ1.1 to SQ1.5.

Phase 1 Preamble – three studies

Table 2.11 outlines 'Phase 1 Preamble' that comprised Studies 1.1, 1.2 and 1.3 and was designed to delineate the background of the study, providing insight and illumination. It constituted an initial empirical exploration of the ad hoc use of mobile technology to enhance teaching and learning in higher education contexts.

Table 2.11: Phase 1 Preamble

Phase 1: Preamble			
Respondents	Study 1.1 Domain Expert	Study 1.2 Institutional Repository	Study 1.3 Faculty Academics (A1 – A5)
	The gatekeeper responsible for the facilitation of the part-time architectural technology programme	N/A	A purposive, non-probabilistic sample of convenience selected from various departments in the same faculty
Instruments	Interview protocol	N/A	Custom-designed questionnaires
Data-collection methods	Face-to-face, unstructured interview	Review and analysis of online documents	Online submission of a custom-designed, web-based research instrument
Purpose	Determination of initial contextual information, feasibility of data collection, scan of first draft of questionnaire survey instrument design	Review of course-related information and support for the draft of the initial questionnaire survey instrument	Piloting of the questionnaire survey instrument. Data collection from departmental lecturers who formed part of the faculty complement

Study 1.1 Domain Expert

Study 1.1 comprised an initial, unstructured and fact-finding interview with a facilitator, the domain expert and educational technology champion responsible for a part-time and blended architectural technology programme.

Hattie (2003) designates educators as experts based on five dimensions: providing essential subject matter, scaffolding of learning through interactivity, monitoring of learning and feedback, and supporting emotional needs. From a design-thinking perspective, Gachago et al. (2017) suggest champions demonstrate: collaboration and generosity, learner empathy, problem orientation, exploration and play, reflection and resilience, a focus on practice, and change agent capabilities.

The domain expert is a registered architect and senior lecturer in the Department of Architectural Technology. She holds a Bachelor of Architecture from the University of Port Elizabeth and a Higher Diploma in Higher Education and Training, and is currently engaged in doctoral studies in architecture. She has taught undergraduate and master's programmes, focusing on history, theory and the design studio for more than 20 years. Her recent responsibilities embrace the implementation of a joint architecture and interior design foundation programme, acting as work-integrated learning coordinator for the faculty.

The study aimed to establish rapport, gauge feasibility of the planned data collection and gather preliminary, in-depth information concerning the architectural technology programme. The interview was conducted in a departmental office and lasted around 40 minutes. Notes were taken recording questions and responses. However, recordings of conversations were not made. The domain expert offered useful links to documentation stored online in the institutional repository. This step justified the inclusion of Study 1.2 that explored the nature of the architectural technology programme via an analysis of institutional documentation.

Prior to Study 1.3, the domain expert desk-scanned the paper-based version of the questionnaire instrument. The appraisal considered layout, logical flow, grammatical and syntactical errors, question-type format and contents. Layout issues were addressed and clarified, resulting in a greater focus being placed on course content, the learning portal, the use of YouTube videos and social networking sites such as Facebook for educational purposes. Several vaguely worded questions were adjusted to avoid respondent confusion, for example, the term 'Blackboard' replaced 'learning portal'. Five-point Likert-type questions became four-point questions to avoid central bias. The review highlighted a need for deeper exploration of blended-learning resources and a closer mapping of survey questions to the architectural technology context.

Study 1.2 Institutional Repository

Study 1.2 served two purposes. Firstly, it provided opportunities to comprehensively review course-related documents stored online in the institutional repository. Thus, during an analysis of documentation, I immersed myself in the details of the architectural technology programme, enabling a deeper appreciation of its focus, content, delivery mechanisms and digital context. Documentation contained information concerning:

- Enrolment requirements;
- Course content – student learning portal, academic partners, and OpenArchitecture;
- Course delivery mechanisms – block sessions, YouTube videos, resources, and webinars;
- Facebook, a socially-mediated educational space – individual and group postings;
- SharePoint portal – announcements, coursework, design journals, hangout files, recorded and screened critiques; and
- Faculty and institutional handbooks.

Secondly, it supported the formulation of the custom-designed questionnaire survey instrument, reviewed by the domain expert prior to administration among faculty academics (Study 1.3). These respondents were selected owing to their expertise in teaching and learning.

Study 1.3 Faculty Academics

Study 1.3 served two purposes. Initially as a pilot study, it aimed to improve the rigour of the research (Nunes et al., 2010) by achieving validity and verifiability of the questionnaire instrument. A pilot study may be defined as a "small scale version … in preparation for a major study" (Polit & Hungler, 1994:467). Blaxter et al. (2001:138-139) suggest:

> You may think that you know well enough what you are doing, but the value of pilot research cannot be overestimated. Things never work quite the way you envisage, even if you have done them many times before, and they have a nasty habit of turning out very differently from how you expected.

Similarly, Babbie (2008:283) emphasises the importance of pretesting questionnaire instruments, commenting:

> … there is always the possibility…of error…some mistake…an ambiguous question…some…violation of the rules…

As a pilot study, Study 1.3 aimed to:

- Evaluate consistency, comprehension, clarity and user-friendliness of the instrument (Baker, 1994);
- Gauge the feasibility of data collection by survey (Peat et al., 2002);
- Inform methodological decisions, rectifying design defects (Kilanowski, 2011);
- Improve quality – reliability and validity of the research (Cohen et al., 2007);
- Address logistical issues such as the operationalisation of the self-administered, online data-collection process (National Centre for the Replacement Refinement and Reduction of Animals in Research, 2014); and
- Determine time required to complete the questionnaire (Van Teijlingen & Hundley, 2001).

The study played a secondary and pivotal role in the research design as a stand-alone exploration. It gathered contextual perceptions of the potential of mobile technology to enhance teaching and learning in a higher education environment.

A team of teaching and learning faculty academics with technology acumen, digital expertise and academic responsibilities was drawn from the case study population (Section 2.6.1). Potential respondents were purposively recruited from a panel of available, suitably qualified educators.

Response rate is calculated as "… the number of people participating in a survey divided by the number selected in the sample …" (Babbie, 2008:288). Ten faculty academics were invited to complete online questionnaires; however, five respondents agreed, leading to a 50 percent response rate.

Table 2.12 summarises attributes of the respondent group for Study 1.3.

Table 2.12: Study 1.3 Faculty Academics

#	Department	Qualification	Educational expertise
A1	Architectural Technology	DTech	Senior Lecturer: Architectural Technology, architect, postgraduate supervisor
A2	Information Technology	DTech	Lecturer: Educational Technology
A3	Graphic Design	BTech	Lecturer: Graphic Design, postgraduate student
A4	Information Technology	PhD	Senior Lecturer: Information Technology, education specialist – research methodology, postgraduate supervisor
A5	Interior Design	MA	Lecturer: Interior Design, researcher – doctoral student, postgraduate supervisor

Respondent feedback highlighted minor questionnaire confusion that required clarification and remediation. Consequently, while some questions were excluded for lecturers, others were inserted for students. In addition, the academics recommended cosmetic improvement to the look and feel of the instrument, indicating a need for improved logic and flow. Furthermore, respondents identified a few grammatical errors requiring rectification. Owing to the small number of reported issues, I decided to incorporate responses to questions in the analysis process. Thus, Study 1.3 offered a data-collection opportunity that contributed to the answering of research questions.

This study presented a piloting challenge as it combined qualitative with quantitative data-collection methods. Quantitative research is often characterised by the use of questionnaire instruments for data-collection purposes (Cohen et al., 2007). Although a qualitative strategy was adopted, the research method atypically incorporated data collection by digital questionnaires. Whereas quantitative researchers are averse to the inclusion of pilot study data in the analysis process (Peat et al., 2002), qualitative researchers may use data collected early during pilot studies in analysis strategies (Thabane et al., 2010). Inclusion of this data is advocated as long as questions being asked are reasonably comparable with the questions being asked in other data-collection methods (Van Teijlingen & Hundley, 2001). Several factors supported the decision to use data from Study 1.3 for analysis purposes:

- The questionnaire was piloted twice – firstly by the domain expert then by faculty academics where the collected and analysed data was of value to the subsequent synthesis of the mobile technology-enhanced learning framework;
- Faculty lecturers were not exposed twice to the questionnaire as they only participated in Study 1.3;

- The minor adjustments to the instrument, as a consequence of Study 1.3, were mostly cosmetic and grammatical;
- The content of the survey instruments administered among faculty academics and architectural technology respondents was very similar even though worded slightly differently; and
- The educational respondents constituted the respondents from the same faculty, hence were representative of the same case study context.

In summary, 'Phase 1 – Preamble' collected preliminary data. In addition, it supported the need for minor changes to the survey instruments, contributing to 'Phase 2 – Cohort' that gathered data from architecture students.

Phase 2 Cohort – one study

'Phase 2 – Cohort' consisted of a single study that digitally administered questionnaires among architecture students.

Study 2.1 Architecture Students

'Phase 2 – Cohort' surveyed architecture students via online questionnaires, exploring habits and opinions regarding the informal use of mobile technology for educational purposes.

Potential respondents received emailed invitations and regular encouragement to complete the questionnaire that incorporated ethical consent requirements – confidentiality, anonymity and right to withdraw. On completion, a gift of a flash drive – a small incentive – compensated for the cost of data usage.

Table 2.13 summarises Phase 2, Study 2.1.

Table 2.13: Phase 2 Cohort

Phase 2: Cohort	
Respondents	Study 2.1 Architecture Students (S1 – S14)
	A purposive, non-probabilistic sample of convenience comprising the entire cohort of students enrolled for the part-time architectural technology programme
Instruments	Custom-designed questionnaires
Data-collection methods	Online submission of a custom-designed, web-based research instrument
Purpose	Data collection encompassing student-oriented feedback – opinions and attitudes, contributing to the answering of the research questions from a student perspective

The responses of the entire cohort of students (*n*=14) contributed digitally to feedback gathered during Study 2.1.

Phase 3 Faculty – two studies

Table 2.14 outlines 'Phase 3 – Faculty' that consisted of two studies: Study 3.1 Architecture Lecturers (*n*=3) and Study 3.2 Faculty Head (*n*=1).

Table 2.14: Phase 3 Faculty

Phase 3: Faculty		
Respondents	Study 3.1 Architecture Lecturers (L1 – L3)	Study 3.2 Faculty Head
	A purposive, non-probabilistic sample of convenience comprising the entire cohort of students enrolled for the part-time architectural technology programme	The dean responsible for the Faculty of Informatics and Design and its departments e.g. Architectural Technology, Graphic Design, Information Technology and Interior Design
Instruments	Custom-designed questionnaires	Interview protocol
Data collection methods	Online submission of a custom-designed, web-based research instrument	A recorded digital conversation in the form of a semi-structured interview
Purpose	Data collection encompassed lecturer-oriented feedback – opinions and attitudes, contributing to the answering of the research questions from a lecturer perspective	Review of the educational strategy underpinning the architectural technology blended model from a strategic perspective

Study 3.1 Architecture Lecturers

Table 2.15 details the roles played by the three lecturer respondents labelled L1 to L3 associated with Study 3.1 Architecture Lecturers, while simultaneously illustrating their expertise in both the architecture and education domains.

Table 2.15: Study 3.1 Architectural Technology Lecturers

#	Roles	Educational expertise
L1	Senior lecturer, architect, programme facilitator, researcher	As a senior lecturer responsible for part-time distance learning architecture students, her educational focus is on teaching of theory and design. Recent responsibilities incorporate the implementation of a joint architecture and interior design foundation programme, acting as work-integrated learning coordinator for the faculty and establishing the part-time programme.
L2	Senior lecturer, architect	He is a registered professional architect, specialising in residential, educational, geriatric, healthcare, industrial and commercial projects.
L3	Professor, educator, external examiner, programme director	She is a registered professional architect with more than 20 years of experience in architecture education. She has filled examiner, leadership and director-level roles with a focus on architectural design, housing and urban design. She is widely published and is a winner of a number of awards.

Architecture lecturers contributed a departmental perspective, providing feedback to questions similar to those in student instruments.

Study 3.2 Faculty Head

A semi-structured interview with the faculty head was conducted via smartphone and digitally recorded, using an application entitled RecordMyCall. Study 3.2 ascertained an institutional and leadership perspective regarding the potential of educational technology.

The faculty head fills dual roles of Dean of Informatics and Design and research professor. He has been a visiting professor at the Sudan University of Science and Technology in Khartoum; Addis Ababa University in Ethiopia; the University of Eastern Finland in Joensuu; and the University of Bergen in Norway. His research interests are mobile learning, constructivist learning, and problem-based learning. He has an avid interest in educational technology and has a prestigious list of graduate master's and doctoral students and a prolific output of academic publications. He has been an instrumental stakeholder in the establishment of the part-time architectural technology programme – the focus of the case study underpinning this research.

The interview protocol for Study 3.2 (Appendix B.5) incorporated four key questions. The questions were disseminated via WhatsApp prior to the interview but not presented in a specific sequence to ensure a natural flow of conversation:

- Thinking back to beginnings of discussions, what strategic institutional issues were being addressed with the implementation of the part-time, blended-learning, architectural technology programme?
- What, in your opinion, has worked really well?
- What, do you believe, still needs to be addressed, can be improved?

- Looking at a bigger picture, under what circumstances would you implement a similar project within other departments in your faculty?

Responses to these questions were transcribed (Appendix C.2), and imported into ATLAS.ti V8.0 for analysis.

2.7 Analysis and interpretation of results

This section reports methods used for the analysis and interpretation of theoretical sources conducted in Chapter 3. In addition, it sets out methods used to accomplish analysis of empirical data (Chapter 4). The applied methods aim to determine theoretically based and empirically determined components of the framework for mobile technology-enhanced learning in the context of the study.

Data analysis makes sense of "text and image data. It involves preparing the data for analysis, conducting different analyses, moving deeper and deeper into understanding the data … peeling back the layers of the onion … representing the data … making an interpretation of the larger meaning of the data …" (Creswell, 2009:183). Analysis techniques aimed to achieve rich and thick descriptions (Lincoln & Guba, 1985).

In accordance with Merriam (2009:23) who suggests "the unit of analysis is a bounded system, a case", the unit of analysis was defined in two ways. For theoretical sources extricated during the systematic literature review, the focus of analysis comprised the set of 55 articles detailed in Chapter 3 as Table 3.3 to Table 3.7. For empirical data, the unit of analysis consisted of the case associated with the study and incorporated all data collected in the unique and extreme educational context.

Although empirical data was collected at an individual level from the domain expert and faculty head, the faculty academics, architecture students and architecture lecturers, findings from the six studies (Section 2.6.3) was ultimately aggregated into one framework of elements comprising constructs, categories, sub-categories and items – the outcome of a hierarchical case study strategy (Trochim, 2006). In keeping with Yin (2014), the unit of analysis of this study equated indistinguishably and directly to the case itself. This approach is referred to as a congenital design comprising one case study and one unit of analysis (Grünbaum, 2007).

Data contributed to a final and overall landscape, implying the collective view of the group emanates from the aggregation of individual input (Cohen et al., 2007). In the process of defining the unit of analysis, the group of respondents was small. Additional potential individuals were deemed to be within the "neighbourhood" (Cohen et al., 2007:31) of the case. However, they were not directly relevant to the research topic and were thus excluded as possible contributors. The category of excluded respondents included administrators, full-time undergraduate and postgraduate architectural technology students and their dedicated lecturers and supervisors.

The units of observation comprised case study respondents, namely Study 3.1 – the Faculty Head [FH] and Study 1.1 – Domain Expert [DE], Study 1.3 – Faculty Academics (A1 – A5), Study 2.1 – Architecture Students (S1 – S14) and Study 3.1 – Architecture Lecturers (L1 – L3). In addition, Study 1.2 that reviewed content linked to the architectural technology programme stored in the institutional repository (IR), served as a unit of observation.

Likert-type and matrix-like data were aggregated and analysed quantitatively leading to basic descriptive statistics, performed to determine demographic and descriptive indices. This data were summarised and visualised (Wexler, 2017). Tabular and graphical formats represented comparisons in differing ways (Preece et al., 2015).

All respondent feedback was indexed and anonymised enabling the maintenance of confidentiality. Interview data was transcribed, stored as Microsoft Word and PDF files and then imported into ATLAS.ti V8.0 in readiness for analysis and interpretation. Similarly, qualitative data gathered from open-ended questions, was downloaded from Google Forms as Microsoft Excel files and then sorted, collated and cleansed. Raw data was safely stored as cloud-based sources in Google Drive folders and in the institutional repository.

Data analysis was determined by all interview data and a selection of pertinent questions per Farley et al. (2015:3) who commented: "The data presented in this article is drawn from a subsection of the questions from the … online survey." Chapter 4 reflects the questions pertinent to analysis (Table 4.3, Table 4.5, Table 4.7, Table 4.9 and Table 4.11).

Theoretically-based codes emerged during the systematic literature review reported in Chapter 3 that formed the foundation for data analysis performed in Chapter 4 (Appendix D). A primary cycle of open-coding applied theoretically based codes (Appendices D.1 to D.5) to data segments. The analysis strategy looked for confirmatory outcomes in Chapter 4, establishing synergy between theoretical premises reported in Chapters 3 and 4. The resulting snippets consisted of hermeneutic segments that reflected attitudes and opinions of respondents. A secondary cycle of coding involved axial coding and led to support for initial sub-categories and framework items. Additional sub-categories and associated empirically determined codes emerged, expanding the codebook of the study. The newly uncovered sub-categories and framework items contributed to the amendment of the framework for mobile technology-enhanced learning.

Encoded, open-ended snippets and matrix-like and Likert-type questions from interviews and questionnaire surveys led to grouped respondent feedback, in readiness for analysis. Aggregated and analysed feedback from all data sources contributed towards a framework of constructs, categories, sub-categories and items.

During analysis, I reviewed research findings and then interpreted the meaning of signs, clues and evidence in a complex, changing and digital environment. Hence, implemented methods entailed processes where:

> …analysis then could be used to analyse such observational data. Once the observations have been documented in some manner, the information then could be coded and chunked, and then the chunked codes could be organized into themes that could be used to generate new theory or, more typically, to support or refute initial codes that have been extracted from other sources (e.g., extant print or digital literature)—as part of the selective coding research synthesis stage (Onwuegbuzie et al., 2012:14).

The approach to analysis of Glaser and Strauss (1967:105) was adopted, whereby the analysis of data occurred by iteratively reviewing lines, sentences and paragraphs of transcribed interview and downloaded responses to open-ended questions. The application of codes to concepts was based on my interpretation of best fit.

In the context of this study, the four stages, identified by Glaser and Strauss, are reflected as follows:

- The comparison of reported events and perceptions relative to previously identified framework categories;
- The integration of categories together with associated descriptors;
- Alignment to theoretical constructs; and
- Reporting of theoretical premises.

Repeated cycles of analysis distinguished categories and sub-categories and established interrelationships and dimensions contributing to the structure of the mobile technology-enhanced learning framework. Categorisation and encoding of selected data during the document analysis process led to the construction of an understanding of reality, as demonstrated by Plowright (2011). In this way, patterns that recurred and the framework that emerged at the end of Chapter 3 evolved further in Chapter 4 where the empirical findings were analysed and interpreted.

Analysis and subsequent interpretation of data was achieved using ATLAS.ti V8.0 as a qualitative data- analysis tool. The sorting of words and phrases applied codes as symbolic representations of reality, where hierarchical artefacts appear as tables and arrays (Miles & Huberman, 1994).

Secondary research questions (SQ1.1 to SQ1.5) guided the use of analytic techniques such as pattern matching and explanation building to further evolve the code book (Yin, 2014). Qualitative data analysis is guided by the inclusion of summarised options. Runeson and Höst (2009:153) recommend the use of "*a priori* codes, i.e. codes are defined based on findings of the researcher …".

A logical coding format was established during the analysis of sources selected for the systematic literature review (Chapter 3). It concretised the coding system and constituted a starting point for the codebook, finalised as Appendix D. Codes were prefixed with either the letter 'T' to theoretically based analysis or 'E' to indicate the code resulted from empirical analysis. Thereafter, an additional letter informed category type followed by a numerical item. For example, code TA01 'Change management' signifies a code with a theoretical origin and links to the concept 'Change management' to Category A. The code EA13 represents the numbered concept 'Access to information' as resulting from empirical analysis and belonging to Category A. This coding strategy emulates the approach advocated by Friese (2014).

2.7.1 The researcher's role and reflexivity

One of the problems underlying a qualitative study is the role and the potential influence of the researcher, highlighting the possibility of subjectivity and researcher bias (Mruck & Breuer, 2003). The possibility of subjectivity requires proactive management. Acknowledgement of researcher impact on the research process and the necessary incorporation of reflexivity may enhance trustworthiness of the study.

Merriam (1988:7) suggests the researcher role is an important facet of qualitative research:

> The importance of the researcher in qualitative case study cannot be overemphasized. The researcher is the primary instrument for data collection and analysis. Data are mediated through this human instrument, the researcher, rather than through some inanimate inventory, questionnaire, or machines.

The research was conducted within a formal and existing blended technology-enhanced learning context where mobile technology was used by respondents as a personal preference. First-hand experiences and perception emphasise the need for awareness of a personal context within the research being undertaken (Gentles et al., 2014).

Begoray and Banister (2010:788) define reflexivity as:

> … the process of becoming self-aware. Researchers make regular efforts to consider their own thoughts and actions in light of different contexts. Reflexivity, then, is a researcher's ongoing critique and critical reflection of his or her own biases and assumptions and how these have influenced all stages of the research process. The researcher continually critiques impressions and hunches, locates meanings, and relates these to specific contexts and experiences.

Moreover, Malterud views reflexivity as "an attitude of attending systematically to the context of knowledge construction, especially to the effect of the researcher, at every step of the research process" (Malterud, 2001:484). Kuo (2008) introduces three forms of reflexivity: personal – authorial presence, epistemological – there are multiple social realities, and methodological – consideration of validity and trustworthiness. The lack of reflexivity in a study may indicate a shortcoming (Newton et al., 2011). However, Newton et al. recommend the inclusion of reflexivity justifies the adequacy of a single researcher, saying when a research project is:

> …done with sensitivity, adequate reflexivity and within a constructivist framework, the interpretation of a single researcher should be considered an acceptable qualitative approach (Newton et al., 2011:15).

2.7.2 Computer Assisted Qualitative Data Analysis (CAQDAS)

Qualitative data was analysed using ATLAS.ti V8.0[3], a computer-supported qualitative data-analysis software (CAQDAS). ATLAS.ti (2015) advocates the use of a CAQDAS tool, citing triangulation, a focus on respondent opinions, context, the need to manifest control, and serendipity as supportive reasons:

- Triangulation – multiple-method data collection is supported, providing possibility for integrated and co-ordinated interpretation of feedback;
- Focus on respondent opinions – feedback kept in close proximity;
- Context – always at hand, part of the research picture;
- Researcher control of research process – ensured at all times; and
- Serendipity – chance to experience surprise.

The study did not depend on a pre-existing codebook. However, it was dependent on open and axial coding. Quotations comprised the selection of snippets of text while memos were interspersed to record my observations and notes. Queries constituted purpose-specific exploration of groups of nodes and network maps visualised relationships between identified framework patterns and components, namely, constructs, categories, sub-categories, and elements. Friese (2014:6) says of ATLAS.ti V8.0: "It allows qualitative researchers to move out of black box analysis and to make the entire analytic process more transparent." ATLAS.ti V8.0 permits the categorisation of textual data and respondent.

In this study, ATLAS.ti V8.0 facilitated the assigning of open codes to textual content in literature sources and in verbal responses gathered from respondents during interviews and from open-ended questions. This allocation of codes and the inclusion of my personal research memos supported the emergence of abstract constructs and a hierarchy of framework components, namely user-defined categories, sub-categories and elements. These components evolved iteratively and were consolidated based on observed commonalities. The initial set of theoretically based codes formed a platform for the subsequent application of *a priori* codes to empirical data. Additional codes enhanced the initial codebook, culminating in a final set of codes from the study (Appendix D). The cyclical analysis process led to the synthesis of themes, consolidating theoretical and empirical portions.

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[3] http://atlasti.com/qualitative-data-analysis-software

2.7.3 Qualitative analysis: thematic aspects

The study was delineated by an interpretive lens comprising a set of binoculars – moderate constructionism (Section 2.3.1), a compass – a systematic literature review (Section 2.5) and an exploratory case study (Section 2.6), a toolbox of research gadgets (Table 2.2) and a map (Figure 2.10). Several artefacts were typographically represented via diagrammatic representations that visually communicated the findings of the study (Dixon, 2015). These illustrations incorporated conceptual and theoretical models, various network diagrams, matrices comprising constructs, categories, sub-categories and elements (Miles et al., 2013) and a framework for mobile technology-enhanced learning.

A hybrid approach to qualitative analysis comprised theoretical foundations where an initial codebook which emerged from literature sources. This initial codebook established an *a priori* template of codes that was later applied during qualitative analysis of empirical data (Boyatzis, 1998). Moreover, further analysis of empirical sources led to additional codes, expanding the codebook. Rigour of thematic analysis is enhanced by the inclusion of both theoretical and empirical coding during theme development (Fereday & Muir-Cochrane, 2006). Outcomes of thematic analysis of sourced articles additionally informed the design of questions for the collection of qualitative data – the empirical component of the study.

Interview feedback was transcribed and then imported as PDF documents into ATLAS.ti V8.*0* "to identify emerging themes" (Souleles et al., 2015:4). Responses to open-ended questions were similarly added to hermeneutic units in the ATLAS.ti V8.0 database.

The emergence of initial themes (theoretical origin) augmented by additional themes (empirical origin) constituted the basis for the answering of research questions SQ1.1 to SQ1.5. Hence, the main research questions MQ1 and MQ2, outlined in Section 2.2, were addressed. Themes were extracted from qualitative data and, where applicable, converted to quantitative data for numerical analysis and interpretation (Oates, 2006).

Analysis of literature sources reported in Chapter 3 was followed by analysis of interview transcripts (Appendices C.1 and C.2) and responses to closed-ended questions discussed in Chapter 4. In accordance with Patton (1980:306), analysis processes are the mechanisms by which "the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis". Analysis processes aimed to identify emerging patterns via iterative application of codes using the "constant comparison" method delineated by Glaser and Strauss (1967:105).

2.7.4 Reporting and dissemination of findings

The qualitative report of this research is characterised in specific ways and takes cognisance of the guidelines suggested by Miles et al. (2013):

- It tells a very specific story sharing the nature of a case study;
- It is supported by historical anecdotes;
- The report communicates an understanding of steps taken, involved respondents and methods employed during the research; and
- The data are focused on coherently illuminating research conclusions while addressing the influence of context.

On a simplistic level and in accordance with Yin (2014:188-189), the reporting of the systematic literature review and the exploratory case study adopted a "linear-analytic … compositional structure". At a deeper level, the approach resonates with Yin who advises the adoption of a "theory-building" structure that constitutes a chain of evidence …" where "the theory may constitute a framework for the analysis". This approach is evident in the study as the interdependent findings of the systematic literature review and the empirical studies are reported in Chapters 3 and 4 respectively, cohesively linking the outcomes of Chapter 3 to the findings of Chapter 4.

Analysed data were categorised, presented as sub-categories in tabular format and interspersed between thick descriptions. The reporting strategy aimed to support transferability of findings (Creswell, 2009).

2.7.5 Ethical considerations

Institutional ethical clearance was acquired, permitting the collection of empirical data (Appendix B.1). Before commencing the empirical studies, informed consent was sought via emailed correspondence with respondents, guaranteeing their right to withdraw or refuse to participate at any phase. Reassurance of anonymity and confidentiality was provided. Respondents were asked to complete online informed consent agreements (Appendix B.3), that affirmed that findings may be viewed as outcomes of academic research and presented at conferences and published in academic journals.

A covering letter was sent providing a clear explanation of the research purpose and procedure together with my contact details. Studies were conducted in a professional manner in a safe and secure research environment. After completing the questionnaire surveys and interviews, respondents were debriefed and thanked for their support and time.

I indicated the intention to avoid plagiarism and to adhere to correct citation principles.

2.8 Trustworthiness

Lincoln and Guba (1985) suggest qualitative research may be evaluated by examining the trustworthiness of the study. They posit trustworthiness links to credibility, transferability, dependability and confirmability and recommend techniques that establish trustworthiness. In this study the following techniques were applied: triangulation, member checking, thick descriptions, an inquiry audit and reflexivity to support the enhancement of credibility (Section 2.8.1), transferability (Section 2.8.2), dependability (Section 2.8.3) and confirmability (Section 2.8.4).

2.8.1 Credibility – triangulation and member checking

Runeson and Höst (2009:136) comment that triangulation may be defined as "… taking different angles towards the studied object and thus providing a broader picture …". The study included respondent and method triangulation. New dimensions were revealed when evidence was systematically combined, focusing on discovery rather than verification (Dubois & Gadde, 2002).

In this study, triangulation comprised "rigorous techniques and methods for gathering high-quality data" (Patton, 1999:1190). Respondent triangulation (Miles & Huberman, 1994; Attewell & Webster, 2005) involved the collection of a spectrum of stakeholder opinions, namely, attitudes of the faculty head, a domain expert, faculty academics, architecture students and architecture lecturers. In addition, method triangulation (Cohen et al., 2007) comprised multiple ways in which data was collected, such as semi-structured and unstructured interviews, document analysis, and online questionnaire surveys. Processes supported the analysis of conclusions from different perspectives (Pérez-Sanagustín et al., 2012:183). Collected data was subjected, where applicable, to thematic and basic statistical analysis providing "more grist for the research mill" (Patton, 1999:1192).

Member checking that aimed to contribute to the validity of the findings was implemented among interview respondents (Denzin, 1978; Creswell, 2009). However, some sources share the concern that the technique is flawed as a credibility tool (Sandelowski, 1993; Morse, 1994; Angen, 2000). Stakeholders communicated personal perspectives. Differing interpretations can lead to conflicting opinions rather than a single truth. Nevertheless, member checking gave interview respondents a platform, affording them the opportunity to verify or challenge my interpretation of their feedback.

2.8.2 Transferability – thick descriptions

In this study, thick descriptions established explicit and contextualised guidelines leading to patterns of and preferences for the use of mobile technology for educational purposes. This approach contributed to the achievement of external validity (Geertz, 1973; Holloway, 1997) and hence transferability of findings to other faculties, departments and domains (Lincoln & Guba, 1985). Detailed descriptions of case study outcomes during qualitative data analysis allowed the gauging of the extent to which resonance and analytical generalisation (Yin, 2014) made the drawing of conclusions from emergent themes a possibility.

2.8.3 Dependability – an external audit

Various sources indicate that external audits improve dependability (Miles & Huberman, 1994; Creswell, 2009). A community of fellow researchers and senior academics – outsiders with expertise in educational technology – reviewed thesis content. This process aimed to evaluate the extent to which codebook synthesis, analysis of respondent feedback, emergent categories and themes, recommendations and conclusions were supported by theoretical sources and raw data.

2.8.4 Confirmability – reflection

I did not set out to confirm theoretical findings by juxtaposing theoretical and empirical results. Rather, the synthesis of a framework of constructs, categories, sub-categories and elements, supported by sources of evidence, emphasised the enhancement and augmentation of theoretical data.

Reflexivity is an important consideration in this study. Researcher reflexivity ensured a prolonged engagement with qualitative data during analytical iterations, where data reduction led to crystallisation (Borkan, 1999; Ellingson, 2009; Liddy et al., 2014) and the evolution of themes. Tobin and Begley (2004:388) link triangulation to crystallisation, intimating that "when multiple types of triangulation are used appropriately as the 'triangulation state of mind', they approach the concept of crystallisation, which allows for infinite variety of angles of approach". In addition, methods employed to collect and analyse data were "intrinsically linked to the researchers' philosophical position, experiences and perspectives" (Noble & Smith, 2015:34). Reflexivity snippets drawn from researcher journal entries differentiated between my research voice and that of other stakeholders.

Carefully worded and applicable questionnaires informed by literature sources and customised for the studies (Cohen et al., 2007), were designed to measure the intended dimensions (Preece et al., 2015). In addition, care was taken to ensure the integrity of data from the consistent dissemination of valid questionnaires so that research questions were answered (Oates, 2006).

2.9 Limitations and delimiters

Researchers are challenged to remain cognisant of the potential for biased interpretation and reporting (Yin, 2014). The inclusion of my voice and background may have contributed to research bias as the researcher in a qualitative study plays an important albeit subjective role. Interpretation is subjective in suggesting the value of providing details of data-collection methods, multi-level analysis and reporting decisions. So, although this initiative contributed to a feasible and applicable research environment, researcher bias was an important consideration. Biased researcher views may impact findings and conclusions (Yin, 2014). As explained earlier in Section 2.7.1, researcher reflexivity is an important research constituent, likely to improve confirmability of research findings (Section 2.8.4).

There is a problematic belief that the case study method is unscientific owing to the inability to generalise statistically from findings (Dubois & Gadde, 2002). The case study strategy requires that researchers make choices concerning research boundaries – this limitation presents a sampling challenge. Dubois and Gadde indicate boundaries are seen as practical delimiters, enabling concrete and process-centric outcomes while the real-world situation continues. This limitation is best resolved by researching a specific context. Follow-up studies and future research have the propensity to extend case study boundaries, enabling the exploration of new frontiers. Transferability of findings (Section 2.8.2) is improved when rich and thick data is produced. In addition, the case study process produces unwieldy volumes of data, resolved in the design by avoiding lengthy descriptions and stories. Furthermore, the process is difficult, requiring consultation with expert and literature sources while developing skills and acumen.

Dubois and Gadde (2002:558) refer to the dilemma of choice, commenting:

> … both empirical observations and interaction with other researchers may confuse the researcher in the process. The confusion concerns both what patterns can be found among the collected pieces and also which of the many puzzles the researcher should concentrate on. Whatever choices are made in the process, there will surely be pieces left, which fit other puzzles. A selection must be made because, when the case is finally turned into a 'product', there should be no confusing pieces left…

Case study challenges incorporate the need to start with a case study design and use all its methods to conclusion – without deviating to another strategy.

Runeson and Höst (2009) highlight case study issues such as rigour, solved partially when rigour is incorporated into the data-collection strategy. Case study research takes long and produces tedious reports. The study should demonstrate a set of structured procedures implemented to counter challenges associated with the chosen methods.

Methodological issues associated with case study research include quality and trustworthiness (Lincoln & Guba, 1985), statistical generalisation and rigour (Yin, 2014), unwieldy volumes of data and implementation difficulties. To counter these issues, the strategy incorporated triangulation (Cohen et al., 2007), ensured rich and thick data, avoiding lengthy descriptions, and accounted for researcher reflexivity. The synthesis of emergent themes emphasised resonance and analytical generalisation in preference to statistical generalisation (Lincoln & Guba, 2002).

Yin (2014) suggests that a case-study strategy is appropriate where the researcher has no control over case-related activities. In this study, I was unable to personally observe the ad hoc use of mobile technology. In addition, I could not interact with distance-learning students as they visited the campus only occasionally for busy block sessions, obviating direct interaction with student respondents, relying instead on reported experiences. Data collection had to, of necessity, be unobtrusive and indirectly achieved via a 'gatekeeper' who emailed all communication necessities and questionnaires. Equally, the study excluded any form of designed intervention or participation in delivery of aspects of the architectural technology blend as these were well-established departmental prerequisites. These requirements limited data-collection efforts.

Methodologically, the study excluded:

- Implementation of the framework and evaluation of maturity and capability;
- The application of the framework in other higher education contexts such as graphic design, interior design, town planning, fashion design, and information technology;
- Student and lecturer interviews as a feasible research method;
- The design of interventions to determine whether informal learning had occurred;
- Feedback from fulltime architectural technology students and their lecturers;
- The determination of achieved learning in personal or social learning contexts;
- The design a longitudinal data-collection strategy reviewing the changing influence of mobile technology over time across faculties and departments; and
- The selection of a large and representative sample of the university's population, enabling generalisation and predictive possibilities.

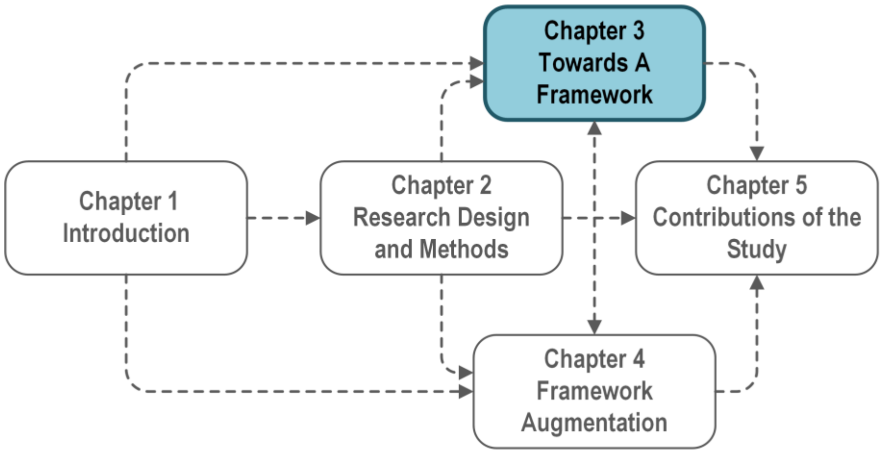
2.10 Crystallisation

This chapter indicated that the synthesis of a structured framework for the ad hoc use of mobile technology in higher education contexts resulted during a dual-approach where two source types provided data. Firstly, existing frameworks supplemented by a set of additional sources linked to mobile technology-enhanced learning constituted theoretical sources, serving as secondary data. The early phases of a systematic literature study (Section 2.5) resulted in a selection of 55 articles. Qualitative data analysis led collectively to the set of elements reported in Table 3.14, Table 3.15 and illustrated as Figure 3.7 at the end of Chapter 3. Secondly, Figure 3.8 represents an initial framework of theoretically based elements.

The empirical research defined in Section 2.6 resulted in primary data. Analysis of this data is reported in Chapter 4 where Table 4.13 and Table 4.14 and Figure 4.31 demonstrate the empirically determined augmentation of the initial, theoretically based framework.

Chapter 3 Towards A Framework: Theoretical Perspectives

We know what we are but know not what we may be
William Shakespeare: Hamlet, Act 4, Scene 5



3.1 Introduction

This chapter sets out the first part of the dual research strategy – the theoretical component outlined in Chapter 1. I briefly outlined findings of a preliminary review of sources associated with various learning modalities in Chapter 1. The review highlighted volumes of publications that severally address critical success components for e-learning, m-learning, technology-enhanced learning and blended learning in higher education contexts. Consequently, I sought a structured and repeatable review strategy that would elicit theoretically based elements for the ad hoc use of mobile technology-enhanced learning from relevant source material. This strategy is the focus of Chapter 3, where I discuss outcomes of a systematic literature review, conducted to inform theoretical perspectives of the study extensively and methodically.

Throughout the chapter, mobile technology-enhanced learning refers to the ad hoc use of mobile technology defined by principles associated with e-learning, m-learning, technology-enhanced learning (TEL) and blended learning. The chapter operationalises a four-phase systematic literature review (SLR) adapted for and adopted in this study – as outlined in Section 2.5 in Chapter 2. The four-phase strategy comprised Phase 1: Planning, Phase 2: Selection, Phase 3: Extraction, and Phase: 4 Execution. Section 3.2 reports the findings of Phase 3: Extraction. In addition, Chapter 3 shares the outcomes of Phase 4: Execution. It presents the categorised findings of the SLR in Sections 3.3 to 3.7 that contribute to the initial, theoretically based framework. The chapter culminates with Figure 3.7 and Figure 3.8 that severally illustrate theoretically based elements for the ad hoc use of mobile technology-enhanced learning and a structured framework comprising components and interrelationships. Chapter 3 forms the theoretical foundation for Chapter 4, the empirical part of the dual-focus data-collection strategy of the research.

3.2 Phase 3 Extraction – findings

The extraction phase comprised five levels of extraction (E1 to E5), summarised in Table 3.1, where the purpose of each extraction level is indicated.

Table 3.1: Extraction levels – qualitative data analysis scans

Level	Dimension	Purpose
E1	Source attributes	To establish context and content
E2	Constructs	To extricate foci, structural dimensions
E3	Categories	To synthesise a set of macro-level concepts
E4	Sub-categories	To explore meso-level perceptions
E5	Items	To define micro-level linkages

The extraction levels E1: Source attributes (Section 3.2.1) and E2: Constructs (Section 3.2.2) in Table 3.1 are briefly discussed. The extraction of categories, sub-categories and items is respectively reported in Sections 3.2.3, 3.2.4 and 3.2.5.

3.2.1 E1: Source attributes

Figure 3.1 provides an analysis of article attributes designated as learning modalities, article sources, article types, research strategy, research methodologies, and analysis methods.

The learning modality attribute of the sourced articles comprised five different yet intertwined educational designs: e-learning (11%), m-learning (29%), technology-enhanced learning (22%), blended learning (5%) and mobile technology-enhanced learning (33%). However, these articles did not all report frameworks as end results of their research. Frameworks emerged in 45% of the articles, while the additional sources (55%) dealt with allied issues. Journal articles comprised the major portion of the selected sources (58%). To some extent the small number of articles implementing a mix of theoretical and empirical research strategies (4%) highlights the pertinence of this study that encompasses both theoretical and empirical components. Furthermore, survey research (20%) and systematic literature review (13%) resonate with this study that opted for the inclusion of both methodologies. Finally, sixteen different analysis methods were noted, indicating both the complex and exotic nature of qualitative research. Of specific interest to this study is the prevalence of content analysis (25%) and evaluation methods (15%).

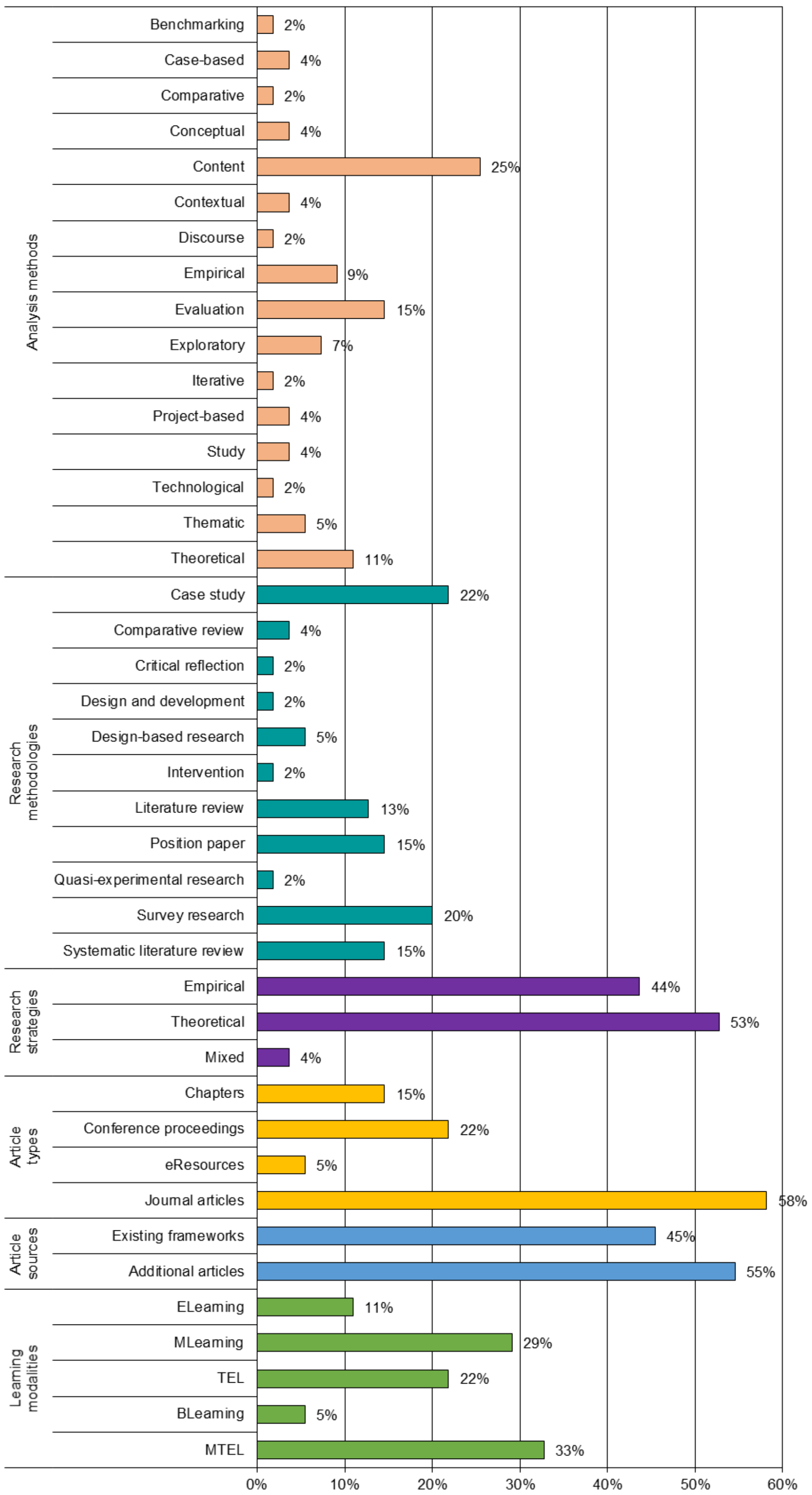


Figure 3.1: Attributes of the final selection of 55 articles

3.2.2 E2: Constructs

Qualitative data analysis of literature sources using ATLAS.ti identified 11 constructs in Table 3.2, the abstract and non-tangible encoded concepts deemed to be article foci, namely, Application, Approach, Approval, Enthusiasm, Excellence, Execution, Integration, Maturity, Measurement, Pedagogy, and Social Media.

Table 3.2: Constructs with supporting examples

Construct	Supportive examples from literature sources
CO01 Application	Graham et al. (2013) propose criteria that guide application of blended learning, suggest necessity of clarification of institutional purpose and nature of blended courses, and aim to achieve success of initiatives.
CO02 Approach	An approach to the design of m-learning environments addresses improved user experiences (Harpur & De Villiers, 2015a). The framework enhances the potential of accelerating educational innovation offered by mobile devices and applications.
CO03 Approval	An adapted task-level technology acceptance model (Schoonenboom, 2014) determines approval for the use of technology in e-learning contexts. The model measures intentional use, usefulness and ease-of-use, guiding the recommendation of specific technological tools.
CO04 Enthusiasm	The Motivational Framework concerns the design of learning processes, guiding lecturers to ensure enthusiastic student participation in m-learning contexts (Laurillard, 2007).
CO05 Excellence	Inglis (2005) compares two quality-oriented frameworks suited to e-learning excellence. A framework that guides process-centric quality improvement may support design of technology-enhanced learning courseware (Mhlanga et al., 2013).
CO06 Execution	Khaddage et al. (2015) recommend a framework of guidelines that inform the implementation of m-learning projects, where project execution considers both the learning context and goals.
CO07 Integration	The TCPK framework for the integration of technology into teaching is proposed by Mishra and Koehler (2006). It assimilates the complexity of technology-enhanced learning and in situ knowledge. A framework that motivates student engagement aims at integrating formal and informal m-learning (Lai et al., 2013).
CO08 Maturity	The eMM framework determines and informs organisational change aligned to maturity of e-learning initiatives (Marshall, 2010).
CO09 Measurement	A toolkit that evaluates m-learning is posited, reviewing needs of mobile lecturers and students (Farley & Murphy, 2013). While Fetaji and Fetaji (2011) propose a framework of usability guidelines for m-learning, Harpur and De Villiers (2015b) catalogue a framework of criteria for both usability and UX for assessment of m-learning applications (MUUX). Tedre et al. (2011) suggest practical measurement guidelines for technology-enhanced learning designers.
CO10 Pedagogy	Botha et al. (2012) propose a curriculum framework for m-learning, systematically exploring ways that mobile technology could be used in educational contexts, while a pedagogical model for e-learning best practices is proposed by Mileva et al. (2008).
CO11 Social Media	A framework presents support for the utilisation of mobile social media enabling pedagogical change within in higher education situations (Cochrane et al., 2015).

The 11 constructs were elicited and mapped to the selection of articles, linked to the learning modalities associated with the study and delineated as follows:

- E-learning (six constructs): application, approach, approval, excellence, maturity, social media;
- M-learning (nine constructs): application, approach, approval, enthusiasm, execution, integration, measurement, pedagogy, social media;

- Technology-enhanced learning (eight constructs): approval, enthusiasm, execution, integration, maturity, measurement, pedagogy, excellence;
- Blended learning (two constructs): application, integration; and
- Mobile technology-enhanced learning (seven constructs): application, approach, enthusiasm, excellence, integration, pedagogy, and social media.

Each of the tables that follows includes categorised outcomes of the preliminary analysis of extracted and indexed articles, demonstrating links between learning modalities (LMs) and constructs. The final column includes the contribution made by selected articles to the study. Framework-based articles (Table 3.3, Table 3.4 and Table 3.5) are reported separately from additional sources (Table 3.6 and Table 3.7).

Table 3.3: Existing frameworks underpinning the study – E-learning

#	LM	Framework	Construct	Contribution to the study
P01	EL	Benchmarking and Quality Improvement Frameworks (Inglis, 2005)	Excellence	Outlines quality assurance and quality management principles
P02	EL	E-learning Maturity Model (eMM) (Marshall, 2010)	Maturity	Reviews maturity levels of learning, resource creation, project support and the educational institution
P03	EL	Technology Acceptance Model (TAM) (Schoonenboom, 2014)	Approval	Focuses on technology acceptance during initial stages of design and development

Note: LM = Learning Modality, EL = E-learning

Table 3.3 illustrates a subset of three framework articles that relate to the e-learning aspect of the mobile technology-enhanced learning framework.

Table 3.4: Existing frameworks underpinning the study – M-learning

#	LM	Framework	Construct	Contribution to the study
P04	ML	Framework of Critical Success Factors for M-learning (Alrasheedi & Capretz, 2015)	Approval	Leads to dimensions of technology acceptance: technology, management support, pedagogical approach
P05	ML	Mobile Learning Curriculum Framework (Botha *et al.*, 2012)	Pedagogy	Proposes curriculum-oriented guidelines for the acquisition of subject knowledge and academic and practical digital skills
P06	ML	Pedagogical Framework for Social Media (Cochrane et al., 2015)	Social media	Supports the use of mobile social media, implemented in higher education for enhancement of educational experiences
P07	ML	M-learning Evaluation Framework (Farley & Murphy, 2013)	Measurement	Offers an evaluation toolkit supporting assessment and facilitation
P08	ML	Usability Evaluation Framework (Fetaji & Fetaji, 2011)	Measurement	Delineates nine usability evaluation factors
P09	ML	Evaluation of Usability and User Experience of m-Learning (MUUX-E) (Harpur & De Villiers, 2015b)	Measurement	Emphasises aspects of evaluation strategies including usability and user experience
P10	ML	Framework of Design Guidelines for m-Learning Contexts (Harpur & De Villiers, 2015a)	Approach	Suggests design guidelines based on empirical data for m-learning environments
P11	ML	Framework for Challenges Associated with Implementation of m-Learning (Khaddage et al., 2015)	Execution	Analyses pedagogical, technological, policy and research challenges associated with implementation of m-learning
P12	ML	Framework for the Rational Analysis of Mobile Education (FRAME) (Koole et al., 2010)	Measurement	Examines mobile education, addressing complexity, usefulness and its effect on distance e-learning
P13	ML	Conversational Framework (Laurillard, 2007)	Enthusiasm	Describes minimal requirements for motivation of technology-supported learning processes
P14	ML	Pedagogical Model (Mileva et al., 2008)	Pedagogy	Demarcates approaches to teaching and learning, emphasising roles of policies, procedures and training
P15	ML	A Pedagogical Framework for Mobile Learning (Park, 2014)	Pedagogy	Addresses various pedagogical topics linked to m-learning, including, socialised vs personalised learning
P16	ML	3-Level Evaluation Framework (M3) (Vavoula & Sharples, 2009)	Measurement	Provides hierarchical recommendations, structured for evaluation and improvement of m-learning initiatives

Note: LM = Learning Modality, ML = M-learning

Table 3.4 illustrates the subset of 13 framework articles, addressing the m-learning aspect of the mobile technology-enhanced learning framework.

Table 3.5: Existing frameworks underpinning the study – Technology-enhanced learning and blended learning

#	LM	Framework	Construct	Contribution to the study
P17	TEL	Quality Evaluation Framework (Casanova et al., 2011)	Measurement	Delivers a tool for the monitoring and evaluation of quality
P18	TEL	Six-Phase Quality Improvement Process (Mhlanga et al., 2013)	Excellence	Aims to improve quality of online learning experiences by addressing successes and challenges
P19	TEL	Technological Pedagogical Content Knowledge Framework (TPCK) (Mishra & Koehler, 2006)	Integration	Assesses acceptance through three lenses: technology, pedagogy, and content knowledge, together with interactivity
P20	TEL	Framework for a Systemic View of Educational Technology (Tedre et al., 2011)	Measurement	Posits a single evaluation comprising teaching and learning, socio-economic influences, and technology
P21	TEL	United Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2016)	Approval	Reports on acceptance of technology as a key success factor
P22	TEL	Framework for Evaluating Technology-Enhanced Learning Policy Effectiveness (Wong et al., 2015)	Measurement	Summarises evaluation of effectiveness of institutional policy and associated approaches
P23	BL	Blended Learning Adoption Framework (Graham et al., 2013)	Application	Encompasses three categories of adoption: strategy, structure, and support, highlighting early and mature implementation
P24	BL	Mobile Blended Collaborative Learning Model (Lai et al., 2013)	Integration	Suggests an integrated bridge that traverses a perceived gap between formal and informal learning
P25	BL	Complex Adaptive Blended Learning Systems Framework (Wang et al., 2015)	Integration	Highlights blended-learning issues resulting from scaling up of integration in higher education

Note: LM = learning modality, TEL = technology-enhanced learning, BL = blended learning

Table 3.5 illustrates the subset of nine framework articles associated with the technology-enhanced learning and blended-learning aspects of the mobile technology-enhanced learning framework.

Table 3.6: Additional sources underpinning the study – E-learning, M-learning and TEL

#	LM	Additional source	Construct	Contribution to the study
P26	EL	Web 2.0 technologies (Bennett et al., 2012)	Social media	Explores students' use of Web 2.0 technologies to support social learning
P27	EL	Continuation of e-learning initiatives (McGill et al., 2014)	Application	Proposes favourable conditions that improve adoption levels
P28	EL	Authentic e-learning design principles (Teräs & Herrington, 2014)	Approach	Identifies design principles for authentic e-learning associated with professional development skills
P29	ML	M-learning success factors (Alrasheedi et al., 2015)	Execution	Reviews implementation levels, offering a map with milestones to successful adoption
P30	ML	Scaling m-learning technologies (Bird & Stubbs, 2015)	Integration	Suggests integration of social networking software, e.g., Facebook and Twitter; enhances use of mobile devices and technology
P31	ML	Opportunities offered by m-learning (Brown & Mbati, 2015)	Application	Addresses challenges and risks presented by the adoption of m-learning
P32	ML	Psychological challenges of m-learning (Terras & Ramsay, 2015)	Approach	Indicates learning materials should be designed for delivery by mobile devices and wireless networks
P33	TEL	Transformation with emerging technologies (Bozalek et al., 2013)	Integration	Discusses the integration and adoption of emerging technologies in higher education institutions
P34	TEL	Adaptation to technological advancements (Kukulska-Hulme, 2012)	Maturity	Debates the evolution and maturation of higher education contexts with diverse groups of students using social technologies
P35	TEL	Affordances of new digital technologies (Ng, 2015)	Enthusiasm	Indicates resource accessibility and sharing via mobile devices enhance student motivation
P36	TEL	Technology integration (Oh & Reeves, 2014)	Pedagogy	Posits students' educational preferences and habits are changing and met increasingly by innovative digital media
P37	TEL	Technology-enhanced learning: quality (Othman et al., 2014)	Excellence	Suggests quality of e-learning systems is improved by a staged strategy comprising design, development and implementation
P38	TEL	Technology-enhanced learning: advances (Wild et al., 2013)	Execution	Identifies implementation issues, e.g., focus on cost-savings providing solutions that satisfy needs of lecturers and students

Note: LM = learning modality, EL = e-learning, ML = m-learning, TEL = technology-enhanced learning

Table 3.6 illustrates the subset of 13 additional articles reporting features of e-learning, m-learning and TEL, applicable to mobile technology-enhanced learning framework.

Table 3.7: Additional sources – mobile technology-enhanced learning (MTEL)

#	LM	Additional source	Construct	Contribution to the study
P39	MTEL	Technology-enhanced learning: environments (Cober et al., 2015)	Approach	Incorporates expertise of all stakeholders – lecturers and students – who potentially offer designers valuable acumen and digital skills
P40	MTEL	Tablets in HE environments (Fischer et al., 2013)	Social media	Proposes tablets support. exploration of personal social networking spaces and access to web-based content
P41	MTEL	Impact of mobile personal learning environments (García-Peñalvo & Conde, 2015)	Pedagogy	Includes pedagogical interactivity between LMSs, PLEs, mobile devices and informal learning experiences
P42	MTEL	Mobile devices and social media (Gikas & Grant, 2013)	Social media	Posits devices and social media support interactivity, collaboration, engagement, communication and connectivity
P43	MTEL	Educational effects of social media (Holotescu & Grosseck, 2012)	Social media	Suggests students' needs guide learning calling for greater use of social applications, e.g., Facebook and Twitter
P44	MTEL	Mobile technology-enhanced learning trends (Hwang & Wu, 2014)	Application	Investigates the adoption of ad hoc mobile technology-enhanced learning, impacted by smartphones and tablet PCs
P45	MTEL	Bridging formal and informal learning gaps (Khaddage et al., 2016)	Social media	Differentiates between formal and informal learning via social media calling for knowledge links and skill transfer
P46	MTEL	Perception of the effect of social networking use (Kitsantas et al., 2016)	Social media	Evaluates social networking technologies, communication and sharing services and cloud-based tools, wikis, blogs, podcasts
P47	MTEL	Social networking contexts (Lytras et al., 2014)	Integration	Suggests effective design of learning environments is challenged by the integration of evolving digital technologies
P48	MTEL	Effective adoption of tablets (Mang & Wardley, 2012)	Adoption	Recommends the mandatory adoption of tablet technology in classroom contexts
P49	MTEL	Enhanced blended learning via mobile technology (Mayisela, 2013)	Excellence	Incorporates quality-oriented, wireless connectivity via portable devices and a mobile-friendly, institutional LMS
P50	MTEL	iPad devices in HE contexts (Nguyen et al., 2015)	Integration	Explores the explicit integration into higher education contexts of iPad devices among lecturers and students
P51	MTEL	Educational affordances of iPad devices (Oldfield & Herrington, 2012)	Pedagogy	Proposes a set of principles for mobile authentic learning, suggesting support for educational activities using iPad devices
P52	MTEL	Mobile computer-based learning experiences (Pérez-Sanagustín et al., 2012)	Enthusiasm	Suggests a unique and motivating learning environment, integrating educational activities both on and off campus
P53	MTEL	Learning with and from Facebook (Rambe & Ng'ambi, 2014)	Approach	Recommends lecturers design ways to integrate social technologies, e.g., Facebook into curricular activities
P54	MTEL	Using tablets in the classroom (Stickel & Hum, 2008)	Application	Evaluates effectiveness of adopted tablet technology from lessons learned during classroom experiences
P55	MTEL	Pedagogy and ICT (Webb, 2014)	Pedagogy	Combines ICT with individual educational activities for personal study and collaboration exercises for team skills

Note: LM = learning modality, MTEL = mobile technology-enhanced learning

Table 3.7 illustrates the subset of 17 articles, contributing to the mobile technology-enhanced learning aspect of the framework.

The in-depth, analysis of the final selection of 55 extracted theoretical sources led to the emergence of an initial theoretically based framework. A codebook evolved, and open-coded content expanded to incorporate framework constructs, categories, sub-categories and elements.

3.2.3 E3: Categories

The preliminary scan of literature summarised as a conceptual model (Figure 1.2) in Section 1.4.6 highlighted five key areas of interest perceived to be: enablement – institutional decision making, environment – contextual influences, interactivity – relationships mediated by social technology, dynamics – teaching and learning in a mobile milieu, and mobility – technological aspects emanating from being mobile. These concepts provided a suitable starting point for the qualitative data analysis of literature sources. Thus, initial qualitative analysis of coded text led to a consolidated hierarchy of 60 theoretically based elements, grouped within the five macro-level categories: enablement, environment, interactivity, dynamics, and mobility.

'Enablement' concerns higher education institutions taking ownership of organisational factors (Preece et al., 2015). The informal use of mobile technology incorporates criteria that support mobility via an institutional lens. Mobile contexts are constantly changing (Traxler, 2010a). The concept 'Environment' is described and influenced by factors in the educational environment such as attitudes of stakeholders to digital education, idiosyncrasies of mobile technology, and the nature of the domain of study. 'Interactivity' refers to educational technology mediated by social media and mobile technology providing web-based opportunities for lecturers and students. In design studios, teamwork and information sharing characterise interactive student activities (Morkel, 2012). 'Dynamics' embraces ubiquitous mobile devices and applications that are influencing teaching and learning patterns, suggesting modifications to mobile pedagogy (Kearney et al., 2015). 'Mobility' speaks to advances in mobile technology that support seamless learning across boundaries (Kukulska-Hulme et al., 2011; Pimmer, 2016). Criteria take account of components of educational mobility.

3.2.4 E4: Sub-categories

Sixteen sub-categories linked to the defined categories emerged during a second iteration of qualitative data analysis. Likewise, the sub-categories were associated with framework items. Table 3.8 is an extract from Appendix F.1. It tabulates a portion of extracted categories, sub-categories and encoded items that emerged during qualitative data analysis of selected documents (Sections 3.3 to 3.7) using ATLAS.ti V8.0.

Table 3.8: Categories, sub-categories and items

Category	Sub-category	Item
A. Enablement	A1 Preparedness and maintenance	DA03 Design & development
		DA04 Evaluation
		DA05 Implementation
	A2 Continuous improvement	DA01 Change management
		DA08 Quality
		DA12 Training
		DA10 Sustainability
		DA11 Time orientation
	A3 Competitive advantage	DA02 Competition
		DA06 Inclusiveness
		DA07 Logistics
		DA09 Strategy

Table 3.8 illustrates crystallisation of findings in Section 3.3.4 where categories, sub-categories and associated items of Category A. Enablement are tabulated. The same approach has been adopted for the additional four categories: Categories B, C, D and E. Sub-categories were labelled to reflect associated categories and the logical and subjective grouping of categorised items.

3.2.5 E5: Categorised items

The five categories comprised 60 items, allocated as follows:

- Category A. Enablement – 12 items (20%);
- Category B. Environment – 12 items (20%);
- Category C. Interactivity – 9 items (15%);
- Category D. Dynamics – 14 items (23%); and
- Category E. Mobility – 13 items (22%).

Items were alphabetised per category, indexed and numbered to highlight whether they were theoretically based (T) or empirically determined (E). An additional character indicated category association. For example, TA03 Design and development refers to the third item in Category A. Enablement.

The study aimed to assemble a set of elements leading to the synthesis of a single, holistic framework where a compartmentalised approach separately addressed each of the five major categories. This strategy is theoretically and practically beneficial to educational technology experts. It serves as a basis for the future development of conceptual frameworks. Network diagrams resulted from data analysis, mapping micro-level items to five macro-level categories. In Section 3.8.1, Figure 3.7, Table 3.14 and Table 3.15 aggregate findings of the chapter while in Section 3.8.2 the complex dimensions of the framework are illustrated in Figure 3.8.

3.3 Secondary question SQ1.1: What elements inform institutional decision making?

In this section, strategic facets of the informal use of mobile technology are addressed via an institutional lens where aspects of enablement inform educational thinking and decision making. The category 'Enablement' reviews the extent to which higher education institutions take ownership of strategic organisational facets of the informal use of mobile technology (Preece et al., 2015).

Category A. Enablement comprises three sub-categories: preparedness and maintenance, continuous improvement, and competitive advantage.

3.3.1 Preparedness and maintenance

Higher education institutions face several design and development challenges when implementing and evaluating mobile technology-enhanced initiatives. Khaddage et al. (2015) allude to pedagogical challenges, the need to establish rapport between multiple role players, and a lack of established policies for integration of mobile applications.

Design and development

The design and development of successful and encouraging mobile technology-enhanced learning environments depend on the affordances of devices and applications. However, Lai et al. (2013) speak to the incorporation of mobile habits and social worlds into educational design, with integration of formal and informal learning, despite lecturers' resistance. Design criteria should incorporate customised local content incorporating pragmatic and hedonic aspects (Harpur & De Villiers, 2015b) and the ability to change dynamically while considering context and stakeholder needs (Khaddage et al., 2015). Development that ignores sound design principles for usability and UX, should be circumvented (Harpur & De Villiers, 2015a). Student-centric design (Wild et al., 2013) and development processes should embrace technical and instructional design support

(Schoonenboom, 2014) with a focus on student requirements (Harpur & De Villiers, 2015b) aligned to participation in cross-contextual social considerations (Park, 2014; Khaddage et al., 2015). Multiple and iterative processes are evolutionary and incorporate stages and levels of design and development (Vavoula & Sharples, 2009) with a focus on aesthetically pleasing, minimalism (Harpur & De Villiers, 2015b). Designs should consider suitability for different devices, platforms and operating systems (Khaddage et al., 2015) and must comprise quality assessment with required improvement of online courses (Mhlanga et al., 2013).

Evaluation

Evaluation of mobile technology-enhanced learning is best informed by suitable guidelines; however the process is both beneficial and challenging. Projects are strengthened (Tedre et al., 2011) while higher education stakeholders receive support regarding the impact of ICT (Casanova et al., 2011). Vavoula and Sharples (2009) list a number of evaluation challenges, inter alia, issues are more social than technical, m-learning attributes are informal, the evaluation context is constantly evolving, stakeholder co-operation is often difficult to achieve, evaluation methods need to change to accommodate mobility, and it is difficult to assess what has been learned. Evaluation criteria are justified as they support contextual judgement of evaluators and establish benchmarks for what is considered 'quality' of evaluated dimensions (Casanova et al., 2011).

Implementation

Successful implementation is achieved in diverse ways by applying specific criteria but presents educational technologists with difficulties. Implementation of designed programmes may be effected to support students (Inglis, 2005) and to introduce quality measures (Khaddage et al., 2015). Challenges include: controls exerted by institutional policies (Khaddage et al., 2015; Wong et al., 2015), reducing expectation gaps (Vavoula & Sharples, 2009), maintaining an awareness of best practices and possible barriers (Khaddage et al., 2015), and consideration of various hardware devices and software types (Park, 2014).

Several researchers suggest guidelines for successful implementation. Success depends on acceptance and likelihood that stakeholders actually use the products of the initiative (Harpur & De Villiers, 2015b). Technologies need to be robust (Vavoula & Sharples, 2009) and well understood (Khaddage et al., 2015). All stakeholder roles, whether formal or informal, should be involved (Mileva et al., 2008; Wong et al., 2015; Khaddage et al., 2016). Implementation is an iterative and contextual process (Khaddage et al., 2015; Wong et al., 2015).

3.3.2 Continuous improvement

Evolution of mobile technologies challenges HEIs to address quality essentials, necessitating strategies for improvement processes, targeting long-term sustainability and training programmes.

Change management

Change management is paralleled by ongoing pressure to demonstrate flexibility where teaching and learning must continually adapt, staying abreast of mobility trends. Traxler (2010a) comments that context is a constantly changing, mobile reality as educational stakeholders need to stay connected regardless of time, place or experience.

Quality

Capability and maturity are associated with the quality of an institution's teaching and learning models and may be measured from a technology use perspective. McGill et al. (2014) intimate that if e-learning technology is extensively used, it may be regarded as having good quality. New assessment technologies support benchmarking of quality (Marshall, 2010). However, measurement of quality of technology-enhanced learning initiatives is complex as quality is viewed as embedded and multi-dimensional (Mhlanga et al., 2013), requiring defined quality standards (Casanova et al., 2011). The inclusion of quality-orientation dimensions in institutional strategy is admirable; however the sole focus on technological issues while neglecting other matters presents challenges (Inglis, 2005). Literature sources offer a range of essential considerations linked to quality. Besides in situ quality management and assessment processes, a focus on several dimensions is maintained (Inglis, 2005). In m-learning contexts, effective quality is linked to evaluation with the subsequent highlighting of institutional maturity and capability levels (Harpur & De Villiers, 2015b). Critical success factors, principles, dimensions and indicators associated with quality (Casanova et al., 2011; Cochrane et al., 2015) establish a theoretical foundation for quality. Stakeholders play an important role in the implementation of quality, ensuring it is incorporated into institutional strategy (Khaddage et al., 2015). In blended-learning contexts, a quality evaluation theme highlights the nature and magnitude of quality as well as its gaps (Wang et al., 2015).

Sustainability

Sustainability of initiatives depends on favourable conditions. A stable workforce, capable of garnering support, improves adoption levels (McGill et al., 2014). Farley and Murphy (2013) indicate stakeholders move beyond piloted projects to embrace well-funded and visibly implemented strategies with assurance of positive impact on teaching and learning. Additionally, sustainability implies transferability to other contexts.

Training

Training programmes are central to the success of mobile technology-enhanced learning. Allocation of time to skills development is an important component for improved adoption of mobile technology for educational purposes (McGill et al., 2014). Skills developed by students should be relevant to the inclusion of Web 2.0 tools

(Bennett et al., 2012). Khaddage et al. (2015) recommend the undertaking of training that supports the use of mobile devices for teaching and learning, stressing integration into classrooms. This view is supported by Mileva et al. (2008). A 'constantly learning' attitude characterises mature students – this ongoing process is required for the world of work (Mileva et al., 2008; Kukulska-Hulme, 2012). The call of Lai et al. (2013) for professional development of lecturers linked to evolution of teaching practices involves higher education policies, a common set of goals, and both formal and informal learning using educational technology.

Time orientation

Benchmarks for digital learning evolve dynamically over time, are influenced by technology and not judged as static, necessitating flexibility of frameworks and criteria. M-learning curricula need to be kept current also (Botha et al., 2012). Wang et al. (2015) view blended learning as an evolving and working product.

3.3.3 Competitive advantage

Higher education institutions are under pressure to keep abreast of developments in mobile technology and to take advantage of innovative learning models to remain competitive.

Competition

Several factors influence the strategic quest to remain competitive by achieving maximal student enrolment. Inglis (2005) suggests the establishment of a competitive position combining tools and processes to stay ahead. Awareness of competitors – their strengths and weaknesses – is a key factor. However, differential funding mechanisms produce uneven competitive environments (Tedre et al., 2011).

Inclusiveness

Blended-learning models offer opportunities to integrate up-to-date devices and mobile technology-enhanced learning experiences. Several factors are worthy of consideration: subject matter, levels of lecturer engagement with technology, interactivity between lecturers and students, and institutional support (Wang et al., 2015). Blended-learning models represent the epitome of pressure to achieve inclusiveness, overcoming complexity with systems that comprise a mix of face-to-face and technology-enhanced learning.

Bring-Your-Own-Device (BYOD) initiatives specifically encompass the integration of a broad spectrum of device types where diverse applications are seen as tools for a range of purposes (Lai et al., 2013). Successful integration of mobile technologies is dependent on the willingness of lecturers (Bennett et al., 2012), seamlessness and mobility for personal learning environments (Wild et al., 2013; Oh & Reeves, 2014); patterns of teaching and learning inclusive of technologies that mimic everyday usage (Oh & Reeves, 2014) and curriculum decisions (Lai et al., 2013). While Oh and Reeves (2014) question levels of technology integration and academic productivity, Holotescu and Grosseck (2012) regard the use of multiple social media technologies for educational purposes as problematic.

The implementation process should be broad and pragmatic, inclusive and resilient (Botha et al., 2012), while a sustained post-implementation focus aims to achieve up-to-date technology, maturity and stability (McGill et al., 2014).

Logistics

Logistical challenges concern digital delivery mechanisms such as tablet technology and encompass limitations of mobile tools and equipment (Casanova et al., 2011) as well as typical physical delivery challenges (Tedre et al., 2011).

Strategy

Educational role players participate in diverse digital strategies, assimilate many responsibilities and demonstrate differing mobile usage patterns. Strategies aim to improve students' performance via m-learning capabilities (Hwang & Wu, 2014) and may include active or passive learning models but may even involve traditional approaches (Tedre et al., 2011). Graham et al. (2013) highlight differing adoption strategies emphasising implementation is one thing, but embedding into institutional systems is another. Student centricity is advocated (Lai et al., 2013) where students generate content (Cochrane et al., 2015). Practical support is advocated (Mileva et al., 2008).

Oh and Reeves (2014) emphasise the role of educational technologists who manage required changes to maintain a competitive edge. Institutional decision makers carry the responsibility for mobile friendliness of portals such as Blackboard (Mayisela, 2013). Holotescu and Grosseck (2012) call on educational management to change, suggesting social media be embraced as part of educational strategy.

Schoonenboom (2014) reviews the manner in which learning-management systems are used by lecturers, where active use by institutional stakeholders may support technological competitiveness. The implementation of digital evaluation tools such as quizzes enhances the institution's strategy (Brown & Mbati, 2015). Champions of m-learning view this educational modality as part of selected domains and disciplines, improving competitive visibility (Botha et al., 2012). However, mobile technology-enhanced learning is not a solution but an opportunity and a key educational strategy (Wang et al., 2015).

3.3.4 *Crystallisation – taking ownership of organisational features*

This section supports the secondary question SQ1.1: *What elements inform institutional decision making?* It additionally contributes to the first main question (MQ1), where outcomes are reflected in Table 3.9. Consequently, it partially answers the second main question (MQ2), illustrated as Figure 3.2. This section links to Category A. Enablement, which comprises three sub-categories and a total of twelve designated items.

Table 3.9: Category A. Enablement – sub-categories and items from theoretical sources

Category	Sub-category	Item
A. Enablement	A1 Preparedness and maintenance	TA03 Design and development TA04 Evaluation TA05 Implementation
	A2 Continuous improvement	TA01 Change management TA08 Quality TA10 Sustainability TA11 Time orientation TA12 Training
	A3 Competitive advantage	TA02 Competition TA06 Inclusiveness TA07 Logistics TA09 Strategy

Figure 3.2 proffers a network map for Category A. Enablement, constructs and items.

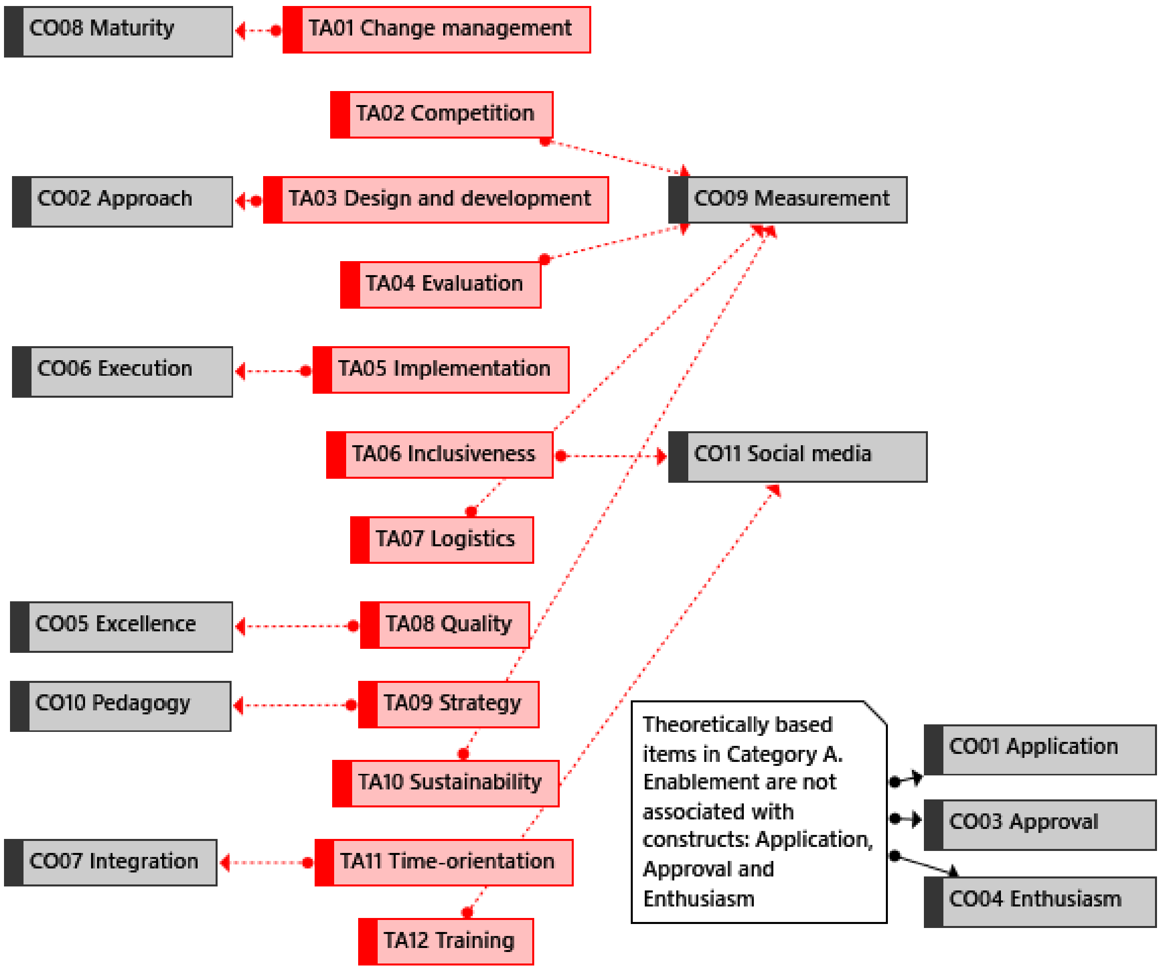


Figure 3.2: Network map – Category A. Enablement from theoretical sources

3.4 Secondary question SQ1.2: What elements reflect contextual influences?

Section 3.4 reviews Category B. Environment which refers to contextual influences, recognising a constantly changing environment. It comprises three sub-categories: personal responses to mobile technology, external elements, and vibrant evolution.

Mobile contexts are constantly changing (Traxler, 2010a) and influenced by factors in the educational environment such as attitudes of stakeholders to digital education, idiosyncrasies of mobile technology, and the domain of study. Gikas and Grant (2013) suggest that learning in a digital context is enhanced by technological appeal and novelty. For example, although students may influence or even drive the incorporation of tablet technology into teaching and learning, lecturers may either facilitate or hamper its effective integration. Furthermore, effectiveness of teaching and learning via tablets depends on the capabilities of tablet technology.

3.4.1 Personal responses to mobile technology

The way educational stakeholders accept, adopt and respond to mobile technology is idiosyncratic – characterised by personal and constantly evolving attributes.

Acceptance

Institutional role players may or may not perceive the introduction of mobile technology into educational settings as advantageous, demonstrating differential uptake of mobile technology-enhanced learning. Perceived usefulness of the institutional learning-management system determines technology acceptance (Schoonenboom, 2014). In addition, acceptance may be influenced by a combination of task, context and interface. Alrasheedi and Capretz (2015) link success of m-learning to perceived benefits.

Wong et al. (2015) highlight three role-playing features of technology-enhanced learning acceptance: roles of leadership and academics, institutional norms and values, and effectiveness of institutional policies. Venkatesh et al. (2016) offer different perspectives indicating acceptance is influenced by motivation, price (value for money), personal digital habits, and actual use of technology. All features are purported to be moderated by age, gender and experience. In addition, Venkatesh et al. associate acceptance with charismatic leadership.

Adoption

Adoption of evolutionary mobile options integrated into and supporting teaching and learning contexts is characterised by both drivers and barriers. Botha et al. (2012) comment that adoption levels are influenced by designing and developing curricula specifically tailored to suit the educational context. The adoption of mobile technology requires a common-sense platform supporting new types of learning experiences where context incorporates mobile social media (Cochrane et al., 2015).

Adoption of emerging technologies may be driven by both institutional adoption and personal usage patterns (Farley & Murphy, 2013). Institutional uptake is slow and lagging, highlighting a gap in the adoption of social networking technologies in particular (Lytras et al., 2014). Levels of uptake of Web 2.0 are influencing technology-enhanced learning (Wild et al., 2013). Sometimes institutions support faculty-based rather than institution-based adoption, causing loss of credibility and indicating a need for strategic support (Graham et al., 2013). Enthusiastic lecturer adoption may enhance likelihood of success and drive student enthusiasm (Wild et al., 2013). Differences in cultures and attitudes have the propensity to influence adoption of educational technology (Tedre et al., 2011).

Critical success factors are changing as rates of adoption change (Alrasheedi & Capretz, 2015), implying frameworks would need to evolve dynamically. As mobile technology evolves, affordances of devices are altering with the emergence of new challenges and issues (Brown & Mbati, 2015). The adoption of social media is pervasive; external sources are thus pressuring higher education institutions to adapt and to implement change mechanisms (Kukulska-Hulme, 2012). Mang and Wardley (2012) suggest institutional adoption and experimentation has led to the piloting of tablet devices. These devices are now in use by many lecturers and students and some institutions have progressed experimentation beyond pilot phases to strategic rollouts. Mang and Wardley emphasise tablet usage should go beyond note taking.

Decisions regarding adoption and subsequent integration of Web 2.0 should be driven by pedagogical and contextual effectiveness (Oh & Reeves, 2014), incorporating attributes of formality and informality (Vavoula & Sharples, 2009). Factors that influence adoption include: lecturer criteria for use of learning-management systems (Fetaji & Fetaji, 2011; Schoonenboom, 2014; Ng, 2015); phase of adoption (Venkatesh et al., 2016); faculty engagement processes (Kukulska-Hulme, 2012); and informal, on-campus use of smartphones and tablets for anywhere, anytime m-learning purposes (Hwang & Wu, 2014; Lytras et al., 2014).

Support mechanisms are required. McGill et al. (2014) mention a need for ongoing delivery of resources and development programmes where skills evolve to suit shifts in innovation. Institutional policies designed for blended-learning models should support adoption (Graham et al., 2013).

Personal learning environments

The emergence of personal learning environments emphasises the responsibilities of all educational stakeholders to incorporate technologies into teaching and learning contexts. Personal digital contexts are diverse and may be defined in many ways, inter alia, as inclusive of pedagogical perspectives (Mileva et al., 2008), distance and informal social learning environments where students are active in their own spaces (Lai et al., 2013; Park, 2014), problem-based learning opportunities (Wild et al., 2013), formal and informal m-learning contexts (Khaddage et al., 2016) and innovative stakeholder environments (Bozalek et al., 2013).

García-Peñalvo and Conde (2015) caution that technological environments, for example, learning-management systems such as Moodle, are university-centric and not designed to suit all students. However, m-learning may provide flexible customisable contexts (Nguyen et al., 2015) and offer benefits associated with on- and off-campus access (Pérez-Sanagustín et al., 2012). The tablet context is personalisable, focused on the domain of study and the delivery of digital books (Fischer et al., 2013).

Responsibility for creating personal learning environments vests with lecturers who then empower students with facilitating contexts to do it their own way (Khaddage et al., 2016). Yet lecturer training is required. Students need to build confidence with m-learning and with the capabilities of their devices.

The addition of social networking and cloud technologies makes learning not only social but personal. Thus, learning platforms should effectively incorporate mobile technology and cloud computing with personalisation capabilities (Lytras et al., 2014). The integration of Web 2.0 technologies has implications for the design of and support for tasks and should accommodate practices of teaching and learning (Bennett et al., 2012). Many institutions designate mobile technologies as personal tools with the problem of restricted use in educational settings and a resultant call for change (Bozalek et al., 2013).

Stakeholder involvement

Stakeholder involvement is critical to the adoption of mobile educational technology, requiring design and development considerations, concomitant skills upliftment and a stable workforce. A broad spectrum of roles constitutes the stakeholder group likely to access the institutional virtual learning environment (Mileva et al., 2008). This observation has implications for design and development decisions that could aid effective access by smartphone or tablets. Wang et al. (2015) promote institutional involvement in blended learning where solutions can be sought across the organisation – with many stakeholders involved in the Vision to resolve cost factors and to address challenges (Harpur & De Villiers, 2015a). Staff stability contributes to stability of initiatives (McGill et al., 2014). The leveraging of lecturer expertise and teamwork seen as dynamic partnerships helps processes succeed (Cober et al., 2015).

Student-centricity and engagement have the potential to contribute to quality-oriented educational contexts (Kukulska-Hulme, 2012; Mang & Wardley, 2012; Mayisela, 2013). Three interrelated dimensions are worthy of consideration: student involvement, lecturer expertise, and the assurance of management support (Webb, 2014). Mang and Wardley (2012) note lecturers should be experienced, fill role of the expert and communicate confidence in the use of tablet technology.

3.4.2 External elements

Contextual impacts outside of the influence of higher education institutions and their stakeholders have the potential to impact the likely success of mobile technology-enhanced learning initiatives.

Affordability

Affordability encompasses institutional investment and financial support, funding and costs (Inglis, 2005; McGill et al., 2014; Schoonenboom, 2014). Proposed investment in new technologies establishes a toolkit that gathers supportive mobile technology information (Farley & Murphy, 2013). Besides infrastructure expenditure, technological costs cover bandwidth, communication, software and technical support (Lai et al., 2013). Since costs are one of many considerations regarded as crucial to technological decision making (Tedre et al., 2011), a focus is often placed on cost savings, especially the cost of ensuring adoption (Wild et al., 2013).

Impact

M-learning decisions and associated policies may impact learning environments (Farley & Murphy, 2013). In turn, evaluation of this impact may present barriers to change (Khaddage et al., 2015). Evaluation of institutional maturity is a continuous process, impacting processes that change over time (Vavoula & Sharples, 2009).

Roles

Profiles of students may impinge on levels of technology uptake within wider socio-cultural contexts such as societies and communities, in addition to university spaces. Student profiles demonstrate differences in motivation, attitudes, experiences, and preferences, contributing to or detracting from success of educational technology environments (Terras & Ramsay, 2015). In addition, cultural and ethnic profiles that constitute a typical university environment may influence the uptake of technology (Mileva et al., 2008; Fetaji & Fetaji, 2011).

Wider contextual influences connected to mobility include societies, the economy of countries, ethical issues, and philosophical change (Botha et al., 2012). The university, its culture, staff and standards are all influential factors outside of m-learning yet impinging on m-learning contexts (Mileva et al., 2008). Learning activities occur individually as well as socially. Communication technology plays a mediating part (Park, 2014).

Socio-cultural factors

New positions emerge influenced by social media with implications for greater awareness of socio-cultural rather than technological differences.

The institutional learning-management system is seen as a tool that should support lecturers' use of mobile devices, mentoring and pedagogical approaches, communication and file-sharing (Mileva et al., 2008). Consequently new positions emerge, for example, experts in use of social media where the concept 'socio-cultural space' is used in preference to 'technological context' (Holotescu & Grosseck, 2012).

TEL contexts are often misunderstood owing to socio-cultural differences emanating from regional divides, for example, Africa compared to Europe or cultural disparities, for example, wealthy versus poor communities (Tedre et al., 2011). Higher education administrators also constitute a culture. Although there is pressure to incorporate social networking technologies, this should be done with care as this sentiment may not be supported by all cultural groups (Kitsantas et al., 2016).

Support

A broad spectrum of support types provides educational stakeholders with tools to manage challenges they may encounter. On the one hand, Khaddage et al. (2016) highlight the following m-learning challenges: there are limited resources to support necessary and specific training; different applications and software versions are needed for different devices and operating systems; and m-learning is better suited to contextual learning than for content delivery. However, Farley and Murphy (2013) advise that m-learning policies should provide support for long-term planning. Technical infrastructure should be accompanied by standards and protocols while institutional practices should comprise criteria that guide implementation of m-learning. M-learning contributes to gap reduction, facilitating personal learning opportunities (Harpur & De Villiers, 2015b). The integration of e-learning and m-learning supports educational needs (Laurillard, 2007).

Support is delivered by higher education institutions, management teams, lecturers and parents (Alrasheedi et al., 2015). Although Graham et al. (2013) comment that blended-learning models are dependent on administrative support, Lai et al. (2013) suggest mobile technology supports blended learning, motivating students and encouraging them to engage. Applications share data and support communication and collaboration activities (Park, 2014). Cochrane et al. (2015) indicate iPad devices support collaboration and the use of mobile social media. Support occurs for both academic and technical learning (Wang et al., 2015).

3.4.3 Vibrant evolution

Educational technologies are evolving dynamically and establishing new mobile environments that influence pedagogical goals with concomitant issues. Mobile milieux are characterised by vibrant evolution.

Big picture

The exploration of m-learning embraces diverse strategies while including tablets in classrooms and simultaneously bridging digital gaps. There is limited knowledge concerning the manner in which mobiles are used in universities (Alrasheedi & Capretz, 2015). Additionally Lai et al. (2013) call for strategies for interesting learning contexts. In the bigger scheme of things, Wang et al. (2015) highlight a need to bridge gaps in blended learning with the aim of establishing a systematic and holistic perspective. The use of tablets in class presents new possibilities, not seen before in education (Stickel & Hum, 2008).

Innovation

Innovation in educational technology presents challenges with the resetting of goals and implications for integration of social media. Innovative change leads to challenges, requiring redesign to meet new requirements of emerging educational technologies (Khaddage et al., 2015). While design of learning experiences should aim to be innovative, the development of a technological understanding of mobile apps may improve implementation. Educational technologists are encouraged to integrate mobile social media so that change is specific to these technologies, enabling usage based on personal behavioural patterns of practitioners, lecturers and students (Cochrane et al., 2015).

Technologies

When integrating mobile technologies, consider methods applied to other technologies and consider the capabilities of mobile devices and apps (Khaddage et al., 2016). The introduction of mobile scheduling and calendaring tools may improve self-organisation while simultaneously supporting data sharing, communication and collaboration (Park, 2014). The in-class use of mobile devices is encouraged. Blended-learning models should be both structured around traditional classroom activities and technological, with a student-centric focus (Othman et al., 2014).

There are differing opinions regarding the capabilities and issues of technology types and the impact of dynamic change on mobile users. Mobile technology is increasingly in use, especially by young students (Alrasheedi & Capretz, 2015). However, a dichotomy is noted between young techno-savvy students and the establishment represented by its lecturers who lag behind in digital capabilities and are hesitant to adopt technology in their classes. Casanova et al. (2011) believe the impact of ICT on learning experiences should be regularly evaluated.

Ubiquity of devices drives uptake of technologies for educational purposes (Park, 2014). Wang et al. (2015) refer to chaos and stability, and a required balance between the two, while maintaining dynamic qualities linked to innovation. There is a dynamic relationship between students (their needs drive the system), lecturers (seen as facilitating experts), technology (in constant state of flux) and institutional support.

Technology drives mature students to improve skills while social technologies contribute to a toolkit (Kukulska-Hulme, 2012). Oh and Reeves (2014) express a contrary view, showing concern for time-wasting activities of students using technologies. Wang et al. (2015), on the other hand, suggest blended learning tends to stagnate. Change refers to changing device types used by lecturers (Hwang & Wu, 2014).

A mobile learning context presents issues associated with pedagogy, technological considerations and institutional policies (Khaddage et al., 2015). The technology itself may be a constraining influence (Mileva et al., 2008). Every form of technology has limitations, for example, devices bring challenges (Park, 2014). Costs of higher education drive universities to implement technological solutions to a greater extent (Wild et al., 2013). Informal learning has emerged largely owing to Web 2.0, highlighting an observed gap (Lai et al., 2013). Complexity is a reality (Wang et al., 2015).

Types of educational technology include:

- Learning management systems and massive open online courses (MOOCs) (McGill et al., 2014);
- Part of the infrastructure (Inglis, 2005);
- Support for teaching and learning (Alrasheedi & Capretz, 2015);
- Mobile technology – integration of situation, devices, wireless connections facilitating communication, interfaces, applications and apps (Lai et al., 2013);
- Tablet technology improved by regular use, addressing integration of tablet technology into classroom environments, considering academic as well as social aspects (Mang & Wardley, 2012); and
- Google Docs, global positioning systems (GPSs), Bluetooth (Mang & Wardley, 2012).

3.4.4 Crystallisation – recognising a constantly changing context

This section supports the secondary question SQ1.2: *What elements reflect contextual influences?* It additionally contributes to the first main question (MQ1), where outcomes are reflected in Table 3.10. Consequently, it partially answers the second main question (MQ2), illustrated as Figure 3.3.

Table 3.10: Category B. Environment – sub-categories and items from theoretical sources

Category	Sub-categories	Items
B. Environment	B1 Personal responses to mobile technology	TB01 Acceptance TB02 Adoption TB07 Personal learning environments TB10 Stakeholder involvement
	B2 External elements	TB03 Affordability TB05 Impact TB08 Roles TB09 Socio-cultural factors TB11 Support
	B3 Vibrant evolution	TB04 Big picture TB06 Innovation TB12 Technology

This section links to Category B. Environment, which comprises three sub-categories and a total of twelve designated items.

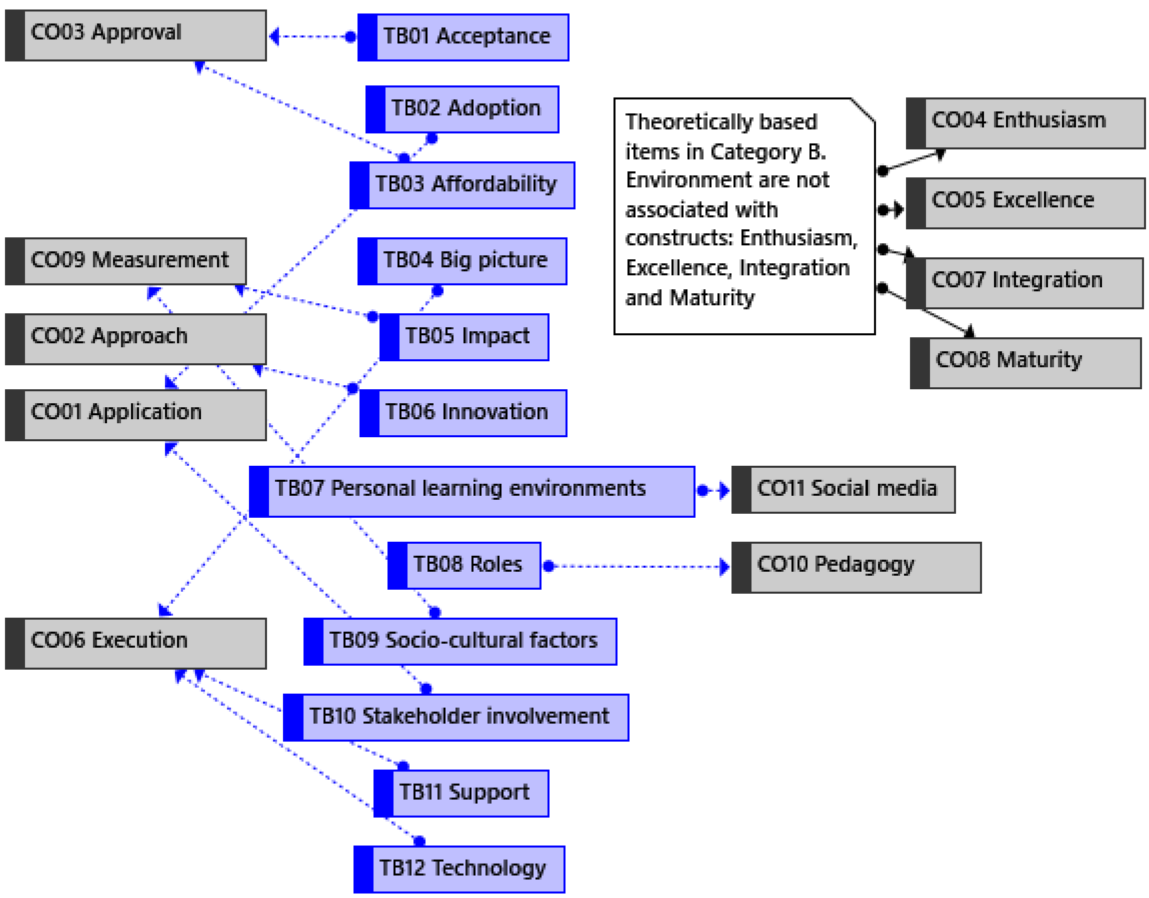


Figure 3.3: Network map – Category B. Environment from theoretical sources

3.5 Secondary question SQ1.3: What is the nature of relationships mediated by social technology?

In design studios, student activities are characterised by teamwork and information sharing (Morkel, 2012), where interactivity is a given occurrence. Technology-enhanced learning may be mediated by social media and by mobile education, providing web-based opportunities for lecturers and students to share information. While situated learning occurring in particular contexts is complex (Koole, 2009), Stickel and Hum (2008) indicate that tablet technology could be used to extend the classroom in an exclusive way.

The category 'Interactivity' is reviewed via three sub-categories: learning-management systems, technological requirements, and socially driven mobile education.

3.5.1 Learning-management systems

Institutional learning-management systems facilitate interactivity between stakeholders, providing conduits for delivery of educational content while supporting collaboration and communication activities.

Collaboration

Successful collaboration between educational stakeholders is dependent on support mechanisms and adequate tools. Park (2014) emphasises the role of students as stakeholders, interacting with one another and with their lecturers. E-portfolio applications enhance learning experiences from a social perspective, supporting students working in groups (Cochrane et al., 2015), while digital tools such as Google Apps mediate collaborative learning activities and document sharing (Lai et al., 2013). Tools such as WhatsApp and Instagram are popular among students collaborating on projects (Ng, 2015).

Communication

Communication tools have the propensity to enhance educational experiences of some stakeholders, while prohibitive costs adversely affect others with a consequent digital divide. Bandwidth costs limit the ability to communicate (Lai et al., 2013). This issue highlights notable divides introduced by differences in ICT services that include both ability to connect and contextual technological set-up (Botha et al., 2012).

Various communication activities are afforded by mobile devices, such as mentoring, file-sharing and interactivity between lecturers and students (Mileva et al., 2008). Lecturers and students may be at a distance from one another, benefiting from communication via a tool that bridges the distance (Park, 2014). Digital tools and media offer opportunities to exchange thoughts and concepts, encouraging content creation (Ng, 2015). WiFi connectivity, together with mobile devices, supports communication both on and off campus, of images, text and presentations where communication is sometimes synchronous and at other times asynchronous (Lai et al., 2013; Mayisela, 2013). Social media sites offer many communication functionalities, for example, sharing of photos and videos and blogging for educational purposes (Kitsantas et al., 2016).

Learning portal

Learning-management systems such as Blackboard and Moodle are used in combination with other tools (García-Peñalvo & Conde, 2015) and serve as tools for on-campus or at-home use (Wild et al., 2013; Ng, 2015). They allow access to quizzes and assessment activities (Ng, 2015), delivery of multimedia and text (Othman et al., 2014), questionnaire design and completion (Pérez-Sanagustín et al., 2012) and the upload of subject-related material such as course guides and notes (Mayisela, 2013).

Learning portals may present issues. Students expect certain tools like Web 2.0 to deliver a wide range of options (Wild et al., 2013), unavailable when the portal is out of action (Bennett et al., 2012). The management of differing passwords may cause confusion (Khaddage et al., 2015). Compatibility of and access to Blackboard may be problematic via mobile devices (Mayisela, 2013). Perceived effectiveness is dependent on quality of interconnectivity between lecturers and students (Casanova et al., 2011). Seamlessness is a sought-after yet challenging prerequisite (Khaddage et al., 2015).

3.5.2 Technological requirements

Technological contexts emphasise requirements for compatibility, connectivity and effective Internet access for all educational stakeholders.

Compatibility

Compatibility issues are social and contextual, and involve lecturers and their tools. Schoonenboom (2014) refers to a match between the lecturer, digital tools, the tasks at hand, and the interface. Alrasheedi and Capretz (2015) intimate compatibility is a contextual challenge where lecturers and students work in differing spaces and times suited to their situations. Ongoing maintenance with centralised updates is required to ensure compatibility with social and technical contexts (Tedre et al., 2011).

Connectivity

Wang et al. (2015) emphasise the importance of digital connections between students and their peers and lecturers using WiFi connectivity, whether face to face in classrooms or remotely and online with other communities of students.

Internet access

Internet access facilitates many educational possibilities and is defined by specific requirements. Stakeholders require ubiquitous access to the Internet, facilitating a mix of formal and informal learning (Lai et al., 2013). Students must be able to access the Internet easily via the institutional learning-management system. Consequently, institutions need to install wireless 'hotspots' wherever students are, for example, in the library and at their residences (Mayisela, 2013).

Internet access offers lecturers and students many possibilities:

- Streamlining of support for infrastructure, ensuring continuous functioning of all digital systems (Mileva et al., 2008);
- Supply via the institutional virtual learning environments of Internet access for mobile device type and apps (Kukulska-Hulme, 2012); and
- Incorporation of digital access to instant messaging, websites, games, music, downloads for educational purposes and research sessions in and beyond classrooms (Lai et al., 2013).

3.5.3 Socially-driven mobile education

Web 2.0 technologies and social media platforms are driving ways mobile devices are used to enhance teaching and learning, calling for adaptation and flexibility.

Digital platforms

There are many types of digital platforms, designed according to standards and to address educational requirements and issues. Web applications have proliferated and adapted to suit a range of mobile device types (Khaddage et al., 2015), accommodating educational demands. Effectiveness of content management systems – also seen as digital platforms – is dependent on a reliable power supply (Tedre et al., 2011) and wireless coverage for mobile Internet connectivity (Mayisela, 2013). Unfortunately, developers may see educational technologies in a negative light, being fully aware of the vagaries of emerging technologies that appear unstable with limited expansion potential (Mileva et al., 2008).

Social networking

Social networking tools such as Facebook, Twitter and Instagram originated as social communication hypes; they are mediated by the Internet and accessed via mobile devices or PCs and focus on like-mindedness and common zones of interest (Kitsantas et al., 2016). Researchers list a range of socially driven contexts deemed useful for educational purposes:

- Photos, e.g., Flickr (Bennett et al., 2012);
- Videos, e.g., YouTube (Park, 2014);
- Search engines (Google) and Wikis (Wikipedia) (Terras & Ramsay, 2015); and
- Microblogging – Twitter and social media – Facebook (Park, 2014; Cochrane et al., 2015).

Paradoxically, social networking tools present adoption challenges. From one perspective, the phenomenon is characterised by the excitement of its potential educational benefits. From another view, it is characterised by low uptake rates (Lytras et al., 2014). Institutions are experiencing a technological evolution and are challenged to adapt to the influence of social technologies in an environment of diverse student groups (Kukulska-Hulme, 2012).

Social technologies may serve as a means to deliver additional course content digitally via tablets (Harpur & De Villiers, 2015b). This opportunity emphasises students' contributions to content where content may be gathered while being on the move (Cochrane et al., 2015). Rambe and Ng'ambi (2014) refer to collaborative benefits, indicating that the use of Facebook helped with the management of large classes, provided a private communication space, and supported shy and 'silent' students.

Rambe and Ng'ambi (2014) indicate social networking presents educational challenges:

- Trial-and-error approaches rather than bona fide options worthy of integration;
- Academic-dominated activities rather than inter-student undertakings;
- Limited demonstration of technology-rich backgrounds; and
- Confusion between social and academic contexts.

Social networking technologies are change agents (Cochrane et al., 2015) supporting greater levels of user-generated content – lecturers, students and lifelong learning (Kukulska-Hulme, 2012). Mobile devices and applications show potential to change educational design, influenced by time and space factors. Anywhere, anytime learning is a feasibility (Lai et al., 2013; Lytras et al., 2014). Hierarchical boundaries are reduced when students find they may consult lecturers formally yet on their own terms (Rambe & Ng'ambi, 2014). An implication of integrated educational mobile technology includes the evaluation of acquired versus achieved skill sets, suited to academic environments (Holotescu & Grosseck, 2012). Finally, Kitsantas et al. (2016)

comment that while social networking technologies have a positive effect on learning, communication, and motivation, they also present negatives, for example, feelings of isolation.

Web 2.0 tools

Integrated Web 2.0 tools enhance and opportunistically extend traditional classroom scenarios rather than replace them, requiring adaptation to user perspectives and informal learning. Web 2.0 tools offer opportunities such as sharing and interacting (Bennett et al., 2012), informal learning (Lai et al., 2013), increased volume of learning resources (Wild et al., 2013) and greater interaction, collaboration, student engagement, and communication (Gikas & Grant, 2013).

3.5.4 Crystallisation – incorporating web-based opportunities

This section supports the secondary question SQ1.3: *What is the nature of relationships mediated by social technology?* It additionally contributes to the first main question (MQ1). Consequently, it partially answers the second main question (MQ2).

Table 3.11: Category C. Interactivity – sub-categories and items from theoretical sources

Category	Sub-category	Item
C. Interactivity	C1 Learning-management systems	TC01 Collaboration TC02 Communication TC07 Learning portal
	C2 Technological requirements	TC03 Compatibility TC04 Connectivity TC06 Internet access
	C3 Socially driven mobile education	TC05 Digital platforms TC08 Social networking TC09 Web 2.0 tools

Table 3.11 aggregates data associated with the aspects of social technology associated with Category C. Interactivity. It reflects three sub-categories together with nine framework items recorded in the final column. Figure 3.4 refers to the network map representing constructs, sub-categories and items in Category C. Interactivity.

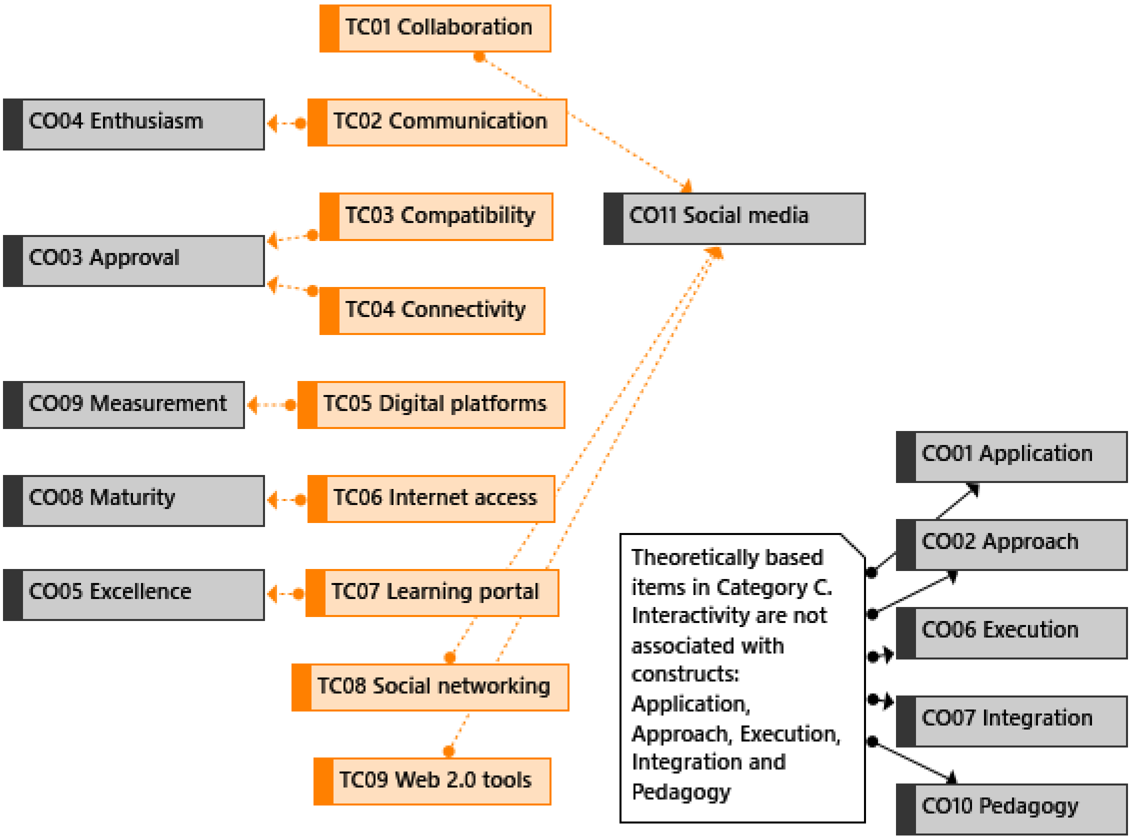


Figure 3.4: Network map – Category C. Interactivity from theoretical sources

3.6 Secondary question SQ1.4: What are the implications of teaching and learning in a mobile milieu?

Section 3.6 reviews literature informing Category D. Dynamics, which encompasses the concept 'mobile milieu'. Educational stakeholders are under pressure to adjust to an evolving, mobile pedagogy.

Rapidly evolving mobile devices and applications are dynamically influencing teaching and learning patterns, suggesting modifications to mobile pedagogy (Kearney et al., 2015). Oldfield and Herrington (2012) propose that tablet devices support teaching and learning where both lecturers and students participate in authentic learning underpinned by sound pedagogical principles.

This section appraises the following sub-categories: educational preferences, on-the-move education and decision-making trends.

3.6.1 Educational preferences

Lecturers and students demonstrate differential skill levels and personal preferences for the use of informal social learning tools in educational contexts.

Digital skills

Mobile practices emphasise the accumulation of necessary digital skills to establish competence, paralleled by an awareness of emergent digital divides. Educational practices in the mobile era require accumulation of digital skills (Tedre et al., 2011; Botha et al., 2012), questioning digital competence of lecturers and students and required skill levels (Alrasheedi & Capretz, 2015; Brown & Mbati, 2015). An emergent digital divide highlights differences in digital skills and literacy levels, requiring remediation (Harpur & De Villiers, 2015b).

Informal social learning

Cloud computing supports an informal learning approach and preferences for personalisation and customisation of social technologies designed for off-campus teaching and learning. BYOD models improve accessibility, connectivity, formal learning and personalised learning (Lai et al., 2013), whereas seamless and blended m-learning is preferred to the formalising of informal learning practices (Khaddage et al., 2016). Social learning is both informal and accidental rather than purposive (Kitsantas et al., 2016), benefiting from personal effort and group collaboration (Webb, 2014). Suitable goals and outputs are best formulated during participation in the target learning context (Laurillard, 2007), where mobile devices fill roles of both tools and learning associates, supporting student and lecturer activities (Mileva et al., 2008).

Informal social learning is scaffolded by cloud-based technologies that facilitate customisation and personalisation (Lytras et al., 2014). Students may interact off campus where they build personal learning profiles (García-Peñalvo & Conde, 2015). Additionally, the interoperability of institutional learning-management systems supports access to formal learning material and activities via mobile devices. Lecturers should consider usage of tools such as Google Docs, supporting synchronous collaboration in preference to emphasising the impact of technological factors (Khaddage et al., 2016).

Tools

Numerous tools integrate digital collaboration, co-ordination and communication via mobile devices, virtual learning environments and social technologies. Social technologies used as personal learning tools bridge campus–private world chasms (Lai et al., 2013). Twitter and Facebook offer co-ordination and communication opportunities, while Google Apps support collaboration. Facebook as an educational tool provides opportunities to connect lecturers and students both on and off campus (Rambe & Ng'ambi, 2014), highlighting needs to co-ordinate social learning activities, for example, chat, collaboration, blogs and discussion. Mobile devices support educational tasks such as recording of lessons, file sharing and communication between lecturers and students via institutional virtual learning environments (Mileva et al., 2008).

3.6.2 On-the-move education

Higher education practices in a mobile world are impacted by implications for curricula design, invoking digital adjustments to content, learning activities and assessment mechanisms.

Assessment

Digital devices and applications supply a range of traditional and mobile assessment mechanisms. Digital assessment may be achieved using mobile devices and applications in differing ways, via:

- Online self-assessment (Schoonenboom, 2014);
- Existing assessment mechanisms (Khaddage et al., 2015);
- Web 2.0 services (Mileva et al., 2008);
- Authentic contexts linked to mobile social media (Cochrane et al., 2015);
- Automatically generated quizzes (Wild et al., 2013); and
- Institutional learning-management systems (Ng, 2015).

Curriculum

Educational contexts influence the adaptation of curriculum designs and delivery mechanisms to integrate the benefits of mobile technologies for on-the-move, socially focused students. New curriculum design necessitates restructuring of the educational content to suit learning contexts influenced by mobile technology (Mileva et al., 2008; Oh & Reeves, 2014). These adjustments impact the teaching profession and ways lecturers are prepared for mobile contexts (Mishra & Koehler, 2006). In addition, newer delivery mechanisms such as massively open online courses (MOOCs) have evolved (McGill et al., 2014). The on-the-move evolution necessitates a greater focus on mobile students and mobile contexts than on mobile technology (Botha et al., 2012). Lai et al. (2013) advise that mobile interactive media should be incorporated into curricular decisions.

Digital content

Mobile tools and technologies potentially influence the design of digital content, challenging perceptions of quality and mobility, bandwidth and device capabilities. Bandwidth constraints may challenge effectiveness of podcasting and video lectures, implying content size considerations for diverse device capabilities (Tedre et al., 2011).

There is a change in the capabilities of digital technology away from purely desktop technology to include mobile technology with consequential acknowledgement that campus-wide implementation of tablet technology has merit (Harpur & De Villiers, 2015b). Khaddage et al. (2015) observe that tablet technology is not just beneficial for content delivery. Stakeholder mobility influences requirements of platform functionality, transfers management of mobile content to students, and incorporates lecturers (Alrasheedi & Capretz, 2015). The design of mobile content is customised to suit local circumstances (Botha et al., 2012), while virtual lessons should reach students whenever suitable and wherever students may be (Ng, 2015). These factors encourage a positive relationship between good mobile content, friendly design and student perception.

Interventions

Interventions serve several purposes such as a quality-centred focus on personal learning as a supplementary educational practice and the exploration of the attributes of change. Personal learning modifies educational practice, as students may explore resources delivered by YouTube where lecturers do not take care of the process, supplementing formal learning (Park, 2014). Interventions permit the exploration of change characterised by user perception, context, effectiveness, usage and outcomes (Venkatesh et al., 2016). In addition, interventions scheduled to upskill lecturers and students may focus on design and development of course content and multimedia. The quality of courses may be impeded by developers' lack of pedagogical acumen (Mhlanga et al., 2013). The successful implementation of blended-learning models by some institutions potentially guides instantiations of others (Graham et al., 2013).

Learning activities

Integration of learning activities provides support for linked goals where scenarios are designed to suit course and learning environment (Casanova et al., 2011). Learning activities may be integrated via platforms such as Moodle and Google Docs (Pérez-Sanagustín et al., 2012) enabling support and sharing between community-oriented peers (Teräs & Herrington, 2014). A broad range of learning activities is worth considering, such as real-life events (Teräs & Herrington, 2014), interactive exercises (Harpur & De Villiers, 2015b), collaboration (Park, 2014), authentic learning (Cochrane et al., 2015) and online assessment (Casanova et al., 2011).

Outcomes

The likelihood of successful outcomes depends on student involvement with technology. Group, culture and societal factors are influential (Tedre et al., 2011), as well as consideration of the likelihood of success in light of student time and behavioural involvement with technology (Oh & Reeves, 2014).

3.6.3 Decision-making trends

Decisions concerning trends in mobile education are influenced by reigning policies and principles, achieved accreditation and appropriateness of educational models in subject domains.

Accreditation

Accreditation requirements emanating from external educational authorities impact blended-learning decisions (Graham et al., 2013).

Approach

Contextual dimensions impact innovative approaches to teaching and learning and direct supported integration and training decisions. A stable environment with an adequate complement of resources reduces the risk of unidentified constraints (Tedre et al., 2011). Teaching and learning approaches are changing, parallel to technological advances (Mileva et al., 2008) where mobile devices and technologies support connectivity requirements (Lai et al., 2013). Furthermore, Mishra and Koehler (2006) emphasise that the adopted technological approach cannot disregard the relevance of and relationship between pedagogical, contextual and knowledge dimensions.

The integration of social networking technologies is regarded as innovative, motivating and scaffolded by capabilities of mobile devices such as smartphones and tablets (Lytras et al., 2014). Both the provision of support and instruction itself lead decisions to integrate mobile devices (Mileva et al., 2008). In addition, the approach should adjust to needs of a diverse group of students. Education enhanced by mobile device usage requires innovative redesign of course material, strategy, and management styles (Khaddage et al., 2015), with greater stakeholder involvement.

Innovation should focus on how to get the mobile approach right rather than the nebulous inquiry of whether or not it could be achieved, a move from a technological to a pedagogical approach (Botha et al., 2012). Besides technology integration, an emphasis is placed on curriculum adjustments (Oh & Reeves, 2014), incorporating a consolidated blend of multimedia (Othman et al., 2014). Training for lecturers to teach with technology should accompany innovative educational approaches and include acquired hardware and software competencies (Mishra & Koehler, 2006).

Researchers comment on various approaches, characterised by:

- Lifecycle design and evaluation (Vavoula & Sharples, 2009);
- Increase in practical components with reduced traditional lecturing (Mishra & Koehler, 2006);
- Adoption preceded by everyday patterns of usage (Kukulska-Hulme, 2012);
- Integration of facilitating software enabling anywhere, anytime teaching and learning, e.g., Blackboard Collaborate (Ng, 2015);
- Traditional (lecturer-centric) and lab-oriented (student-centric) blended learning (Othman et al., 2014);
- Student-centricity (Lai et al., 2013); and
- Potential of mobile technology reviewed with a single blended-learning course and a learning-management system (Mayisela, 2013).

Domain

Contextual influences such as mobile social media suggest engagement with mobile technology is a necessary component of educational domain knowledge, considered as one dimension of educational context (Botha et al., 2012). Engagement with mobile social media leads to the evolution of the social use of mobile technology to meet requirements for an educational domain (Cochrane et al., 2015).

Models

Educational models define lecturer vs student practices, lifelong learning, location independence and emergent technologies. Adoption of mobile and social networking technologies for educational purposes is gradual – a lifelong learning model (Kukulska-Hulme, 2012).

Pedagogical concepts comprise underpinnings, practices, philosophy, structure, and design; however the appropriateness of existing pedagogy is questioned. Mileva (2008) comments that lecturers have the habit of doing it their way, considering what they expect students to learn – a lecturer-centric approach. Necessary adjustments should be made to suit emergent educational technologies. Adoption of mobile technologies must offer perceivable benefits, gleaned from everyday social experiences (Kukulska-Hulme, 2012). Innovation must simultaneously mediate the continuum of traditional, lecturer-centric strategies on one end and constructivist, student-centred approaches on the other (Tedre et al., 2011).

Policies, principles

Policies and principles govern device and technology choices and social media use with implications for design, practicability, collaboration effectiveness and integration. Formalised institutional policies need to be drafted and implemented to accommodate the ramifications of tablet technology integration (Cochrane et al., 2015).

A dynamic approach is necessary when considering design, enforcement, assessment, and evaluation (Tedre et al., 2011). These measures review practicability, ensuring the possibility of a pedagogical strategy determined by technological considerations. The required institutional attributes support integration and flexibility. Openness as a strategy would not be effective as an add-on. First levels of success depend on collaborating seniors saying 'Yes', but thereafter a broad spectrum of stakeholder adoption is required (Bozalek et al., 2013). Links between the roles of formal and informal learning in many contexts need to be encouraged and built into policies (Lai et al., 2013).

Cochrane et al. (2015) observe that some lecturers have begun implementing personal approaches to integration of social media but add that communities of practice are needed too. According to Holotescu and Grosseck (2012), social media are increasingly in use without formalised institutional policies.

The implementation of policies and procedures is not without challenges. Khaddage et al. (2015) suggest mobile growth rates with iterative cycles of new technologies are leading to new pedagogies. The lack of policy for mobile technology integration and the prohibition of students using their own devices are also prohibiting factors. It is necessary to institute ongoing change to rules and regulations (Tedre et al., 2011). Personal mobile device usage occurs off campus, offering digital liberty to students. However, a mechanism is needed for change to be achieved (Cochrane et al., 2015).

3.6.4 Crystallisation – adjusting to an evolving, mobile pedagogy

This section supports the secondary question SQ1.4: *What are the implications of teaching and learning in a mobile milieu?* It additionally identified multi-faceted components contributing to the first main question (MQ1), where outcomes are reflected in Table 3.12. Consequently, it partially answers the second main question (MQ2), illustrated as Figure 3.5.

Table 3.12: Category D. Dynamics – sub-categories and items from theoretical sources

Category	Sub-category	Item
D. Dynamics	D1 Educational preferences	TD06 Digital skills TD08 Informal social learning TD14 Tools
	D2 On-the-move education	TD03 Assessment TD04 Curriculum TD05 Digital content TD09 Interventions TD10 Learning activities TD12 Outcomes
	D3 Decision-making trends in mobile education	TD01 Accreditation TD02 Approach TD07 Domain TD11 Models TD13 Policies, principles

Table 3.12 summarises theoretically based findings in Category D. Dynamics. Three sub-categories emerged together with 14 appropriately allocated items. A review of literature sources indicated the relevance of these concepts to teaching and learning in a mobile world.

The network map (Figure 3.5) illustrates framework items in Category D. Dynamics, associated with sub-categories and constructs.

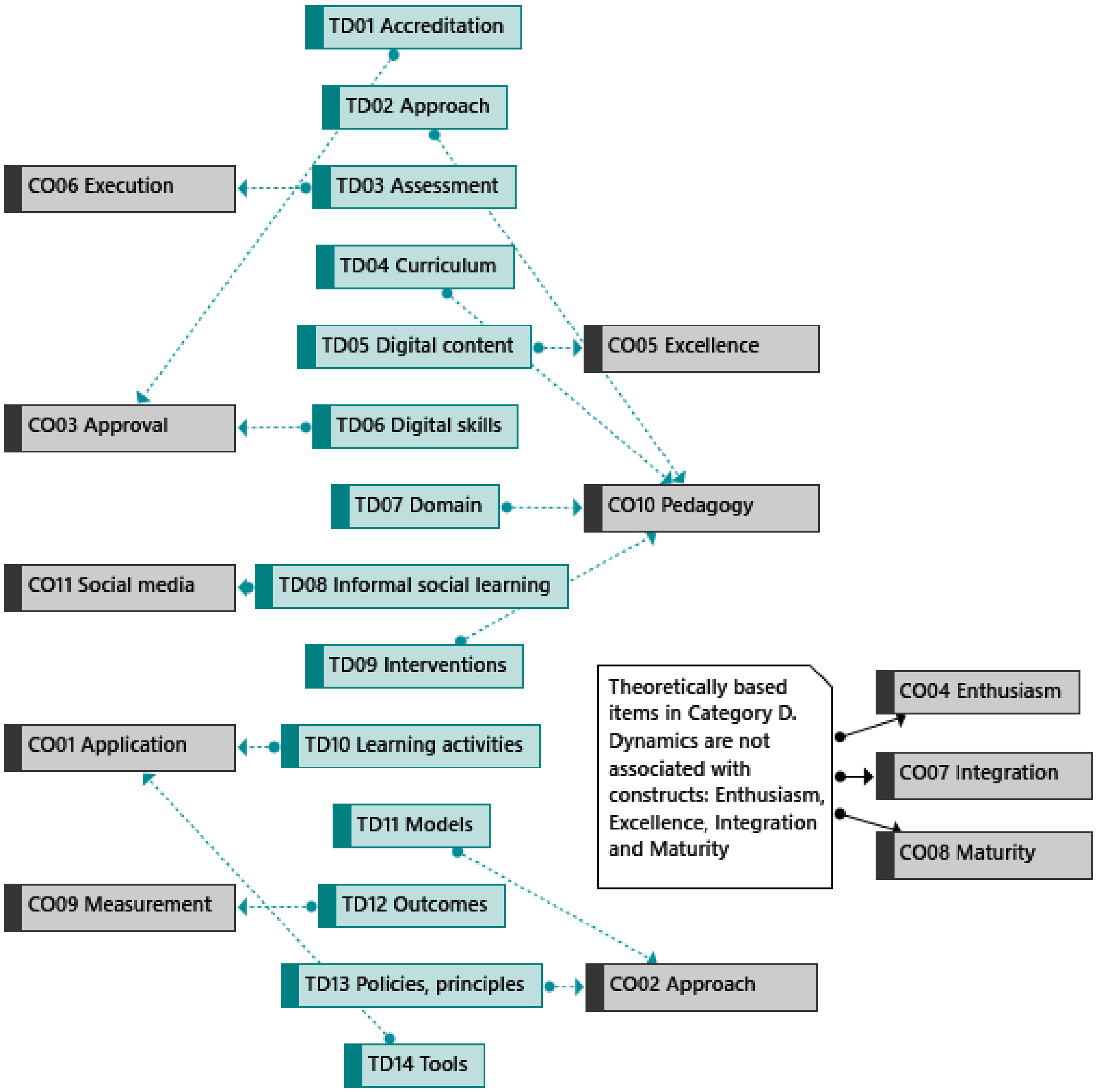


Figure 3.5: Network map – Category D. Dynamics from theoretical sources

3.7 Secondary question SQ1.5: What aspects emanate from being mobile?

Advances in mobile technology support seamless learning across boundaries (Kukulska-Hulme et al., 2011; Milrad et al., 2013; Pimmer, 2016), impacting educational expectations and defining the concept 'mobility'. Educational stakeholders have become mobile knowledge workers, capable of impacting educational expectations and behaviour. Consequently, delivery media traditionally used for fun and entertainment, have become tools for teaching and learning.

The category 'Mobility' is discussed in four sub-categories: hardware and software dimensions, patterns of personalisation, mobile champions, and quality-focused considerations.

3.7.1 Hardware and software dimensions

Multi-dimensional considerations include device types and specifications together with applications in use by mobile educational stakeholders.

Applications

The bundled and complex nature of mobile-specific applications implies the necessity of attention to attributes such as compatibility, connectivity, interoperability and support. Applications should encompass flexibility, embracing both formal and informal learning, reducing this gap (Khaddage et al., 2016); demonstrate compatibility (Mileva et al., 2008); provide the ability to schedule, get organised and communicate (Park, 2014); support complexity linked to individual and networked communication (synchronous and asynchronous) for differing contexts and purposes (Park, 2014); and deliver courseware using Facebook (Mayisela, 2013). Virtual learning environments such as Blackboard and Moodle are receptacles for bundled tools with differing communication and file-sharing functionalities (Mileva et al., 2008).

Mobile-specific applications are web-enabled and specific to smartphones and tablets, and offer seamless compatibility across many platforms (Khaddage et al., 2015). Synchronous collaboration via mobile device is useful but is dependent on interoperability (Mileva et al., 2008) and connectivity (Tedre et al., 2011). Park (2014) highlights that student support is required. Web 2.0 technologies and applications are defined by blogs, wikis, Twitter and YouTube, and social networking systems such as Facebook.

Device specifications

Portability and usability determine perceived educational capabilities of mobile devices, adapted to deliver digital textbooks yet manifesting limitations. Mobile specifications need to adapt to the delivery of digital textbooks, distributed via tablets (Harpur & De Villiers, 2015b). In addition, capabilities of mobile technology present wireless connectivity opportunities for poorer communities. Mobile devices are portable, offering flexibility. Students are able to carry information around and interact with experts and peers (Koole et al., 2010).

Limitations of mobile devices are traditionally keyboard size, memory restrictions, interface constraints and navigability issues (Harpur & De Villiers, 2015b). Campus connectivity and the supply of suitable devices may be restricting factors. However, these limitations are ameliorated by technological advancements as well as changing attitudes to device capabilities.

Device types

Mobile technology-enhanced learning incorporates device types such as smartphones and tablets (Mayisela, 2013; Lytras et al., 2014), ultrabooks and laptops (Stickel & Hum, 2008; Mayisela, 2013), presents many usability challenges, and highlights a need for ongoing training programmes. Mobile technologies may substitute for computers (Harpur & De Villiers, 2015b).

Tablets, an addition to laptop technology (Fischer et al., 2013), are loaded with PDF documents providing a convenient transport mechanism (Mang & Wardley, 2012), ensuring the download of educational applications and a focus on audio-visual presentations (Nguyen et al., 2015). The tablet technology industry is constantly and rapidly evolving with new technologies and new tablet versions with greater capabilities (Oldfield & Herrington, 2012). An attribute of tablet technology has influenced user behaviour with the consequent expectation that “always on” is the way (Fischer et al., 2013).

The attribute ‘accessibility’ highlights the importance of effectively reaching courseware via mobile devices (Mayisela, 2013). Khaddage et al. (2015) mention issues associated with funding, institutional policies and device variability experienced with BOYD models, where lecturers and students bring their own devices to campus (Lai et al., 2013). In addition, the potential of theft, a lack of integrated training and lecturer negativity to mobile devices are problematic. These factors highlight the role of institutions that should exploit emerging technologies and supply required resources (Mileva et al., 2008).

3.7.2 Patterns of personalisation

The design of educational environments should be informed by digital preferences and usage patterns of stakeholders, while aiming to support mobile productivity.

Digital preferences

Mobile educational stakeholders demonstrate diverse digital preferences advocating student-centric mobile strategies. Preferences indicate the inclusion of audio features due to resolution variations and the maintenance of simple images with few real-world colours (Fetaji & Fetaji, 2011). From a lecturer perspective, the learning-management system serves specific purposes, but is not suited to all tasks (Schoonenboom, 2014). For students, cultural and social factors influence what interface features are used (Fetaji & Fetaji, 2011). If personalisation is supported, many choices are needed, inclusive of active contribution to learning experiences (Mileva et al., 2008). Although listening to podcasts on desktops is reported to be preferred to on-the-move activity, it is likely that technological advancements negate this claim. Park (2014) advocates positive support by students for collaborative activities.

Mobile productivity

Mobile devices such as smartphones are tools that support educational and personal productivity while being mobile (Herrington 2010, cited in Kukulska-Hulme, 2012). Mileva et al. (2008) believe that mobile tools support lesson preparation and maintenance, communication and sharing of files, delivery of e-books, quizzes and collaborative activities. Park (2014) highlights the production of content and options for scheduling, while Cochrane et al. (2015) mention production of e-portfolios while moving. Presentation and assignment activities become digitally feasible (Nguyen et al., 2015).

Usage patterns

Perceived usefulness of learning-management systems, as well as tablet technologies and educational social media, determines usage patterns. Usage of learning-management systems is determined by perceived usefulness (Schoonenboom, 2014). Holotescu and Grosseck (2012) observe that social media assist with search and discovery where online sharing may build a network of contacts. However, faculties are still unprepared to use social media, showing resistance to integration. Tablet technologies present great educational opportunities but usage patterns should be determined by situations where this activity is the best option (Stickel & Hum, 2008). Consideration should be given to the time and effort required for conversion of lecture material to suit tablet interfaces.

3.7.3 Mobile champions

Stakeholders may exhibit different attitudes to mobile technology by either championing or sabotaging efforts to motivate support for its use in educational contexts.

Attitude

Positive attitudes to digital change transform perceptions of educational stakeholders to embrace faculty engagement, adoption strategies and feedback. Mileva et al. (2008) call for changed attitudes to m-learning, going beyond the use of mobile technology. Implementation of quality is achieved in various ways, all of which influence stakeholder attitudes to change (Inglis, 2005). The incorporation of lecturer and student feedback recognises opinions of stakeholders (Mileva et al., 2008), while engagement of faculty in adoption strategies enhances perception of possible personal benefits (Kukulska-Hulme, 2012). In addition, lecturers' attitudes to ICT in education are more likely to be positive if there is the belief that the required skills have been assimilated (Webb, 2014).

Motivation

Students are positively motivated to explore emerging technologies. This enthusiasm should include all stakeholders and be supported by skill development programmes (Alrasheedi & Capretz, 2015). Students are naturally and positively motivated in respect of new technologies, suggesting innate self-motivation; yet motivation levels also depend on levels of skill development (Mileva et al., 2008). Furthermore, mobile devices are motivating tools communicating with and reaching out to distant students, emulating everyday usage. Tedre et al. (2011) underscore motivational differences between lecturers and students, noting evidence of positive motivation in some circumstances but not in others, possibly linked to cognitive abilities.

Perception

Stakeholder views and participation determine perceived ease of use and usefulness (Schoonenboom, 2014), emphasising benefits of student involvement in the resolution of issues. Mileva et al. (2008) promote the inclusion of lecturers in phases – from designing to implementation of mobile technology – so that acceptance may be enhanced. There is the perception that users of social networking for educational purposes may experience isolation and have privacy concerns (Kitsantas et al., 2016).

Alrasheedi and Capretz (2015) share the following perspectives:

- The review of current project experience informs future implementations;
- User-friendly design and content is more likely to reflect positive perception;
- Students with positive perceptions demonstrate flexibility and are prepared to use and try out features of an m-learning platform in a range of contexts; and
- Students with greater levels of competence are more likely to manifest negative perceptions.

3.7.4 Quality-focused considerations

User expectations and associated satisfaction with education enhanced by mobile technology are dependent on perceived usability – pragmatic features and user experience – hedonic elements.

Expectations

Pre-conceived and increased expectations of educational technology define usage behaviour and highlight digital differences as gaps between student culture and lecturer ethos. M-learning initiatives have a knock-on effect. Students are paying higher fees to accommodate the costs of educational technology. Consequently, they have great expectations of what their fees will deliver (Wild et al., 2013). Emergent expectations are evident from techno-savvy communities who were once new to mobile technology (Mileva et al., 2008). In addition, emerging technologies facilitate data sharing and determine both experiences and expectations (Kukulska-Hulme, 2012). This observation is borne out by Venkatesh et al. (2016) who associate experience, intention to use technology and expectations of the experiences.

Students have preconceived expectations of m-learning. Vavoula and Sharples (2009) demarcate the difference between m-learning actuality and expectancy Pedagogical gaps linked to student needs may emerge and require remediation. Finally, this consideration applies to both formal and informal m-learning practices and is designed to narrow the gap (Farley & Murphy, 2013).

Staff and students belong to differing cultures with differing expectations (Mileva et al., 2008). Casanova et al. (2011) describe student expectations of lecturer attitudes as “present” rather than “active”. Expectations of students may drive lecturers to adopt e-learning (McGill et al., 2014). Mileva et al. (2008) indicate recent enrolees at higher education institutions may manifest greater digital expectations. In summary, universities need to respond to increased expectations of students, adopting and implementing ICT to a greater extent (Wild et al., 2013).

Satisfaction

There is a direct link between mobile usability and satisfaction (Harpur & De Villiers, 2015b), seen as a subjective usability attribute (Fetaji & Fetaji, 2011). Equally, mobile usability is associated with satisfaction (Ji et al. (2006), cited in Harpur & De Villiers (2015b), and hence hedonic aspects of user experience.

Usability

Usability refers here to attributes of mobile devices, deemed to be measured as pragmatic factors by applying a set of criteria and evaluation statements (Harpur & De Villiers, 2015b).

User experience

User experience incorporates both hedonic experiences and expectations of its use. Experiences are characterised by perceptions and responses from use or anticipated use (International Organization for Standardization (ISO). 2010). Mileva et al. (2008) advise that students should be regarded as stakeholders. Kukulska-Hulme (2012) adds that mature students have specific hopes for positive experiences of technology.

3.7.5 Crystallisation – supporting seamlessness across boundaries

This section supports the secondary question SQ1.5: *What aspects emanate from being mobile?* It additionally identified elements associated with the first main question (MQ1), where outcomes are reflected in Table 3.13. Consequently, it partially answers the second main question (MQ2), illustrated as Figure 3.6.

Table 3.13: Category E. Mobility – sub-categories and items from theoretical sources

Category	Sub-category	Item
E. Mobility	E1 Hardware and software dimensions	TE01 Applications TE03 Device specifications TE04 Device types
	E2 Patterns of personalisation	TE05 Digital preferences TE07 Mobile productivity TE12 Usage patterns
	E3 Mobile champions	TE02 Attitude TE08 Motivation TE09 Perception
	E4 Quality-focused considerations	TE06 Expectations TE10 Satisfaction TE11 Usability TE13 User experience

Table 3.13 reflects technological topics linked to Category E. Mobility, with four sub-categories and thirteen items.

Figure 3.6 illustrates colour-coded mobility items and constructs.

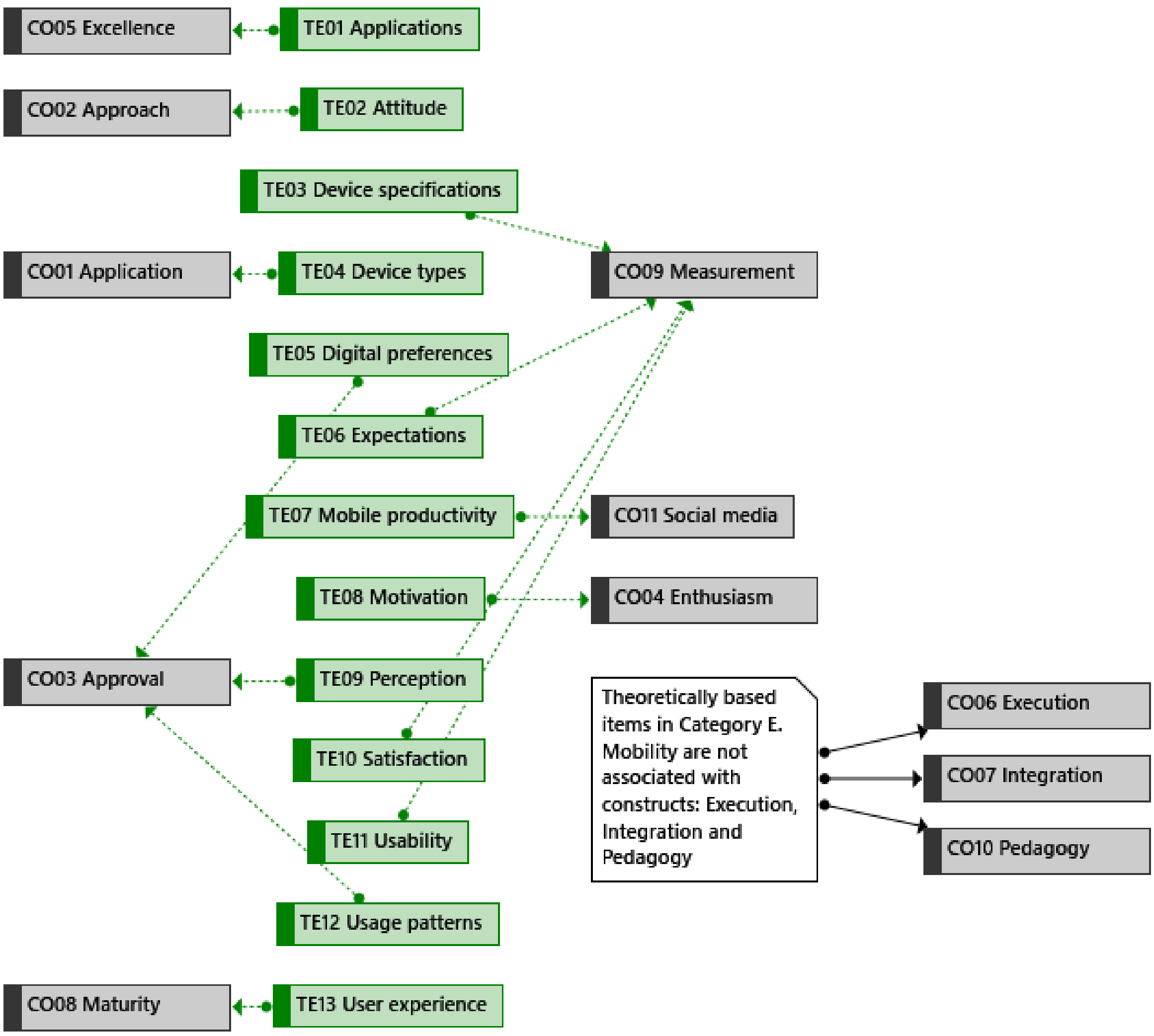


Figure 3.6: Network map – Category E. Mobility from theoretical sources

While the construct CO09 Measurement is well supported in this category, no affiliation was noted with the constructs: Execution, Integration and Pedagogy.

3.8 Crystallisation

Structured decisions led to a holistic synthesis of disparate sources where analysis options were based on researcher subjectivity. However, there are many ways that the synthesised outcome could have been achieved. This observation invites comment and further research. In addition, the theoretical structure offers benefits of partial application, multi-dimensions and a continuum of possibilities. The hierarchical framework presents a powerful toolbox of groupings. It incorporates scientific value and contributes rigorously to the body of knowledge associated with the educational technology discipline, owing to rigorous, theoretical underpinnings.

3.8.1 An initial set of theoretically based elements (MQ1)

This chapter addressed the theoretical component of the research and is characterised by a systematic literature review of existing frameworks and models plus additional sources. It included both the methodological considerations underpinning the extraction strategy adopted for the systematic literature review (Section 3.2) and its findings (Sections 3.3 to 3.7). The findings recommend the issues introduced in Chapter 1 and investigated in this chapter remain relevant, unique and worthy of exploration.

This chapter indicated that the following research questions, outlined in Chapter 1, remain relevant:

MQ1: What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?

- **SQ1.1:** What elements inform institutional decision making?
- **SQ1.2:** What elements reflect contextual influences?
- **SQ1.3:** What is the nature of relationships mediated by social technology?
- **SQ1.4:** What are the implications of teaching and learning in a mobile milieu?
- **SQ1.5:** What aspects emanate from being mobile?

MQ2: How are the elements, identified in MQ1, related?

The major findings of the systematic literature review contribute to an initial set of theoretically based elements for the ad hoc use of mobile technology-enhanced learning. The chapter simultaneously speaks to SQ1.1 to SQ1.5, partially answering the first main question, MQ1. Figure 3.7 summarises the findings that are detailed in Table 3.14 (Enablement, Environment and Interactivity) and Table 3.15 (Dynamics and Mobility). The elements identified in this chapter are summarised diagrammatically in network format as Figure 3.8 that addresses MQ2, leading to a preliminary, structured framework for the ad hoc use of mobile technology-enhanced learning.

At this point in the study, I have answered the first main question partially by reiterating theoretically based elements identified from literature sources in Sections 3.3 to 3.7. The first main question sought emergent elements for the ad hoc use of mobile technology-enhanced learning from analysis of data collected during a systematic literature review. I identified 11 constructs, five categories, 16 sub-categories and 60 theoretically based items. The first column of Table 3.14 and Table 3.15 reflects categorised items, colour coded according to learning modalities. Identified items are then mapped to contributory literature sources. Figure 3.7 further expands my understanding of the set of elements for the ad hoc use of mobile technology-enhanced learning by presenting interlinked, theoretically based elements. These elements constitute the backbone of the empirical analysis, reported in Chapter 4.

Table 3.14: Elements linked to Categories A. Enablement, B. Environment and C. Interactivity

		ELearning						MLearning																	Technology-Enhanced Learning												Blended Learning			Mobile Technology-Enhanced Learning																	
Category	Items	Bennett et al., 2012	Inglis, 2005	Marshall, 2010	McGill et al., 2014	Schoonenboom, 2014	Teräs & Herrington, 2014	Alrasheedi & Capretz, 2015	Alrasheedi et al., 2015	Bird & Stubbs, 2015	Botha et al., 2012	Brown & Mbati, 2015	Cochrane et al., 2014	Farley & Murphy, 2013	Fetaji & Fetaji, 2011	Harpur & De Villiers, 2014	Harpur & de Villiers, 2015	Khaddage et al., 2015	Koole et al., 2010	Laurillard, 2007	Mileva et al., 2008	Park, 2014	Terras & Ramsay, 2015	Vavoula & Sharples, 2009	Bozalek et al., 2013	Casanova et al., 2011	Kukulska-Hulme, 2012	Mhlanga et al., 2013	Mishra & Koehler, 2006	Ng, 2015	Oh & Reeves, 2014	Othman et al., 2014	Tedre et al., 2011	Venkatesh et al., 2016	Wild et al., 2013	Wong et al., 2015	Graham et al., 2012	Lai et al., 2013	Wang et al., 2015	Cober et al., 2015	Fischer et al., 2013	García-Peñalvo & Conde, 2015	Gikas & Grant, 2013	Holotescu & Grosseck, 2012	Hwang & Wu, 2014	Khaddage et al., 2016	Kitsantas et al., 2016	Lytras et al., 2014	Mang & Wardley, 2012	Mayisela, 2013	Nguyen et al., 2015	Oldfield & Herrington, 2012	Pérez-Sanagustín et al., 2012	Rambe & Ng'ambi, 2014	Stickel & Hum, 2008	Webb, 2014	Guidelines for best practices
Category A. Enablement	TA01 Change management	■	■									■				■											■				■				■		■																				Adapt to needs for ongoing adjustment and refinement
	TA02 Competition		■																														■																								Respond to digital trends and market pressures in education
	TA03 Design and development					■										■	■	■				■		■				■							■			■																			Formulate activities, courseware, assessment
	TA04 Evaluation																	■			■	■		■		■							■			■																					Provide estimation of maturity, capability, effectiveness
	TA05 Implementation		■													■		■			■	■		■												■									■											Delineate a strategy for deployment, maintenance and migration
	TA06 Inclusiveness	■			■						■										■										■				■			■	■					■													Incorporate transparency, seamlessness and integration
	TA07 Logistics																									■							■																								Define proximity, procurement, co-ordination and operations
	TA08 Quality		■	■	■								■			■		■				■				■		■											■																		Emphasise effectiveness, enhancement and excellence
	TA09 Strategy		■			■					■	■	■								■						■				■		■				■	■	■					■	■					■							Formulate tactics, procedures, planning and direction of initiatives
	TA10 Sustainability				■									■																																										Maintain endurance, resolution and strength of digital projects
	TA11 Time-orientation		■								■																											■	■																		Combine scheduling, timeliness, currency and prevalence
	TA12 Training	■			■													■			■						■											■	■																		Facilitate upliftment of digital skills and awareness
Category B. Environment	TB01 Acceptance					■		■																										■		■																					Assimilate the benefits of technology use in education
	TB02 Adoption				■	■		■			■	■	■	■	■	■								■			■			■	■		■	■	■		■								■			■	■								Incorporate the participative use of pedagogical technology
	TB03 Affordability		■		■	■		■						■																			■		■			■																			Assess cost considerations
	TB04 Big picture							■																■														■	■																■		Include technology into education
	TB05 Impact		■											■				■						■																																	Involve the influence and challenges of a mobile milieu
	TB06 Innovation												■			■		■			■			■																																	Provide novelty, improvement, re-invention and uniqueness
	TB07 Personal learning environments	■																■			■	■			■										■	■		■			■	■				■	■	■			■		■				Consider the complexity of digitally-influenced environments
	TB08 Roles																				■																							■													Define educational functions and responsibilities
	TB09 Socio-cultural factors										■				■						■	■	■	■									■														■										Incorporate diversity of groups, beliefs and patterns of society
	TB10 Stakeholder involvement				■			■									■				■						■								■	■		■	■	■						■	■		■	■						■	Consult the institution, administrators, educators and students
	TB11 Support							■					■	■		■		■		■		■															■	■	■																		Scaffold digitally-enhanced teaching and learning
	TB12 Technology		■		■			■	■									■			■	■		■		■	■				■	■			■			■	■						■			■	■	■			■				Establish a digital milieu conducive to effectiveness
Category C. Interactivity	TC01 Collaboration												■									■																■			■					■											Encourage project team participation and co-operation
	TC02 Communication										■		■								■	■								■								■									■			■			■				Enable the exchange of information, via Web 2.0 apps
	TC03 Compatibility					■		■																								■																									Support working in teams via a network of diverse technologies
	TC04 Connectivity																																					■												■							Enable seamless interactivity for users
	TC05 Digital platforms																	■			■											■																		■							Provide data channels via mobile-enabled applications
	TC06 Internet access																				■						■											■												■							Maintain access to web-based sites for educational purposes
	TC07 Learning portal	■			■													■								■	■			■					■		■						■								■			■				Mediate bi-directional educational dialogue
	TC08 Social networking	■								■			■			■						■	■				■											■						■			■	■		■				■			Include social media, social technologies, social networking tools
	TC09 Web 2.0 tools	■																																■				■					■				■			■			■				Support user-interoperability, distinct from social networking

Table 3.15: Elements linked to Categories D. Dynamics and E. Mobility

		ELearning						MLearning																	Technology-Enhanced Learning												Blended Learning			Mobile Technology-Enhanced Learning																	
	Items	Bennett *et al.*, 2012	Inglis, 2005	Marshall, 2010	McGill *et al.*, 2014	Schoonenboom, 2014	Terås & Herrington, 2014	Alrasheedi & Capretz, 2015	Alrasheedi *et al.*, 2015	Bird & Stubbs, 2015	Botha *et al.*, 2012	Brown & Mbati, 2015	Cochrane *et al.*, 2014	Farley & Murphy, 2013	Fetaji & Fetaji, 2011	Harpur & De Villiers, 2014	Harpur & de Villiers, 2015	Khaddage *et al.*, 2015	Koole *et al.*, 2010	Laurillard, 2007	Mileva *et al.*, 2008	Park, 2014	Terras & Ramsay, 2015	Vavoula & Sharples, 2009	Bozalek *et al.*, 2013	Casanova *et al.*, 2011	Kukulska-Hulme, 2012	Mhlanga *et al.*, 2013	Mishra & Koehler, 2006	Ng, 2015	Oh & Reeves, 2014	Othman *et al.*, 2014	Tedre *et al.*, 2011	Venkatesh *et al.*, 2016	Wild *et al.*, 2013	Wong *et al.*, 2015	Graham *et al.*, 2012	Lai *et al.*, 2013	Wang *et al.*, 2015	Cober *et al.*, 2015	Fischer *et al.*, 2013	García-Peñalvo & Conde, 2015	Gikas & Grant, 2013	Holotescu & Grosseck, 2012	Hwang & Wu, 2014	Khaddage *et al.* 2016	Kitsantas *et al.*, 2016	Lytras *et al.*, 2014	Mang & Wardley, 2012	Mayisela, 2013	Nguyen *et al.*, 2015	Oldfield & Herrington, 2012	Pérez-Sanagustín *et al.*, 2012	Rambe & Ng'ambi, 2014	Stickel & Hum, 2008	Webb, 2014	Guidelines for best practices
Category D. Dynamics	TD01 Accreditation																																				■																				Review officially certified qualifications and courseware
	TD02 Approach										■							■			■			■		■	■		■	■	■	■	■		■			■									■		■								Specify pedagogical processes and attitudes
	TD03 Assessment					■							■					■			■									■					■																						Define methods for evaluation of levels of achievement
	TD04 Curriculum				■						■										■								■		■							■																			Detail qualification subject matter and course content
	TD05 Digital content							■			■					■		■											■	■			■		■			■												■							Deliver digitised resources and course material
	TD06 Digital skills							■			■	■				■																	■																								Outline required and acquired digital literacies
	TD07 Domain										■		■																■																												Describe instructive subset in a particular educational discipline
	TD08 Informal social learning																			■	■																	■				■		■		■	■	■								■	Incorporate socially-oriented learning strategies
	TD09 Interventions																					■						■						■			■																				Include exploratory steps aimed at evaluation and improvement
	TD10 Learning activities						■						■			■					■	■				■					■		■																				■				List course-related events underpinning pedagogy-in-action
	TD11 Models																				■						■						■																								Propose a selection of approaches to teaching and learning
	TD12 Outcomes																														■		■																								Present end-results and consequences of educational experiences
	TD13 Policies, principles, practices												■					■							■								■					■						■													Define philosophies underpinning techniques and tools
	TD14 Tools																				■																	■																■			Support teaching and learning via digital mechanisms
Category E. Mobility	TE01 Applications								■						■						■	■											■													■				■							Include software packages, mobile apps and web-enabled systems.
	TE02 Attitude		■																		■						■																													■	Review attitude to technology use in educational contexts.
	TE03 Device specifications															■			■																	■																					Consider attributes of devices used by educational stakeholders.
	TE04 Device types															■		■			■			■														■			■								■	■	■	■			■		Represent types of devices used in higher education.
	TE05 Digital preferences					■									■						■	■																																			Accommodate idiosyncratic choices of devices and applications.
	TE06 Expectations				■									■		■					■			■		■							■	■	■																						Suggest anticipated opportunities offered by mobile devices.
	TE07 Mobile productivity												■								■	■					■																								■						Offer educational potential for on-the-move efficiency.
	TE08 Motivation							■													■												■																								Encourage users to accept and adopt mobile technology.
	TE09 Perception					■		■													■																										■										Indicate awareness of technological potential.
	TED10 Satisfaction														■	■																																									Consider user happiness, enjoyment and approval.
	TE11 Usability															■																																									Determine effectiveness and efficiency in mobile contexts.
	TE12 Usage patterns					■																																						■											■		Define patterns of mobile technology use for teaching and learning.
	TE13 User experience															■					■						■																														Acknowledge hedonistic responses to mobility.

Figure 3.7 concretises the overall findings of Chapter 3. It demonstrates centrally the 11 constructs from 01 Application to 11 Social media, associated with five colour-coded categories. For example, construct 07 Integration, only links to A. Enablement, whereas the final construct, 11 Social media, relates to all five categories. In addition, it reflects peripherally five categories, namely A. Enablement, B. Environment, C. Interactivity, D. Dynamics and E. Mobility. Finally, it illustrates the 60 theoretically based items associated with the five categories.

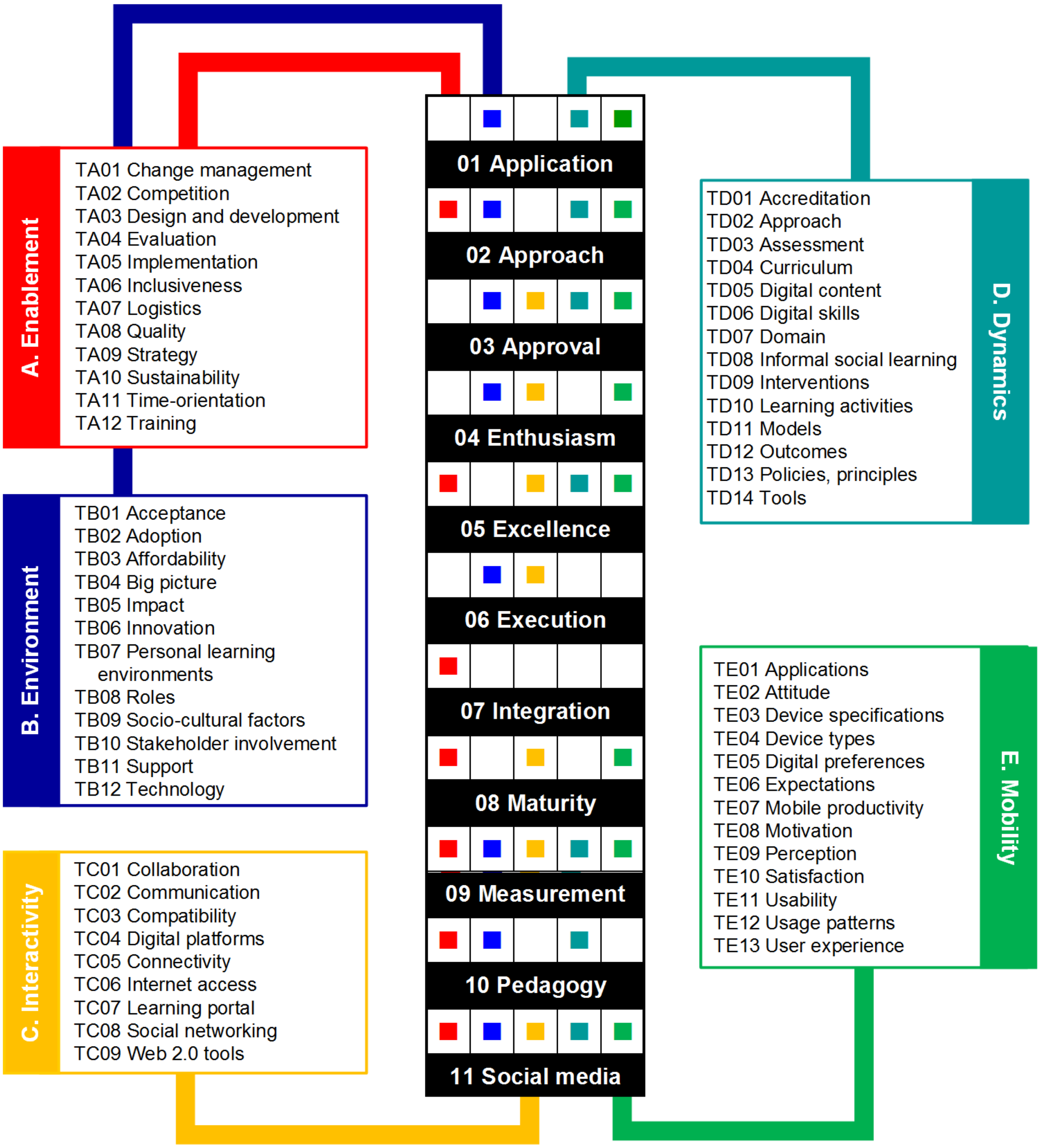


Figure 3.7: Interlinked, theoretically based elements – constructs, categories and items

3.8.2 Structure of the initial framework (MQ2)

I provided a preliminary, theoretically based answer to the first main question in Section 3.8.1. I now answer the second main question, MQ2, that explored the way the elements identified in the first main question, MQ1, are related. An initial analysis of selected literature sources highlighted eleven constructs based on four learning modalities, namely e-learning, m-learning, TEL, and blended learning that collectively provide an operational definition of mobile technology-enhanced learning. Subsequent iterations were guided by five categories from Chapter 1 that acted as conceptual lenses – Enablement, Environment, Interactivity, Dynamics, and Mobility. Categories were divided into sub-categories during rigorous and iterative qualitative data analysis. Finally, framework elements were linked logically to constructs, sub-categories and hence to categories.

The proposed, multi-dimensional framework was underpinned by secondary data derived during the systematic literature review, analysed and reported in Sections 3.3 to 3.7. This framework is defined by the network map illustrated as Figure 3.8 that details the relatedness of components of the framework. It comprises the 11 constructs from Table 3.2 linked to 60 items and the five categories from Table 3.14 and Table 3.15. The 16 emergent sub-categories associated with Categories A. Enablement, B. Environment, C. Interactivity, D. Dynamics, and E. Mobility are respectively built into Table 3.9, Table 3.10, Table 3.11, Table 3.12 and Table 3.13, and form part of Appendices F.1 to F.5.

Chapter 3 represents the theoretical dimension of the study and operationalises the methodology outlined in Chapter 2. Chapter 4 augments the theoretically based elements proposed in this chapter and contributes empirically determined perspectives to the framework for the *ad hoc* use of mobile technology-enhanced learning.

I constructed the network map presented as Figure 3.8 to illustrate the relationships between elements identified during the partial answering of the first main question, MQ1. This map is extended by components of the empirically determined framework, Figure 4.31, presented at the end of Chapter 4. The synthesis of these diagrams constitutes the finalised structure of the framework presented in Chapter 5 as Figure 5.2. This diagram delineates the combination of theoretically based and empirically determined elements that structure the framework and thus finally answers the second main question, MQ2.

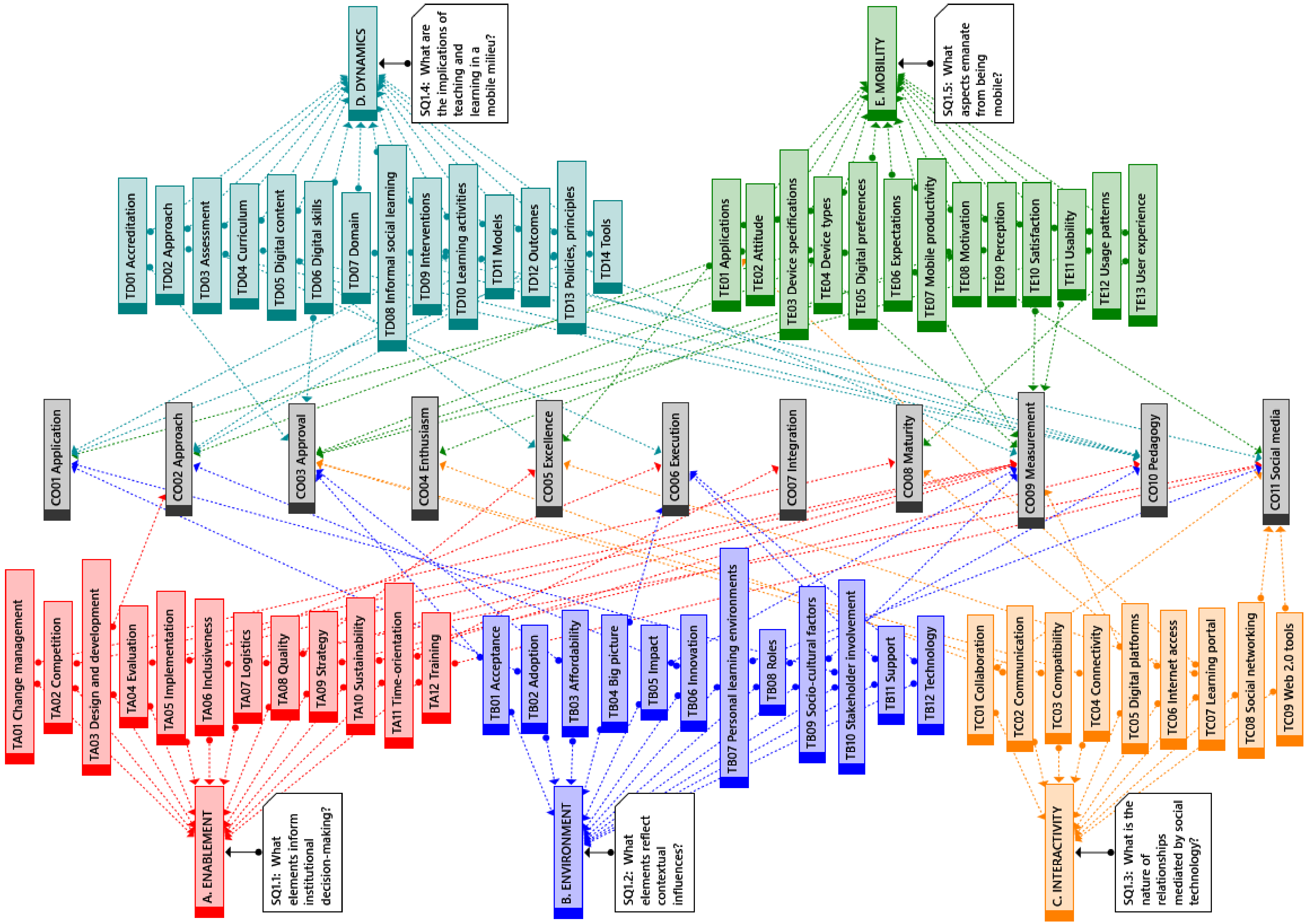
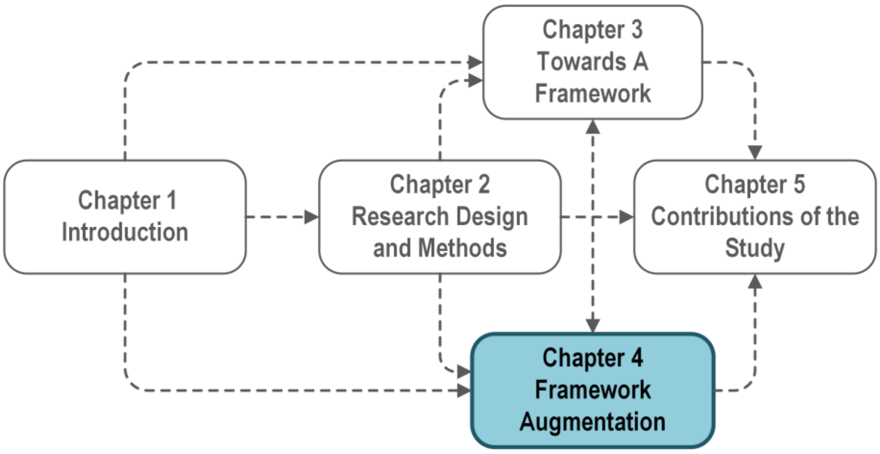


Figure 3.8: Elements of an initial theoretically based framework for the use of ad hoc mobile technology-enhanced learning

Chapter 4 Framework Augmentation: Empirical Findings

All the world's a stage, and all the men and women are merely players
William Shakespeare: As You Like It, Act 2, Scene 7



4.1 Introduction

A structured relationship exists between Chapter 3 and this section of the thesis – Chapter 4. In Chapter 3, the first part of the dual strategy underpinning the study, I synthesised an initial set of elements for mobile technology-enhanced learning, based on theoretical premises. I then mapped emergent elements that constituted an initial framework and illustrated several interrelationships. These theoretically based elements form a foundation for the empirical part of the study – the second part of the dual research strategy outlined in Chapter 2. Although some aspects reported in Chapter 3 are not supported in Chapter 4, Chapter 4 augments the outcomes reported in Chapter 3. It augments the set of theoretically based elements to incorporate empirically determined constructs, categories, sub-categories and items. In this way, the chapter establishes a form of symbiotic research rigour and contributes cohesively to the answering of the first main question, MQ1. The findings of the chapter further define the structure of a framework for ad hoc mobile technology-enhanced learning, addressing the second main question, MQ2.

The theoretical underpinnings introduced in Chapter 1 (Section 1.2, Problem statement) informed interview questions and the customisation of the questionnaire (Cohen et al., 2007). The systematic literature review undertaken in Chapter 3 contributed to the theoretical component of the mobile technology-enhanced learning framework. The review grounded the structure of the framework and linked theoretical premises to secondary research questions.

Chapter 4 adopts the structure applied in Chapter 3 and addresses the secondary research questions SQ1.1 to SQ1.5 respectively in Sections 4.4 to 4.8. Thus, it contributes empirically to the main research questions, MQ1 and MQ2. The close of each section includes crystallisation of findings, highlighting the contribution of emergent empirical components, aggregating findings as Figure 4.12, Figure 4.17, Figure 4.20, Figure 4.24 and Figure 4.30. These components augment the theoretical framework presented in Chapter 3 as Figure 3.8 and presented holistically in Chapter 5 as Figure 5.2.

First, Chapter 4 revisits the five secondary research questions that emerged during the review of literature (repeated in Section 4.2). Thereafter, analysis of interview transcripts, digital programme documentation and selected questionnaire content collectively establishes contextual support for the case study (Section 4.3). Sections 4.4 to 4.8 and their sub-divisions respectively report and discuss empirical contributions that map to secondary questions (Section 4.2). In addition, each sub-section closes with associated empirically determined elements, thereby addressing the main research questions and expanding the synthesised framework and its structure (Sections 4.9.1 and 4.9.2).

4.2 Revisiting the research questions

The set of seven questions comprising two main and five secondary research questions were introduced and justified in Chapter 1. The questions are repeated here:

MQ1: What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?

- **SQ1.1:** What elements inform institutional decision making?
- **SQ1.2:** What elements reflect contextual influences?
- **SQ1.3:** What is the nature of relationships mediated by social technology?
- **SQ1.4:** What are the implications of teaching and learning in a mobile milieu?
- **SQ1.5:** What aspects emanate from being mobile?

MQ2: How are the elements, identified in MQ1, related?

Whereas Studies 1.1 and 1.2 (Section 4.3) define the case study context and provide a rich and thick background for the study, Studies 1.3, 2.1, 3.1 and 3.2 specifically address aspects of a framework for the ad hoc use of mobile technology in higher education contexts.

4.3 Case study context

This prologue provides background information establishing the context for the case study. The section outlines the architectural technology programme (Section 4.3.1) based on selected data from Studies 1.1 and 1.2. Thereafter an analysis of case study stakeholders (Section 4.3.2) determines demographic content gathered from Studies 1.1, 1.3, 2.1, and 3.1.

Table 4.1 lists secondary questions mapped to phases, studies, methods and foci.

Table 4.1: Research design - the studies

Phases	Studies and methods	SQ1.1	SQ1.2	SQ1.3	SQ1.4	SQ1.5	Foci
1 Preamble	1.1: Domain Expert Unstructured interview	-	-	■	■	-	Rapport
	1.2: Institutional Repository Document analysis	-	-	■	■	-	Context
	1.3: Faculty Academics Questionnaire surveys	■	■	■	■	■	Exploration
2 Cohort	2.1: Architecture Students Questionnaire surveys	■	■	■	■	■	Collection
3 Faculty	3.1: Architecture Lecturers Questionnaire surveys	■	■	■	■	■	Investigation
	3.2: Faculty Head Semi-structured interview	■	■	■	■	■	Enrichment

As indicated in Chapter 2, the following naming convention interchangeably describes case respondents as: faculty head [FH], domain expert [DE], faculty academics [A1 to A5], architecture students [S1 to S14] and architecture lecturers [L1 to L3].

4.3.1 Architectural technology programme

The innovative architectural technology programme was introduced in Chapter 1. It targeted working students who were unable to attend fulltime classes. The programme was delivered as a part-time blended-learning model and comprised a mix of distance-learning activities and periodic block sessions when all students attended campus classes. Conceptualisation of the innovative programme embraces technological change and capabilities. Garraway and Morkel (2015:24) comment: “despite new advances in technology and a rapidly changing world, architectural education has remained mostly unchanged since the early twentieth century”.
At the outset, the interview with the domain expert, a senior lecturer, course facilitator and educational technology champion (Table 2.11, Section 2.6.3) addressed the curriculum, activities, interventions, assessment and tools associated with the architectural technology programme. Students received online course content and worked on projects. In addition, contextual influences included Internet connectivity, the student profile, the format of the blended-learning programme, project-based activities, Facebook and Skype as

communication mechanisms, emerging technologies, differential levels of digital expertise and the SharePoint virtual learning environment (VLE).

The domain expert indicated mature, working apprentices from different parts of the country enrolled in the fourth year of a part-time architectural technology degree defined by the prescriptions of OpenArchitecture. The blended-learning programme comprised design studio block sessions and online activities. The design incorporated both on-campus get-togethers and access to digital content with online submission of assessment tasks and project work. A student-centric social networking group was established via a closed Facebook group to support communication. In addition, students had "*another Facebook place where they do their own thing*" [DE]. However, feedback from Study 1.1 highlighted a lack of awareness of students' patterns of personal mobile device and technology usage.

The interviewee expressed dissatisfaction with the existing institutional VLE – a version of Blackboard, indicating it did not meet expectations. For this reason, a decision was made to avoid implementing it owing to *"… too much hassle getting support …"* [DE], hinting at the likelihood of poor adoption of Blackboard based on historic experience. However, programme activities comprising lessons with multiple-choice and open-ended questions were distributed via a customised SharePoint portal. Students uploaded their work from various locations around the country via an Internet-enabled, web-based SharePoint platform. In addition, they were encouraged to use the portal during discussions.

The domain expert believed the initial enrolment comprising 24 students, would likely reduce owing to dropouts. This observation is supported by a final cohort of 14 students, all of whom contributed to the study. Three lecturers filled dedicated educational roles for the part-time blend during the 2014–2015 period.

The success of the technology-oriented blended-learning context was largely dependent on digital literacy and proficiency of all stakeholders. Despite expecting issues with digital capabilities, students needed relatively minimal training and support in the use of the diverse technologies associated with the architectural technology programme.

Online critiques followed the upload of project work, facilitating discussion and deeper research. A closed Facebook group site played a pivotal educational role where lecturers encouraged students to contribute to group activities by posting comments and suggestions. Although assessment involved critiques of uploaded work, continuous assessment was both formative and summative and incorporated reviews of practical work together with theoretical components, characterised by ongoing development and evaluation of portfolios.

Features of the technologically rich and educationally innovative context of the programme are encapsulated in the comment:

> Several technologies are used. SharePoin*t* was customised and implemented by CCN under licence for OpenArchitecture. This is the chosen VLE environment for webinar material and upload of coursework for online assessment. Skype sessions are held to communicate and facilitate lessons and crits. A proportion of course content is facilitated via Web 2.0 tools such as TED-Ed [DE].

Owing to time limitations, the domain expert advised a thorough review of programme documentation located in the institutional repository[4]. This examination is the focus of Study 1.2, which aimed to achieve deeper familiarisation with curricular content and course design.

A review of digitalised institutional documentation highlighted key considerations. The architectural technology programme was customised for students who were previously unable to attend the fulltime fourth-year programme. Entrance to the fourth-year offering was achieved by completing a three-year National Diploma: Architectural Technology or an equivalent qualification. Students completing the additional part-time, two-year programme, acquired an Architectural Technology (Applied Design) degree.

Further review of programme documentation elicited enrolment requirements as: a year of working experience, current employment in an architectural capacity, computer literacy, 24/7 access to the Internet, mentoring support from an employer and availability to attend occasional assessment and block sessions.

Programme constituents included:

- OpenArchitecture – an online presence (Figure 4.1);
- Bi-annual block sessions (Figure 4.2);
- Portfolio assessment (Figure 4.3); and
- Webinars (Figure 4.4).

The inclusion of TED-Ed lessons, YouTube videos, digital content delivery via a customised SharePoint portal, Facebook postings – a closed, social networking communication group – and online discussions of course-related topics, for example, architecture theory enriched distance-learning experiences. Real-time and recorded lectures were made possible.

[4] http://digitalknowledge.cput.ac.za/xmlui/handle/11189/3090

The images provided here represent a selection of the programme constituents (IR)[5], namely the online nature of OpenArchitecture (Figure 4.1), student activities undertaken during periodic block sessions (Figure 4.2), the virtual studio environment that facilitates critique sessions (Figure 4.3) and a webinar session in progress (Figure 4.4).

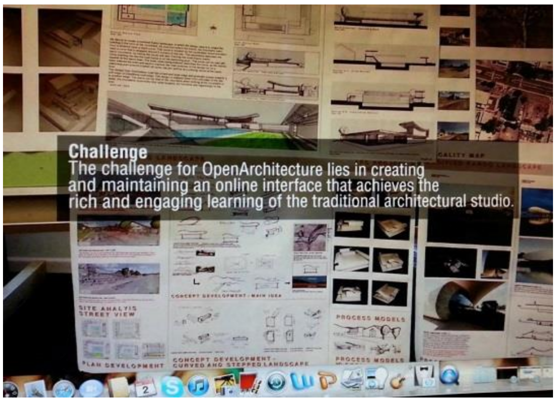


Figure 4.1: Online view of OpenArchitecture

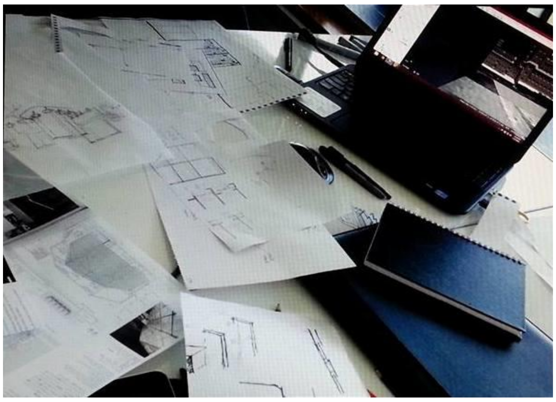


Figure 4.2: Students in a block session

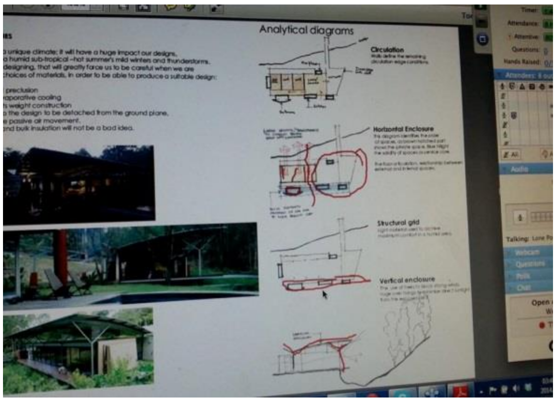


Figure 4.3: Virtual studio critique in progress

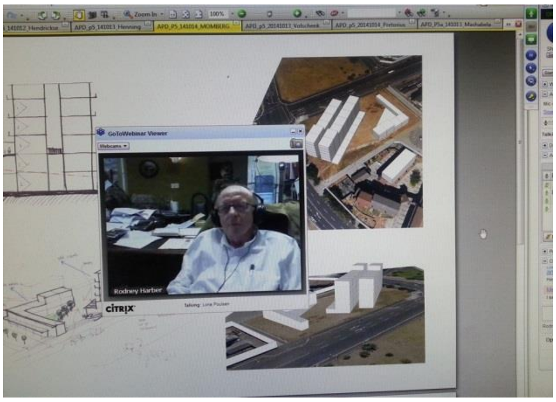


Figure 4.4: Webinar in progress

The blended model combined bi-annual, face-to-face block sessions with a range of distance-oriented, online activities achieved through the implementation of emerging digital technologies. The combination of online and offline parts constituted a virtual architecture design studio (Pektaş, 2015) and digitally emulated a typical architecture design space. Briefs provide all the details connected with practical activities while critiques review work, the sharing of ideas, problem resolution and suggested solutions.

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[5] www.Facebook.com/architectureopen

The South African Institute of Architects (SAIA) accredits courses through the South African Council for the Architectural Profession (SACAP), a professional body for registered architects. Employers providing positions for programme applicants were registered with SACAP. The programme was presented in collaboration with OpenArchitecture[6] (OA) (2015) and facilitated by an interactive SharePoint portal (2009). It offered office-based and online education as an alternative to full-time architectural studies.

Students were requested to bring the following to an initial pre-programme interview:

> 1. A3 portfolio that contains evidence of a broad range of skills, media and competence. 2. CV. 3. Full academic record. 4. Letter of support of employer. 5. Pencils/ felt-tip pen/s for a 2-hour design test. 6. A written assignment will be briefed at the interview submission by e mail on the following Monday (IR).

During Study 3.2, Semi-structured Interview, the faculty head communicated the strategic perspective that inspired the programme:

> Came about if I remember correctly when the champion et al. talked about an office-based BTech, thinking about expanding for future using technology, so they could actually meet students when they are not on campus … I thought it could be useful if we did the same with BTech. Second years are off campus for a year but come in on a Friday; they were at that stage supported through Blackboard, although not that well. Model was there, thought the model would be useful, useful to work according to that model … idea was two-fold … extend reach of campus, lower the amount of teaching that we were doing and amount of floor space that was necessary. Don't need students on campus if they can do their work at the office…[FH].

4.3.2 Stakeholders

The previous section (Section 4.3.1) provided background for the case study where Studies 1.1 (domain expert), 1.2 (institutional repository) and 3.1 (faculty head) highlighted key contextual aspects pertaining to the architectural technology programme.

This section provides respondent details, expanding contents of Table 2.11, Table 2.12, Table 2.13 and Table 2.14 from Chapter 2, supplemented by findings after the analysis of interview and questionnaire data.

Faculty Head and Domain Expert

The faculty head fills the senior role of dean of the faculty with the responsibility of institutional leadership. He has been a visiting professor at the Sudan University of Science and Technology in Khartoum; Addis Ababa University in Ethiopia; the University of Eastern Finland in Joensuu; and the University of Bergen in Norway.

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6 www.OpenArchitecture.co.za

His research interests include mobile learning, constructivist learning, and problem-based learning. He is an authority on educational technology, has published widely in prestigious journals and has supervised many masters and doctoral students.

The domain expert has championed the cause of the part-time architectural technology programme with responsibilities for the design, facilitation and implementation of a joint architecture and interior design foundation programme. She has presented papers at international conferences and published widely, including the co-authoring of three book chapters on sustainable design, urban design, and learning design.

Faculty Academics, Architecture Students and Architecture Lecturers

Table 4.2 tabulates demographic data collected during Studies 1.3, 2.1, and 3.1 and improves the understanding of the case study context, outlined earlier in Section 4.3.1.

Table 4.2: Demographics – Faculty Academics, Architecture Students and Architecture Lecturers

Aspect	Study 1.3: Faculty academics	Study 2.1: Architecture students	Study 3.1: Architecture lecturers
Respondents	Faculty academics: 5 Comprising: ・ Senior lecturer: 2 ・ Lecturer: 3	Architecture students: 14 Working experience: ・ > 3 years: 12 ・ 2 – 3 years: 2	Architecture lecturers: 3 Consisting of: ・ Professor: 1 ・ Senior lecturers: 2
Gender	Male: 3 Female: 2.	Male: 12 Female: 2	Male: 1 Female: 2
Age bracket	Age range: ・ 21 to 30: 1 ・ 31 to 40: 1 ・ 41 to 50: 2 ・ 51 to 60: 1	Age range: ・ 20 to 25: 2 ・ 26 to 30: 4 ・ Over 30: 8	Age range: ・ 41 to 50: 2 ・ Over 60: 1
Departments	Architectural Technology Graphic Design Information Technology Interior Design	Architectural Technology	Architectural Technology
Education Models	Blended learning: 1 Fulltime: 3 Face-to-face: 1	Part-time, blended and distance learning education	Part-time, blended and distance-learning education

Table 4.2 illustrates that unlike the architectural technology focus of students and lecturers, faculty academics represented a cross-section of diverse departmental disciplines.

Besides the demographic idiosyncrasies outlined in Table 4.2, a review of questionnaire responses highlighted differences in attitudes to the potential of the ad hoc use of mobile technology for educational purposes. For example, faculty academics [Study 1.3 Q12], architecture students [Study 21 Q37] and architecture lecturers [Study 3.1 Q37] were asked: In what ways could mobile devices and applications be used for educational purposes? Feedback from the five faculty respondents communicated an open attitude to the ad hoc use of mobile technology for educational purposes.

Their comments indicate mobile devices may be used to:

- Deliver educational games;
- Communicate via social media;
- Improve productivity by reading mobile e-books and papers;
- Watch and share YouTube videos;
- Search for information;
- Facilitate one-on-one consultations with students during discussions;
- Send unofficial Facebook messages to students' phones; and
- Prepare work from home.

Paradoxically, opinions of architectural technology lecturers seemed less creative and more pragmatic. One lecturer suggested students could use their mobile devices as a substitute during webinar sessions if they were unable to access office PCs or laptops. Additionally, mobile technology provided personal and informal social learning opportunities. The second respondent was satisfied with the way things were, commenting the *"current usage works well … on a formalised laptop platform"*. The third respondent offered a traditional digital communication perspective that included notifications to students, brief discussions, the posting of relevant information and students connecting with each other.

The next five sub-sections report selected data from the questionnaires administered among faculty academics (Study 1.3), architectural technology students (Study 2.1) and lecturers (Study 3.1), and the faculty head (Study 3.2). A large volume of data was collected. Analysed responses to all open-ended items has been included in this report. However selected close-ended data items were found to lack pertinence and to represent repetitive feedback. In essence, all open-ended responses were analysed and included as interviews were not possible. These items produced rich and thick data. This observation informs the content of survey questionnaires designed for further research. In retrospect, the design of questionnaire instrument was too complex and could have been simplified.

In keeping with a case study methodology, the inclusion of different stakeholder perspectives in the study established a spectrum of opinions and attitudes associated with strategic, tactical and operational lenses. Framework categories, sub-categories and items emerging during the systematic literature review (Chapter 3) led to a set of theoretically based codes. These items regarded as *a priori* codes were mapped to the most pertinent questions for the empirical part of the study, leading to the discovery of additional empirically determined codes.

4.4 Secondary question SQ1.1: What elements inform institutional decision making?

Section 4.4 is associated with Section 3.3 and addresses aspects of Category A. Enablement, analysed in Chapter 3. Besides sub-categories determined from theoretical sources, the section identifies additional perspectives based on the analysis of empirical data.

This section reviews the following topics:

- Preparedness and maintenance (Section 4.4.1);
- Continuous improvement (Section 4.4.2);
- Competitive advantage (Section 4.4.3);
- User-centricity (Section 4.4.4); and
- Digital facilitation (Section 4.4.5).

Table 4.3 presents an analysis of Studies 1.3, 2.1, 3.1 and 3.2, illustrating sub-categories and items mapped to studies and question-types with open, matrix-like and Likert-type questions.

Table 4.3: SQ1.1 – Sub-categories and items mapped to studies and question-types

		Study 1.3			Study 2.1			Study 3.1			Study 3.2
Sub-category	**Item**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**
Section 4.4.1 Preparedness and maintenance	TA03 Design and development	14	-	-	38, 41, 71	-	-	-	-	-	-
	TA04 Evaluation	-	-	-	-	-	-	-	-	-	-
	TA05 Implementation	14	-	-	-	-	-	-	-	-	1
Section 4.4.2 Continuous improvement	TA01 Change management	42	47	-	-	77	-	-	53	-	-
	TA08 Quality	-	-	26	46. 59	-	-	-	-	-	-
	TA10 Sustainability	-	-	-	-	-	-	-	-	-	-
	TA11 Time orientation	-	-	-	10	-	-	-	-	-	-
	TA12 Training	20	-	36	61	-	53	15, 46	-	38	-
Section 4.4.3 Competitive advantage	TA02 Competition	-	-	32	-	-	57	-	-	34	-
	TA06 Inclusiveness	-	-	25	10	-	50	-	-	27	-
	TA07 Logistics	-	-	29	-	-	54	-	-	31	-
	TA09 Strategy	14	-	27	71	-	52	46	-	29	1
Section 4.4.4 User-centricity	EA13 Access to information	33	-	-	25	-	-	16	-	-	-
	EA16 Ethics	15	-	-	-	-	-	-	-	-	-
	EA17 Focus on the user	14	-	-	25, 76	-	-	-	-	-	-
Section 4.4.5 Digital facilitation	EA14 Bandwidth	-	-	-	41, 59, 60	-	-	36	-	-	-
	EA15 Campus WiFi	42	-	-	60	-	-	15	-	-	-
	EA18 Internet connectivity	-	-	-	10, 70	-	-	-	-	-	-
	EA19 Wireless connectivity	-	-	-	39, 75, 76	-	-	15	-	-	-

4.4.1 Preparedness and maintenance

The sub-category 'Preparedness and maintenance' forms part of Category A. Enablement: taking ownership of organisational features, outlined in the initial theoretically based framework (Section 3.3.1) and presented at the end of Chapter 3. Empirical findings incorporate two theoretically based elements: design and development, and implementation. However, supportive evidence for the item 'evaluation' was not noted.

Design and development

Design and development practices relate to the formulation of activities, courseware, and assessment, where *"educators and students from all levels need to be involved with the design and implementation of … curricula"* [A1]. This observation is supported by one student who suggested an improved orientation towards mobile-friendliness and a greater institutional awareness of students' use of mobile technology (S14].

Implementation

An implementation strategy delineates deployment, maintenance and migration processes. The strategy should *"implement structures that enhance the use of mobile technology"* [S14]. The faculty head communicated some of the experienced difficulties associated with the model implemented for architectural technology, mentioning from an organisational perspective that *"the effort of trying to get this thing off the ground"* [FH] was a challenge. Furthermore, he referred to a studio set-up in Bellville, Cape Town, commenting:

> … the domain expert should have her own [studio], be at home, no need to come in, put Internet in her house. That's the sort of thing that should be done. I think that's what the domain expert says BTech should be about. The domain expert is working on heuristics but she needs to write the algorithm. If you have so many students in a class, then you need so many exercises that need to be done, with so many hours spent working.

Looking towards the future of 'big picture' implementations, the Vision for innovative learning models is encapsulated in the comment:

> …you don't need to be an e-learning expert or enthusiast. It just becomes part of your regular job, things to be done… [FH].

4.4.2 Continuous improvement

The sub-category 'Continuous improvement' forms part of Category A. Enablement: taking ownership of organisational features, included in the initial theoretically based framework (Section 3.4.2) and presented at the end of Chapter 3. It incorporates four theoretically based items: change management, quality, time orientation and training. However, supportive evidence for the item 'sustainability' was not noted.

Change management

A change management strategy guides ongoing adjustment and refinement. In answer to the questionnaire item Q42 (Study 1.3) – 'What changes are needed to meet your expectations for mobile technology-enhanced learning?', one faculty academic [A1] responded: *"I don't have specific expectations for mobile technology enhanced learning,"* while another felt *"students don't have enough data and are not always able to connect to … WiFi"* [A3]. Further exploration of attitude to change is demonstrated in Figure 4.5 that illustrates opinions of faculty academics, architecture students and architecture lecturers to the statement: 'The future of education is changing to a more mobile, flexible, boundary-free conversation between students.'

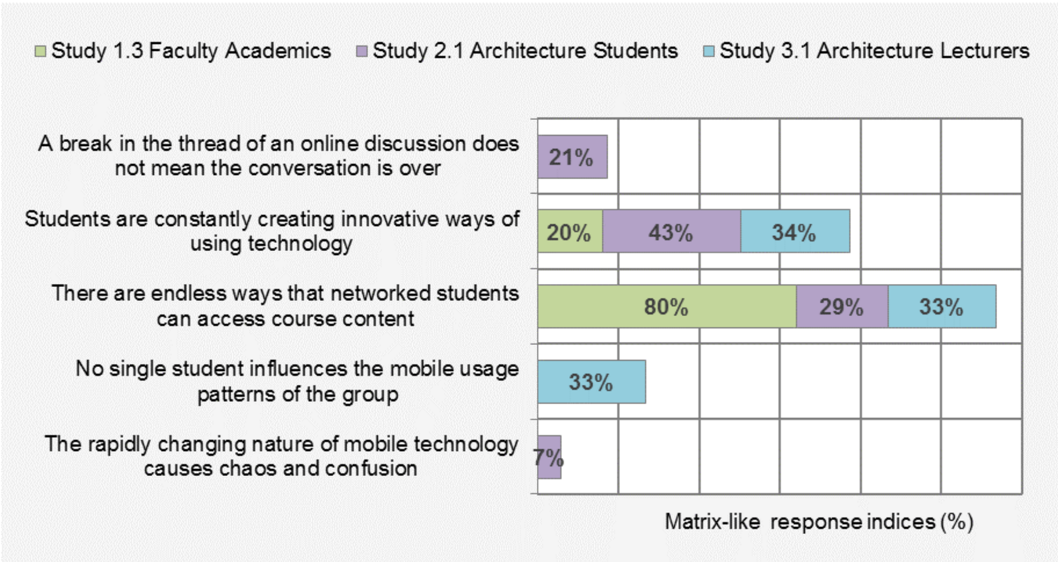


Figure 4.5: The future of education is changing to a more mobile, flexible, boundary-free conversation between students

Most students (43%) believe they are innovative in the ways they apply technology. This response rate exceeds that of faculty academics (20%) and architecture lecturers (34%). While responses of 21% of architecture students indicate an understanding of ongoing and boundary-free digital communication, none of the faculty academics or architecture lecturers support this statement. Only 7% concur that chaos and confusion occur owing to the educational changes resulting from mobile technology. Many faculty academics (80%) believe networked students have many ways to access course content. Interestingly, some architecture students and architecture lecturers indicate agreement, but to a lesser extent. These differing responses to the possibility and nature of change suggest the need for a consolidated and proactive change management approach that incorporates seamless mobile technology.

Quality

Quality forms part of improvement efforts and emphasises effectiveness, enhancement and excellence. Figure 4.6 reviews attitudes to the quality of learning where course content is accessed via mobile devices and applications. Similar and limited disagreement expressed by faculty academics (20%) and architecture students (14%) shows a lack of belief in mobile technology as an enhancing educational medium.

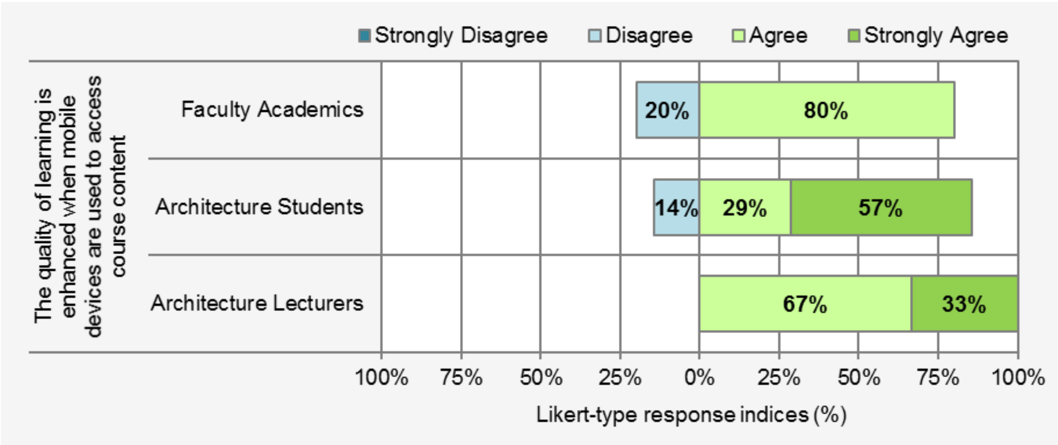


Figure 4.6: Quality – effectiveness, enhancement and excellence

When asked about required quality improvements, a student [S7] expressed the opinion that technology had been upgraded in response to student requests to enrich satisfaction.

Time orientation

An awareness of time orientation that combines scheduling, timeliness, currency and prevalence should consider student pressures. Students reported various time-related issues, including, mentors and employers providing insufficient time for submission to meet deadlines of online critiques [S1, S2] and time needed for design and thinking about online lectures and activities [S4]. A student [S12] recommended an adjustment from larger to *"smaller design projects"* as bigger projects consumed time for presentations. This modification would permit more design time and testing options.

Training

Training facilitates upliftment of digital skills and awareness. Figure 4.7 illustrates attitudes to the need for mobile technology training. While faculty academics – 60%, architecture students – 57%, architecture lecturers – 67% demonstrated strong support for additional training in the use of mobile technology, results also highlight that 28% of students feel confident enough not to need training.

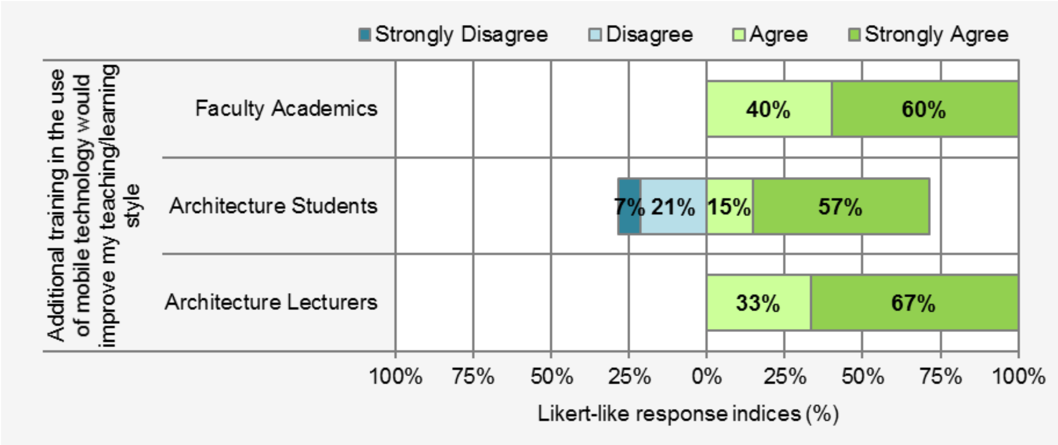


Figure 4.7: Training – upliftment of digital skills and awareness

Specific training requirements differed for the three groups. Faculty academics indicated training should focus on emerging technologies [A2], digital literacy in general [A3] and a range of tools [A4]. A faculty academic hinted at technological overwhelm, commenting:

> Currently, we are trying to remain up to date with the demand rather than always being ahead of everyone else [A5].

Architecture students called for architecture-specific training in the use of 3D programs and Photoshop [S6], together with a better understanding of how their mobile devices could support their studies [S12]. Architecture lecturers suggested training should address mobile applications used to support teaching strategies [L1] supplemented by improved institutional support, more resources and better training of staff [L2].

4.4.3 Competitive advantage

The sub-category 'Competitive advantage' forms part of Category A. Enablement: taking ownership of organisational features, outlined in the initial theoretically based framework (Section 3.3.3) and presented at the end of Chapter 3. It incorporates four theoretically based items: competition, inclusiveness, logistics, and strategy.

Competition

Higher education institutions are aware of competitive forces where faculties and departments compete for student enrolments. This competitive environment reflects digital trends and market pressures. Figure 4.8 communicates that whereas all faculty academics believe rollouts involving mobile technology emanate from outside competition, all architecture lecturers disagree with this notion. Overall responses from architecture students expressed diverse attitudes to competitive influences.

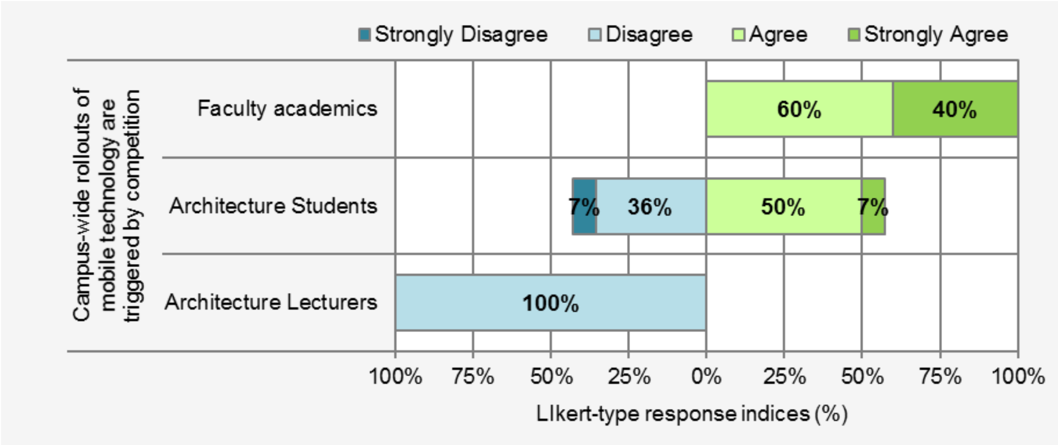


Figure 4.8: Competition – responses to digital trends and market pressures

Students are aware of digital facilities on offer at other universities, especially situations that support the ability to make use of their mobile devices and applications. Although faculty academics indicate the possibility of campus-wide rollouts emanating from competitive influences, the opinion of architecture lecturers differs substantially.

Inclusiveness

Inclusiveness incorporates transparency, seamlessness and integration. From a student's perspective, the integration of educational and working worlds should integrate time for studies while meeting work deadlines [S1], the co-ordination of timely mentor administration [S3], and employer support [S6].

Figure 4.9 illustrates responses to the statement: 'Course material is integrated for m-learning across all platforms'. Both faculty academics and architecture lecturers expressed disagreement with this statement, indicating a shortfall in the integration of course material across platforms. On the contrary, opinions of 79% of architecture students indicated they experienced some level of integration.

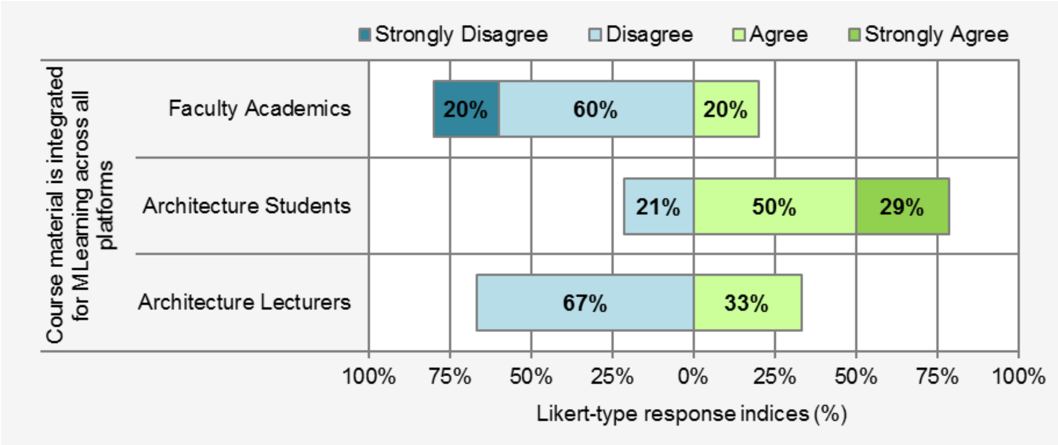


Figure 4.9: Inclusiveness – transparency, seamlessness and integration

With reference to perceived integration of courseware, there is some agreement between faculty academics and architecture lecturers that integration is not in evidence. Ironically, this is not necessarily the experience of students.

Logistics

Proximity, procurement, co-ordination and operations define logistics. Figure 4.10 reports feedback based on the statement 'distance between lecturers and students presents challenges'. Faculty academics (60%) expressed agreement with the statement. They did not participate in the custom-designed blended-learning model implemented for part-time architectural technology students. As expected, architecture lecturers were all personally associated with the blended-learning design, expressing strong disagreement (67%). Similarly, 72% of the architecture students disagreed that distance between lecturers and students was a challenge.

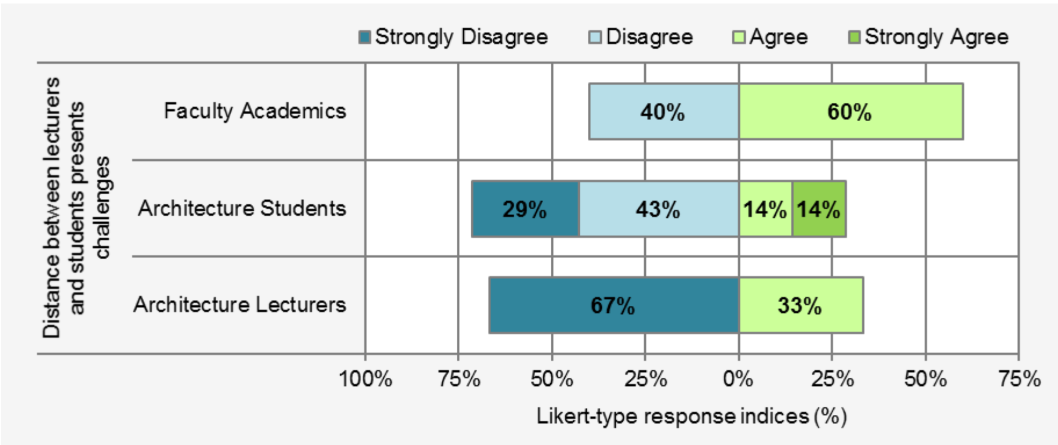


Figure 4.10: Logistics – proximity, procurement, co-ordination and operations

Despite some agreement that logistical challenges are present in distance-learning environments, most architecture respondents demonstrate support for this modality.

Strategy

Strategy formulates tactics, procedures, planning and direction of initiatives. Figure 4.11 explores institutional strategy via the statement, 'University decisions influence technology-enhanced project outcomes', and demonstrated dedicated support by almost all respondents.

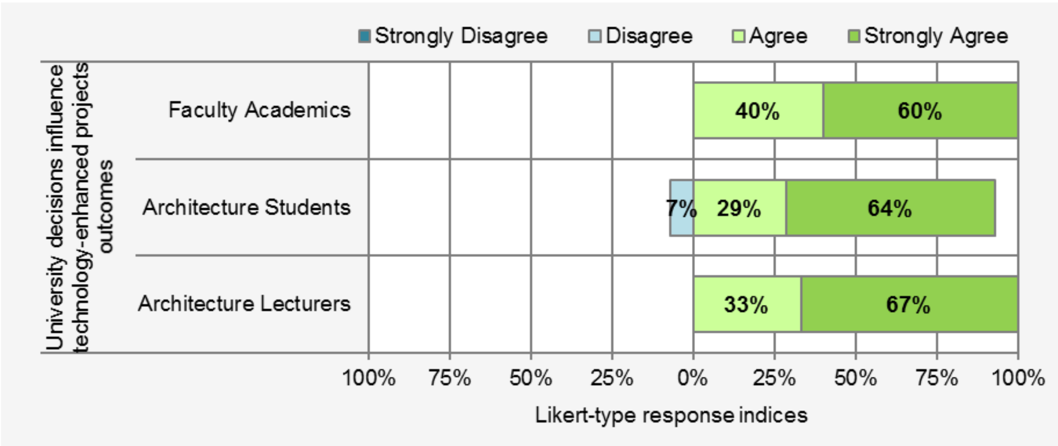


Figure 4.11: Strategy – tactics, procedures, planning and direction of initiatives

Academics indicate time is required specifically to prepare course material for learning-with-technology activities [A3], suggesting institutional stakeholders develop an understanding of the possibilities offered by mobile technology [A4].

An architecture student commented:

> Institutions need to be aware that students use mobile technology … they need to implement structures that enhance the use of mobile technology [S14].

Finally, the faculty head communicated a strategic, big-picture view of the future:

> … majority of the work I have been doing has been mainly for pedagogical rather than economical purposes, so for the next step let's start scaling…[FH].

4.4.4 User-centricity

The sub-category 'User-centricity' arose from empirical data and incorporates three empirically determined items: access to information, ethics, and focus on the user. Thus, this sub-category augments Category A. Enablement: taking ownership of organisational features, while adding to the initial theoretically based framework outlined at the end of Chapter 3.

Access to information

The timeous granting of access to information requires designated permissions and privileges. Faculty academics indicated that in their teaching contexts, the timeous access with permissions and privileges to shared information, stored in cloud-based spaces such as Dropbox and Google Drive, proved to be successful. Open-source platforms should thus be considered to satisfy student access requirements [A4]. The institutional LMS, Blackboard, was used as a source of information; however students needed to be reminded of this option [A3]. Architecture students highlighted the use of social media as a route to information receipt from lecturers and colleagues. Information included announcement, alerts, updates, shared ideas and discussion topics characterised as *"as soon as something arises"* [S1], and *"whenever I want'* [S2] attitudes. One student commented: *"I used mobile technology to acquire various information pertaining to certain projects … on the go"* [S14]. Architecture lecturers observed the benefit of using mobile devices and applications to have access to information from anywhere. However, this feature required improvement.

Ethics

The concept 'ethics' is associated with privacy, principles, actions, rights and rules. From an ethical perspective, *"confidentiality and confidence"* [A2] are benefits of using mobile technology for educational purposes, defining the relevance of privacy, principles, actions, rights and rules.

Focus on the user

A focus on the user embraces user-centricity and profiles. The faculty should change to embrace user- centricity and profiles where *"…educators and students from all levels need to be involved with … curricula"* [A1]. This approach would ensure successful implementation of mobile technology for learning. For architecture students, the ability to network with each other via social media should be the focus of facilitation.

4.4.5 Digital facilitation

The sub-category, ‘Digital facilitation’, arose from empirical data and incorporates four empirically determined items: bandwidth, campus WiFi, Internet connectivity, and wireless connectivity. Thus, this sub-category augments Category A. Enablement: taking ownership of organisational features, and adds to the initial theoretically based framework outlined at the end of Chapter 3.

Bandwidth

Bandwidth requirements characterised by transmission speed and data transfer capacity should be maximised. As expected, architecture students indicated dissatisfaction with bandwidth experiences, expressed as limitations of using mobile devices and applications for educational purposes. Maximised transmission speed and improved data transfer capacity is a necessity, as evidenced by comments such as: *“Bandwidth!!!!”* [S12] and *“Network at work is slow”* [S1]. From a student’s perspective, the solution entailed *“uncapped Internet with a high line speed and WiFi connectivity”* [S9]. However, a contrary device-associated view was expressed by one architecture lecturer who failed to comment on bandwidth, but noted instead the *“suitability of tablets, laptops”*, and added *“cell phones did not work”* [L2].

Campus WiFi

Adequate network facilities via the campus WiFi is a critical requirement; however, wireless services are not always available. This observation is supported by a faculty academic who commented: *“Students don't have enough data and are not always able to connect to WiFi”* [A3]. When questioned about recommended changes, a student called for improved WiFi requirements on campus, saying: *“…they should have an uncapped Internet facility”* [S4]. Furthermore, an architecture lecturer added that in addition to ensuring availability, the institution should provide WiFi that works.

Internet connectivity

Internet connectivity has a prime function – the support for Internet-based course requirements and research. Course and research requirements included *“Internet connectivity”* [S14]. Students reiterated that a good data connection is necessary as *“data is not cheap and is still a luxury in South Africa. Not everyone has access to the same quality of hardware that enables one to connect to the various platforms”* [S11].

Wireless connectivity

Besides access to the on-campus WiFi, the performance of off-campus wireless connectivity is based on network allowances where students may be *"connected to WiFi"* [S9] where *"one does not need to be connected to a server, you can do everything wireless[ly]"* [S10]. Students communicated that wireless connectivity facilitates *"short messages via WhatsApp … as responses are immediate"* [S14]. The benefits of wireless technology are limited by students' abilities to afford connectivity. While architecture lecturers concur that working WiFi is critical for the effective use of mobile devices and applications, success is also dependent on the ability of students to own their own devices. Additionally, *"educators should be trained to use relevant apps and teaching strategies"* in a wireless environment [L1].

4.4.6 Crystallisation – taking ownership of organisational features

Section 4.4.6 addresses aspects associated with institutional ownership and supports the secondary question *SQ1.1: What elements inform institutional decision making?*

Table 4.4 denotes the additional sub-categories and empirically determined items associated with Category A. Enablement, highlighting contributions from respondents in Studies 1.3, 2.1, 3.1 and 3.2. It shows that student feedback (Study 2.1) produced most of the items, while paradoxically, the interview with the faculty head (Study 3.2) offered no items in this category.

Table 4.4: Category A. Enablement – sub-categories and items from empirical data

Sub-category	Item	Study 1.3	Study 2.1	Study 3.1	Study 3.2
AI4 User-centricity	EA13 Access to information	■	■	■	-
	EA16 Ethics	■	-	-	-
	EA17 Focus on the user	■	■	-	-
AI5 Digital facilitation	EA14 Bandwidth	-	■	■	-
	EA15 Campus WiFi	■	■	■	-
	EA18 Internet connectivity	-	■	-	-
	EA19 Wireless connectivity	-	■	■	-

Table 4.4 and Figure 4.12 comprise various encoded elements. These elements include constructs, sub-categories, and items. COnstructs are labelled as COxy, where xy ranges from 11 to 18. The letter 'A' prefixes numbered sub-categories to indicate association with Category A. Enablement. Indices 'TA' and 'EA' suggest Theoretical and Empirical items in Category A. For example, the code 'TA01' represents the theoretically based item 'Change management', originating from the analysis of literature sources in Chapter 3. However, 'EA13' symbolises the empirically determined item 'Access to information'.

Furthermore, the network map presents a holistic and visualised view. It depicts enabling guidelines for decisions that support the ad hoc use of mobile technology by higher education stakeholders. Links denote relationships between the secondary question, SQ1.1 and items. Four of the empirically determined constructs relate to Category A. Enablement items. For example, item 'IA13 Access to information' is logically associated with the construct 'CO14 Information'. In addition, the map incorporates four non-associated constructs. Finally, except for items 'DA04 Evaluation' and 'DA10 Sustainability' from Chapter 3, empirical data supports all theoretically based items associated with Category A. Enablement in Table 3.9.

Findings included in this section augment the theoretical foundations established in Chapter 3, thereby contributing to the answering of both main questions, MQ1 and MQ2.

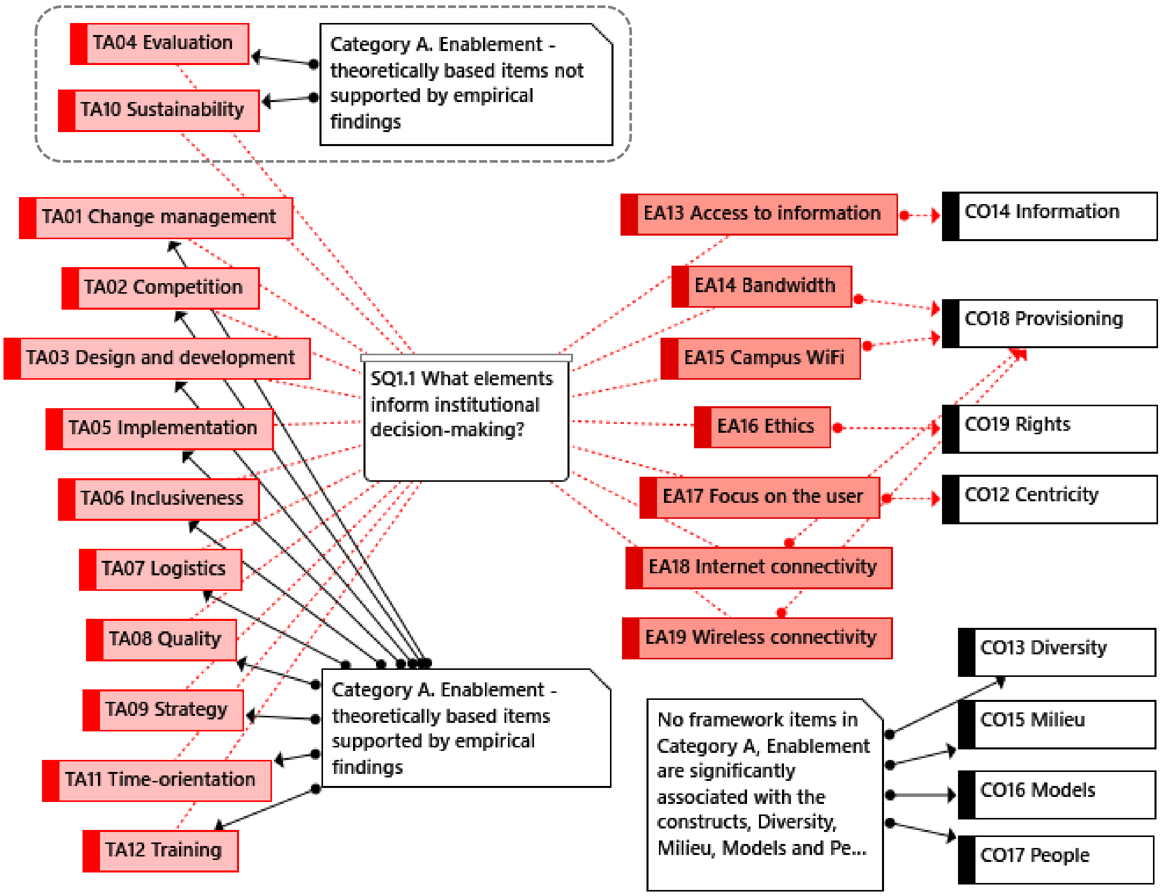


Figure 4.12: Network map – Category A. Enablement from empirical data

4.5 Secondary question SQ1.2: What elements reflect contextual influences?

Section 4.5 explores contextual influences linked to Category B. Environment. This section parallels theoretical perspectives emerging in Section 3.4, identifying additional, empirically determined components.

This section investigates the following topics:

- Personal responses to mobile technology (Section 4.5.1);
- External elements (Section 4.5.2);
- Vibrant evolution (Section 4.5.3); and
- Dealing with distances (Section 4.5.4).

Studies 1.3, 2.1, 3.1 and 3.2 in Table 4.5 illustrate related sub-categories and items. Mapped question types comprise open, matrix-like and Likert-type questions.

Table 4.5: SQ1.2 – Sub-categories and items mapped to studies and question types

		Study 1.3			Study 2.1			Study 3.1			Study 3.2
Sub-category	**Item**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**
Section 4.5.1 Personal responses to mobile technology	TB01 Acceptance	-	-	-	-	-	-	-	-	-	-
	TB02 Adoption	-	-	-	-	-	-	-	-	-	-
	TB07 Personal learning environments	14	-	-	12	-	-	16	-	-	2
	TB10 Stakeholder involvement	-	-	-	87	-	-	-	-	-	-
Section 4.5.2 External elements	TB03 Affordability	17	-	41	46	-	68	15, 16, 18, 51	-	43	-
	TB05 Impact	-	-	-	70	-	-	-	-	-	-
	TB08 Roles	5	-	40	-	-	67	-	-	42	4
	TB11 Support	-	-	-	75	-	-	46	-		-
Section 4.5.3 Vibrant evolution	TB04 Big picture	-	-	-	71, 87	-	-	-	-	-	-
	TB06 Innovation	14, 20	-	38	-	-	65	23	-	40	1, 3, 4
	TB09 Socio-cultural factors	-	-	-	46, 71	-	-	51	-	-	-
	TB12 Technology	34	49	-	61	79	-	14, 35, 64	55	-	-
Section 4.5.4 Dealing with distances	EB13 Cloud facilities	17, 33	-		61	-	-	15	-	-	-
	EB14 Off-campus benefits	-	-	-	12	-	-	-	-	-	-
	EB15 Off-campus issues	-	-	-	12, 41, 59, 61, 71, 76	-	-	-	-	-	-
	EB16 Ubiquity	-	-	-	28, 37	-	-	16	-	-	-

4.5.1 Personal responses to mobile technology

The sub-category 'Personal responses to mobile technology' forms part of Category B. Environment: recognising a constantly changing context, outlined in the initial theoretically based framework (Section 3.4.1) and presented at the end of Chapter 3. It incorporates two items: personal learning environments and stakeholder involvement. However, supportive evidence for the items 'acceptance' and 'adoption' was not noted.

Personal learning environments

Contextually enabled, personal learning environments (PLEs) involving mobile devices are worthy of consideration. PLEs should *"include … contextual assessment"* [A1]; however, *"not all students … have access to the latest smartphone and certain technology"* [A3]. A combination of mobile technology and students' PLEs may improve their practical on-site work. For example, students reported they could: take photos [S2], carry information on tablet devices [S4], communicate easily and make quick decisions [S5] and use Autodesk to draw up site details quickly for discussion with builders [S7, S9]. In addition, they could *"connect to work computers to access specific drawings or files urgently needed on site"* [S7]. PLEs benefit teaching and learning activities by *"blurring boundaries between different sites of learning, e.g., campus, community, workplace, online"* [L1]. The faculty head commented that the *"creation of a virtual learning community of students"* [FH] worked well.

Stakeholder involvement

Stakeholder involvement consists of the participation of the institution, administrators, lecturers and students. When questioned about the features of mobile technology capable of supporting architectural technology studies, a student accepted the benefits but added a sobering perspective: *"… the fundamentals never change like doing the work, asking questions when you don't understand, and interaction helps gain new and unique perspectives …"* [S7].

4.5.2 External elements

The sub-category 'External elements', forms part of Category B. Environment: recognising a constantly changing context, included in the initial theoretically based framework (Section 3.4.2) and presented at the end of Chapter 3. It incorporates four items: affordability, impact, roles, and support.

Affordability

The costs of mobile technology form part of affordability considerations. Figure 4.13 explores attitudes to the cost of educational mobile technology, reviewing whether it is affordable. Whereas most faculty academics felt the cost was beyond budgetary constraints, architecture students and lecturers disagreed.

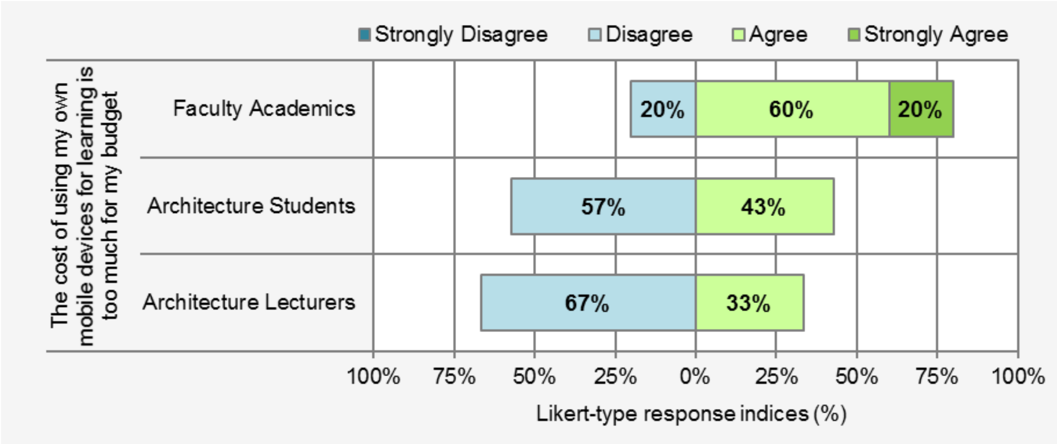


Figure 4.13: Affordability – cost considerations

A faculty academic highlighted the expense of developing and customising apps [A1]. However, architecture students addressed affordability issues in many ways, commenting:

- "I am not fully limited financially by the choice made, as I do have access to some forms of technology, but would love to have much more access and not feel limited" [S4];
- "I am still a student, I sometimes lack the finances to purchase the required mobile technology" [S8];
- "They are expensive and have a high running cost, which makes owning most devices impossible" [S9];
- "Finances limit access to quality mobile devices to enable easy access and the cost of data" [S11];
- "I have the resources" [S12]; and
- "Some of the good devices are beyond my financial reach" [S13].

Architecture lecturers called for lower access costs [L2], affordable mobile technology for students [L3] and the consideration of indirect costs such as data expenses to be covered [L2].

Impact

The impact of a mobile milieu presents external challenges such as those experienced by students working in huge offices [S5].

Roles

Educational functions and responsibilities of key *roles* need explanation. Figure 4.14 explores perception of the changing nature of the lecturer's role. There is strong agreement among the academics and lecturers that motivational purpose is replacing instructional purpose. In contrast, 36% of the students disagreed, affirming a belief in the traditional role of lecturers.

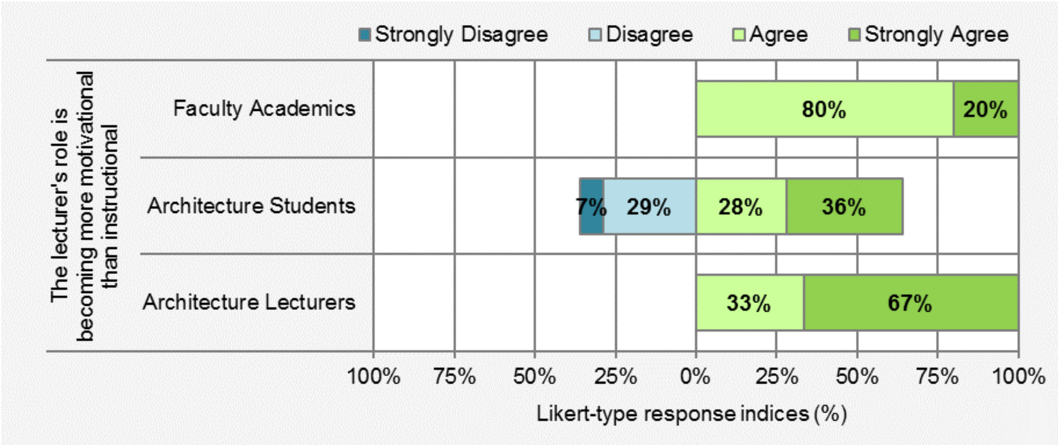


Figure 4.14: Roles – educational functions and responsibilities

Considering the impact of technological advances of educational roles, the faculty head remarked: *"… lecturers just do not have self-assurance…"* [FH], drawing attention to a need for upliftment of digital skills.

Support

Support for digitally enhanced teaching and learning is recommended. Help takes the form of peer support that makes it *"easy to see some students' work if you [are] lost"* [S1] and improved institutional support [L2].

4.5.3 Vibrant evolution

The sub-category 'Vibrant evolution' forms part of Category B. Environment: recognising a constantly changing context, outlined in the initial theoretically based framework (Section 3.4.3) and presented at the end of Chapter 3. It incorporates four items: big picture, innovation, socio-cultural factors, and technology.

Big picture

In this study, a big picture strategy implies the holistic inclusion of technology into education. According to students, this concept calls for mobile decisions – an awareness to be inculcated into higher education structures [S14]. In the process, decision makers would gain new and differing perspectives on mobile educational technology [S7].

Innovation

Novelty, improvement, reinvention and uniqueness characterise educational innovation that requires some creative adjustment when mobile devices and applications are considered as part of a learning strategy.

Figure 4.15 addresses the concept 'innovation'. Results reflect that academics, students and lecturers agree with changes made to their teaching and learning styles.

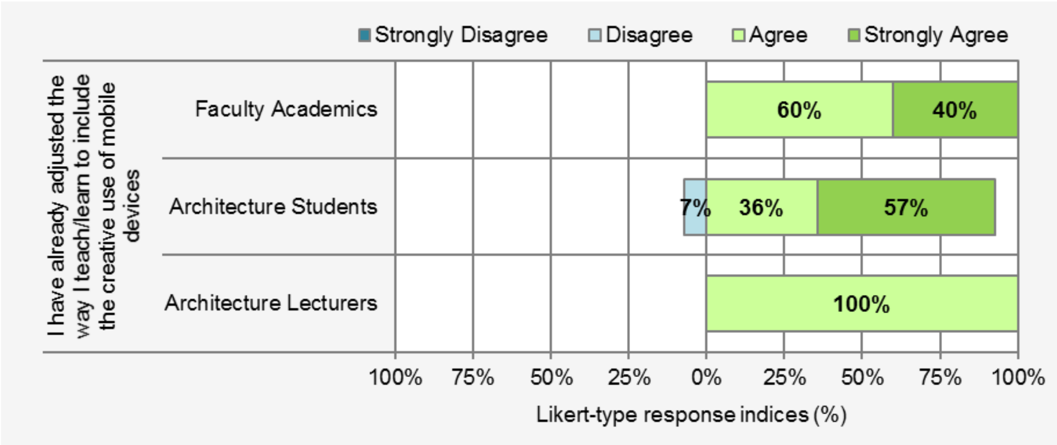


Figure 4.15: Innovation – educational functions and responsibilities

Innovative emerging technologies highlight existing possibilities associated with mobile technology [A2, A4]. An architecture lecturer expanded this thought, saying:

> I find it very useful for teaching and learning, my research, and see the future of teaching and learning as embracing technologies [L1].

The faculty head explained the thinking behind the innovative approach to a virtual studio environment, commenting:

> Idea was two-fold … extend reach of campus, lower the amount of teaching that we were doing and amount of floor space that was necessary" [FH].

When asked whether this innovation had merit for other departments, he responded:

> Yes, absolutely. Already in negotiations with the domain expert to choose a model for BTech nights which I believe is ready for this kind of thing" [FH].

Socio-cultural factors

Diversity of groups, beliefs and patterns constitute socio-cultural factors. For instance, an architecture student commented: *"… there's bills and family that I have to take care of"* [S6]. Students may find that accessing the preferred hardware is a challenge [L2].

Technology

A mobile milieu conducive to educational technology contributes to teaching and learning effectiveness. Faculty academics reported being aware that the use of technologies such as Edmodo, Blackboard and Mendeley may improve effectiveness [A1, A3]. Architecture students confessed they wanted to improve their use of digital technologies such as Dropbox [S4]. Perceived improvements included the use of *"sound through smart webinar crits and general tools"* [S7] as well as a better understanding of in-use technologies [S12]. An architecture student made a significant observation, sharing that *"online platforms accessed need to be made more mobile-technology friendly"* [S14]. In contrast, one architecture lecturer articulated concern that technology tools might dominate educational decision making [L1]. Another architecture lecturer expressed satisfaction with the status quo, commenting: *"… our current usage works well … on a formalised laptop platform"* [L2].

Respondents were asked how they felt teaching and learning had been evolving owing to the influence of mobile technology. Figure 4.16 elicited responses to a selection of statements concerning technology in education.

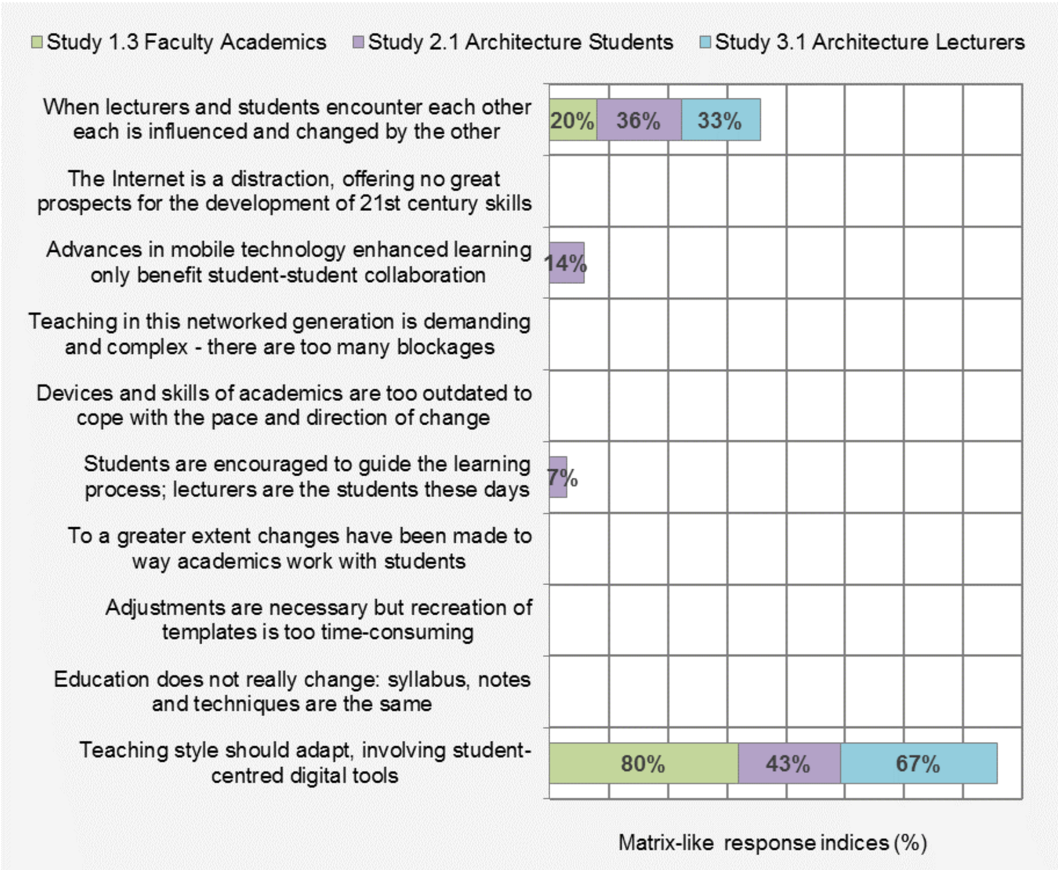


Figure 4.16: Technology – a digital milieu conducive to educational effectiveness

Preferences for the value of technology demonstrated by faculty academics (80%), architecture students (43%) and architecture lecturers (67%) demonstrated a preponderance for the opinion that teaching styles should change and involve student-centred digital tools. Of secondary significance, some respondents noted that when lecturers and students meet, each is influenced by the other. Contrary to the views of two students, academics and lecturers failed to support the notion that advances in ad hoc mobile technology-enhanced learning only benefited students. Finally, one architecture student (7%) communicated the opinion that in a mobile context, students are becoming the teachers – a paradoxical switch in role responsibility.

4.5.4 Dealing with distances

The sub-category 'Dealing with distances' arose from empirical data and incorporates four empirically determined items: cloud facilities, off-campus benefits, off-campus issues, and ubiquity. Thus, this sub-category relates to Category B. Environment: recognising a constantly changing context (Section 3.4), and extends the initial theoretically based framework outlined at the end of Chapter 3.

Cloud facilities

Cloud facilities incorporating Internet-enabled, web-based tools and applications serve a key purpose: *"reliable back-up facilities"* [A3]. In addition, cloud storage serves to protect data in case it is lost or corrupted. Cloud technology supports distance-learning students to connect digitally with one another and to *"host and share files"* [A1]. A key benefit of cloud facilities is an in-use *"Dropbox account"* [S4]. Free and mobile cloud functionality is epitomised by a student's shared observation: *"All my work will be saved on one drive (cloud), thus making all work accessible from all devices"* [S9]. If mobile devices and applications are to be effective tools of learning, the *"integration of platforms, e.g., using cloud services that are compatible"* [L2] is a necessity.

Off-campus benefits

There are off-campus benefits to be derived from being mobile. Architecture students experience *"improved understanding of technology which can be used in the office"* [S8] as well as *"drawing a detail … discussing digital drawings on site with builders"* [S9]. Off-campus benefits improve the ability to *"communicate with clients and other staff on projects"* [S12] and to do so *"at whatever time is convenient to me"* [S13].

Off-campus issues

Off-campus issues such as digital problems are encountered when lecturers and students are away from campus. Listed issues incorporated a lack of *"advanced equipment such as printers, scanners"* [S12] and *"load shedding"* [S8]. *"A slow network at home, missing headphones when webinars occur and perhaps the* *relationships between the employer and university"* [S1] may contribute to difficulties for distance-learning students. A student commented: *"There has to be control in the work place to ensure productivity"* [S7].

Ubiquity

Ubiquity is characterised by mobile technologies and social and educational pathways that intermingle and permeate all higher education avenues. One architecture student [S3] shared that *"the use of a tablet for crit sessions was excellent, could be critted anywhere, in the car, office, kitchen, park"*. Another enjoyed the possibility of *"accessing info on the go while doing other daily activities like travelling, shopping"* [S4]. Yet another was happy *"being able to carry study material anywhere while on the move"* [S5].

Students indicated an enthusiasm for ubiquitous mobile technology that offers them several educational opportunities:

- Watching lectures and working while travelling [S6, S10];
- Studying and sharing information while on the go [S3];
- Storage and moving of necessary study materials – anywhere and at any time [S4, S5]; and
- Location independence [S12].

Students can attend *"webinars no matter where you are in the world"* [S8]. On a simplistic level, information may be *"accessed from anywhere"* [L3].

4.5.5 Crystallisation – recognising a constantly changing context

Section 4.5.5 addresses aspects associated with contextual changes and supports the secondary question *SQ1.2: What elements reflect contextual influences?*

Table 4.6 summarises the additional sub-categories and empirically determined items associated with Category B. Environment, highlighting contributions from respondents in Studies 1.3, 2.1, 3.1 and 3.2. It shows that student feedback (Study 2.1) contributed to all items in this category, while paradoxically the interview with the faculty head (Study 3.2) produced no items.

Table 4.6: Category B. Environment – sub-categories and items from empirical data

Sub-category	Item	Study 1.3	Study 2.1	Study 3.1	Study 3.2
BI4 Dealing with distances	EB13 Cloud facilities	■	■	■	-
	EB14 Off-campus benefits	-	■	-	-
	EB15 Off-campus issues	-	■	-	-
	EB16 Ubiquity	-	■	■	-

Table 4.6 and Figure 4.17 comprise various encoded elements. These elements include constructs, sub-categories and items. COnstructs are labelled as COxy, where xy ranges from 11 to 18. The letter 'B' prefixes numbered sub-categories to indicate association with Category B. Environment. Indices 'TB' and 'EB' suggest Theoretical and Empirical items in Category B. For example, the code 'TB01' represents the theoretically based item 'Acceptance', originating from the analysis of literature sources in Chapter 3. However, 'EB13' symbolises the empirically determined item 'Cloud facilities'.

Furthermore, Figure 4.17 concretises the outcomes in Section 4.5, illustrating framework components and interrelationships emerging in Category B. Environment. This category refers to constantly changing higher education contexts, permeated by the influence of mobile technology. Links denote relationships between the secondary question, SQ1.2, and items. Two of the empirically determined constructs relate to Category B. Environment items. For example, item 'EB14 Off-campus benefits' is logically associated with the construct 'CO15 Milieu. In addition, the map incorporates six non-associated constructs. Finally, except for items 'TB01 Acceptance' and 'TB02 Adoption' from Chapter 3, empirical data supports all theoretically based items associated with Category B. Environment, in Table 3.10.

Findings included in this section augment the theoretical foundations established in Chapter 3, thereby contributing to the answering of both main questions, MQ1 and MQ2.

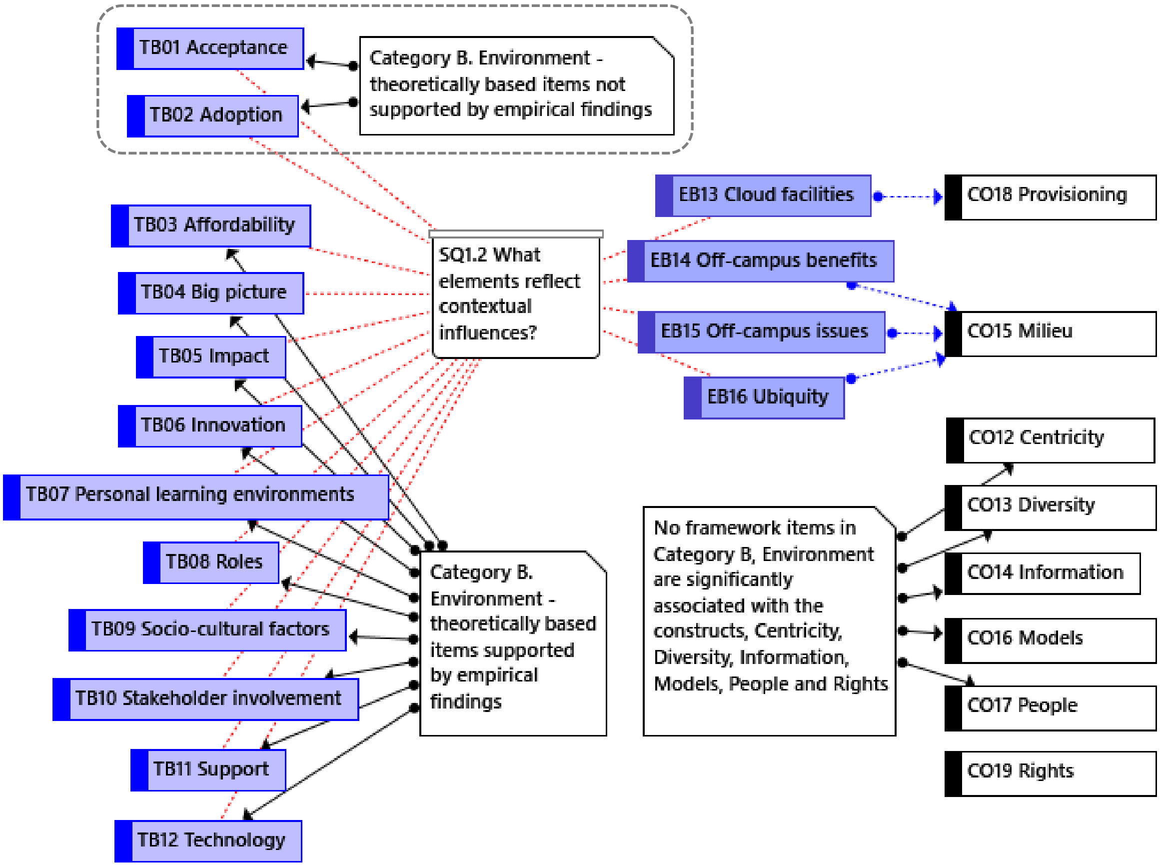


Figure 4.17: Network map – Category B. Environment from empirical data

4.6 Secondary question SQ1.3: What is the nature of relationships mediated by social technology?

This section reviews empirically determined items of Category C. Interactivity, mirroring theoretically based items reported in Chapter 3, Section 3.5. Besides sub-categories determined from theoretical sources, Section 4.6 proposes additional empirically determined items.

The section explores the following topics:

- Learning-management systems (Section 4.6.1);
- Technological requirements (Section 4.6.2);
- Socially driven mobile education (Section 4.6.3); and
- Relationships with others (Section 4.6.4).

Table 4.7 outlines relationships between Studies 1.3, 2.1, 3.1 and 3.2, sub-categories and items where open, matrix-like and Likert-type question types are mapped to associated items.

Table 4.7: SQ1.3 – Sub-categories and items mapped to studies and question types

		Study 1.3			Study 2.1			Study 3.1			Study 3.2
Sub-category	**Item**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**
Section 4.6.1 Learning-management systems	TC01 Collaboration	46	-	-	76	-	-	51, 52	-	-	-
	TC02 Communication	45	-	-	25, 75	-	-	14, 16, 18, 46	-	-	-
	TC07 Learning portal	34	-	23	38	-	48	35	-	25	-
Section 4.6.2 Technological requirements	TC03 Compatibility	-	-	-	41	-	-	15	-	-	-
	TC04 Connectivity	15, 42	-	-	18	-	-	36	-	-	-
	TC06 Internet access	34	-	-	58, 60	-	-	14	-		-
Section 4.6.3 Socially driven mobile education	TC05 Digital platforms	17, 33	-	-	11	-	-	15	-	-	-
	TC08 Social networking	46	-	-	25	-	-	14, 35	-	-	-
	TC09 Web 2.0 tools	12	-	-	58	-	-	14	-	-	2
Section 4.6.4 Relationships with others	EC10 Information sharing	12, 33, 46	-	-	25	-	-	52	-	-	-
	EC11 Interconnectivity	-	43	-	11, 25, 28	72	25	-	55	-	-
	EC12 Interpersonal contact	-	-	-	70	-	-	18	-	-	-

4.6.1 Learning-management systems

The sub-category 'Learning-management systems' forms part of Category C. Interactivity: incorporating web-based opportunities, outlined in the initial theoretically based framework (Section 3.6) and presented at the end of Chapter 3. It incorporates three items: collaboration, communication, and learning portal.

Collaboration

Project team participation and co-operation encourage collaboration. Digital tools such as Facebook and WhatsApp, together with mobile devices, are the main vehicles for collaboration [A5]. Architecture students were asked what they had noticed about the way students use mobile devices and applications to work on projects with each other. Responses included: *"Some [mobile devices and applications] seem to work very well and others not"* [S5], *"… [collaboration] … happens on a very tiny scale"* [S10] and *"not much … [collaboration]… has been noticed"* [S14]. These observations are supported by an architecture lecturer who commented: *"They don't collaborate as much as they should"* [L2]. This perceived lack of collaboration did not seem to stem from apathy, as students seemed *"… very comfortable and eager to learn if not familiar with the devices and applications"* [L3].

Communication

Exchange of information via Web 2.0 applications supports communication. Faculty academics experienced student communication in numerous ways:

- In some cases, students want instant communication with lecturers [A1].
- Lecturers prefer email contact, keeping their mobile phone numbers private and complaining about receipt of WhatsApp or SMS communication at inappropriate times [A3].

For architecture students, effective communication served several purposes. Networking with fellow students ensured *"getting information and alerts from … lecturers as soon as something [arose] …"* [S1]. Communication meant being able to *"… discuss topics and share ideas on … 'Hangout' page"* [S7] and participate in *"discussions related to studying"* via closed Facebook and WhatsApp groups [S8].

Students were asked to comment on the way they used mobile devices and applications to connect with other students. In response, they noted making *"very GOOD use of mobile devices"* [S3]. In addition, they felt the process was efficient, adding it was *"… not really much of an adjustment because in … [their] ... daily lives, technology … [influenced]… a great part of how … [they communicated] … anyway"* [S7]. Communication occurred in differing ways [S12]. Facebook communication was easy, allowing for continuing conversations [S8], while the sending and receiving of short messages via WhatsApp worked well owing to immediacy of responses [S14].

Mobile technologies facilitated the effective and efficient communication of notifications [L3] *"set on the SharePoint site to alert students of new posts"* [L1]. However, one of the architecture lecturers expressed concern that the use of mobile technologies for communication purposes resulted in *"no eye contact"* [L2].

Learning portal

The learning portal mediates bi-directional educational dialogue. Figure 4.18 summarises the statement *'the learning portal facilitates learning via any chosen device type'*. Twenty percent of faculty academics demonstrated strong disagreement, while 40% disagreed with the statement. These opinions paralleled those of architecture students, where a total of 57% disagreed. These observations suggest issues worthy of attention were experienced with the learning portal. On the contrary, there was 100% agreement among architecture lecturers whose opinions indicated they found no issues with chosen device types.

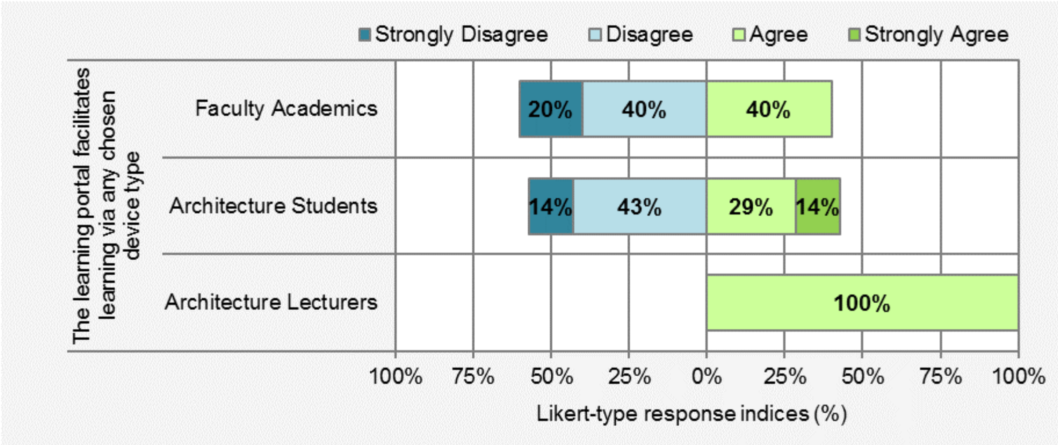


Figure 4.18: Learning portal – bi-directional educational dialogue

Regarding Blackboard, the institutional learning-management system [A2], a faculty academic advised that *"students avoid accessing it"* [A4]. This comment is supported by architecture students who called for improvements such as customised quick and easy access [S1], user-friendliness and good interface for all mobile devices as *"smart phones have trouble accessing the portal"* [S2, S4, S11], accessibility via mobile devices, simulating laptop performance [S7] and revision of the portal *"to avoid overwrites of other students' work"* [S6]. From a student perspective, the learning-management system could take lessons from Facebook that benchmarked a satisfying environment with features well suited to the improved receipt of notifications [S8]. Additionally, *"the portal can perhaps look at adding more colour to its page so it looks more attractive"* [S4]. Finally, students suggested the conversion of the portal to an app enabling on-the-move access to webinars via mobile devices [S9, S13].

4.6.2 Technological requirements

The sub-category 'Technological requirements' forms part of Category C. Interactivity: incorporating web-based opportunities, outlined in the initial theoretically based framework (Section 3.5.2) and presented at the end of Chapter 3. It incorporates three items: compatibility, connectivity, and Internet access.

Compatibility

Compatibility of working teams via a network of diverse technologies depends on support for and integration of technologies. Mobile access should consider *"as many mobile operating systems and devices as possible"* [S11] and incorporate the integration of platforms using *"cloud services"* [L2].

Connectivity

Connectivity allows seamless interactivity for users. Connectivity is a big problem when students do not have sufficient data and are unable to connect to the campus WiFi [A1, A3]. However, successful connectivity offers architecture students the chance to *"connect and listen to other students' crits and comments while working"* [S1], create hotspots, connect laptops to mobile devices [S2], and use mobile phones to link via WiFi for crits, webinars and work [S7, S8, S9]. According to the understanding of architecture lecturers, students *"use laptops, some use tablets, none use cellphones"* [L2] and *"are extremely comfortable using mobile devices and applications"* [L3]. Connectivity issues include bandwidth limitations [L2] and erratic network connectivity [L3].

Internet access

Web-based sites provide Internet access to educational resources. A faculty academic expressed a concern, commenting:

> The web has become a distraction and is not always used for the purpose it was created, namely, a resource rather than the main source to gather information [A5].

For architecture students, the Internet facilitates the uploading of work [S9] and access to online critiques and sessions [S9, S10]. Students recommended the inclusion of uncapped and reliable links to the Internet [S4, S9] while a lecturer called for Internet-enabled webinar sessions [L1].

4.6.3 Socially driven mobile education

The sub-category 'Socially driven mobile education' forms part of Category C. Interactivity: incorporating web-based opportunities outlined in the initial theoretically based framework (Section 3.5.3) and presented at the end of Chapter 3. It incorporates three items: digital platforms, social networking, and Web 2.0 tools.

Digital platforms

Digital platforms offer data channels via mobile-enabled applications. Faculty academics suggested digital platforms should not be limited within the institutional framework [A5], but rather be based on *"open source platforms that students can access easily"* [A4]. A lack of integration concerned an architecture student who commented:

> … so many times during my crit session I wish I had … [a] … great sketching pad that … [could] … be integrated with the platform that we're using" [S6].

An architecture lecturer also expressed the need for both compatibility and integration attributes of digital platforms [L2].

Social networking

Social networking incorporates social media, social technologies and networking tools. For faculty academics, social networking is synonymous with *"communication services like WhatsApp"* [A1, A3], Both Instagram and Facebook are social communication sources in use by students who *"share info easily"* [A4, A5].

Architecture students reported using social networking technologies for various purposes. They reported networking with fellow students [S1], visiting educational pages on Facebook, using Pinterest, Google+ and Twitter and streaming videos on YouTube [S4, S6, S7, S14]. In addition, students kept up to date with course-based announcements, collaborated with classmates and touched base with industry professionals [S6]. They uploaded their online work and participated in critique sessions with both architects and other students [S7]. The WhatsApp group was used to discuss many architectural topics [S8, S9], to share ideas and to get information and updates [S10]. Social networking technologies supported communication with lecturers [S12], scaffolded research opportunities and allowed the study of architecture website pages and the work of prominent architects [S13]. An architecture lecturer supported the use of social media for educational reasons, indicating social technologies served informal learning purposes [L1].

Web 2.0 tools

Web 2.0 tools enhance user interoperability, distinct from social networking. One faculty academic indicated the use of iPad technology during face-to-face student interactivity to *"further illustrate or refer to examples during discussion"* [L3]. *TED-Ed* sessions [S3] and webinars [S5, S13] were deemed by students to be satisfactory aspects of the OpenArchitecture programme. Web 2.0 tools supported brief discussions and the posting of relevant information [L3].

Feedback from the faculty head encapsulates the positive influence of Web 2.0 tools, contributing to the success of the architectural technology programme. He commented: *"Students talk to each other even before class, amazing what Facebook does in creating a hype and so the vibe on campus when these students arrive is almost electric"* [FH].

4.6.4 Relationships with others

The sub-category 'Relationships with others' arose from empirical data and incorporates three empirically determined items: information sharing, interconnectivity, and interpersonal contact. Thus, this sub-category augments Category C. Interactivity: incorporating web-based opportunities, and expands the initial theoretically based framework outlined at the end of Chapter 3.

Information sharing

To facilitate information sharing, a team culture of mutually supportive members should be encouraged. For example, lecturers can easily share information and *"video clips or reference materials"* [A3]. The sharing of information, helpful links for studying purposes and design ideas among students and their lecturers becomes feasible. Facebook provided a platform, a sharing space where *"most ideas and guides were posted"* [S14]. Most students seemed very comfortable with the ability to *"share information openly"* [L3].

Interconnectivity

An orientation towards a holistic and rhizomatic system highlights the importance of interconnectivity between stakeholders *"in different geographical areas, thereby enriching the culture and ideas from different corners of the world"* [S3].

Students viewed interconnectivity via social technologies as:

- Networking with fellow students [S1];
- Determining the availability of course-related briefs [S2];
- Staying ahead with alerts of deadlines [S1];
- Receiving helpful reminders via Facebook and WhatsApp [S8, S9];
- Collaborating with industry professionals [S6]; and
- Having architects review uploaded concepts [S7].

Interconnectivity should support convenient, quick and easy communication with lecturers and other students using WhatsApp. Peers can *"bounce off ideas and answer queries"* [S4]. Mobile technology makes *"research and interaction with others much easier"* [S13].

Respondents were asked about interconnectivity technologies (Figure 4.19). Twitter was reportedly of use only to faculty academics (20%) while no support for WeChat was noted.

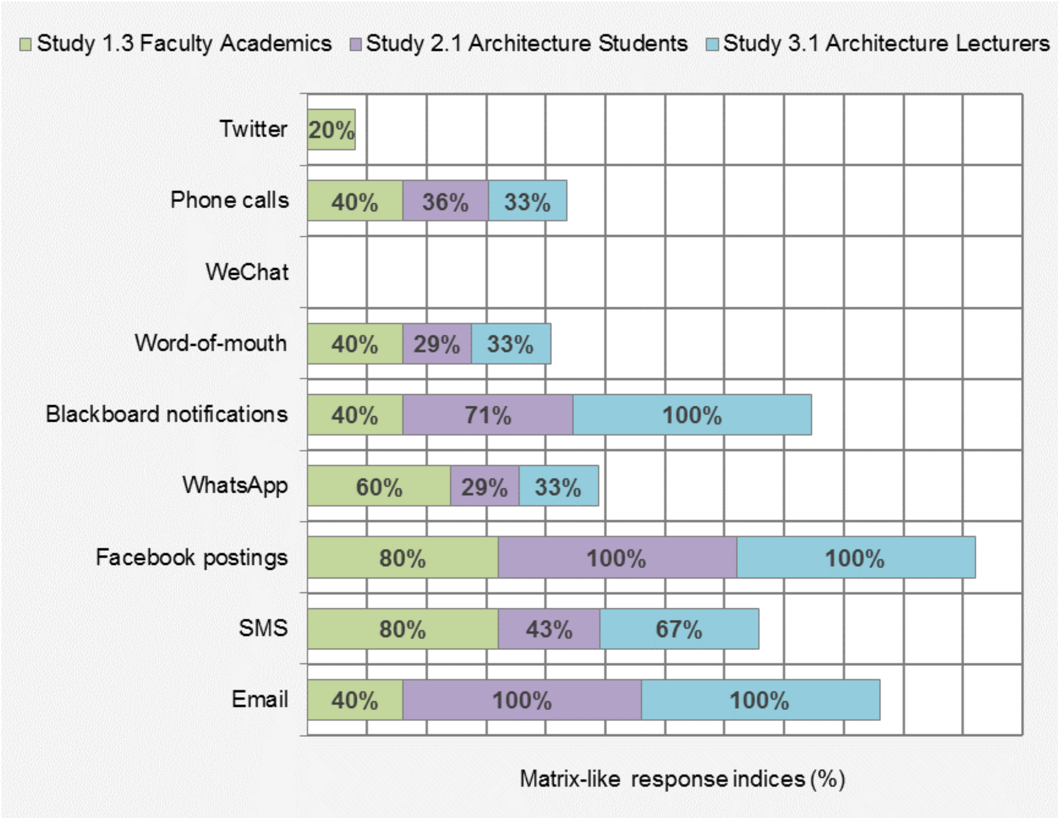


Figure 4.19: Technologies used by respondents to connect with each other

All architecture students and architecture lecturers used Facebook postings and email. However, even though Blackboard notifications were in use by all lecturers, Blackboard was used to a lesser extent by academics (40%) and students (71%).

Interpersonal contact

Interpersonal contact describes an exchange between people making connections, hindered to some extent by poor Internet speed [S9]. An architecture lecturer lamented the loss of interpersonal contact due to students' preoccupation with their mobile devices. He added: *"… can't keep track of exactly what the students are up to, video connections doesn't really help"* [L2].

4.6.5 Crystallisation – incorporating web-based opportunities

Table 4.8 encapsulates the additional sub-category, CI4 Relationships with others, and its empirically determined items. Section 4.6.5 supports the secondary question *SQ1.3: What is the nature of relationships mediated by social technology?*

Table 4.8: **Category C. Interactivity – sub-categories and items from empirical data**

Sub-category	Item	Study 1.3	Study 2.1	Study 3.1	Study 3.2
CI4 Relationships with others	EC10 Information sharing	■	■	■	-
	EC11 Interconnectivity	-	■	-	-
	EC12 Interpersonal contact	-	■	■	-

Furthermore, the network map (Figure 4.20) aggregates concepts associated with the incorporation of web-based approaches into higher education teaching and learning. It provides links between constructs and items, for example, item EC11, Interconnectivity, is associated with construct CO17, People. However, the map indicates several constructs were not supported. Finally, all theoretically based items associated with Category C. Interactivity (Table 3.11), were reinforced by empirical data.

Findings included in this section extend theoretical foundations, contributing to the answering of the main questions, MQ1 and MQ2.

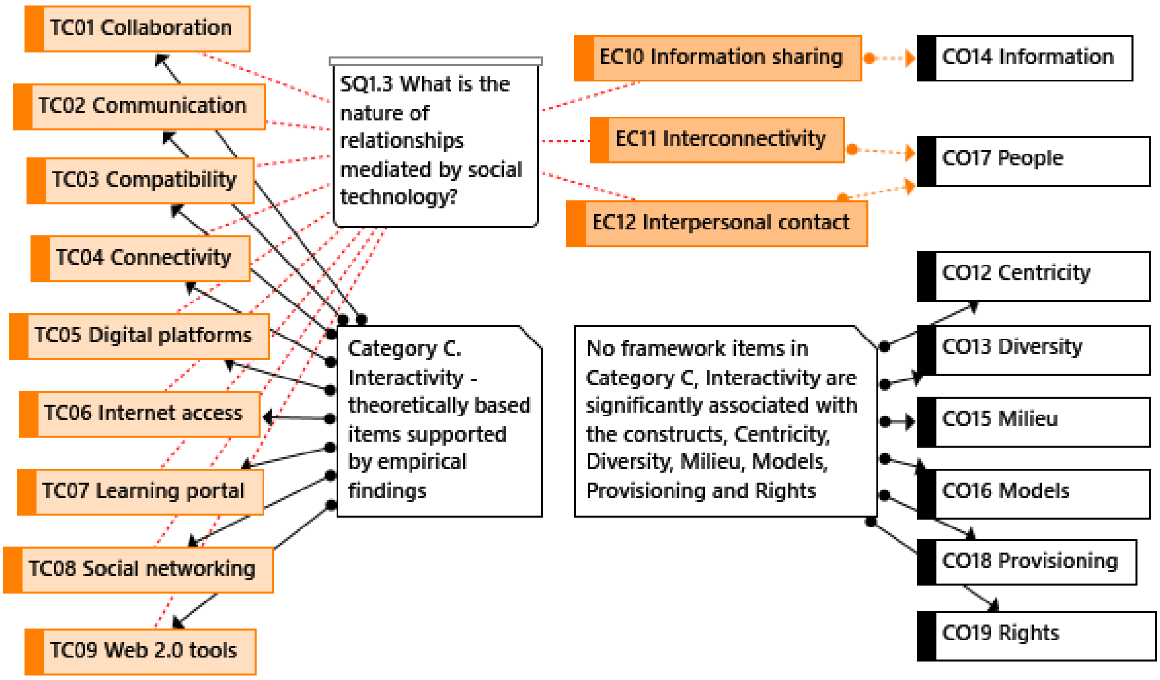


Figure 4.20: Network map – Category C. Interactivity from empirical data

4.7 Secondary question SQ1.4: What are the implications of teaching and learning in a mobile milieu?

Section 4.7, associated with Section 3.6, addresses teaching and learning in a mobile milieu – the focus of Category D. Dynamics. Besides sub-categories and items determined from theoretical sources, the section contributes extra perspectives regarding ad hoc mobile technology-enhanced learning.

This section considers the following topics:

- Educational preferences (Section 4.7.1);
- On-the-move education (Section 4.7.2);
- Decision-making trends (Section 4.7.3);
- Productivity (Section 4.7.4); and
- Digital designs (Section 4.7.5).

Table 4.9 tracks links between Studies 1.3, 2.1, 3.1 and 3.2, sub-categories and items, and provides a map to open, matrix-like and Likert-type questions.

Table 4.9: SQ1.4 – Sub-categories and items mapped to studies and question types

		Study 1.3			Study 2.1			Study 3.1			Study 3.2
Sub-category	**Item**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**
Section 4.7.1 Educational preferences	TD06 Digital skills	14	21	-	46	45	-	23	22	-	1
	TD08 Informal social learning	-	-	-	-	-	-	-	-	-	-
	TD14 Tools	12, 45	-	48	-	-	78	64	-	54	-
Section 4.7.2 On-the-move education	TD03 Assessment	-	-	-	58	-	-	16	-	-	-
	TD04 Curriculum	14	-	-	25	-	-	-	-	-	-
	TD05 Digital content	12	-	-	37	-	-	23	-	-	-
	TD07 Domain	-	-	-	12. 25, 39, 76, 87	-	-	15, 64	-	-	-
	TD09 Interventions	-	-	-	-	-	-	-	-	-	-
	TD10 Learning activities	33, 34, 46	-	-	12	-	-	16, 35, 51	-	-	-
	TD12 Outcomes	-	-	-	-	-	-	-	-	-	-
Section 4.7.3 Decision-making trends	TD01 Accreditation	-	-	-	-	-	-	-	-	-	-
	TD02 Approach	14	-	50	-	-	81	18, 23	-	57	-
	TD11 Models	-	-	-	-	-	-	-	-	-	-
	TD13 Policies, principles	12, 20	-	-	-	-	-	-	-	-	-
Section 4.7.4 Productivity	ED18 Efficiency learning	-	-	-	12, 71	-	-	14, 51	-	-	-
	ED20 Multi-tasking	46	-	-	28	-	-	-	-	-	-
	ED21 Resources	-	-	-	39	-	-	46	-	-	-
Section 4.7.5 Digital designs	ED15 BLearning	-	-	-	11, 58	-	-	64	-	-	1, 2
	ED16 BYOD	-	-	-	71	-	-	15	-	-	-
	ED17 TEL	-	-	-	46	-	-	-	-	-	-
	ED19 MLearning	12	-	-	11, 39	-		16	-	-	1, 4

4.7.1 *Educational preferences*

The sub-category 'Educational preferences' forms part of Category D. Dynamics: adjusting to an evolving, mobile pedagogy, outlined in the initial theoretically based framework and (Section 3.6.1) presented at the end of Chapter 3. It incorporates two items: digital skills and tools. However, supportive evidence for the item 'informal social learning' was not noted.

Digital skills

Stakeholders differentiate between required and acquired digital skills. One faculty academic called for the determination of *"capabilities and needs of respective educators"* … as well as the *"capabilities and needs of students"* [A1].

Varying descriptions of a mobile 'digital personality' (adapted from Horrigan, 2010) were noted among students:

- A lack of the necessary skills [S5];
- No understanding of uses and benefits of mobile technology [S12];
- Possession of necessary skills [S10];
- Technological adeptness [S8];
- Conversant with latest technology and devices [S9]; and
- Accumulated and acquired proficiency, enabling use in 80% of studies [S14].

In response to the questionnaire item reviewing the status of digital skills suited to mobile technology, an architecture lecturer emphasised the satisfactory operation of the innovative architecture model, adding *"… so it is now a question of refining it: it works"* [L2]. However, he failed to address facets of his own 'digital personality'. Another lecturer admitted: *"Technology development moves very fast and it is quite hard to keep up"* [L3]. Finally, the faculty head intimated: *"Has to do with a feeling I had that we tend to teach way too much, way too little getting students to learn"* [FH].

Figure 4.21 aggregates responses concerning 'digital personalities'. None of the faculty academics indicated they were digitally committed, that is, 'have the skills, resources and finance for mobile technology-enhanced learning' contrasting with architecture students (36%) and architecture lecturers (67%). Equally, none of the students and lecturers reported a distant 'digital personality' defined as 'not interested in mobile technology-enhanced learning at all', while some academics (20%) saw themselves as having distant digital personalities.

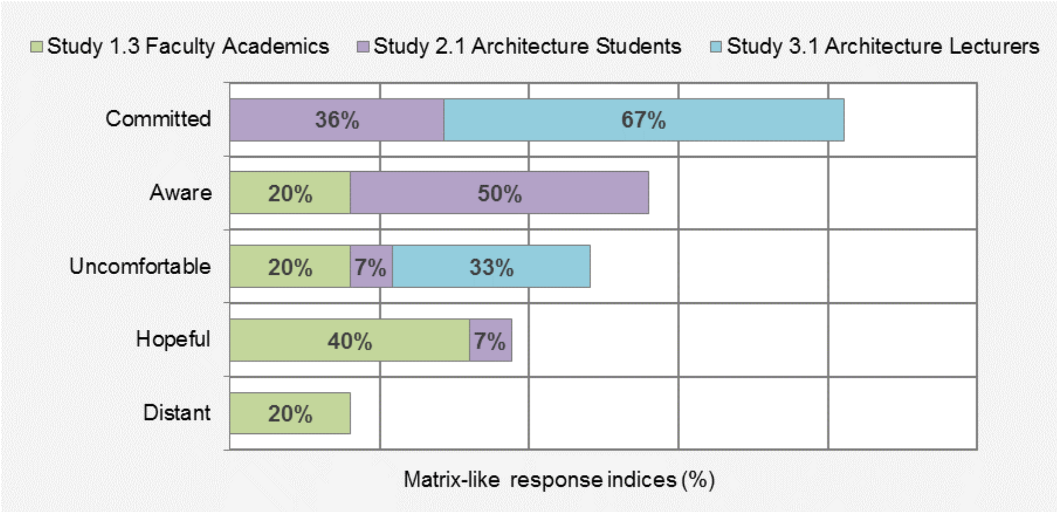


Figure 4.21: Categorisation by respondents of their digital personalities

Perhaps of greatest interest is the observation that 50% of students indicated being digitally aware: 'have the skills for mobile technology enhanced learning but am limited by financial constraints'. None of their lecturers saw themselves in this category. These responses could reflect the words '… but am limited by financial constraints' applicable to student constraints but not necessarily to those of lecturers.

Tools

Digital tools and mechanisms support teaching and learning. Academics suggested tools are needed for *"some form of instant communication"* [A1] via WhatsApp, SMS, Instagram or preferably email [A3]. Other tools include Facebook [A4], Blackboard and Dropbox [A1, A5], YouTube video [A1] and mobile eBooks [A1]. A lecturer [L1] advised that although mobile tools are useful, even important, they should not dominate educational considerations.

Figure 4.22 demonstrates responses to the statement 'the mobile phone, originally a means of communication, has become a tool for the enhancement of learning'. Responses of faculty academics (40%), architecture students (71%), and architecture lecturers (67%) resonated with one another, expressing strong agreement.

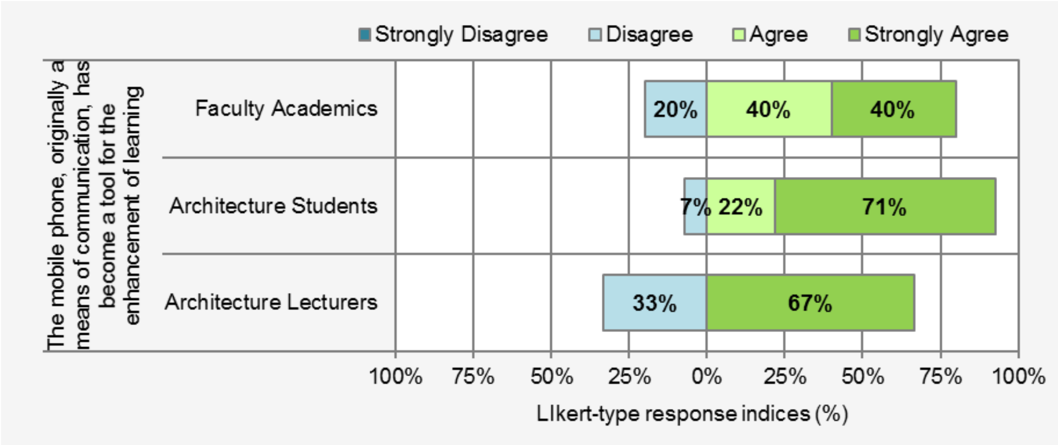


Figure 4.22: Tools – teaching and learning via digital mechanisms

Additionally, the statement elicited some disagreement, especially from an academic, a student and a lecturer.

4.7.2 On-the-move education

The sub-category 'On-the-move education' forms part of Category D. Dynamics: adjusting to an evolving, mobile pedagogy, outlined in the initial theoretically based framework (Section 3.7.2) and presented at the end of Chapter 3. It incorporates five items: assessment, curriculum, digital content, domain, and learning activities. However, supportive evidence for the items 'interventions' and 'outcomes' was not noted.

Assessment

Methods used to achieve assessment reflect levels of achievement. Students commented on assessment via online critiques, that although they appreciated the feedback via an easy-to-access communication platform, they experienced some drawbacks [S4, S6, S9, S10 and S12]. A lecturer [L2] identified limitations of evaluation mechanisms, indicating that it should be easier.

Curriculum

The curriculum details qualification subject matter and course content. A faculty academic expressed the opinion that *"educators and students from all levels need to be involved with the design and implementation of … curricula"* [A1], while a student wanted *"updates on the latest subject requirements"* [S10].

Digital content

Digitised resources and course material deliver digital content in the form of mobile eBooks and papers, where tablets helped in class with specific learning [A1]. Video clips and reference material were prepared; then the content was prepared specifically for learning with technology – a time-consuming requirement [A3].

A student has all the necessary materials stored in digital format, enabling convenient and unhindered mobility, irrespective of time and place [S5]. Immediacy is important for students who want to receive emailed notifications and lecturer delivery of digital content instantaneously regarding their assignments [S8, S13]. Students advocated making education available on mobile applications and devices [S11].

Domain

The domain describes an instructive subset of a specific educational discipline. On-the-move architecture students benefited from the ad hoc use of mobile technology to take photos when on site [S2]. In addition, they could visit educational pages in Facebook such as ArchDaily [S4]. One student highlighted a need for apps that communicate information on architecture-related subjects, thus substituting for a physical library [S2]. Architecture lecturers could foresee the benefit of adapting the learning portal to mobile and discipline-specific needs [L3]. Experience had shown that a blended-learning environment designed for mobile students suited *"teaching design and creative work"* [L2].

Learning activities

Learning activities include course-related events underpinning pedagogy in action. Faculty academics shared personal anecdotes regarding ways digital technology supported learning activities of their multi-tasking, such as the use of Microsoft PowerPoint for presentations, together with Edmodo, Blackboard and Mendeley [A1, A2]. Mobile students carried essential information on their tablets [S4] and took photos when on site [S2], *"allowing quick decisions to be made"* [S5]. Students reported understanding the benefits of mobile technology while doing fieldwork. The ability to be technologically mobile during on-site activities improved productivity, as demonstrated by the following examples:

- "By having Autodesk as an app, one could quickly draw up a detail on site, take a picture and then putting it on a title block, issue it right on site" [S7]; and
- "The use of tablets/iPads can be used on site in the construction industry to provide quick ideas" [S14].

One student noted an *“improved understanding of technology which can be used in the office”* [S8], while another realised he could *“communicate with clients and other staff on projects … and … send information from site back to office”* [S12].

An architecture lecturer felt an important benefit of using mobile devices and applications for educational purposes was the sought-after blurring of boundaries *“between different sites of learning, e.g., campus, community, workplace, online”* [L1].

4.7.3 Decision-making trends

The sub-category ‘Decision-making trends’ forms part of Category D. Dynamics: adjusting to an evolving, mobile pedagogy, outlined in the initial theoretically based framework (Section 3.6.3) and presented at the end of Chapter 3. It incorporates three items: approach, models, and policies and principles. However, supportive evidence for the items ‘accreditation’ and ‘models’ was not noted.

Approach

The specification of pedagogical approach incorporates processes and attitudes. Figure 4.23 illustrates that respondents supported the emergence of new and resourceful ways of teaching and learning. The feedback from architecture lecturers (strongly agree: 67% and agree: 33%) epitomises attitudes of a group of lecturers, already committed to the introduction of emerging technologies into their pedagogical strategies. The reticence expressed by a small selection of faculty academics (20%) indicates that there is already a changing approach towards innovation. A few students (14%) still appreciate the traditional face-to-face classroom approach.

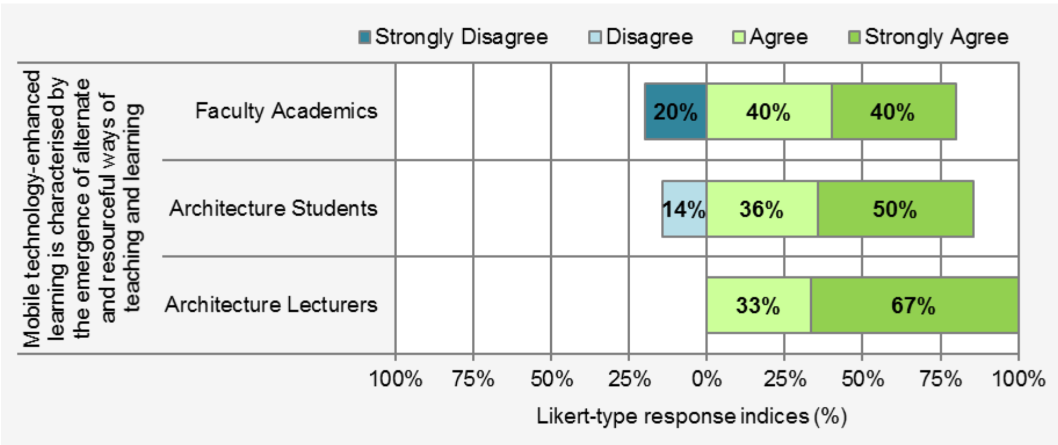


Figure 4.23: Approach – pedagogical processes and attitudes

Academics realise a change in attitude towards a new pedagogical approach is essential [A2], as is an understanding of the possibilities that exist [A4]. Traditional material needs realignment for a mobile teaching and learning environment, implying increased time allowances for preparation [A3]. An architecture lecturer shared her changing approach: *"I find it very useful for teaching and learning, [and] my research, and see the future of teaching and learning as embracing technologies"* [L1].

Policies, principles

Formal institutional policies and principles underpin techniques and tools. One faculty academic indicated mobile technology was used to share video clips and reference resources [A3]. Another academic noted institutional policies had not yet been adjusted in response to competitive influences, saying *"currently, we are trying to remain up to date with the demand rather than always being ahead of everyone else"* [A5]. A different attitude to mobile access was encapsulated in the following comment: *"There should be no reason for students not to access information"* [A5].

4.7.4 Productivity

The sub-category 'Productivity' arose from empirical data and incorporates three empirically determined items: efficiency learning, multi-tasking, and resources. Thus, this sub-category augments Category D. Dynamics: adjusting to an evolving, mobile pedagogy (Section 3.7), and contributing to the initial theoretically based framework outlined at the end of Chapter 3. In this way, it also contributes to the answering of the main questions, MQ1 and MQ2.

Efficiency learning

Casual and lifelong learning experienced off-campus has become the 'way of life' – an efficient and mobile way to learn. According to a student's opinion, efficiency learning offers improved understanding of technology that can be used in the office [S8]. However, efficiency learning requires the development of skills necessary for *"using mobile networks in a more efficient way"* [S4]. A lecturer commented: *"As educator I use it a lot for social media/informal learning purposes"* [L1]. In alignment with a student's need for mobile skills, another lecturer said she was *"eager to learn if not familiar with the devices and applications"* [L3].

Multi-tasking

The simultaneous performance of differing digital tasks, termed multi-tasking, is facilitated by mobile technology. A faculty academic [A2] reported being aware that students multitask, while another added they were in the habit of *"constantly communicating via WhatsApp and Instagram"* [A3]. However, multi-tasking reported by students seemed to focus on educational activities, showing propensity for *"accessing info on the go while doing other daily activities like travelling, shopping, etc."* [S4]. In addition, complex and multiple mobile undertakings included *"multi-tasking between different devices for different projects"* [S9].

Resources

Resources incorporated include VLEs, multimedia, e-literature, devices and applications. In addition, students may access *"multitudes of similar lectures by many different individuals"* [S13]. Mobile technology brings *"resources at the fingertips"* of students [S5]. Shortfalls in campus resources are supplemented by mobile devices and applications that students *"would be able to use … as a library"* [S2]. While an architecture student suggested that mobile technology provides benefits that are faster, more effective and provide anytime accessibility to important resources, an architecture lecturer emphasised the need for more resources.

4.7.5 Digital designs

The sub-category 'Digital designs' arose from empirical data and incorporates four empirically determined items: blended learning, BYOD, technology-enhanced learning, and m-learning. Thus, this sub-category augments Category D. Dynamics: adjusting to new forms of mobile pedagogy (Section 3.7), and evolving from the initial theoretically based framework outlined at the end of Chapter 3.

Blended learning

Blended learning is viewed simply as a mix of differing teaching and learning modalities. It offers students the ability to *"study while still being able to earn an income"* [S8]. For some students, technology-based learning is a natural way to learn, as it incorporates *"everyday media use to incorporate and study online"* [S7]. An architecture lecturer suggests: *"Teaching design and creative work requires a blended environment … if not blended there would be minimal alignment as teaching this only online is not effective"* [L2]. The faculty head supports blended-learning strategies as lecturers *"don't need students on campus if they can do their work at the office"* [FH].

BYOD

Departmental lecturers may specifically design suitable BYOD initiatives where personally owned mobile devices and applications are used for educational purposes [L1].

TEL

A technology-enhanced learning plan potentially integrates aspects of mobile technology. There is an awareness among students of the manner in which mobile technology is integrated to enhance learning [S11]. In addition, although some students believed they had the appropriate technological skills, they were constrained by insufficient funds.

M-learning

M-learning models formally incorporate mobile technology into teaching and learning contexts. This is achieved in several ways such as *"through the use of games … mobile eBooks and papers"* [A1]. Tablet technology is useful for the watching of *"YouTube videos"* and for *"looking for information"* [A1]. An architecture student noted: *"I use my iPad in one-on-one consults with students to further illustrate or refer to examples during discussion"* [A3]. Students highlight the educational benefits of social media, suggesting Facebook and Twitter and general websites support the ability to achieve quick access to information. This permits students to 'study' in many situations, such as *"while waiting, standing in lines, lunch at work"* [S2] and allows *"mobile access to … online learning facilities"* [S11]. An architecture student indicated he could *"learn from where ever you are in the world … never miss out on work or lectures thanks to online access"* [S8]. From a lecturer perspective, the benefit of m-learning for distance-learning purposes is the practicality of *"less repetition of lectures"* [L2]. The faculty head intimated that the future adoption of m-learning deserves action, saying: *"There's another next step, let's start practising it"* [FH].

4.7.6 Crystallisation – adjusting to an evolving, mobile pedagogy

Table 4.10 summarises the additional sub-categories and empirically determined items. Section 4.7.6 supports the secondary question *SQ1.4: What are the implications of teaching and learning in a mobile milieu?*

Table 4.10: Category D. Dynamics – sub-categories and items from empirical data

Sub-category	Item	Study 1.3	Study 2.1	Study 3.1	Study 3.2
DI4 Productivity	ED17 Efficiency learning	-	■	■	-
	ED19 Multi-tasking	■	■	-	-
	ED20 Resources	-	■	■	-
DI5 Digital designs	ED15 BLearning	-	■	■	■
	ED16 BYOD	-	■	■	-
	ED18 MLearning	■	■	■	■
	ED21 TEL	-	■	-	-

Furthermore, the network map (Figure 4.24) visualises the findings of Section 4.7. Where applicable, constructs and items are associated. For example, item ED17, Efficiency learning, relates to construct CO12, Centricity. Apart from TD01 Accreditation, TD08 Informal social learning, TD09 Interventions: TD12 Outcomes and TD11 Models, all theoretically based items in Category D. Dynamics (Table 3.12), were supported by empirical data.

Findings included in this section expand theoretical foundations, contributing to the answering of the main questions, MQ1 and MQ2.

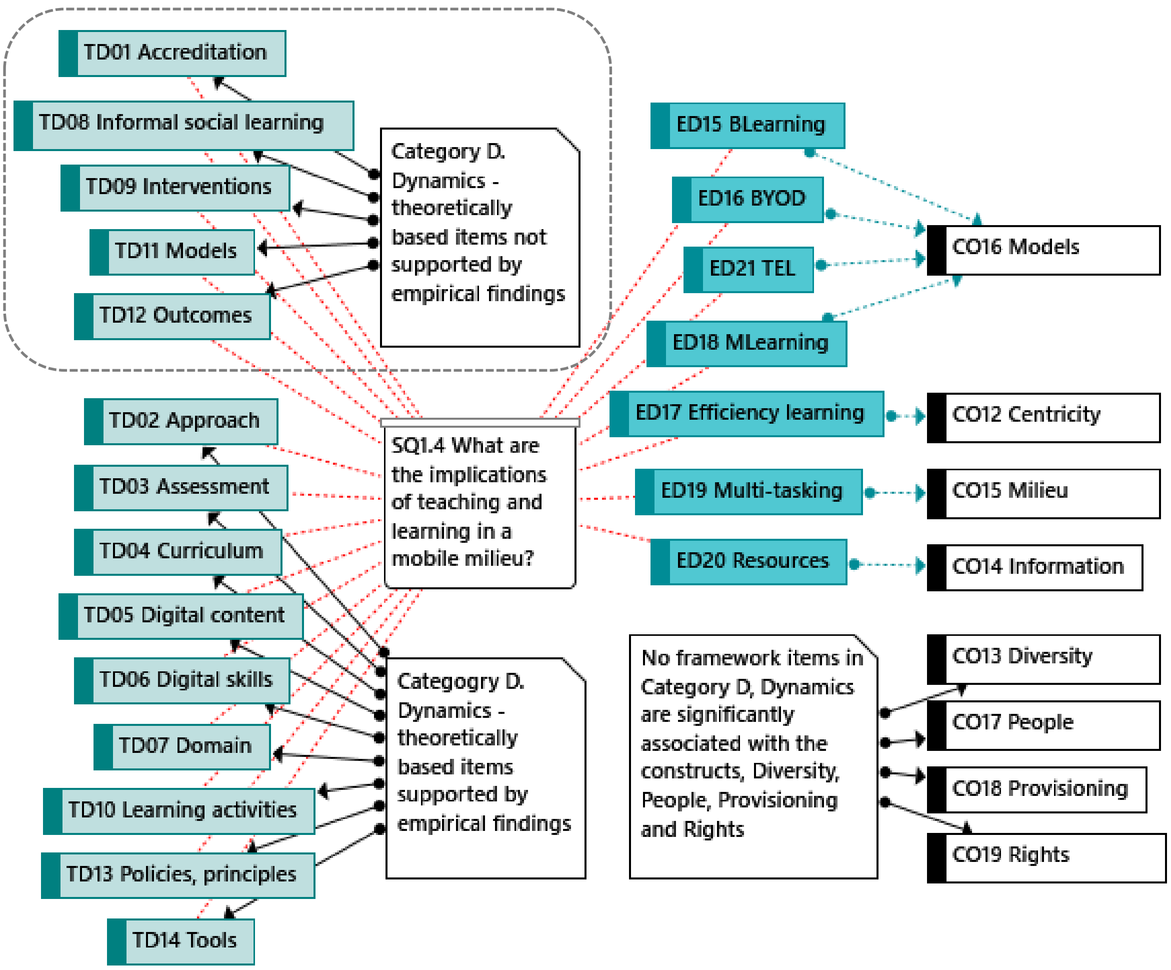


Figure 4.24: Network map – Category D. Dynamics from empirical data

4.8 Secondary question SQ1.5: What aspects emanate from being mobile?

Section 4.8 investigates aspects of Category E. Mobility, analysed from theoretical sources in Chapter 3, Section 3.7. This section identifies additional perspectives based on empirically determined analysis, extending sub-categories determined from theoretical sources.

This section examines the following topics:

- Hardware and software dimensions (Section 4.8.1);
- Patterns of personalisation (Section 4.8.2);
- Mobile champions (Section 4.8.3);
- Quality-focused considerations (Section 4.8.4);
- Affective factors (Section 4.8.5); and
- Embracing differences (Section 4.8.6).

Table 4.11 tabulates relationships between Studies 1.3, 2.1, 3.1 and 3.2, sub-categories and items, and open, matrix-like and Likert-type questions.

Table 4.11: SQ1.5 – Sub-categories and items mapped to studies and question-types

		Study 1.3			Study 2.1			Study 3.1			Study 3.2
Sub-category	**Item**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**	**Matrix**	**Likert**	**Open**
Section 4.8.1 Hardware and software dimensions	TE01 Applications	12	-	-	25	-	-	15	-	-	-
	TE03 Device specifications	-	-	-	59, 61	-	-	36, 51	-	-	-
	TE04 Device types	12	8	-	71	32	-	36	9	-	-
Section 4.8.2 Patterns of personalisation	TE05 Digital preferences	45	-	35	46	-	62	14	-	37	-
	TE07 Mobile productivity	12	18	-	11	42	-	23	19	-	-
	TE12 Usage patterns	-	-	-	18, 37	-	-	-	-	-	-
Section 4.8.3 Mobile champions	TE02 Attitude	14	-	39	41, 60	-	66	14, 18, 46	-	41	4
	TE08 Motivation	15	-	-	-	-	-	52	-	-	2
	TE09 Perception	46	-	-	87	-	-	23	-	-	-
Section 4.8.4 Quality-focused considerations	TE06 Expectations	42, 45	-	-	-	-	-	46	-	-	-
	TE10 Satisfaction	15, 17, 33	-	28	59	-	53	52	-	30	-
	TE11 Usability	15	-	-	38	-	-	16, 35, 50, 51	-	-	-
	TE13 User experience	14	-	-	46	-	-	52	-	-	2
Section 4.8.5 Affective factors	EE14 Alignment	-	-	-	-	-	-	64	-	-	-
	EE16 Confusion	-	-	-	10	-	-	-	-	-	-
	EE17 Convenience	-	-	-	11	-	-	14, 15	-	-	-
	EE20 Distractions	34	-	-	76	-	-	-	-	-	-
	EE21 Flexibility	-	-	-	87	-	-	-	-	-	-
	EE22 Immediacy	45	-	-	11	-	-	-	-	-	-
	EE25 On-the-go	-	-	-	11, 28	-	-	-	-	-	-
	EE26 Portability	-	-	-	12, 28	-	-	-	-	-	-
	EE27 Safety and security	-	-	-	38	-	-	15	-	-	-
Section 4.8.6 Embracing differences	EE15 Encouragement	45	-	-	-	-	-	-	-	-	4
	EE18 Digital difference	-	-	-	11, 25, 28, 46, 60, 75, 87	-	-	23, 50, 51	-	-	-
	EE19 Digital divide	-	-	-	41	-	-	18, 50	-	-	-
	EE23 Mobile discussion	-	-	-	18, 59, 87	-	-	-	-	-	-
	EE24 Mobile research	12	-	-	18	-	-	-	-	-	-

4.8.1 Hardware and software dimensions

The sub-category 'Hardware and software dimensions' forms part of Category E. Mobility: supporting seamless teaching and learning across boundaries, outlined in the initial theoretically based framework (Section 3.7.1) and presented at the end of Chapter 3. It incorporates three items: applications, device specifications, and device types.

Applications

Applications include software packages, mobile apps and web-enabled systems. Faculty academics reported using productivity tools for reading and writing [A1] and teaching and reporting [A2]. As already discussed, architecture students use Facebook for the review of educational pages together with Pinterest, Twitter, WhatsApp and Google+ [S4, S7, S9]. An architecture lecturer said she used apps that are relevant to her teaching strategies [L1].

Device specifications

Educational stakeholders use instruments characterised by their device specifications, such as always-on-hand headphones needed for webinars that depend on reliable sound systems [S1, S8, and S13]. However, limitations were noted. For example, a student found that *"drawing on screen didn't work well"* [S6]. A lecturer observed that tablets were not always suitable or accessible [L2].

Device types

Devices types used in higher education contexts should be considered. One faculty academic indicated she used her iPad device *"in one-on-one consults with students"* [A3]. Another academic explained that teaching with a tablet and appropriate apps allowed him to do preparation at home, adding he preferred the digital format that surpassed the printed page [A5].

The learning portal must be easy to use, accommodating capabilities of mobile phones [S2]. Students are always aiming to improve their devices even though they battle financial constraints [S3]. In addition, they intimated they would enjoy *"setting up of more efficient networks for [their] mobile devices"* [S4]. Digital pens used during webinars facilitated easier explanation [S8], and yet the learning platform was not satisfactorily customised for communication via mobile devices and critiques not adequately utilised for tablets [S11, S12]. The experiences of an architecture lecturer implied laptops and desktops worked well but highlighted limitations such as bandwidth issues and tablet suitability. However, *"cell phones did not work"* [L2].

Figure 4.25 maps various mobile device types – laptops, netbooks, smartphones and tablets to departmental activities – projects, teaching/learning, administration, learning portal, and library access. The following salient features were observed:

- Laptops were also used by all three groups;
- Only one architecture student (7%) reported the use of a netbook for projects;
- A smartphone was reportedly used by one architecture student (7%) for administrative purposes only;
- Tablets were used for all listed activities but only by students;
- Laptops were the chief device type used for all activities by all architecture lecturers (100%);
- Except for project work, 'N/A, responses communicated that certain device types were not used at all. For example, 60% of the faculty academics said they did not use any of the device types for teaching, administration and library access; and
- Finally, reported values imply that in many cases, respondents reported simultaneous use of more than one device type.

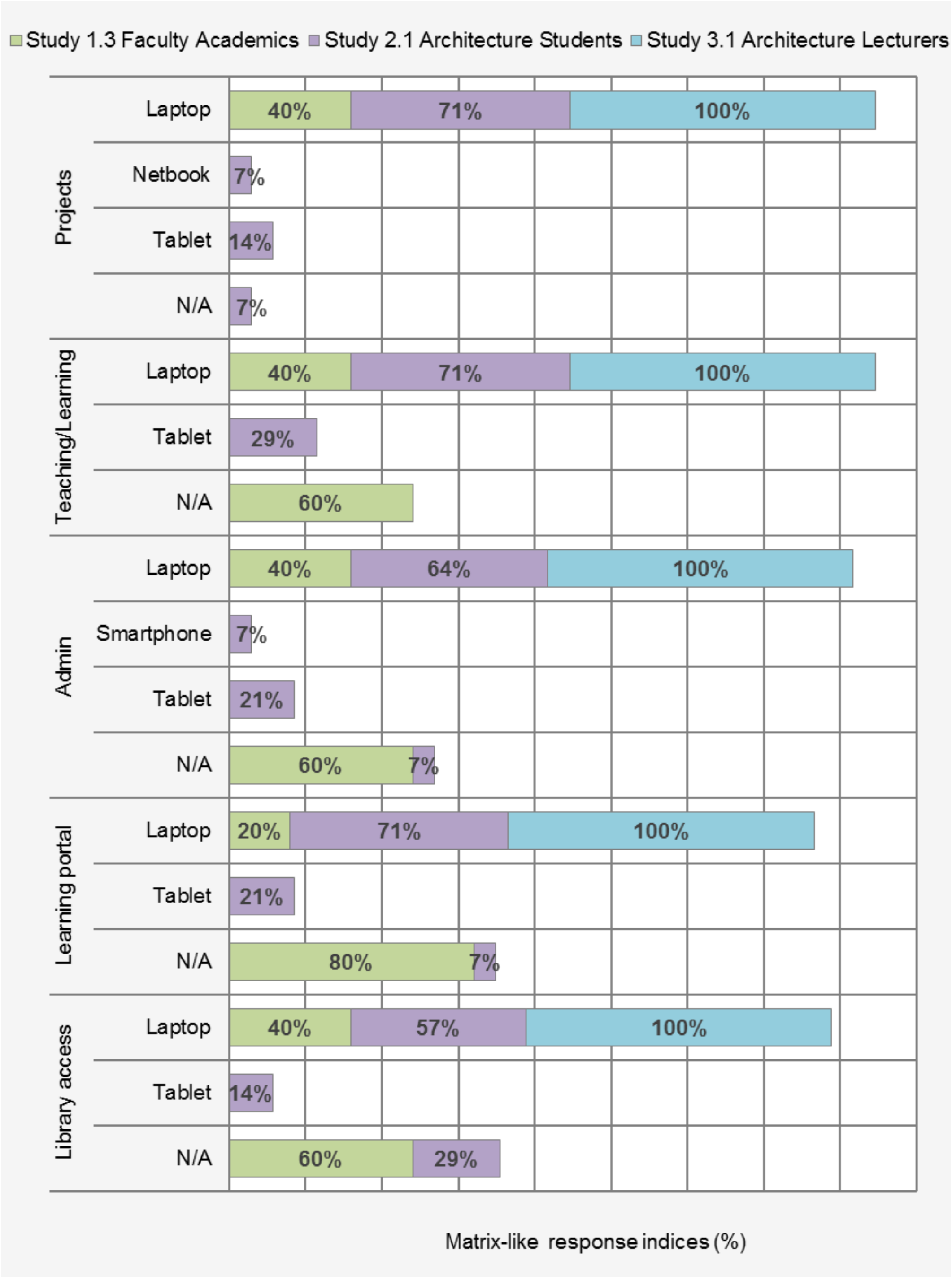


Figure 4.25: Mobile device types used by respondents, linked to their educational activities

4.8.2 Patterns of personalisation

The sub-category 'Patterns of personalisation' forms part of Category E. Mobility: supporting seamless teaching and learning across boundaries, outlined in the initial theoretically based framework (Section 3.7.2) and presented at the end of Chapter 3. It incorporates three items: digital preferences, mobile productivity, and usage patterns.

Digital preferences

Designers and decision makers should accommodate idiosyncratic digital preferences, defined by faculty academics as:

- The demand for *"instant communication"* [A1];
- A preference by academics for emailed communication, keeping personal cellphone numbers private [A3]; and
- Multiple technologies – Facebook, WhatsApp, Blackboard and Dropbox [A5].

Architecture students demonstrated personal preferences. One student felt the best apps were prohibitively expensive [S2]. Another student preferred using a laptop and a tablet, as well as a smartphone [S3]. A third student shared: *"I have been using a tablet for the duration of the year and I am aware of the apps that can be beneficial"* [S4]. From the perspective of an architecture lecturer, students seemed to use digital capabilities in differing ways. They posted relevant information, connected with one another to achieve mobile productivity, and engaged in brief discussion [L3].

Mobile productivity

Mobile technology-enhanced learning offers educational potential for mobile productivity. Architecture students indicated they were mobile and educationally productive in many ways while at work. This behaviour was characterised by doing on-the-move research – 10 (41.7%), keeping digital project notes – 6 (25%), collaborating in teams via Facebook – 5 (20.8%), using Twitter to contact colleagues and clients – 2 (8.3%) and integrating project activities – 1 (4.2%). S3.1 Q23 (1): *"I find it very useful for teaching and learning, my research and see the future of teaching and learning as embracing technologies"* [L1].

Usage patterns

Mobile technology used for teaching and learning is defined by usage patterns, characterised by an architecture student as follows:

> I always connect it to the office WiFi. I use it during my lunch breaks, or tea breaks. I will use it during working hours; however this is when I don't have too much to do. The device often remains on charge while at work [S4].

Another student appreciated the ability to take *"photos with smartphones, scanning with scanners of mobile phones"* [S3].

Figure 4.26 reflects the way digital technologies were reportedly used by faculty academics, architecture students and architecture lecturers to support teaching and learning. Except for Instagram, respondents reported using all the listed technologies, indicating patterns of usage are characterised by a personalised toolbox comprising many options. In all three studies, respondents preferred Dropbox to Google Drive. The popularity of Facebook as an educational tool exceeded that of Twitter; lecturers (100%) and students (100%) unanimously and equally perceived the value of Facebook. Students indicated a preference for WhatsApp (57%) compared with SMSs (21%). Finally, although both students and lecturers registered full support for the learning portal, few academics (40%) testified using the portal.

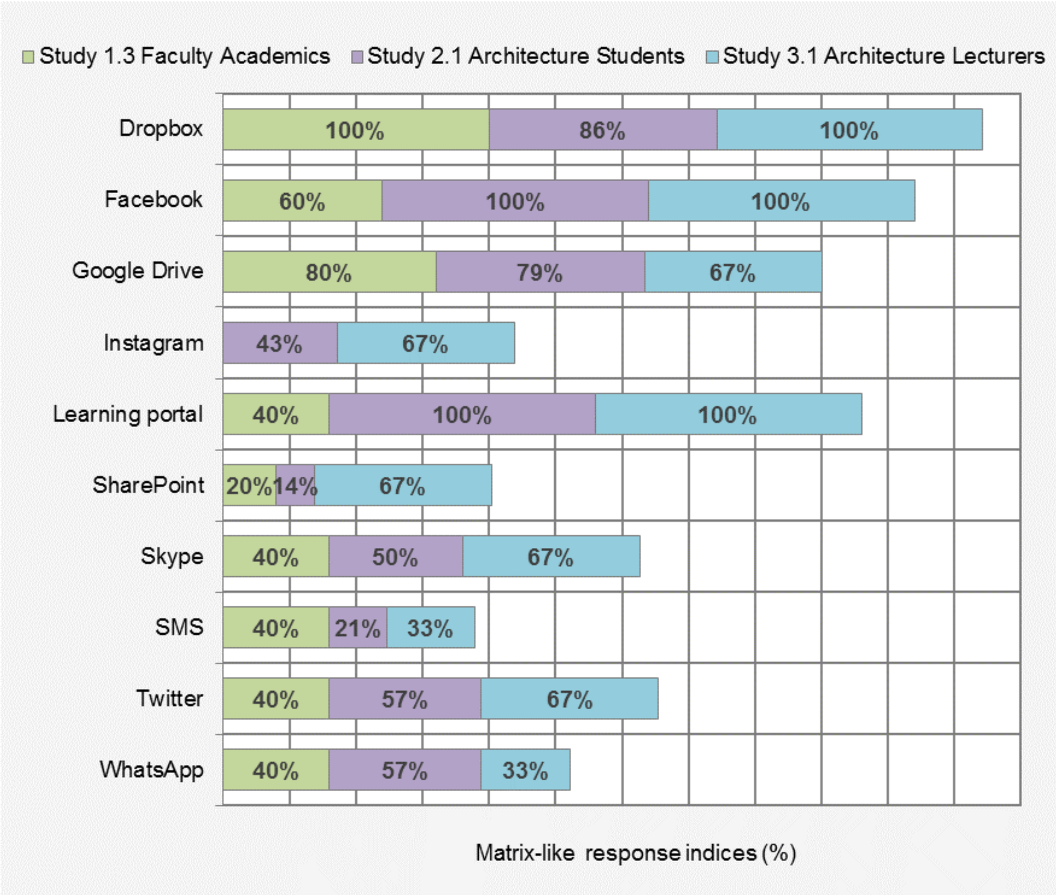


Figure 4.26: Respondents' experience of support provided by digital technologies

These findings suggest the integration of diverse, compatible and personal teaching and learning technologies, indicated by a broad spectrum of usage patterns, would be beneficial in educational environments.

4.8.3 Mobile champions

The sub-category 'Mobile champions' forms part of Category E. Mobility: supporting seamless teaching and learning across boundaries, outlined in the initial theoretically based framework (Section 3.7.3) and presented at the end of Chapter 3. It incorporates three items: attitude, motivation, and perception.

Attitude

Attitude to technology use in educational contexts powerfully influences success rates. Figure 4.27 illustrates attitudes of respondents to the statement: 'A positive attitude to the use of mobile devices is necessary for success of blended learning in the future.' Overall agreement is noted while only one academic expressed disagreement. Institutions need to cultivate and nourish a positive attitude to champion-improved success.

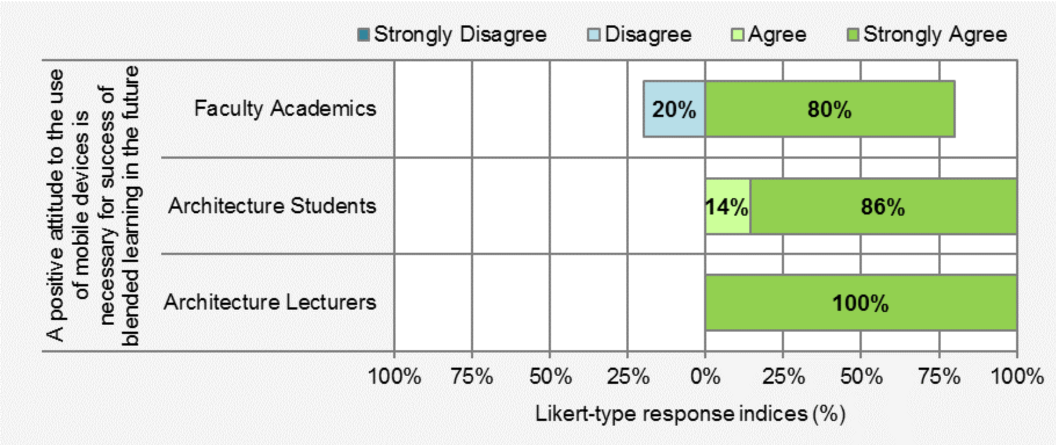


Figure 4.27: Attitude – technology use in educational contexts

Consideration should be given to attitude change as a necessary condition [A2], departmental planners should allocate additional time to support preparation of ad hoc mobile technology-enhanced learning material [A3] and leaders should inculcate in academics the possibilities that exist [A4]. One student called for a remedy for the negative attitude *"against the 'digital educational age',* adding *"mobile technology is there … to engage in, use it … interact with each other through it"* [S7]. A lecturer concurred, calling for *"more awareness and open attitudes"* [L3]. Finally, the faculty head emphasised the positive attitude of a dedicated champion, saying: *"…there's a whole lot to be said of the actual person driving, typical example of a course driven by a champion who puts in way more effort than what could be required of a regular lecturer …"* [FH].

Motivation

Stakeholders need motivation, encouraging the educational use of mobile technology and focusing on *"confidentiality and confidence"* [A2). A lecturer expressed the reservation that motivation would endure as stakeholders were *"enthusiastic to start but it wanes"* [L2]. The faculty head observed motivation was intrinsic to educational technology champions, noting they *"…: come there very much motivated to work"* [FH].

Perception

Perception of the technological potential of mobile technology supports its usage. Academics indicated that to some extent they are aware that students constantly use communication services like WhatsApp, Instagram and Facebook to socialise, multitask and share information [A1 to A5]. Student perceptions included an awareness that *"the fundamentals never change, like doing the work"* [S7], *"the smartphone is the best tool for communication"* [S12] and *"quick access to information makes us learn in a different way by acquiring info from the Internet"* [S14]. A lecturer expressed the view that she could *"see the future of teaching and learning as embracing technologies"* [L1].

4.8.4 Quality-focused considerations

The sub-category 'Quality-focused considerations' forms part of Category E. Mobility: supporting seamless teaching and learning across boundaries, outlined in the initial theoretically based framework (Section 3.7.4) and presented at the end of Chapter 3. It incorporates four items: expectations, satisfaction, usability, and user experience.

Expectations

Mobile devices create educational opportunities and expectations.

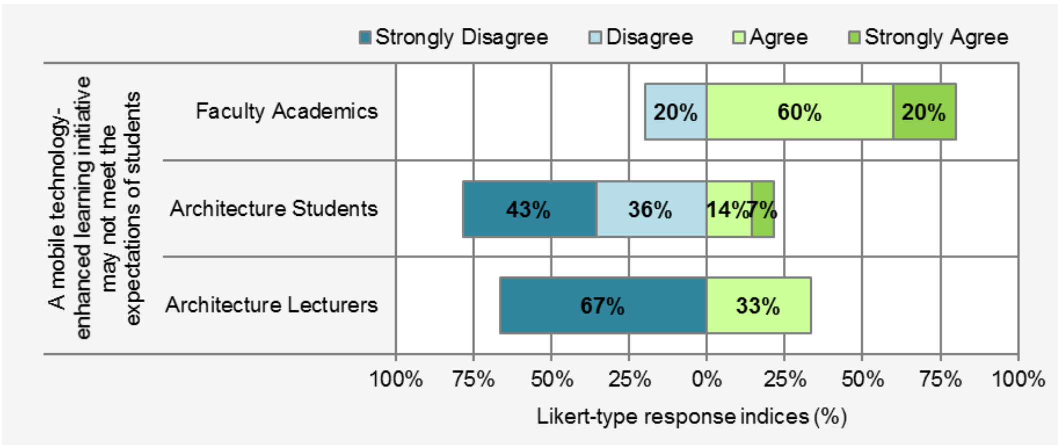


Figure 4.28: Expectations – anticipated opportunities offered by mobile devices

Figure 4.28 reviews opinions of respondents relative to the statement: 'An ad hoc mobile technology-enhanced learning initiative may not meet the expectations of students.' In general, faculty academics expressed agreement (80%), while a substantial proportion of architecture students (79%) and to a lesser extent architecture lecturers (67%) disagreed. The differences between academics and the architectural technology contingent could the influence of the exposure in the architectural technology domain to emerging technologies. An academic stated, *"I don't have specific expectations for mobile technology-enhanced learning,"* but added instant communication with lecturers is a student expectation [A1]. Another academic highlighted student expectations, pinpointing their need for data and effective WiFi connectivity on campus.

Satisfaction

User satisfaction links to happiness, enjoyment and approval. Figure 4.29 explores responses to the statement: 'Issues emerging from technology are addressed quickly, leading to improvements.' The views of academics, students and lecturers indicated general satisfaction that technological issues are timeously remedied. In particular, 40% of academics and 50% of students demonstrated strong support for the comment. However, not all respondents seemed satisfied with improvement performance.

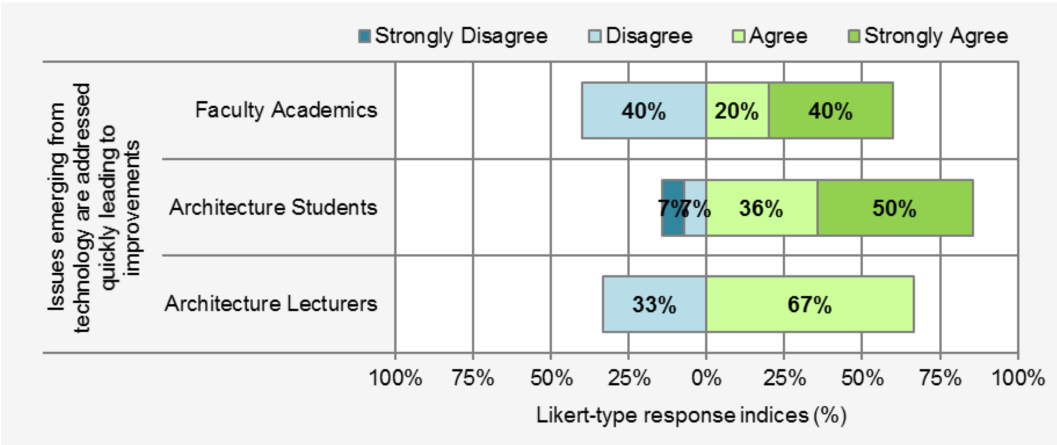


Figure 4.29: Satisfaction – user happiness, enjoyment and approval

Mobile satisfaction implies all forms of mobile technology are regarded seamlessly as the same concept, namely, *"mobile vs tablet vs PCs … should now all be doing the same thing"* [A4]. For academics, satisfactory use of mobile technology means *"email communication with PDF attachments for preparation" and "in-class presentations using PowerPoint"* [A1] are feasible. Students expressed different views on satisfaction such as the ability to *"discuss a piece of written work"* [S4]. One student expressed *"increased satisfaction"* with requested technology improvements [S7].

Usability

In this study, usability determines perception of effectiveness and efficiency in mobile contexts. Diverse attitudes to usability were noted among academics. One academic commented that many students seemed limited by inadequate access to the Internet either at home or during class sessions [A1]. Conversely, another academic believed mobile technology facilitated instant and effective access to information for all students in a flexible manner. For lecturers, effective productivity included efficient updates after initial preparation of course material [A3]. Mobility was viewed as task specific and domain oriented, linked to practical effectiveness of contextual activities such as *“field trips, doing mapping”* [A4]. A socio-cultural perspective encapsulated usability, mobility and the students’ views, indicating *“technology is a part of today’s student makeup”* [A5].

The students’ usability feedback addressed practical suggestions for enhancement of the portal, such as, easy and fast access [S1], improved user-friendliness *“for all mobile devices”*, a focus on use of colour, attractiveness and access issues for smartphones [S4], suitability for the use of tablets [S12] and customisation of study material accessed via the portal, viewed as mobile-friendliness [S14].

Lecturers’ comments highlighted a need for *“easier evaluation”* mechanisms [L2] and improved and easier access via smartphones and tablets [L1, L3].

User experience

User experience vests in hedonistic responses to mobility. Academics highlighted several factors, including, attitude change to the value of mobile technology in education [A2], a need for additional training for both staff and students, accommodating their time constraints [A3] and consideration of preparation time for learning enhanced by mobile technology [A3].

An enthusiastic student with a positive attitude to the potential of mobile technology used to support education commented: *“I do believe that [mobile] technology can be beneficial towards studying, and I have seen how it has assisted me in many aspects … would love to have much more access and not feel limited”* [S4].

When asked the question ‘In your opinion, what worked …?’ the faculty head noted students’ enthusiasm and responded: *“…find experience completely different from regular ‘Yes, OK, we are coming to class’ …”*.

4.8.5 Affective factors

The sub-category ‘Affective factors’ arose from empirical data and incorporates nine empirically determined items: alignment, confusion, convenience, distractions, flexibility, immediacy, on the go, portability, and safety and security. Thus, this sub-category augments Category E. Mobility: supporting seamless teaching and learning across boundaries, and advancing contents of the initial theoretically based framework (Section 3.7) outlined at the end of Chapter 3.

Alignment

One architecture lecturer [L2] commented that the link between mobile technology and blended educational needs should manifest as a transparent association to support the alignment between teaching and purely online learning.

Confusion

Students report confusion when faced with the many pathways to Internet-based information, for example, a student reported: *"I got confused with briefs that were meant for students not doing other subjects"* [S10].

Convenience

Mobile technology provides convenience, scaffolding access for lecturers and students. For students, convenience is characterised by ease, ability to connect *"any time of the day"* [S1], opportunities for being *"continuously engaged in the study activities"* [S5] and ability to *"attend webinar meetings … wherever"* [S7]. Lecturers believe mobile devices – smartphones or tablets – and integrated cloud services provide convenient alternatives to an office PC.

Distractions

Mobile stakeholders experience distractions, losing concentration and focus in cyberspace. A faculty academic concurs, saying: *"The Web has become a distraction and is not always used for the purpose it was created, namely, a resource rather than the main source to gather information"* [A5]. From a student view *"there has to be control in the workplace to ensure productivity"* [S7].

Flexibility

Flexibility entails *"online access through mobile technology"* [S14] to acquire educational content at any time and in any place, via mobile devices and applications.

Immediacy

The ad hoc use of mobile technology supports immediacy – the instantaneous availability of information. Students expect the ability to connect instantaneously with their lecturers. There is evidence that lecturers use WhatsApp, *"but have commented about receiving messages at inappropriate times"* [A3]. For students, the immediacy offered by mobile technology is an important educational facet. Students may keep records of their thoughts and *"instantly upload"* [S7] them to their journals. Additionally, students appreciate notifications of newly uploaded materials, faster receipt of information, communication with lecturers when questions are asked and reduced travelling to and from campus.

On the go

Consideration of on-the-go requirements supports mobile users and their mobile habits such as doing research on tablets when time is found and when they are not at home or behind their desks. Students call for *"unlimited access to lectures"* [S13] and a *"hands-on approach … studies can be accessed anywhere at any time"* [S14].

Portability

Portability incorporates the ability to accommodate diverse mobile platforms, devices and applications. Architecture students see the benefit of being able to use several device types suited to the context they are in, for example, being on campus, *"visiting a site with a tablet"* [S4] or *"to read the required work"* [S12] from home.

Safety and security

Safety and security measures protect user privacy and data integrity. One student highlighted a portal issue, saying it needed *"to be revised to avoid overwrites of other students' work"* [S6]. Owing to the number and range of device types used by students on campus, institutional infrastructure should incorporate *"lockers with charging facility"* to improve safety and security of mobile assets [L1].

4.8.6 Embracing differences

The sub-category 'Emerging differences' arose from empirical data and incorporates five empirically determined items: digital difference, digital divide, encouragement, mobile discussion, and mobile research. Thus, this sub-category augments Category E. Mobility: supporting seamless teaching and learning across boundaries, and advances the initial theoretically based framework (Section 3.7) outlined at the end of Chapter 3.

Digital difference

There is a digital difference between digitally skilled and unskilled users. A wide range of student responses exhibited these differences. One architecture student commented: *"mobile technology is available to me 24/7"* [S13] and included the use of social media, Skype, webinars, videos and pictures. Another student indicated: *"tablets and cellphones, with the technology available today, help students to access their learning platform"* [S14]. From a third perspective, the student limited digital activity to *"networking with fellow students"* [S1]. A final student said he *“did not really use mobile technology for … [an educational] … purpose”* [S2]. Digital differences manifest as personal preferences. Students commented:

- “I prefer the use of a tablet and laptop as my mobile device and including a smartphone to a larger extent” [S3]; and
- “I have been using a tablet for the duration of the year and I am aware of the apps that can be beneficial” [S14].

Mobile technology enthusiasts shared advice regarding familiarisation and engagement needs with colleagues:

- “I suggest they familiarise themselves with all apps and software that makes ease of uploading, collating and downloading work, etc., easy” [S4];
- “The mobile technology is there for you to engage in, use it. Interact with each other through it” [S7]’ and
- “Some of us are very good at it and some are struggling a bit” [S10].

Contrary to student enthusiasm, some reticence was noted among lecturers. Accordingly, technology development was seen as fast paced and *“quite hard to keep up [with]”* [L3]. Lecturers observed that students were *“extremely comfortable using mobile devices and applications”* [L3].

Digital divide

The digital divide refers to a gap between technologically advantaged and deprived users, who *“lack … financial resources to get the devices”* [S5]. Similarly, lecturers recognise that mobile technology may not necessarily be affordable *“for some students”* [L3].

Encouragement

Encouragement incorporates the campaign for innovative technological decisions and processes. Faculty academics note students *“don't usually connect with lecturers with their mobile phones unless the lecturers encourage that”* [A2]. In addition, students *“access Blackboard when reminded to do so”* [A3].

Mobile discussions

Mobile discussions involved forms of synchronous and asynchronous communication with other colleagues [S12], affording *“quick access to information”* [S14]. However, one student [S12] expressed dissatisfaction with the use of technology to discuss written assessments.

Mobile research

The ability to explore web-based resources via mobile devices supports mobile research. A faculty academic commented that *"tablets may be used for looking for information"* [A1]. Students indicated they used their mobile devices and applications for *"presentations and research, including sharing information with my classmates and peers"* [S3], *"sourcing information while … busy with other office tasks"* [S5] and *"searching for information, products"* [S12].

4.8.7 Crystallisation – supporting seamlessness across boundaries

Table 4.12 contributes to the understanding of seamlessness across boundaries (SQ1.5) and hence to Category E. Mobility, discussed in Section 4.8. Section 4.8.7 supports the secondary research question *SQ1.5: What aspects emanate from being mobile?*

Table 4.12: Category E. Mobility – sub-categories and items from empirical data

Sub-category	Item	Study 1.3	Study 2.1	Study 3.1	Study 3.2
EI5 Affective factors	EE14 Alignment	-	-	■	-
	EE15 Confusion	-	■	-	-
	EE16 Convenience	-	■	■	-
	EE19 Distractions	■	■	-	-
	EE21 Flexibility	-	■	-	-
	EE22 Immediacy	■	■	-	-
	EE25 On the go	-	■	-	-
	EE26 Portability	-	■	-	-
	EE27 Safety and security	-	■	■	-
EI6 Embracing differences	EE17 Digital difference	-	■	■	-
	EE18 Digital divide	-	■	■	-
	EE20 Encouragement	■	-	-	■
	EE23 Mobile discussion	-	■	-	-
	EE24 Mobile research	■	■	-	-

Furthermore, Figure 4.30 enhances the understanding of concepts underpinning mobility in higher education contexts. It additionally offers a diagrammatic view of Section 4.8 and links related constructs and items. For example, item EE17, Digital difference, connects with the construct CO13, Diversity. Two constructs, namely, CO16 Models and CO18 Provisioning, are not referenced. Finally, all theoretically based items associated with Category E. Mobility (Table 4.13), were supported by empirical findings.

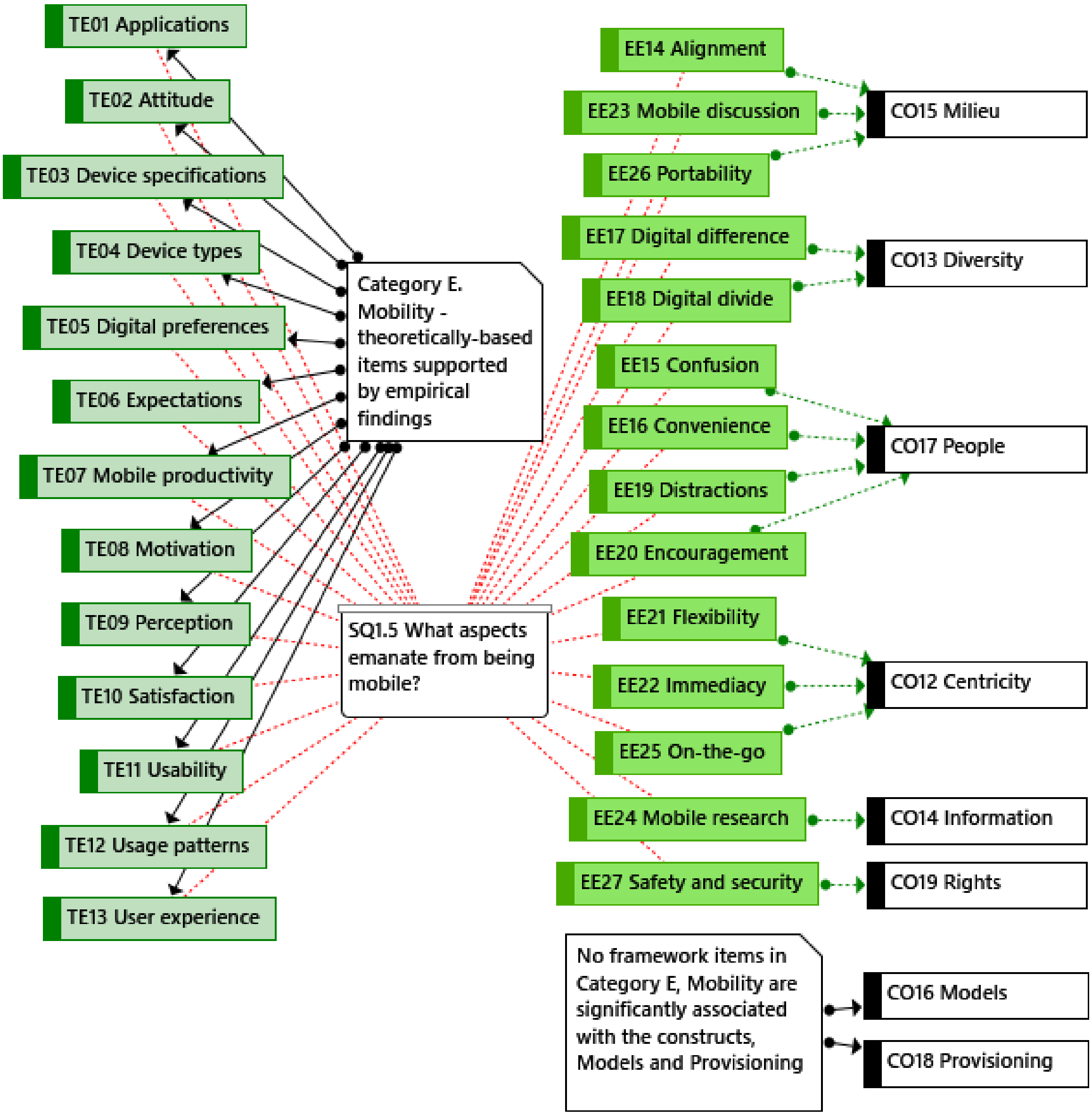


Figure 4.30: Network map – Category E. Mobility from empirical data

4.9 Crystallisation

This chapter established an empirically determined context and rigorously facilitated the holistic synthesis of a framework of constructs, categories, sub-categories and elements. Sections 4.9.1 and 4.9.2 respectively augment theoretical findings in Chapter 3 given as Sections 3.8.1 and 3.8.2. The combination of theoretical and empirical findings provides rigorous solutions to the main questions, MQ1 and MQ2.

4.9.1 Framework elements emerging from empirical data (MQ1)

The combination of Figure 4.12, Figure 4.17, Figure 4.20, Figure 4.24 and Figure 4.30 together with Table 4.4, Table 4.6, Table 4.8, Table 4.10 and Table 4.12, empirically address the first main question, MQ1, via the secondary questions, SQ1.1 to SQ1.5. Categorised empirical findings for the studies are incorporated as Table 4.13 and Table 4.14 and incorporated into Appendices F.1 to F.5, extending outcomes of Chapter 3.

Table 4.13: Empirically determined items associated with Categories A to C

		Phase 1 Preamble					Phase 2 Cohort														Phase 3 Faculty				
		S1.3	S1.3	S1.3	S1.3	S1.3	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S3.1	S3.1	S3.1	S3.2	
	Items	A1	A2	A3	A4	A5	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	L1	L2	L3	FH	Guidelines for best practices
A. Enablement	TA01 Change management	■		■																					Adapt to needs for ongoing adjustment and refinement
	TA02 Competition																								Respond to digital trends and market pressures in education
	TA03 Design and development	■																		■					Formulate activities, courseware, assessment
	TA04 Evaluation																								Provide estimation of maturity, capability, effectiveness
	TA05 Implementation																			■				■	Delineate a strategy for deployment, maintenance and migration
	TA06 Inclusiveness						■		■			■													Incorporate transparency, seamlessness and integration
	TA07 Logistics																								Define proximity, procurement, co-ordination and operations
	TA08 Quality												■												Emphasise effectiveness, enhancement and excellence
	TA09 Strategy			■	■															■				■	Formulate tactics, procedures, planning and direction of initiatives
	TA10 Sustainability																								Maintain endurance, resolution and strength of digital projects
	TA11 Time-orientation						■	■		■								■							Combine scheduling, timeliness, currency and prevalence
	TA12 Training		■	■	■	■						■						■			■	■			Facilitate upliftment of digital skills and awareness
	EA13 Access to information			■	■		■	■												■					Grant timeous access by permissions and privileges
	EA14 Bandwidth						■								■			■				■			Maximise transmission speed and data transfer capacity
	EA15 Campus WiFi			■						■															Ensure wireless network availability
	EA16 Ethics		■																						Define privacy, principles, actions, rights and rules
	EA17 Focus on the user	■																							Embrace user- centricity and profiles
	EA18 Internet connectivity																■			■					Support Internet-based course requirements and research
	EA19 Wireless connectivity														■	■				■	■				Afford off-campus performance based on network allowances
B. Environment	TB01 Acceptance																								Assimilate the benefits of technology use in education
	TB02 Adoption																								Incorporate the participative use of pedagogical technology
	TB03 Affordability	■								■				■	■		■	■	■			■	■		Assess cost considerations
	TB04 Big picture												■							■					Include technology into education
	TB05 Impact										■														Involve the influence and challenges of a mobile milieu
	TB06 Innovation							■		■											■			■	Provide novelty, improvement, re-invention and uniqueness
	TB07 Personal learning environments	■		■				■		■	■		■		■						■			■	Consider the complexity of digitally-influenced environments
	TB08 Roles																							■	Define educational functions and responsibilities
	TB09 Socio-cultural factors											■										■			Incorporate diversity of groups, beliefs and patterns of society
	TB10 Stakeholder involvement												■												Consult the institution, administrators, educators and students
	TB11 Support						■															■			Scaffold digitally-enhanced teaching and learning
	TB12 Technology	■		■						■			■					■		■					Establish a digital milieu conducive to effectiveness
	EB13 Cloud facilities	■		■						■					■							■			Incorporate Internet-enabled, web-based tools and applications
	EB14 Off-campus benefits													■	■			■	■						Describe benefits afforded by being off-campus and mobile
	EB15 Off-campus issues						■						■	■				■							Highlight digital problems encountered away from campus
	EB16 Ubiquity								■	■	■	■				■		■							Permeate all mobile, social and educational pathways
C. Interactivity	TC01 Collaboration					■					■					■				■		■	■		Encourage project team participation and co-operation
	TC02 Communication	■		■			■						■	■				■		■					Enable the exchange of information, via Web 2.0 apps
	TC03 Compatibility																■					■			Support working in teams via a network of diverse technologies
	TC04 Connectivity	■		■			■	■					■	■	■							■	■		Enable seamless interactivity for users
	TC05 Digital platforms				■	■						■										■			Provide data channels via mobile-enabled applications
	TC06 Internet access					■				■					■	■					■				Maintain access to web-based sites for educational purposes
	TC07 Learning portal		■		■		■	■		■		■	■	■	■		■		■						Mediate bi-directional educational dialogue
	TC08 Social networking	■		■	■	■	■			■		■	■			■		■	■	■	■				Include social media, social technologies, social networking tools
	TC09 Web 2.0 tools			■					■		■								■					■	Support user-interoperability, distinct from social networking
	EC10 Information sharing			■																■			■		Encourage a team-culture of mutually supportive members
	EC11 Interconnectivity						■	■	■	■		■	■	■	■				■						Define an orientation towards a holistic and rhizomatic system
	EC12 Interpersonal contact														■							■			Describe an exchange between people making connections

Table 4.14: Empirically determined items associated with Categories D and E

		Phase 1 Preamble					Phase 2 Cohort														Phase 3 Faculty				
		S1.3	S1.3	S1.3	S1.3	S1.3	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S2.1	S3.1	S3.1	S3.1	S3.2	
	Items	A1	A2	A3	A4	A5	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	L1	L2	L3	FH	Guidelines for best practices
D. Dynamics	TD01 Accreditation																								Review officially certified qualifications and courseware
	TD02 Approach		■	■	■																■				Specify pedagogical processes and attitudes
	TD03 Assessment									■		■			■	■		■				■			Define methods for evaluation of levels of achievement
	TD04 Curriculum	■														■									Detail qualification subject matter and course content
	TD05 Digital content	■		■							■			■			■		■						Deliver digitised resources and course material
	TD06 Digital skills	■									■			■	■	■		■		■		■	■	■	Outline required and acquired digital literacies
	TD07 Domain							■		■												■	■		Describe instructive subset in a particular educational discipline
	TD08 Informal social learning																								Incorporate socially-oriented learning strategies
	TD09 Interventions																								Include exploratory steps aimed at evaluation and improvement
	TD10 Learning activities	■	■					■		■	■		■					■		■	■				List course-related events underpinning pedagogy-in-action
	TD11 Models																								Propose a selection of approaches to teaching and learning
	TD12 Outcomes																								Present end-results and consequences of educational experiences
	TD13 Policies, principles			■		■																			Define philosophies underpinning techniques and tools
	TD14 Tools	■		■	■	■															■				Support teaching and learning via digital mechanisms
	ED15 BLearning												■	■								■		■	Propose a mix of differing teaching and learning modalities
	ED16 BYOD																				■				Design personal mobile device initiatives for educational purposes
	ED17 Efficiency learning									■				■							■		■		Embrace casual and lifelong learning experienced off-campus
	ED18 MLearning	■		■													■					■		■	Incorporate mobile technology into teaching and learning
	ED19 Multi-tasking		■	■						■					■										Facilitate the simultaneous performance of differing digital tasks
	ED20 Resources							■		■									■						Include VLEs, multimedia, e-literature, devices and applications
	ED21 TEL																■								Outline a technology-enhanced learning plan
E. Mobility	TE01 Applications	■	■							■			■		■						■				Include software packages, mobile apps and web-enabled systems.
	TE03 Device specifications							■				■		■					■			■			Review attitude to technology use in educational contexts.
	TE04 Device types			■		■		■	■	■				■			■	■				■			Consider attributes of devices used by educational stakeholders.
	TE05 Digital preferences	■		■		■			■	■	■												■		Represent types of devices used in higher education.
	TE07 Mobile productivity																				■				Accommodate idiosyncratic choices of devices and applications.
	TE12 Usage patterns								■	■															Suggest anticipated opportunities offered by mobile devices.
	TE02 Attitude		■	■	■								■										■	■	Offer educational potential for on-the-move efficiency.
	TE08 Motivation		■																			■		■	Encourage users to accept and adopt mobile technology.
	TE09 Perception	■	■	■	■	■							■					■		■					Indicate awareness of technological potential.
	TE06 Expectations	■																							Consider user happiness, enjoyment and approval.
	TE10 Satisfaction	■			■					■			■												Determine effectiveness and efficiency in mobile contexts.
	TE11 Usability	■		■	■	■	■			■								■		■	■	■	■		Define patterns of mobile technology use for teaching and learning.
	TE13 User experience		■	■						■														■	Acknowledge hedonistic responses to mobility.
	EE14 Alignment																					■			Associate mobile technology transparently with educational needs.
	EE15 Confusion															■									Avoid many pathways of Internet-based information.
	EE16 Convenience						■				■		■												Provide mobile accessibility for lecturers and students.
	EE17 Digital difference						■	■	■	■			■			■			■	■			■		Suggest the difference between digitally skilled and unskilled users.
	EE18 Digital divide										■											■			Refer to the gap between technological advantage and deprivation.
	EE19 Distractions					■							■												Support user concentration, avoiding focus loss in cyberspace.
	EE20 Encouragement		■	■																					Campaign for innovative technological decisions and processes.
	EE21 Flexibility																			■					Enable access to educational content at any time and in any place.
	EE22 Immediacy			■									■												Characterise instantaneous availability of information.
	EE23 Mobile discussion																	■		■					Involve forms of synchronous and asynchronous communication.
	EE24 Mobile research	■					■											■							Achieve exploration of web-based resources via mobile devices.
	EE25 On-the-go																		■	■					Support mobile users and their mobile habits.
	EE26 Portability								■	■								■							Accommodate diverse platforms, devices and applications.
	EE27 Safety and security											■									■				Protect user privacy and data integrity.

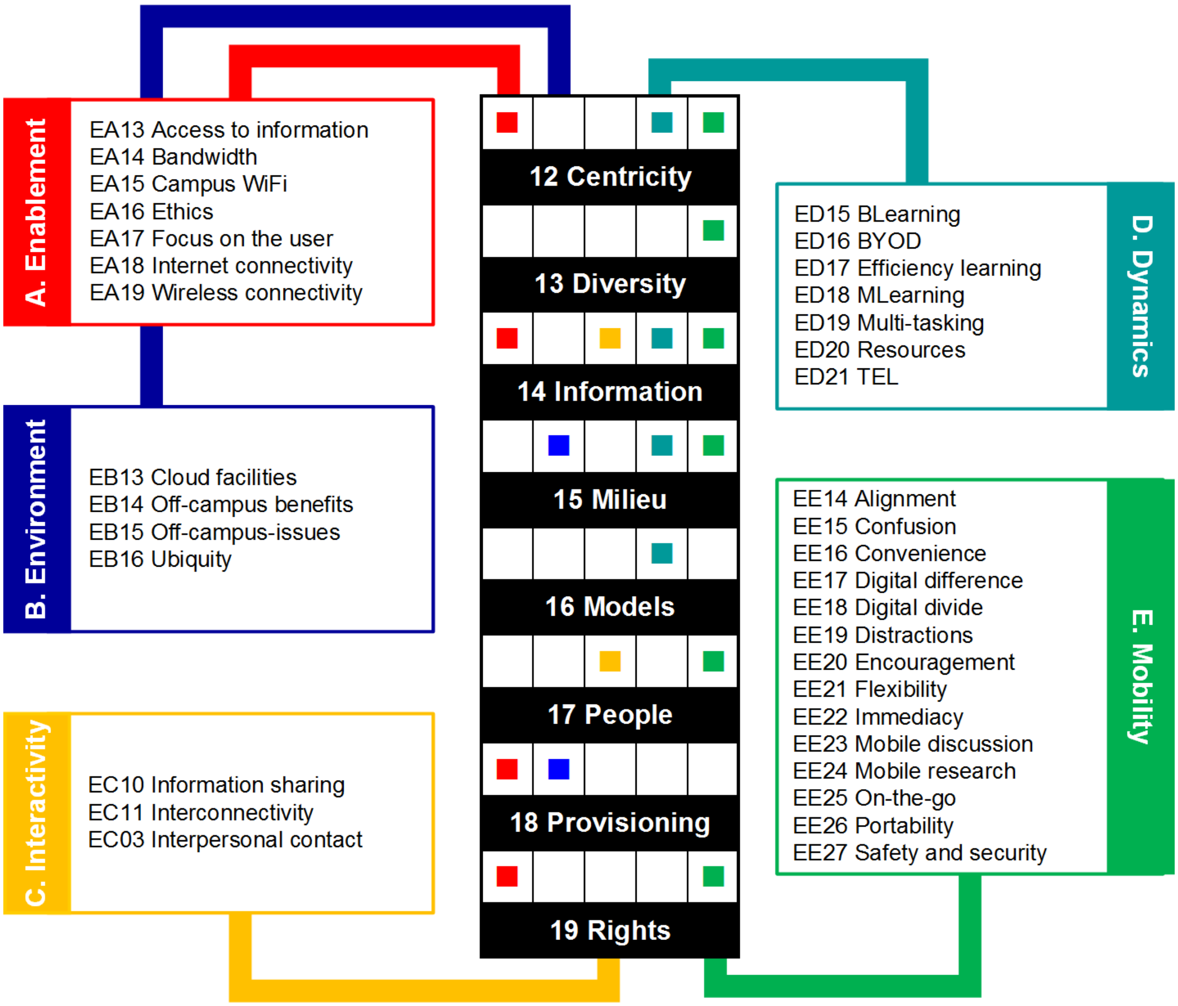


Figure 4.31: Interlinked, empirically determined elements – constructs, categories and items

Figure 4.31 reflects empirically determined elements – constructs, categories and items – emerging during qualitative analysis of data collected from study respondents. The diagram highlights a couple of observations associated with the theoretically based elements illustrated as Figure 3.7 in Chapter 3. Firstly, the diagram provides eight additional constructs numbered CO12 to CO18, extending the 11 theoretically based constructs outlined in Chapter 3. Then, the five categories used to organise framework items in Chapter 3 have been retained. Finally, Figure 4.31 sets out 35 categorised, empirically determined items, augmenting the set of 60 items proposed in Chapter 3.

4.9.2 Empirically determined contributions to the structure of the framework (MQ2)

In Chapter 3, the framework dimension titled 'constructs' served to extricate foci, establishing structural dimensions (Table 3.1). Similarly, Table 4.13 reports the inclusion of eight additional empirically determined constructs, built into Figure 4.12, Figure 4.17, Figure 4.20, Figure 4.24 and Figure 4.30. The constructs emerged during qualitative data analysis applying axial coding alongside iterative reduction of empirical data using ATLAS.ti V8.0. Constructs include Centricity, Diversity, Information, Milieu, Models, People, Provisioning, and Rights. Illustrative examples emanating from empirical code sources delineate construct definitions. Table 4.15 expands the set of constructs extracted as foci in Chapter 3 and listed as Table 3.2. Complete mappings between constructs and elements of the framework are provided in Appendices F.1 to F.5.

Table 4.15: Constructs with supportive examples

Constructs	Supportive examples from empirical sources
CO12 Centricity	A focus on the user (EA17) supports efficient (ED17) and flexible learning opportunities (EE21), affording immediate responses (EE22).
CO13 Diversity	Digital differences (EE17) and divides (EE18) signify diversities that exist between institutional, academic, student and lecturer stakeholders.
CO14 Information	Access to information (EA13) provided as compatible mobile resources (ED20) allows research for educational purposes while being on the move (EE24).
CO15 Milieu	Ubiquitous mobile technology (IB16) provides both off-campus benefits (EB14) and issues (EB15) emanating from multitasking (ED19) in a mobile context. This environment depends on both alignment (EE14) and portability (EE26) of devices and technologies.
CO16 Models	Digital design incorporates a range of learning modalities and their hybrid models, namely, BLearning (ED15), BYOD (ED16), MLearning (ED18) and TEL (ED21).
CO17 People	Mobile stakeholders interconnect (EC11), enjoy interpersonal contact (EC12) and benefit from the convenience of being mobile (EE16). However, they also report feeling confused (EE15) and distracted (EE19) by mobile chatter.
CO18 Provisioning	Educational institutions are charged with the responsibility and cost of providing sufficient bandwidth (EA14) and cloud-based facilities (EB13) via an effective campus WiFi infrastructure (EA15) that ensures satisfactory Internet access (EA18) and wireless connectivity (EA19).
CO19 Rights	Ethical issues (EA16) include safety and security (EE17) where stakeholder privacy is respected and course-related content and assessment outcomes are protected.

Note: Codebook references appear in brackets

The empirically determined framework (Figure 4.32) expands the theoretically based framework (Figure 3.8), contributing to the answering of MQ2. The final synthesised framework combines these two diagrams into Figure 5.2 in Chapter 5.

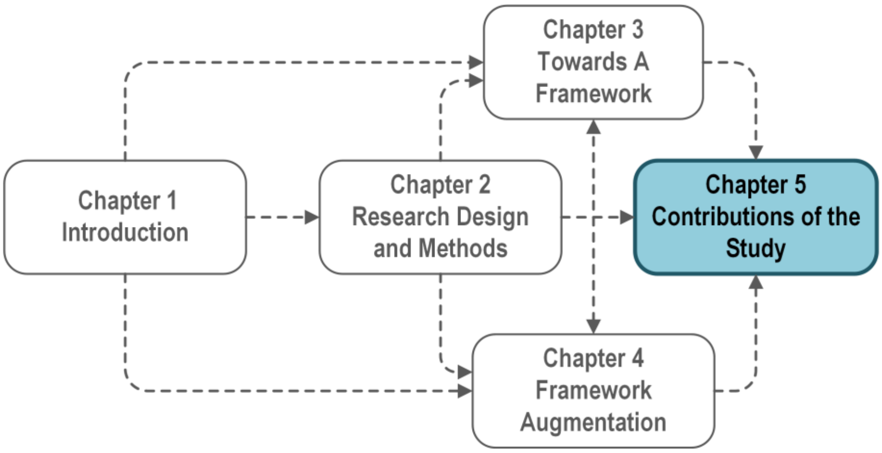
Figure 4.32: Empirically determined contribution of constructs and items to the framework

Chapter 4 outlined the contribution of the empirical findings to the synthesis of framework elements for ad hoc mobile technology-enhanced learning comprising constructs, categories, sub-categories, and items, and to the structure of the framework. Secondary questions, SQ1.1 to SQ1.5, scaffolded a deeper exploration of the first main question, MQ1, and simultaneously contributed to the answering of second main question, MQ2.

While the analysis and interpretation of empirical data collected as part of an exploratory case study was reported in Chapter 4, expanding the theoretically based findings of the systematic literature review contained in Chapter 3, Chapter 5 accounts for the contributions, recommendations, limitations and delimiters, and directions for future research emanating from the study. In the process, all research objectives and questions introduced in Chapter 1 (Table 1.2) are revisited with indications of satisfactory completion.

Chapter 5 Contributions of the Study

Forever, and forever, farewell, Cassius! If we do meet again, why, we shall smile; If not, why then this parting was well made.
William Shakespeare: Julius Caesar, Act 5, Scene 1



5.1 Introduction

In Chapter 1, I introduced the focus of the study, described as an investigation of elements and resultant framework of items for mobile technology-enhanced learning. From my perspective, mobile technology-enhanced learning encompasses a complex modality, grouping aspects of technology-enhanced learning (TEL), accessed in an ad hoc manner via mobile devices and technologies. I designed a systematic literature review to collect theoretically based data in a reproducible and structured manner, while a case study, conducted in a real-world, higher education context, gathered empirically determined data. The research design included a purposively and conveniently selected sample of institutional leaders, academics, lecturers and students associated with a part-time architectural technology programme. I chose this diverse group of respondents as I felt intuitively their feedback would provide insight regarding the informal use of mobile devices and applications to scaffold their educational activities.

Prior to the commencement of this thesis, I experienced a challenging, tablet-based implementation in a private higher education institution in South Africa. During a nation-wide rollout, all students received identical tablet devices, equipped with digital textbooks, course outlines and content. Based on personal perceptions and informed by this involvement with a relatively unsuccessful and haphazard implementation in a higher education context, I was inspired to undertake my current research work, exploring a *different* South African public university. While most lecturers were sceptical and expressed reservations, students responded enthusiastically at first to the potential of access to course material and social media via their tablets. However, disgruntlement and disappointment soon followed when institutional policy makers blocked access to social platforms such as Facebook and LinkedIn. Performance of the wireless infrastructure failed to meet connectivity expectations and inadequate, on-campus power supply led to unusable devices. Crisis-management strategies adopted by well-meaning but ill-informed institutional leaders characterised resolution of critical issues. Academic shortcomings regarding content design and contextual delivery frustrated teaching and learning stakeholders. Additionally, emergent digital divides and digital differences highlighted technological shortcomings of established, infrastructural provisioning. In summary, the hype and thrills associated with mobile education had initially manifested positively among mobile champions. However, it soon led to unhappy lecturers and students who pleaded: "Please, give us books!" The situation pinpointed a gap in the knowledge base for pragmatic guidelines informing the formalised use of mobile mechanisms in higher education contexts in South Africa. Furthermore, I observed that institutional decisions thwarted efforts to use mobile devices and applications informally for teaching and learning purposes. This experience establishes the background to my study and underpins the rationale for my thesis. The issues listed here inspired this dual-purpose study.

An initial scan of literature sources was conducted for solutions guiding the satisfactory and informal use of mobile technology in other educational environments. The brief review produced multiple criteria, presented as disparate frameworks and models, further emphasising a gap in the availability of a structured, consolidated and effective set of best-practice guidelines for the ad hoc use of mobile technology-enhanced learning.

The thesis aimed to describe theoretically based, mobility-oriented elements for the ad hoc use of mobile technology-enhanced learning. These elements could guide institutional decisions for on-the-move stakeholders in an architectural technology context, an unchartered domain (Robson & McCartan, 2016). Table 5.1 revisits the objectives and research questions outlined in Chapter 1 (Table 1.2).

Table 5.1: Mapping research objectives and questions to chapter sections

Research objectives, main and secondary questions	Chapter sections
O1: To identify the elements that inform strategic decisions for ad hoc mobile technology-enhanced learning **MQ1:** What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?	3.8.1, 4.9.1, 5.4.1
SQ1.1: What elements inform institutional decision making?	3.3.1 – 3.3.4, 4.4.1 – 4.4.6, 5.3.1
SQ1.2: What elements reflect contextual influences?	3.4.1 – 3.4.4, 4.5.1 – 4.5.5, 5.3.2
SQ1.3: What is the nature of relationships mediated by social technology?	3.5.1 – 3.5.4, 4.6.1 – 4.6.5, 5.3.3
SQ1.4: What are the implications of teaching and learning in a mobile milieu?	3.6.1 – 3.6.4, 4.7.1 – 4.7.6, 5.3.4
SQ1.5: What aspects emanate from being mobile?	3.7.1 – 3.7.5, 4.8.1 – 4.8.7, 5.3.5
O2: To inform the structure of the framework, defined by its constituent components **MQ2:** How are the elements, identified in MQ1, related?	3.8.2, 4.9.2, 5.4.2

The answering of all five secondary questions, SQ1 to SQ5, addresses the first main question, MQ1, and thus defines the nature of the elements of the mobile technology-enhanced learning framework. In so doing, support for the structure of the framework and its interrelationships is demonstrated (MQ2). The research strategy outlined in Chapter 2 aimed to produce an aggregation of theoretically based data during a systematic literature review and empirically determined data from an exploratory case study, enabling answering of the research questions. The integration and alignment of primary and secondary data-collection strategies contributed to the rigour of the study.

Chapters 3 and 4 respectively produced theoretically based and empirically determined elements for ad hoc mobile technology-enhanced learning. In summary, the interrelated and hierarchical framework of elements for the ad hoc use of mobile technology-enhanced learning in higher education contexts is structured around a backbone of 19 constructs (Appendices G.1 and G.2).

Constructs link in specific ways via sub-categories and items to five core categories. Categories include A. Enablement, B. Environment, C. Interactivity, D. Dynamics and E. Mobility and consist of a total of 24 sub-categories and 95 items (Appendices F.1 to F.5)

Categorised items are distributed as follows:

- Category A. Enablement – five sub-categories and 19 items;
- Category B. Environment – four sub-categories and 16 items;
- Category C. Interactivity – four sub-categories and 12 items;
- Category D. Dynamics – five sub-categories and 21 items; and
- Category E. Mobility – six sub-categories and 27 items.

Findings demonstrate both synergy – elements based on empirical feedback from respondents aligned with literature sources and augmentation – empirical sources expanded the set of theoretically based constructs, sub-categories and items. The consolidation of primary and secondary data meets objectives O1 and O2 and answers the main questions (MQ1 and MQ2). The final set of elements is detailed in Section 5.4.1 as Table 5.2 and Table 5.3 and illustrated as Figure 5.2. For reference purposes, the elements are provided in Appendices D, F and G. The final framework structure is delineated and visualised as a networked map of elements (Figure 5.2).

Section 5.2 provides the methodological contributions of the study, while Section 5.3 offers substantive contributions. The scientific contributions are indicated in Section 5.4, followed by the study's recommendations (Section 5.5), limitations and delimiters (Section 5.6) and directions for future research (Section 5.7). Section 5.8 comprises a final crystallisation that closes the study.

5.2 Methodological contributions

The comprehensive and rigorous systematic literature review (SLR) reported in Chapter 3 contributes to methodological acumen in the field of ad hoc mobile technology-enhanced learning. This study expands the application of the SLR methodology to technology-enhanced studies using mobile technologies by Hwang and Wu (2014) and Nguyen et al. (2015) to incorporate the mobile educational technology domain. Review articles applying the SLR method were noted to be indirectly allied to ad hoc mobile technology-enhanced learning via technology-enhanced learning (Tedre et al., 2011; Wong et al., 2015), m-learning (Farley & Murphy, 2013; Alrasheedi et al., 2015) and blended learning (Wang et al., 2015). This study contributes to the body of knowledge by comprehensively concretising and integrating SLR guidelines gleaned from diverse disciplines such as usability evaluation (Quiñones & Rusu, 2017), research methodology (Zheng, 2015), health and medicine (Liberati et al., 2009) and software engineering (Kitchenham et al., 2009; Inayat et al., 2014). Thus, it adds value for other students embarking on postgraduate research and for researchers, providing guidelines for structured and reproducible literature studies.

Additionally, the study offers a method for the synthesis of theoretically based and empirically determined elements into a single and holistic framework. Pragmatic juxtapositioning of theoretical perspectives (SLR method) and empirical perspectives (case study method) as data-collection mechanisms supports qualitative research grounded in data sources. Sequential and iterative data analysis reported firstly in Chapter 3 and then subsequently in Chapter 4, led to useful interrelated mapping of core constructs, categories, sub-categories, and items. The approach extricated powerful and substantiated themes. In keeping with the social constructionist philosophy outlined In Section 2.3.1 and summarised in Table 2.1, the study demonstrated the value of dependence on contributions of socially interactive stakeholders to inform the building of theoretical concepts.

The study made extensive use of the capabilities of computer-assisted qualitative data-analysis software, ATLAS.ti V8.0, producing the network maps included in Chapters 3, 4 and 5. The maps powerfully communicate interrelationships between concepts. An emergent set of themes expressed as recommendations for higher education policymakers (Section 5.5) constituted additional artefacts. However, ATLAS.ti V8.0 used in isolation of other digital tools would not necessarily have supplied an effective set of analysis methods. I relied on a digital toolbox that interlinked digital referencing, mobile productivity, and online data storage and management methods.

In keeping with the underlying philosophy of the study, the data-collection mechanisms resonate with the social constructionist tenets in Chapter 2, Table 2.1 (Hibberd, 2005; Charmaz, 2008; Järvensivu & Törnroos, 2010). As such, data-collection methods sought the sharing of realities by respondents of their experiences using mobile technology to enhance teaching and learning informally.

Literature sources note qualitative researchers traditionally collect data by interviews and observation. However, these data-collection methods proved to be infeasible. In this case study, attitudes, opinions and perceptions of stakeholders were gathered from academics, students and lecturers via online questionnaire surveys delivered to mobile devices. The necessity of hurried interviews with the domain expert and faculty head, both of whom filled demanding and time-constricted educational roles, led to an innovative strategy. Smartphone technology was implemented to achieve the recording of in-transit, mobile interviews, offering the benefit of successful data collection that would have otherwise been an impossibility. Even though the single exploratory case study sample was small when compared with quantitative research guidelines, data- collection methods produced rich and thick data.

The decision to administer custom-designed survey questionnaires among academics, students and lecturers was beneficial to data collection. However, the approach presented minor constraints. The encouragement of busy and mobile respondents to complete online questionnaires became the responsibility of the domain expert, who emailed reminders. The elicitation of usable data via custom-designed questionnaires was dependent on the asking of appropriate questions and the truthful answering of questions. The questionnaire incorporated several open-ended questions, emulating a structured interview. In some cases, even though the responses were automatically downloaded in Excel spreadsheet format, the objective interpretation of student responses was challenging, requiring data cleansing prior to analysis. The inability to communicate directly with respondents precluded in-depth, follow-up inquiries.

The research design described in Sections 2.5 and 2.6 presented a few challenges. The systematic literature review of theoretical sources was time consuming and required the development of analytical as well as technical skills for the use of ATLAS.ti V8.0. Outcomes of the case study did not support statistical analysis of data. Therefore, generalisability of the findings to other contexts, faculties, departments or domains was infeasible. Consequently, measures to assure trustworthiness were essential. The interpretive strategy called on my awareness of the effect of subjectivity and the need for reported findings to be grounded in both theoretical and empirical data. As I was unable to observe respondents' use of mobile technology for educational purposes directly, the interpretation of feedback may have been influenced by my own bias.

Finally, data-collection methods gathered surprising volumes of data. Data transcription, immersion and analysis leading to the synthesis of themes were conducted until saturation was achieved. These considerations proved to be challenging.

5.3 Substantive contributions

Now that theoretical and empirical data have been analysed, this section focuses on a selection of resultant contributions that are of concrete value to educational stakeholders. Section 5.3 discusses the practical contributions made by the theoretically based and empirically determined evidence reported respectively in Chapters 3 and 4, strengthening answers to the secondary research questions. It additionally incorporates a limited yet illustrative selection of recent publications that did not contribute to the systematic literature review reported in Chapter 3.

The main research questions planned to explore the elements connected with the ad hoc use of mobile technology to enhance learning in higher education contexts (MQ1), leading to the proposal of a structured framework of elements (MQ2). In order to achieve the objectives of the thesis, this section addresses the five secondary research questions, listed here as:

- SQ1.1: What elements inform institutional decision making?
- SQ1.2: What elements reflect contextual influences?
- SQ1.3: What is the nature of relationships mediated by social technology?
- SQ1.4: What are the implications of teaching and learning in a mobile milieu?
- SQ1.5: What aspects emanate from being mobile?

Answers to these questions collectively realise the meeting of the two research objectives introduced in Chapter 1: *O1: To identify the elements that inform strategic decisions for ad hoc mobile technology-enhanced learning,* and *O2: To inform the structure of the framework, defined by its constituent components*. The main research questions MQ1 and MQ2 are subsequently reviewed and respectively answered in Sections 5.4.1 and 5.4.2.

Analysis of literature sources and respondents' comments led to five themes, determined by the five core categories introduced in Chapter 1, expanded theoretically in Chapter 3 and augmented empirically in Chapter 4. Emergent themes included: institutional decision making (Category A. Enablement), contextual influences (Category B. Environment), social technologies (Category C. Interactivity), education in a mobile milieu (Category D. Dynamics) and mobile stakeholders (Category E. Mobility). Sections 5.3.1 to 5.3.5 severally discuss these themes. Categories are subdivided logically into 24 sub-categories and tabulated in Appendix F.1 to Appendix F.5.

5.3.1 Institutional decision making – taking ownership of organisational features

Section 5.3.1 discusses theoretical and empirical findings respectively from Chapter 3 and Chapter 4, linked to the secondary research question *SQ1.1: What elements inform institutional decision making?* This question is associated with Category A. Enablement, exploring the framework elements that inform institutional decision making and the call for institutions to take ownership of organisational features of mobile technology-enhanced learning. This study identified five enabling considerations: preparedness and maintenance, continuous improvement, competitive advantage, user-centricity, and digital facilitation (Appendix F.1).

Preparedness and maintenance

In the context of this thesis, institutional decision making encompasses being prepared, ensuring user-centric mechanisms are in place, and continuously improving quality of educational experiences via ad hoc mobile technology-enhanced learning.

Collective feedback from lecturers and students recommends educational designers should adhere to sound theoretically based and empirically determined design guidelines, resonating with Fetaji and Fetaji (2011). In order to take ownership of organisational aspects of the ad hoc use of mobile technology to enhance teaching and learning, institutional stakeholders would benefit from design and development guidelines (Farah et al., 2016; Walker et al., 2016) that increase the likelihood of successful and informed decision making leading to effective outcomes. In addition, ongoing implementation of maintenance processes would keep the institution abreast of dynamic change – adjusting the application of emerging educational technologies to enhance teaching and learning.

Benefits of mobile technology-enhanced learning include improved access to information and the ability to implement distance-learning modalities. Consideration should be given to upgrades to the learning portal, downloadability of mobile contents, distribution of notifications of additional information via an interactive portal on a par with Facebook technology, seamless integration, and mobile compatibility.

Continuous improvement

Lecturer self-reflection pinpoints gaps in their digital awareness. In agreement with Rivers et al. (2015), academics and lecturers recommend the institutional strategy should incorporate continuously improved training for academic staff with access to increased resource levels and the affordances of social media. In support of this approach, Khaddage et al. (2015) recommend training in the use of mobile devices.

Contrarily, students view themselves as digitally savvy, finding it easy to use their devices and applications to connect and stay in touch. They report being creative and confident, exhibiting reliance on Facebook and WhatsApp for the receipt of notifications, for the sharing of links, for communication and access to the institutional portal via either their mobile phones or laptops.

Additional capabilities such as value of rapid access to online information, speedy academic outcomes and the ability to be simultaneously mobile and productive seem important to students. Resonating with Rodríguez-Triana et al. (2017), they emphasise on-the-move learning activities. Students indicate appreciation for reliable links to cloud facilities that provide one-spot, Internet-enabled storage facilities – available via all device types. They reject location and time hindrances, viewing file-sharing with peers as a necessity. Mobile technology should facilitate anywhere study, where mobile applications provide on-the-go library facilities.

Respondents depict quality as ease linked to experiences, evaluation and access.

Competitive advantage

Literature sources report that supportive and inclusive measures underpinning competitive educational strategies (Lan & Lin, 2016; Samaka & Ally, 2016) may improve the quality of learning experiences, mediated by mobile devices and applications. This feedback is important as students indicate awareness of support provided for mobile devices and applications together with digital facilities offered by other institutions. Student opinions resonate with Inglis (2005), who indicates that mobile tools such as devices, applications and processes enable competitive advantage.

User-centricity

Institutions should consider the student lens that advocates compatible, cloud-based technologies, such as Dropbox and Google Drive. These technologies provide easy connectivity in personalised ways. Students are at ease when using their devices and applications for mobile educational activities, even though hampered by poor bandwidth. Mobile technology-enhanced learning also presents limitations that suggest adaptation is required. Institutions need to improve awareness of students' mobile usage habits, suggesting the implementation of mobile-friendly initiatives.

Digital facilitation

Mobile devices support the review of course-based webinars and blogs, irrespective of location. A lack of effective portal technology facilitating mobile options highlights that institutions would benefit from a Facebook emulation. Enabling factors are ineffective if environmental influences are disregarded. This topic is the focus of Section 5.3.2.

5.3.2 Contextual influences – recognising a constantly changing environment

This section discusses theoretical and empirical findings respectively from Chapter 3 and Chapter 4, linked to the secondary research question *SQ1.2: What elements reflect contextual influences?* It is associated with Category B. Environment, exploring the framework elements that relate to contextual influences whereby stakeholders are urged to recognise that they function educationally in a constantly changing mobile environment.

Owing to the changing nature of features, capabilities, requirements and expectations of mobile technology and its use, stakeholders involved in higher education environments need to ensure contextual influences are constantly reviewed. This study highlighted four contextual components that should be monitored: personal responses to mobile technology, external elements, vibrant evolution, and dealing with distances (Appendix F.2).

Personal responses to mobile technology

Attitudes to and acceptance of the educational use of mobile technology need to change to incorporate greater openness. Whereas Wong et al. (2015) highlight role-playing features of technology-enhanced learning acceptance, lecturers showed concern that their educational contexts were complex, marring attitudes to acceptance. They additionally identified a need to embrace all personal responses to mobile technology and pedagogical environments seamlessly. They acknowledge that indistinct boundaries separate different sites of learning, whether these are campuses, learning communities, the work zone or online spaces. Campus worlds comprise both a physical on-campus world of study and parallel, online digital existences.

Respondents agree with García-Peñalvo and Conde (2015) and suggest mobile personal learning environments (MPLEs), seen as the informal combination of mobile technology and personal learning environments, may offer solutions to requirements for lifelong learning. From this viewpoint and per Mileva et al. (2008), students may make valued recommendations based on informal MPLE choices.

External elements

While higher education institutions invest in formalised learning platforms and consider the cost of mobile equipment, structured environments do not match mobile expectations of students. They battle to pay for running costs and the latest device capabilities. Students respond positively to mobile technology that constitutes a personal and social context (FitzGerald et al., 2017, in press). Contexts are influenced by external elements such as the vibrant evolution of innovative mobile technologies – devices and applications (Flavin, 2016).

Students found that the ad hoc use of mobile technology-enhanced learning reduces their printing costs.

Vibrant evolution

There is a shared enthusiasm for improved quality of hardware and software but regretfully, technological constraints such as limited compatibility and bandwidth issues prevail. Students identify with vibrant evolution of attitudes characterised by mobile friendliness, location independence and a reduction in technological limitations experienced during informal learning activities.

Dealing with distances

Students say they gain a lot while being in a mobile, off-campus space and when using smartphones and applications for educational purposes. This allows them to share with peers and interact with lecturers.

Lecturers suggest distance-learning students should own their devices; lockers are required offering built-in charging opportunities for campus visits; an on-campus, working WiFi configuration is a necessity; and a teaching-with-mobile-technology strategy should receive institutional support.

This section indicates that besides traditional on-campus environmental influences, mobile stakeholders are exposed to a range of contexts. On-the move users are pressured to accommodate the complexities of ubiquity and distances resulting from off-campus interactivity needs. Cloud-based environments offer benefits and limitations for mobile higher education stakeholders, drawing attention to web-based technologies in general and to social technologies in particular. This topic is discussed in Section 5.3.3.

5.3.3 Social technologies – incorporating web-based opportunities

This section discusses theoretical and empirical findings respectively from Chapter 3 and Chapter 4, linked to the secondary research question *SQ1.3: What is the nature of relationships mediated by social technology?* It is associated with Category C. Interactivity, exploring the framework elements associated with social technologies. Evidence suggests there are benefits associated with the incorporation into teaching and learning processes of web-based opportunities.

This study identified four areas of interest to educational stakeholders: learning-management systems, technological requirements, socially driven mobile education, and relationships with others (Appendix F.3).

Learning-management systems

In this study, a dedicated learning portal and a personalised Facebook group established satisfactory conduits for social interactivity and delivery of notifications to students. In addition, Web 2.0 tools facilitated on-the-move discussions and webinar sessions leading to the sharing for "informal learning purposes". Students reported appreciation for the communication of mobile alerts and daily course-oriented updates. The redesign of the learning portal should be informed by user-friendly features of social networking applications such as Facebook. Students said they appreciated instantaneous communication scaffolded by technology.

The challenges of connectivity and Internet access associated with institutional learning portals are well documented (Stickel & Hum, 2008; García-Peñalvo & Conde, 2015). In alignment with identified portal issues, respondents reported Blackboard lacked integration capabilities and was not suited to all mobile device types, establishing a perception of inferior quality of interactive experiences. Consequently, they avoided its use, preferring MPLE mechanisms to achieve interactivity. From a student perspective, Blackboard could take lessons from Facebook.

Compatibility of and access to Blackboard may be problematic via mobile devices (Mayisela, 2013). From a lecturer perspective, interactivity is characterised by a linear, technological focus where mobile conversation reverts to the limitation of poor connectivity in Africa. Lecturers intimate that interactivity is associated with course-related alerts and speedy communication. Contrarily, students contend interactivity should be mobile-specific and expansive – inclusive of anywhere, any-time communication. However, as proposed by Mayisela (2013), the learning-management system may prove to be incompatible with and inaccessible via mobile devices. Students augmented this view, suggesting their learning portal lacked user-friendliness via tablet devices. Their expectations concerning tablet-based technology were not met.

The customisation of the learning-management system should preferably align with features of Facebook, reinforcing a link between quality-oriented, educational activities and social networking platforms – the "own private world" echoing the views of Lai et al. (2013:421).

Technological requirements

Mobile technology-enhanced learning supports anywhere, anytime educational interactivity via digital mechanisms such as webinar sessions. However, mobile technology-enhanced learning is also characterised by issues such as erratic network connectivity. Connectivity is reportedly comprehensive, rhizomatic and supportive of diverse educational routes – a multi-dimensional perspective. Students specify a preference for interactivity via multiple device types paralleled by social experiences, advancing the exposition of generational trends reviewed by Oh and Reeves (2014).

Socially-driven mobile education

Institutional stakeholders are cognisant of the rapidly growing yet measurable impact of social technologies (Sung et al., 2016) and the externally available web-based opportunities they offer. Consequently, there is a need to proactively explore and benefit from the educational relationships they mediate. The architectural technology context of this thesis reported the successful incorporation of Facebook as an information-sharing tool. Facebook provided a platform, an information-sharing space where ideas and guides to course-related topics could be posted. The approach was augmented by video lessons (TED-Ed) and lecturer-designed webinars. Students indicate approval of social communication via Facebook and agree with Sugimoto et al. (2015) that social technologies support mobile education. This finding resonates with Pektaş (2012), who appraised delivery modes in a blended design studio context.

Mobile education is socially driven yet personalised. Mobile personal learning environments (MPLEs) provide easy and fast access to social networks and concomitant social communication patterns enabling collaboration (Fischer et al., 2013; Khaddage et al., 2016) and communication (Stickel & Hum, 2008; Kitsantas et al., 2016). Rather than being socially supported, learning is becoming socially driven owing to the affordances of mobile ICT. This observation emphasises the need for seamless integration of social networking technologies such as Facebook, Twitter and LinkedIn into institutional learning-management systems (Heflin et al., 2017) and portals (Humanante-Ramos et al., 2015; Marin et al., 2016), enabling excellent interconnectivity and interpersonal contact (Naveh & Shelef, 2017).

In this study, respondents suggested the sharing of design concepts between students and their lecturers had become a social feasibility.

Relationships with others

Mobile devices and applications enhance the benefits of social media for effective interpersonal relationships between students and their lecturers. However, lecturers view a loss of eye contact and direct interface with students as a limitation of mobile technology as an educational medium.

This section reviewed affordances of social technologies and concomitant, web-based opportunities, mediated by the ad hoc use of mobile technology for educational purposes. The conceptual discussion focused on interactivity and included learning-management systems, technological requirements, socially driven mobile education and relationships with others. Study emphasises the need for pedagogical evolution instantiated by teaching and learning in a mobile environment. This topic is reviewed in Section 5.3.4.

5.3.4 Education in a mobile milieu – adjusting to an evolving pedagogy

This section discusses theoretical and empirical findings respectively from Chapter 3 and Chapter 4, linked to the secondary research question *SQ1.4: What are the implications of teaching and learning in a mobile milieu?* It is associated with Category D. Dynamics, exploring the framework elements that address education in a mobile milieu. Pressure is exerted on stakeholders to assimilate adjustments to their pedagogical approaches, addressing the impact of a mobile evolution.

While domain content may remain relatively consistent, teaching and learning in a mobile milieu is dynamically evolving and demands equally vibrant adjustments to pedagogical practices. In this section, five topics were noted: educational preferences, on-the-move education, decision-making trends in mobile education, productivity, and digital designs (Appendix F.4).

Educational preferences

The upliftment of digital skills is acknowledged by all respondents in the study as needing attention. However, differences in attitudes were noted. Academics and lecturers called for training in the use of mobile technology, while a portion of students reported digital confidence, expressing the opinion that no additional mobile training was needed. In addition, all respondents believed Web 2.0 tools could facilitate on-the-move discussions and webinar sessions leading to informal sharing for learning purposes.

On-the-move education

Students participate in various mobile technology-enhanced learning activities such as mobile research, the random review of architectural content, the ability to follow the writings and work of prominent architects, and the scanning of optional subscriptions to architectural websites. Students received easy-to-access feedback via online critiques and assessments, reporting however that the mobile process was unsatisfactory. This opinion resonated with a lecturer who commented on the limitations of mobile evaluation mechanisms that lacked 'easiness'.

The study shows that, for typical activities in higher education contexts, the ad hoc use of mobile technology enables the distribution of notifications, brief discussions, the posting of relevant information, and interconnectivity of students. However, based on students' experiences, limited student collaboration occurred. Contrary to the typical activities listed here, students' perspectives encapsulated educational facilitation via mobile technology. They indicated that the use of their tablet devices during critique sessions was excellent, allowing critiques to occur ubiquitously – while driving, filling hours in the office, doing the cooking in the kitchen and when sitting in the park. Lecturers seemed unaware of this benefit.

Decision-making trends

From the perspectives of academics and lecturers, even though the realignment of traditional material to suit mobile technology-enhanced learning requirements would be time-consuming, a change in attitude paralleled by a new understanding was deemed important. Institutional controls may exert undue pressure when outdated policies influence implementation decisions (Khaddage et al., 2015; Wong et al., 2015). Policies may require remediation to accommodate decision-making trends in mobile education (Rivers et al., 2015). Lecturers need to embrace the future of teaching and learning and open their minds to the affordances of emerging technologies by encouraging adjustments to policies and principles.

Productivity

Students emphasised the benefits of mobile efficiency that differ little from the way things are done. In their everyday lives, technology influences a great part of their communication patterns. Additionally, improved portal connectivity and mobile productivity would improve efficient learning (Rodríguez-Triana et al., 2017) and, in accordance with students, support webinar critiques, uploaded work, feedback, technology-based learning and TED-Ed interactivity.

Reported productivity benefits included the feasibility of presentations via CorelDraw, the ability to study anywhere, information sharing with peers, and the convenient uploading of course-specific journals. Students' perspectives highlighted the importance of immediacy and multi-tasking, and an awareness of time-saving educational processes. Immediate access to educational sites and video lectures supports learning activities.

Digital designs

Digital designs are complex and may include variants of m-learning (Wood et al., 2016), technology-enhanced learning (Charlesworth & Sarrasin, 2016; Duval et al., 2017) and blended-learning models (Mtebe & Raphael, 2017). Interactive technologies offer improved self-control and self-regulation of learning experiences. In this study, lecturers recognised mobile technology as a facilitator of non-linear, rhizomatic teaching and learning within boundary-free environments. This notion impacts pedagogical considerations for blended paradigms.

Lecturers regarded the discomfort of losing track of students' activities accompanied by a concomitant feeling of loss of traditional interpersonal contact as a major issue. Measures taken to bridge an interconnectivity divide, such as the incorporation of video sessions into the design of the architectural technology programme, did not necessarily provide solutions. Pedagogical limitations associated with the ad hoc use of mobile technology include a need for specifically customised digital content that meets mobile expectations.

Students are accustomed to the benefits of mobile technology. Pedagogical expectations include the facilitation of mobile research without needing to go to the on-campus library. Effective mobile access to institutional and course-related content may be hampered if information lacks mobile orientation. Mobile students can access educational material wherever and whenever they choose. This reduces time taken in search of people and information. Feedback on assignments is faster and more convenient. Mobile activities are more collaborative as students connect to and learn with each other. Students view the beneficial capabilities of smartphones as a means of achieving many educational activities such as photography, scanning, note-taking, sharing of information, and domain-specific tasks – design journals, hangouts and online 'crits'. Fast access to digital content is critical and more significant than emailed notifications.

Students' recommendations included institutional conversion of the portal into an app, allowing immediate access to webinars on phones while walking or taking taxis. Mobile media could potentially increase accessibility and information exchange.

Students observed inadequate compatibility for all devices that, in their opinions, could potentially be used for 'crits'. The use for educational purposes of a wide spectrum of devices including tablets is indicated.

Section 5.3.4 explored evolutionary facets concerning teaching and learning, influenced by the advent of mobile technology. Relevant topics included educational preferences, on-the-move education, decision-making trends in mobile education, productivity, and digital designs. Having dealt with pedagogical considerations, mobile stakeholders – executives in leadership roles, administrators, developers, academics, lecturers and students – disregard established educational boundaries and need support for seamlessness. Section 5.3.5 addresses these issues.

5.3.5 Mobile stakeholders – supporting seamlessness across boundaries

This section discusses theoretical and empirical findings respectively from Chapter 3 and Chapter 4, linked to the secondary research question *SQ1.5: What aspects emanate from being mobile?* It is associated with Category E. Mobility, and explores aspects connected with mobile stakeholders. Seamlessness across educational boundaries requires support mechanisms.

As long as devices are adequately powered-up, mobile stakeholders are unfettered – free to move rhizomatically, wherever and whenever the mood dictates while traversing physical and digital boundaries. Six core themes emerged in this study, addressing the need to support mobile seamlessness, linked to hardware and software dimensions, patterns of personalisation, mobile champions, quality-focused considerations, affective factors and embracing differences (Appendix F.5).

Hardware and software dimensions

Lecturers view mobile devices as a ‘saving grace’, offering access possibilities for students who have no Internet connectivity via personal computers. Smartphones and tablets provide an easy and convenient alternative to office-bound, wired Internet connectivity. Mobile technology is also characterised by limitations. Lecturers identify bandwidth issues, incompatibility of cloud services and a lack of integration of platforms. Although respondents indicated their laptops worked well, they disagreed about the suitability of tablets and smartphones.

Students offer contrary feedback concerning the educational effectiveness of their devices, indicting their mobile devices and applications represent both current and future trends. They use several mobile device types simultaneously (Reid & Pechenkina, 2016) in an ad hoc manner to enhance learning experiences, indicating satisfaction with smartphones and tablets.

Besides the usual issues – device interface, battery life, connectivity factors, inadequate portal capability and financial constraints – students were particularly dissatisfied with the lack of inclusion of tablet technology to support their studies.

The use of diverse mobile device types is characterised by a need for uninterrupted connectivity and a tendency to hang around coffee shops in search of free Internet access. Several students successfully used more than one mobile device type, seen as an advantage for their studies. In addition, students associated portability with the requirements of their working worlds, indicating their perception of mobile productivity in the construction industry.

Patterns of personalisation

The study suggests there is some congruence between lecturer and student opinions on mobile productivity linked to patterns of personalisation that represent digital preferences (Grant & Eynon, 2017). However, whereas lecturers refer to usefulness, students emphasise preferences for flexibility, immediacy and portability. Students reported experiencing the easiness of accommodating on-the-go use of mobile technology owing to alignment with everyday usage patterns.

An MPLE may comprise a collection of idiosyncratic and customisable technologies used for communication and collaboration activities such as chat, forum, and wiki applications (Prieto et al., 2013). Patterns of personalisation characterise interactivity. Academics, students and lecturers shared personal preferences and patterns of usage that characterise their MPLEs. MPLEs have the potential to facilitate lifelong learning productivity (García-Peñalvo & Conde, 2015) via Web 2.0 tools (Stickel & Hum, 2008; Oldfield & Herrington, 2012; Gikas & Grant, 2013; Kitsantas et al., 2016) and digital platforms (Stickel & Hum, 2008).

Increased institutional effectiveness is defined by students as mobile convenience and mobile productivity. Mobile productivity may increase educational effectiveness. Students said they learned beyond the classroom via their MPLEs where the learning process extended to encompass the world of work.

Mobile champions

This study noted a call to address gaps in attitude to mobile technology and thereby to align academic perspectives. It identified 'the champion' has a positive attitude to the educational application of innovative emerging technologies (Kounaves et al., 2016; Watty et al., 2016), and is a motivated and enthusiastic proponent of the ad hoc use of mobile technology (Yüksel et al., 2017). A lack of awareness of the champion's mobile habits by departmental teams regarding benefits of mobile technology constituted a barrier to successful mobility.

Wang et al. (2015) allude to the minimal levels of research concerning the relationship between lecturers, students, the institution and technology in blended-learning contexts. Of particular interest in this study is the differential attitude to mobile technology noted among lecturers and students.

Quality-focused considerations

Hedonic elements include stakeholder happiness, enjoyment and approval, anticipated use and expectation of experiences. Enthusiastic students with positive attitudes perceive the educational potential of their MPLEs. Respondents enjoyed easy digital communication via a closed Facebook group that enabled the informal sharing of course-related ideas, experienced as a pleasurable reality.

User experience (UX) is associated with subjective and hedonic interactivity. The study supports the view of Kukulska-Hulme (2012) that mature students have specific hopes for positive experiences of technology. In accordance with ISO 9241-2010 (ISO, 2010), UX represents "… a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service". Good UX contributes to perception of quality and hence satisfaction. Stakeholders deem their mobile personal learning environments (MPLEs) to be successful if they are satisfied with interactive experiences and if their expectations are met. This applies to effective interactivity via the institutional learning-management system.

In this study, stakeholders offered examples of both good and poor UX.

Affective factors

In alignment with Park (2014:29), lecturers believe mobile devices provide "pedagogical affordances", communicating a more formal perspective. Additionally, lecturer mobility expresses convenience as a technological, rather than a practical factor. However, students understood that mobile technology offered them convenient opportunities for research via their devices and applications together with improved administrative functionality. From this viewpoint, students perceived mobile technology via a practical lens. They indicated a preference for compatibility of all device types, linking adoption and usage patterns (Trede et al., 2016). Student mobility embraces effective educational benefits, supporting work and campus productivity.

Portable technology has the potential to scaffold mobility. Cochrane and Bateman (2010:13) address "the pedagogical affordances of smartphones in tertiary education", providing guidelines that could inform future m-learning implementations. However, lecturers reported using mostly their laptops, supporting the observation that portability is not viewed by lecturers as a particularly key aspect of mobile academic activities. Contrarily, students perceived their mobile devices as enablers of mobility – an important facet of their educational experiences. This aspect of mobile technology aligns with the notion that in a distance learning context, "mobile devices uniquely support seamless movement" (Park, 2014:44).

While lecturers believed mobile enthusiasm would wane, students hoped for greater openness and technological leadership among academics. Students reported being motivated by key competencies such as mobile flexibility, while lecturers emphasised technological alignment (Harpur, 2017).

Mobile technology was perceived by lecturers to be faddish and not likely to last. Negative attitudes of some academics to the potential of mobile technology were perceived by students as a limitation. Contrarily, students saw mobile technology as an actuality, a crucial immediacy and necessary provision enabling interconnectivity between each other and with lecturers while accessing educational content via many mechanisms at any moment of choice.

The facilitation of quality-oriented activities incorporates provision for safety and security of mobile data, devices and applications. Whereas lecturers seemed concerned with security of student devices, students intimated data loss fears.

Embracing differences

Differences in digital behaviour include choices of social networking technologies used for educational purposes (Holotescu & Grosseck, 2012; Oldfield & Herrington, 2012; Mayisela, 2013; Webb, 2014; Kitsantas et al., 2016).

The study recommends identification and remediation of perceived differences between mobile lecturers and mobile students, informing institutional decisions regarding mobility in educational contexts (Khoza & Manik, 2016). Despite the noted diversity and a perceived lack of integration of informally used mobile technologies, lecturers and students agree with Casanova et al. (2011) that digital proficiencies are essential.

Whereas Section 5.3 briefly aligned substantive contributions of the thesis to the five secondary research questions SQ1.1 to SQ1.5, Section 5.4 addresses the two main research questions MQ1 and MQ2.

5.4 Scientific contributions

Whereas the Section 5.3 communicates the components of the synthesised framework in a textual manner, the framework is best described in both tabular and diagrammatic fashion. Section 5.4.1 outlines elements for the ad hoc use of mobile technology-enhanced learning, addressing the first research question (MQ1) via Figure 5.1. Section 5.4.2 presents Figure 5.2 – the final structure of the proposed framework answering the second main question (MQ2). The strategies applied in the preceding and next sections aim to support an understanding of the complexity of the framework.

This thesis contributes to a gap in the body of knowledge concerning the ad hoc use of mobile technology, applied to enhance teaching and learning in higher education environments. It expands the understanding of elements associated with the ad hoc use of mobile technology-enhanced learning and the resultant structure of a framework comprising emergent elements, meeting objectives O1 and O2 of the thesis.

While the set of elements discussed in Section 5.4.1 addresses the first main question, MQ1, and is linked to a comprehensive collection of guidelines as set out in Appendix D.1 to Appendix D.5, the proposed framework illustrated in Section 5.4.2 answers the second main question, MQ2, but is not an evaluation tool. Rather it informs on many levels the necessary and relevant components of such a tool. The structured framework is described via secondary data resulting from a systematic literature review and primary data gathered during a case study outlined in Section 2.6.1.

The taxonomy of proposed elements represents my interpretation of theoretical findings and is both intuitive and subjective. Institutions may apply the framework to reflect on mobile technology-enhanced learning capabilities, focusing awareness on strengths and weaknesses. The framework is a resource with value for quality and change management, contributing to the consolidation of existing educational policies. Its components provide structured guidelines for best practices – potentially providing greater effectiveness of implementations involving mobile technology. By taking cognisance of the proposed framework elements, higher education stakeholders may leverage the benefits and mitigate the limitations of mobile technology-enhanced learning.

The framework concretises the extent to which the study was able to expand the body of literature on the topic. Additionally, it demonstrates how the empirical findings support and augment the theoretical perspectives underpinning the proposed framework. So, the framework emerging after Chapter 3 was combined with outcomes from Chapter 4, extending it. The research strategy, applied methods and final products from main questions MQ1 and MQ2 contribute to the body of knowledge.

In Section 5.4.1 that follows, I answer the first main question, MQ1. Thereafter, in Section 5.4.2, I address the second main question, MQ2.

5.4.1 Elements for the ad hoc use of mobile technology-enhanced learning (MQ1)

The first objective of the study, O1, set out to establish the elements that inform strategic decisions for ad hoc mobile technology-enhanced learning, enabling the answering of first main question, MQ1: *What elements emerge from data collected firstly during a systematic literature review and subsequently from a case study designed for ad hoc mobile technology-enhanced learning in higher education contexts?*

A preliminary conceptual model was provided as Figure 1.2 in Section 1.4.6, Chapter 1. It resulted from an initial theoretical exploration, suggesting my initial map. It served as a familiarisation platform of key concepts gleaned from literature sources and led to the proposal of five core categories:

- Enablement – institutional decision making;
- Environment – contextual influences;
- Interactivity – social technologies;
- Dynamics – education in a mobile milieu; and
- Mobility – mobile stakeholders.

Analyses conducted in Chapters 3 and 4 resulted in elements described as 19 constructs, five core categories, 24 sub-categories and 95 items, defined by O1 and resulting from SQ1.1 to SQ1.5. Tables 5.2 (Categories A, B and C) and 5.3 (Categories D and E) set out resultant categories, sub-categories, framework items and associated constructs (Appendix G.1 and Appendix G.2). The tables aggregate theoretical perspectives from Chapter 3 (Table 3.14 and Table 3.15) and empirical findings from Chapter 4 (Table 4.13 and Table 4.14).

Figure 5.2 is a diagrammatic summary of Table 5.2 and Table 5.3. It amalgamates Figure 3.7 – the theoretical perspectives presented in Chapter 3 and Figure 4.31 in Chapter 4 – the empirical outcomes of the study. Centrally positioned constructs anchor the core categories: Category A. Enablement (red), Category B. Environment (blue), Category C. Interactivity (orange), Category D. Dynamics (blue) and Category E. Mobility. Each of the colour-coded categories displays associated theoretically based and empirically determined items. The final components reflected in Figure 5.1, Table 5.2 and Table 5.3 achieves O1, the first objective of the study and simultaneously answers the first main question MQ1, indicating the elements suited to the ad hoc use of mobile technology-enhanced learning in higher education contexts.

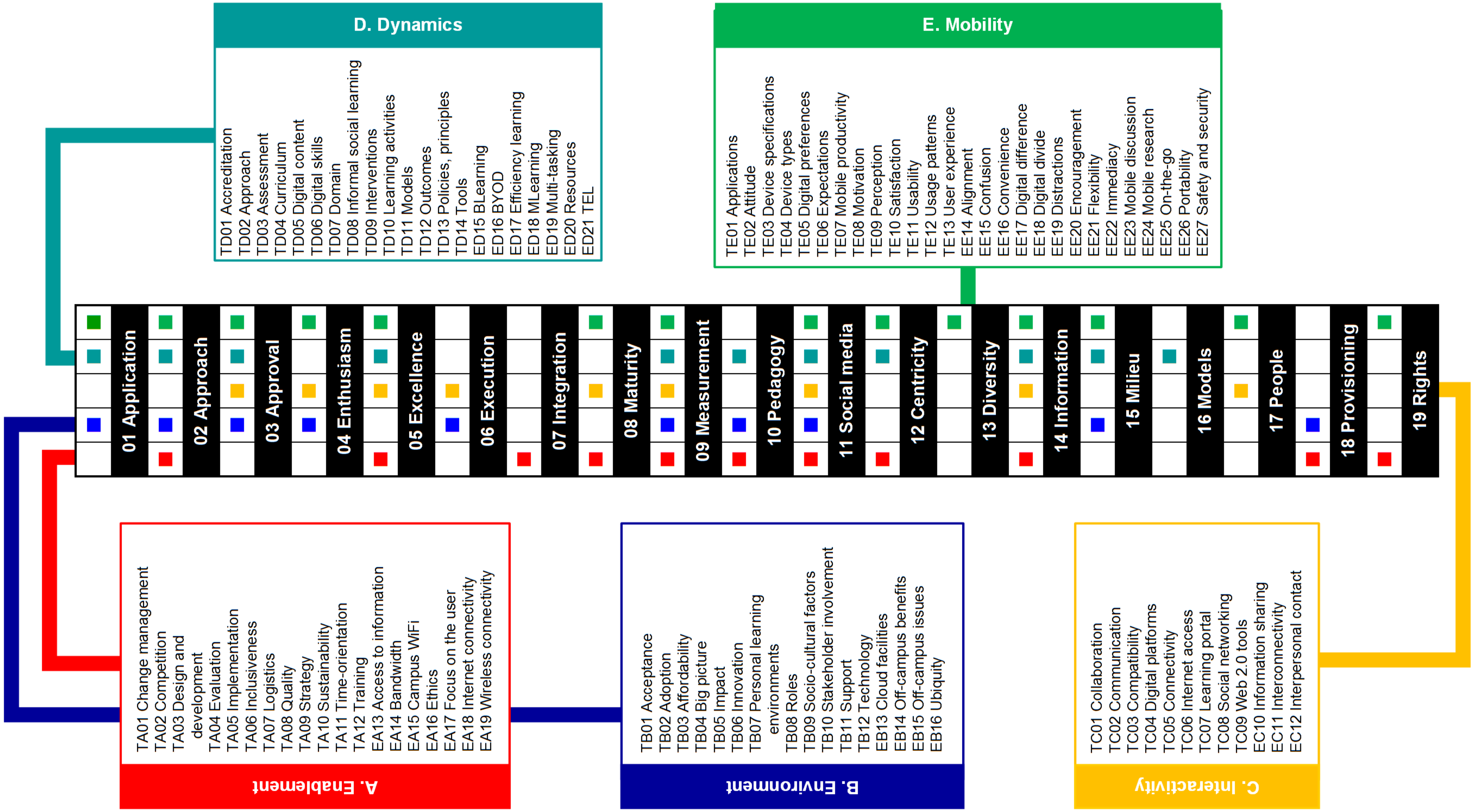


Figure 5.1: Framework elements – constructs, categories and items for ad hoc mobile technology-enhanced learning in higher education contexts

Table 5.2: Categories A. Enablement, B. Environment and C. Interactivity – constructs, sub-categories and items

Sub-category	Item	Construct
A1 Preparedness and maintenance	TA03 Design & development	CO02 Approach
	TA04 Evaluation	CO09 Measurement
	TA05 Implementation	CO06 Execution
A2 Continuous improvement	TA01 Change management	CO08 Maturity
	TA08 Quality	CO07 Excellence
	TA12 Training	CO11 Social media
	TA10 Sustainability	CO09 Measurement
	TA11 Time orientation	CO07 Integration
A3 Competitive advantage	TA02 Competition	CO09 Measurement
	TA06 Inclusiveness	CO11 Social media
	TA07 Logistics	CO09 Measurement
	TA09 Strategy	CO10 Pedagogy
AI4 User-centricity	EA13 Access to information	CO14 Information
	EA16 Ethics	CO19 Rights
	EA17 Focus on the user	CO12 Centricity
AI5 Digital facilitation	EA14 Bandwidth	CO18 Provisioning
	EA15 Campus WiFi	CO18 Provisioning
	EA18 Internet connectivity	CO18 Provisioning
	EA19 Wireless connectivity	CO18 Provisioning
B1 Personal responses to mobile technology	TB01 Acceptance	CO03 Approval
	TB02 Adoption	CO01 Application
	TB07 Personal learning environments	CO11 Social media
	TB10 Stakeholder involvement	CO01 Application
B2 External elements	TB03 Affordability	CO03 Approval
	TB05 Impact	CO09 Measurement
	TB08 Roles	CO10 Pedagogy
	TB09 Socio-cultural factors	CO09 Measurement
	TB11 Support	CO06 Execution
B3 Vibrant evolution	TB04 Big picture	CO06 Execution
	TB06 Innovation	CO02 Approach
	TB12 Technology	CO06 Execution
BI4 Dealing with distances	EB13 Cloud facilities	CO18 Provisioning
	EB14 Off-campus benefits	CO15 Milieu
	EB15 Off-campus issues	CO15 Milieu
	EB16 Ubiquity	CO15 Milieu
C1 Learning-management systems	TC01 Collaboration	CO11 Social media
	TC02 Communication	CO04 Enthusiasm
	TC07 Learning portal	CO05 Excellence
C2 Technological requirements	TC03 Compatibility	CO03 Approval
	TC04 Connectivity	CO03 Approval
	TC06 Internet access	CO08 Maturity
C3 Socially driven mobile education	TC05 Digital platforms	CO09 Measurement
	TC08 Social networking	CO11 Social media
	TC09 Web 2.0 tools	CO11 Social media
CI4 Relationships with others	EC10 Information sharing	CO14 Information
	EC11 Interconnectivity	CO17 People
	EC12 Interpersonal contact	CO17 People

Table 5.3: Categories D. Dynamics and E. Mobility – constructs, sub-categories and items

Sub-category	Item	Construct
D1 Educational preferences	TD06 Digital skills	CO03 Approval
	TD08 Informal social learning	CO11 Social media
	TD14 Tools	CO01 Application
D2 On-the-move education	TD03 Assessment	CO06 Execution
	TD04 Curriculum	CO10 Pedagogy
	TD05 Digital content	CO05 Excellence
	TD09 Interventions	CO10 Pedagogy
	TD10 Learning activities	CO01 Application
	TD12 Outcomes	CO09 Measurement
D3 Decision-making trends in mobile education	TD01 Accreditation	CO03 Approval
	TD02 Approach	CO10 Pedagogy
	TD07 Domain	CO10 Pedagogy
	TD11 Models	CO02 Approach
	TD13 Policies, principles	CO02 Approach
DI4 Productivity	ED17 Efficiency learning	CO12 Centricity
	ED19 Multitasking	CO15 Milieu
	ED20 Resources	CO14 Information
DI5 Digital designs	ED15 BLearning	CO16 Models
	ID16 BYOD	CO16 Models
	ED18 MLearning	CO16 Models
	ED21 TEL	CO16 Models
E1 Hardware and software dimensions	TE01 Applications	CO05 Excellence
	TE03 Device specifications	CO09 Measurement
	TE04 Device types	CO01 Application
E2 Patterns of personalisation	TE05 Digital preferences	CO03 Approval
	TE07 Mobile productivity	CO11 Social media
	TE12 Usage patterns	CO03 Approval
E3 Mobile champions	TE02 Attitude	CO02 Approach
	TE08 Motivation	CO04 Enthusiasm
	TE09 Perception	CO03 Approval
E4 Quality-focused considerations	TE06 Expectations	CO09 Measurement
	TE10 Satisfaction	CO09 Measurement
	TE11 Usability	CO09 Measurement
	TE13 User experience	CO08 User experience
EI5 Affective factors	EIE14 Alignment	CO15 Milieu
	EE15 Confusion	CO17 People
	EE16 Convenience	CO17 People
	EE19 Distractions	CO17 People
	EE21 Flexibility	CO12 Centricity
	EE22 Immediacy	CO12 Centricity
	EE25 On the go	CO12 Centricity
	EE26 Portability	CO15 Milieu
	EE27 Safety and security	CO19 Rights
EI6 Embracing differences	EE17 Digital difference	CO13 Diversity
	EE18 Digital divide	CO13 Diversity
	EE20 Encouragement	CO17 People
	EE23 Mobile discussion	CO15 Milieu
	EE24 Mobile research	CO14 Information

5.4.2 Structure of the framework of elements, emerging from MQ1 (MQ2)

The second objective of the study, O2, aimed to account for the structure of the framework of elements, defined by its constituent components and resulting from the finalisation of O1 and the first main question, MQ1 in Section 5.4.1. This section answers the second main question MQ2: *How are the elements, identified in MQ1, related*?

Figure 5.2 satisfies O2 and hence answers MQ2 by consolidating the theoretically based and empirically determined network maps, included respectively as Figure 3.8 and Figure 4.32 in Chapters 3 and 4. This illustrative visualisation highlights the complexity of mapped and elemental relationships between constructs, categories and framework items and the tracking of all network paths.

Nineteen centrally positioned constructs comprise the backbone of the framework. While the initial 11 theoretically based constructs were extracted In Section 3.2.2 and presented as Table 3.2, Table 4.15 in Section 4.9.2 provided eight additional empirically determined constructs. Appendices G.1 and G.2 consolidate all framework constructs.

Colour-coded linkages indicate relationships between constructs and the 95 framework items. These items are in turn related to five categories: A. Enablement (red), B. Environment (blue), C. Interactivity (orange), D. Dynamics (turquoise) and E. Mobility (green). Colour nuances and code indices differentiate between theoretically based items e.g. TA01 Change management and empirically determined items e.g. EA13 Access to information. Finally, links respectively associate SQ1.1 to SQ1.5 with Category A to Category E.

Although the synthesised set of 24 sub-categories also forms part of the framework structure, these elements have not been incorporated into Figure 5.2 owing to the visual complexity of the final artefact. However, Appendices F.1 to F.5 incorporate the final set of sub-categories and associations with framework constructs, categories and items.

Figure 5.2 and Appendices F.1 to F.5, G.1 and G.2 collectively communicate the manner in which the elements identified in the first main question, MQ1, are related. Consequently, the second objective of the study, O2, has been met and MQ2 is answered.

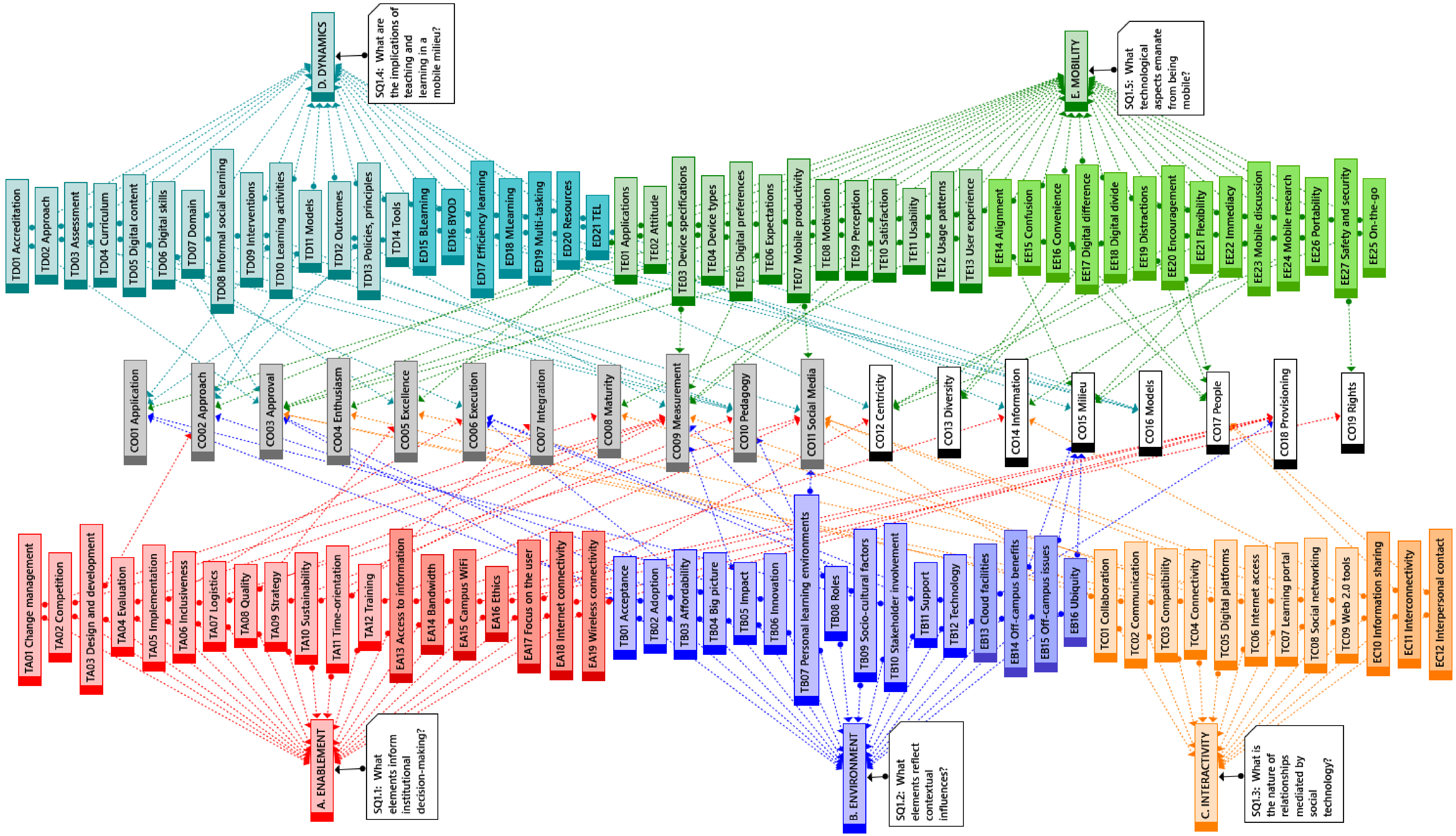


Figure 5.2: Framework structure – elements for ad hoc mobile technology-enhanced learning in higher education contexts

5.5 Recommendations for higher education stakeholders

In the context of this study, educational stakeholders incorporate institutional leadership, policy makers, administrators, designers, practitioners, academics and lecturers, logistical experts, and students. Empirical data was collected from the faculty head, a select group of faculty academics, an architectural technology expert, architectural technology students and lecturers. However, the outcomes of the study have the potential to inform decisions regarding best practices, informing a broad range of educational stakeholders. This section proposes a selection of recommendations, influenced by literature sources and the empirical findings of the study.

An institutional quest for quality assurance and best practices is pertinent and of value at three levels of decision making. At a strategic level, benefits are available for stakeholders filling key leadership roles. The recommendations support tactical functionality of faculty and departmental stakeholders. Finally, the improved operationalisation of the ad hoc use of mobile technology to enhance teaching and learning may become a feasibility.

Table 5.4 maps recommendations to secondary research questions and categories and sub-categories of the framework for ad hoc mobile technology-enhanced learning. The following recommendations presented in this section guide best practices:

- Section 5.5.1 – Improving quality as an ongoing preoccupation (R1).
- Section 5.5.2 – Orienting towards mobile productivity preferences of users (R2).
- Section 5.5.3 – Acknowledging digital differences and diversities (R3).
- Section 5.5.4 – Supporting informed leadership (R4).
- Section 5.5.5 – Integrating constantly changing social technologies (R5).
- Section 5.5.6 – Harnessing the attributes of mobile champions (R6).
- Section 5.5.7 – Exploring mobile personal learning environments (R7).

Table 5.4: Recommendations – best practices for higher education stakeholders

SQs	Categories	Sub-categories	R1	R2	R3	R4	R5	R6	R7
SQ1.1	**A. Enablement**: Taking ownership of organisational features	A1 Preparedness and maintenance	■	-	-	-	-	-	-
		A2 Continuous improvement	■	-	-	-	-	-	-
		A3 Competitive advantage	-	-	-	■	-	-	-
		AI4 User-centricity	-	-	■	-	-	-	-
		AI5 Digital facilitation	■	-	-	-	-	-	-
SQ1.2	**B. Environment**: Recognising a constantly changing context	B1 Personal responses to mobile technology	-	-	■	-	-	-	-
		B2 External elements	-	-	-	-	■	-	-
		B3 Vibrant evolution	-	-	-	-	■	-	-
		BI4 Dealing with distances	-	-	-	-	-	-	■
SQ1.3	**C. Interactivity**: Incorporating web-based opportunities	C1 Learning-management systems	-	-	-	■	-	-	-
		C2 Technological requirements	-	-	-	-	■	-	-
		C3 Socially driven mobile education	-	■	-	-	-	-	-
		CI4 Relationships with others	-	■	-	-	-	-	-
SQ1.4	**D. Dynamics**: Adjusting to an evolving, mobile pedagogy	D1 Educational preferences	-	-	-	-	-	-	■
		D2 On-the-move education	-	-	-	■	-	-	-
		D3 Decision-making trends in mobile education	■	-	-	-	-	-	-
		DI4 Productivity	-	■	-	-	-	-	-
		DI5 Digital designs	-	-	-	■	-	-	-
SQ1.5	**E. Mobility**: Supporting seamless teaching and learning across boundaries	E1 Hardware and software dimensions	-	-	■	-	-	-	-
		E2 Patterns of personalisation	-	■	-	-	-	-	-
		E3 Mobile champions	-	-	-	-	-	■	-
		E4 Quality-focused considerations	■	-	-	-	-	-	-
		EI5 Affective factors	-	■	-	-	-	-	-
		EI6 Embracing differences	-	-	■	-	-	-	-

5.5.1 Improving quality as an ongoing preoccupation

Quality improvement is a continuous process where change management processes require training, should be sustainable, and sensitive to time-dependent evolution of ad hoc mobile technology-enhanced learning technology. Evolution of mobile technologies challenges higher education institutions to address quality essentials, necessitating strategies for improvement processes.

Preparedness and maintenance involves awareness of design and development challenges associated with the implementation and evaluation of mobile technology-enhanced initiatives. Success of initiatives is dependent on perceived levels of digital quality, inclusive of adequate bandwidth and campus WiFi provisioning, ensuring satisfactory Internet connectivity via wireless networks.

Decisions concerning mobile education are influenced by accreditation requirements, domain idiosyncrasies, selected learning modalities, and institutional policies and principles. Quality-focused considerations should include user expectations, and associated satisfaction with education enhanced by mobile technology is dependent on perceived usability – pragmatic features and user experience – hedonic experiences.

Quality improvement is an ongoing preoccupation.

5.5.2 Orienting towards mobile productivity preferences of users

Students recommend the customisation of the learning-management system preferably should align with features of Facebook, reinforcing a link between quality-oriented educational activities and social networking platforms – the "own private world" highlighted by Lai et al. (2013:421).

Success of socially driven mobile education depends on perceived seamlessness of digital platforms, permissions to access integrated social networking sites and the inclusion of supportive Web 2.0 tools. These considerations are relevant as Web 2.0 technologies and social media platforms are driving ways mobile devices are used to enhance teaching and learning, calling for adaptation and flexibility.

Information is shared via digital interconnectivity and interpersonal contact with lecturers and other students so that they are capable of achieving greater efficiency, improved multitasking and convenient access to educational resources. The design of educational environments should allow patterns of personalisation and be informed by digital preferences and usage patterns of stakeholders while aiming to support mobile productivity.

Educational institutions are advised to orient their strategic decisions towards mobile productivity in conjunction with user preferences.

5.5.3 Acknowledging digital differences and diversities

Lecturers seemed concerned with security of student devices. However, students are afraid of losing their data. They call for mobile friendliness, location independence and a reduction in technological limitations experienced during informal learning activities. These observations focus attention on the very real existence of digital differences and diversities and the necessity of user-centricity and stakeholder involvement in their own personal responses to mobile technology. The way educational users accept, adopt and respond to mobile technology is idiosyncratic – characterised by personal and constantly evolving attributes.

Multi-dimensional hardware and software considerations incorporate device types and specifications together with applications in use by mobile educational stakeholders who represent and embrace differences. Decision makers are encouraged to accommodate diversities and institute mechanisms that encourage mobile discussion and research.

Of particular interest in this study is the difference in attitude to mobile technology manifesting as a gap between lecturers' and students' perspectives. From a lecturer viewpoint, interpersonal contact seemed to have been lost. Student activities were no longer able to be tracked. Contrarily, an enthusiastic student relished the engagement and interactivity associated with mobile technology. Lecturers and students demonstrate differential skill levels and personal preferences for the use of informal social learning tools in educational contexts.

Digital differences and diversities should be explored.

5.5.4 Supporting informed leadership

Higher education institutions are under pressure to keep abreast of developments in mobile technology and to take advantage of innovative learning models. To remain competitive, educational strategies should ensure inclusiveness and consider logistical complexities.

Institutional learning-management systems should aim to facilitate interactivity between stakeholders, providing conduits for delivery of educational content while supporting collaboration and communication activities. These provisions are essential for on-the-move digital learning modalities such as blended learning, BYOD, m-learning, technology-enhanced learning and ad hoc mobile technology-enhanced learning. Additionally, higher education practices in a mobile world are impacted by implications for curricula design, invoking digital adjustments to content, learning activities and assessment mechanisms.

5.5.5 Integrating constantly changing social technologies

The educational value of connecting synchronously via social media, for example, WhatsApp, Facebook and Twitter, is appreciated and satisfying. Students exhibit openness to differences. Contextual impacts such as vibrantly evolving social technologies are experienced outside of the influence of higher education institutions. These stakeholder experiences have the potential to impact the likely success of mobile technology-enhanced learning initiatives. For example, external elements represent affordability of mobile devices, applications, and skills upliftment, stakeholder roles, socio-cultural factors and noted levels of support. Educational technologies are evolving dynamically and establishing new mobile environments that influence pedagogical goals with concomitant issues. Mobile milieux are characterised by vibrant evolution. Technological contexts emphasise requirements for compatibility, connectivity and effective Internet access for all educational stakeholders.

Social technologies should be integrated into the design and implementation of higher educational models.

5.5.6 Harnessing the attributes of mobile champions

Stakeholders may exhibit different attitudes to ad hoc mobile technology-enhanced learning by either championing or sabotaging efforts to motivate support for its use in higher education contexts. Educational stakeholders may be early adopters of mobile technology, building its affordances into educational strategies: the champions. Contrarily, they may be averse to and sceptical of on-the-move learning, preferring a focus on perceived limitations and a surreptitious demotivation of efforts to integrate mobile technology into higher education spaces: the saboteurs.

The study proposes mobile technology was perceived to be faddish by a selection of academics and lecturers and not likely to last, while negative attitudes to the potential of mobile technology were viewed by students as a limitation. For students, the ability to use their preferred devices and applications is a necessary educational requirement. They indicated the potential of interconnectivity via mobile technology between each other and with lecturers and supported immediate access to educational content via many mechanisms at any moment of choice.

Role players identified as champions may incorporate institutional leaders, administrators, academics, lecturers and students. This study suggests their positive influence is key to the success of ad hoc mobile technology-enhanced learning – this attributed energy should be harnessed.

5.5.7 Exploring mobile personal learning environments

Students may learn beyond the classroom via their mobile personal learning environments (MPLEs), where the learning process evolves to encompass the world of work. MPLEs deliver many educational benefits. These benefits have the potential to facilitate lifelong learning and productivity (García-Peñalvo & Conde, 2015) via Web 2.0 tools (Stickel & Hum, 2008; Oldfield & Herrington, 2012; Gikas & Grant, 2013; Kitsantas et al., 2016), with cloud-based digital facilities providing ubiquitous, off-campus benefits. Although they demand constantly evolving digital skills, MPLEs accommodate educational preferences and supply tools for informal social learning.

Thus MPLEs, seen as the informal combination of mobile technology and personal learning environments, may indicate solutions to requirements for lifelong learning (García-Peñalvo & Conde, 2015). In agreement with Mileva et al. (2008), students should be viewed as valuable educational stakeholders.

This study recommends that personal mobile preferences should be explored as a gateway to dynamic learning environments.

5.6 Limitations and delimiters

The study was limited in several ways. Owing to data-collection restrictions imposed by the higher education ethics committee, direct access to respondents in Studies 1.3, 2.1 and 3.1 was infeasible. Consequently, face-to-face interviews and observation could not be used as data-collection methods. Although the case study comprised a selection of academics (*n*=5), all facilitating lecturers (*n*=3) and the entire cohort of enrolled students (*n*=14), sample size was small.

The study adopted a cross-sectional, time-horizon strategy, implying it excluded the examination of the shifting influence of mobile technology over time and across faculties and departments. Additionally, it examined attitudes to the informal and slice-in-time use of mobile technology by faculty academics, students and lecturers involved in a part-time architectural technology programme. Responses from stakeholders in other domains are likely to differ. However, both the ad hoc use of mobile technology-enhanced learning and attitudes to its potential have evolved, so perspectives and practices would indubitably have transformed over time.

The higher education population comprised several campuses, faculties and departments covering a wide spectrum of undergraduate domains. However, the study was purposively and conveniently limited to a single case study defined by an innovative, architectural technology programme designed for part-time students. I did not validate framework elements in other faculty contexts, such as graphic design, interior design, town planning, fashion design and information technology. The study focuses empirically on data associated with one context – Architectural Technology in a Higher Education space. This point of departure represents an exploratory case study bounded by its defined environment. The inclusion of other perspectives would definitely have presented advantages that enrich the findings of the study. However, the study was comprehensive and provided rich and thick data. The inclusion of other cases for example differing faculties and blended learning designs is likely to expand the proposed framework – a first of its type.

Interventions designed to determine whether informal learning had occurred were not implemented. Additionally, no effort was made to ascertain the type of formal learning that might have occurred. Similarly, capabilities of social learning were not investigated. Although features of mobile personal learning environments emerged during data analysis, the study did not specifically set out to explore the affordances of personal learning environments.

Furthermore, the study was delimited by a set of exclusions. It explored the ad hoc use of mobile technology in a natural context of use rather than as an experiment. Even though the framework of elements provided guidelines for quality, it was not implemented to evaluate the capability of ad hoc mobile technology-enhanced learning contexts.

Although the conceptual model (Figure 1.3) in Chapter 1 is displayed simplistically as five discrete hubs, the deeper exploration of associated network maps represents a modular view of the space I am exploring. I acknowledge and embrace the complex and unexplored interrelationships and overlaps between the concepts. However, the detailed network maps provided as Figures 3.2 to 3.6 (based on theoretical sources) and Figures 4.12, 4.17, 4.20, 4.24 and 4.30 (based on empirical data) suggest an understanding of these complexities.

The limitations and delimiters discussed in this section inform the directions of future research outlined in Section 5.7.

5.7 Directions for future research

Although the proposed framework comprising constructs, categories, sub-categories and elements is comprehensive, it is unlikely to be an exhaustive end product. In particular, the likely interrelationships and overlaps between categories and category items is worthy of further exploration with resultant publications. Additional exploration of theoretically based and empirically determined categories of items for *ad hoc* mobile technology-enhanced learning in higher education contexts is recommended, supporting the augmentation and consolidation of its structure. Further development work based on capability and maturity evaluations would be beneficial to both the body of knowledge in the mobile technology-enhanced learning domain and to institutional decision makers. A design-based research project that encompasses interactive and integrated interventions could inform educational theory, policies and practices. Deeper intra- and trans-disciplinary research is capable of pinpointing guidelines befitting several higher education domains. The study highlighted several areas worthy of future research. For example, it is hoped that the exploration of differing educational contexts form part of future research studies.

Qualitative analysis of empirical data indicates a lack of support for certain theoretically based framework items, including:

- Taking ownership of organisational features – evaluation and sustainability;
- Recognising a constantly changing environment – acceptance and adoption; and
- Adjusting to an evolving pedagogy – accreditation, informal social learning, interventions, models, and outcomes.

A research design that embraces a larger data set, determined by a representative population of university stakeholders emanating from differing contexts, could verify and validate the framework and its components. The findings of the study may be strengthened by the inclusion of multiple-case, case study research defined by differing faculties. Respondents may be fulltime as well as part-time students and with data collection achieved by interviews and focus groups. A study that incorporates the collection of quantitative data provides opportunities for potential generalisation of findings to other contexts.

It is anticipated that unexplored concepts that identify behaviour of mobile champions – harvesting best practices and mobile saboteurs – mitigating negative influences, are significant avenues for further investigation. A cross-disciplinary study usefully focused on nascent digital differences and divides could potentially provide rich and thick insight, highlighting the nature of observed gaps and informing an understanding of how they could be bridged. This topic invites further research.

A longitudinal study capable of evaluating emergent, evolutionary and ad hoc usage patterns would lead to a greater appreciation of concomitant change management requirements and quality and effectiveness of mobile technology-enhanced learning.

The investigation of aspects of mobile personal learning environments (MPLEs), where on-the-move, higher education stakeholders – academics, lecturers and students – are purported to use mobile devices and applications to learn informally is pertinent to a ubiquitously mobile education society. This study would support an understanding of the nature and effectiveness of MPLEs in higher education contexts.

The study was conducted at a public university. Further research into ad hoc mobile technology-enhanced learning in private higher education contexts could deliver insightful contributions to the body of knowledge. Finally, digital observation of the educational potential of social technologies and the types of informal learning resulting from mobile technology-enhanced learning interactivity are still under-researched topics.

5.8 Final crystallisation

This thesis sought to establish a set of elements for the ad hoc use of mobile technology-enhanced learning in a higher education context. In the process, it proposed a structured framework of elements comprising constructs, categories, sub-categories and items. It addressed a gap in literature for a single holistic framework by synthesising it from a systematic literature review of 55 specifically selected academic resources. An exploratory case study established a bounded data-collection environment where the faculty head, a domain expert, purposively selected faculty academics, part-time distance-learning architecture students, and architecture lecturers filled roles as respondents. Data-collection methods included interviews and custom-designed questionnaire surveys. Data stored in the institutional repository was reviewed, establishing contextual information.

In agreement with literature sources and case study respondents – the faculty head, domain expert, faculty academics, architecture students, and lecturers – access to information linked to social technologies and cloud facilities and supplemented to a lesser extent by ad hoc use of mobile technology-enhanced learning is a relevant topic in higher education contexts. However, findings also demonstrated the existence of realistic digital differences and divides, particularly evident among faculty academics and architecture lecturers.

The qualitative evidence presented in Chapters 3 and 4 was analysed qualitatively, making use of computer-supported qualitative data analysis software (CAQDAS), ATLAS.ti V8.0. This approach contributes to the methodological body of knowledge, supporting the future efforts of researchers and postgraduate students in the educational technology domain. The juxtaposing of a comprehensive systematic literature review as a source of secondary data and an exploratory case study, providing primary data, produced theoretically based information augmented by empirically determined findings, contributing rigour to the study.

Whereas domain experts are traditionally included in research circles as a source of specialist input, this study demonstrated conclusively that in the domain of mobile technology-enhanced learning, student contributions are invaluable sources of research data. They unwittingly and paradoxically fill the role of mobile experts. The incorporation of student-centric considerations in mobile strategies is recommended as they constitute the 'nouveau-expertise' on mobility. Evidence calls for training for lecturers, measures that alleviate the cost of mobile technology and evolution of new mobile attitudes to match transient and dynamic mobile contexts. Shared learning is interactive and social, indicated by the influence of social networking platforms such as Facebook that benchmark student expectations. Students prefer the convenience and trans-platform compatibility of speedily and easily delivered snippets of mobile conversation rather than chunks of paper-like educational content. Teaching and learning is no longer linear – it is rhizomatic and is moving away from regimentation towards personalisation.

The set of tabularised elements comprises 19 constructs, five categories, 24 sub-categories and 95 items and guidelines, leading to an accompanying structured and integrated framework. The study offers a single point of reference for strategic, tactical and operational decision making concerning effective and informal use of mobile technology by higher education stakeholders. It contributes in a modular sense to best practices, capability determination and the awareness of quality-oriented, change management considerations.

Finally, the thesis stimulated focused and academic attention on under-researched topics in higher education contexts, such as mobile champions and mobile saboteurs, digital differences and divides, mobile usage patterns, mobile personal learning environments, and the role of social learning mediated by mobile technology.

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Appendix A Systematic Literature Review

A.1 Search terms

Academic administration
Academic relations on *Facebook*
Academic staff development
Academic use of Facebook
Acceptance of m-learning
Actor-network theory
Ad hoc mobile learning
Adopters of high-impact
Adopters of technology
Adoption by professionals
Adoption by younger generation
Affordances of new digital technologies
Applications
Assessment for learning
Attitudes and motivation
Authentic learning
Being mobile
Best practices
Blended learning course, model
BYOD
Cloud computing
Cognitive tools
Collaboration
Collaborative curriculum design
Collaborative learning and applications
Communication
Complex adaptive system
Computer access
Computer-supported collaborative blend
Connectivity
Constructivism
Critical success factors
Current learning methodologies
Current trends in mobile learning
Design and development strategy
Design guidelines
Desktops
Devices
Diffusion of innovations
Digital assessment
Digital champions
Digital difference
Digital divide
Digital literacy
Digital technologies
Distance learning environment
Education 2.0
Education curriculum
Educational content
Educational software
Educational technology
Educational technology initiatives
Educational technology specialists
E-learning
E-learning maturity model
E-learning quality criteria
Electronic information dissemination
Emerging technologies
Enhanced learning
Environments
E-pedagogy
Essential qualities of teacher
Ethics
Evaluation framework
Evaluation of new technology
Evaluation requirements
Evaluation strategy
Faculty development
Flexibility
Flipped classroom
Framework
Framework of reference
Future of mobile learning
Generational differences
Good practice and principle
Higher education
Higher education policy
Hybrid courses
ICT
Implementation types
Improve flexibility
Informal learning
Informality and formality of learning
Information systems adoption
Informed leadership
Infrastructure
Innovation
Innovations in learning with technology
Innovative collaborative scenarios
Innovatively with mobile and tablet apps
Institutional adoption
Institutional application
Institutional policies
Instructional tasks
Internet access
Interoperability
iPad
Knowledge required for technology integration

Laboratory-based learning
Laptops
Learners' environment
Learning context
Learning ecology
Learning-management systems (LMSs)
Learning outcomes
Learning styles
M4D
Maturity model
Method of application
Misperceptions of mobile learning
M-learning challenges
M-learning evaluation
M-learning potential
Mobile and ubiquitous computing
Mobile apps
Mobile computing
Mobile devices
Mobile learning in higher education
Mobile resources
Mobile social media framework
Mobile solutions
Mobile technologies
Mobility of digital technologies
MoHCI
Motivational impact of digital technology
Multi-level framework
Myths of mobile learning
New technologies
Obstacles that mobile learners encounter
Online course design
Online learning
Organisational change
Pedagogical aspects of mobile learning
Pedagogy
Perceived usefulness
Personal learning environments (PLEs)
Platform to support mobile teaching and learning
PLE integration
Policies and procedures
Post-secondary education
Potential impact on distance learning
Professional development
Quality assurance
Quality enhancement
Quality improvement
Quality of interaction
Research context
Research issues
Research trend
Rhizomatic learning
Scope
Seamless integration
Seamless learning
Self-organising social systems
Similarities, differences between frameworks
Situated form of knowledge
Smart mobile devices
Social interaction
Social media
Social networking sites (SNSs)
Social networking tools
Socio-economic factors
Spread of tablets and mobile devices
Stakeholders
Structures
Students
Support mechanisms
Sustainability
Tablet PC
Teachers
Teachers integrating technology
Teaching and learning
Technical considerations
Technologies as a learning tool
Technology
Technology acceptance and use
Technology Acceptance Model (TAM)
Technology-enhanced learning (TEL)
Technology in education
Technology integration
Ubiquitous learning
Ultrabooks
Usability
User experience
UTAUT
Virtual Learning Environments (VLEs)
Web 2.0, Web 3.0

A.2 Search sources with modality foci used for literature extraction

Sources	ML	TEL	BL
Australasian Journal of Educational Technology	■	■	■
British Educational Research Journal	■	-	-
British Journal of Educational Technology	■	■	-
Computers & Education	■	■	■
Curriculum Models for the 21st Century	■	-	-
Cutting-Edge Technologies in Higher Education	-	■	-
Design and Culture	-	-	■
Distance Education	-	-	■
Education and Information Technologies	■	■	-
Educational Research Review	-	■	-
Educational Technology & Society	-	-	■
Educational Technology Research and Development	■	■	-
Innovations in Education and Teaching International	-	■	-
Innovations in Mobile Educational Technologies and Applications	■	-	-
International Journal of Higher Education	-	■	-
International Journal of Information and Education Technology	-	■	-
International Journal of Interactive Mobile Technologies (iJIM)	■	-	-
International Journal of Mobile Learning and Organisation	■	-	-
International Review of Research in Open & Distance Learning	■	-	-
Internet and Higher Education	■	-	-
Journal of Computer Assisted Learning	■	■	
Journal of Education and Practice	■	-	-
Journal of Educational Technology and Society	-	■	-
Journal of Instructional Pedagogies	-	■	-
Journal of Learning Design	-	■	-
Journal of Open, Flexible and Distance Learning	-	■	
Journal of the Research Center for Educational Technology (RCET)	■	-	-
Learning, Media and Technology	■	■	-
Mobile as a Mainstream–Towards Future Challenges in Mobile Learning	■	-	-
New Digital Technology in Education	■	-	-
Research in Higher Education	-	■	
Research in Learning Technology	■	■	-
South African Journal of Education	■	-	-
Technology in Education	■	-	-
The Internet and Higher Education	-	■	■
The Malaysian Online Journal of Educational Technology	-	■	-
Transactions	-	-	■
Turkish Online Journal of Educational Technology	-	-	■

Note: ML = m-learning, TEL = technology-enhanced learning, and BL = blended learning

A.3 Quality assessment details – article details and criteria

ID	Author(s)	Abbreviated Title	QAC1	QAC2	QAC3	QAC4	Index
P01	Inglis (2005)	Quality improvement, quality assurance, and benchmarking	1	1	0.5	1	3.5
P02	Marshall (2010)	Change, technology and higher education	1	1	0.5	0.5	3
P03	Schoonenboom (2014)	Using an adapted task-level technology acceptance model to explain	1	1	1	1	4
P04	Alrasheedi & Capretz (2015)	Determination of critical success factors affecting mobile learning	1	1	1	1	4
P05	Botha et al. (2012)	Towards a mobile learning curriculum framework	1	1	1	1	4
P06	Cochrane et al. (2015)	Emerging technologies in New Zealand	1	1	1	1	4
P07	Farley & Murphy (2013)	Developing a framework for evaluating the impact and sustainability of mobile learning initiatives in higher education	1	1	1	0.5	3.5
P08	Fetaji & Fetaji (2011)	Devising m-learning usability framework	1	1	1	0.5	3.5
P09	Harpur & De Villiers (2015)	MUUX-E, a framework for evaluating the usability, user experience and learning features of m-learning environments	1	1	1	1	4
P10	Harpur & De Villiers (2015)	Design guidelines for technology-enhanced learning via mobile devices in a tertiary education context	1	1	0.5	0.5	3
P11	Khaddage et al. (2016)	Advancing mobile learning in formal and informal settings via mobile app technology	1	1	1	0.5	3.5
P12	Koole et al. (2010)	Mobile learning in distance education	1	1	1	1	4
P13	Laurillard (2007)	Pedagogical forms of mobile learning	1	1	0.5	0.5	3
P14	Mileva et al. (2008)	A framework for mobile learning pedagogy	1	1	1	1	4
P15	Park (2014)	A pedagogical framework for mobile learning	1	1	1	1	4
P16	Vavoula & Sharples (2009)	Meeting the challenges in evaluating mobile learning	1	1	1	1	4
P17	Casanova et al. (2011)	Technology enhanced learning in higher education	1	1	1	1	4
P18	Mhlanga et al. (2013)	Embedding quality improvement in online courses	1	0.5	0.5	0.5	2.5
P19	Mishra & Koehler (2006)	Technological pedagogical content knowledge	1	0.5	0.5	0.5	2.5
P20	Tedre et al. (2011)	Towards a systemic view of educational technology in developing regions	1	1	1	1	4
P21	Venkatesh et al. (2016)	Unified theory of acceptance and use of technology	1	1	0.5	0.5	3
P22	Wong et al. (2015)	A framework for effectiveness of institutional policies on technology-enhanced learning	1	1	1	0.5	3.5
P23	Graham et al. (2013)	A framework for institutional adoption and implementation of blended learning in higher education	1	1	1	0.5	3.5
P24	Lai et al. (2013)	Blending student technology experiences in formal and informal learning	1	1	1	1	4
P25	Wang et al. (2015)	Revisiting the blended learning literature	1	1	1	0.5	3.5
P26	Bennett et al. (2012)	Implementing Web 2.0 technologies in higher education	1	1	1	0.5	3.5
P27	McGill et al. (2014)	Critical success factors for the continuation of e-learning initiatives	1	1	1	1	4
P28	Teräs & Herrington (2014)	Neither the frying pan nor the fire	1	1	0.5	0.5	3
P29	Alrasheedi et al. (2015)	A systematic review of the critical factors for success of mobile learning in higher education	1	1	0.5	0.5	3
P30	Bird & Stubbs (2015)	It's not just the pedagogy	1	1	0.5	0	2.5
P31	Brown & Mbati (2015)	Mobile learning: moving past the myths and embracing the opportunities	1	0.5	0.5	0.5	2.5
P32	Terras & Ramsay (2015)	The psychological challenges of mobile learning	1	1	0.5	0.5	3
P33	Bozalek et al. (2013)	Transforming teaching with emerging technologies	1	0.5	0.5	0.5	2.5
P34	Kukulska-Hulme (2012)	How should the higher education workforce adapt to advancements in technology for teaching and learning?	1	1	1	1	4

ID	Author(s)	Abbreviated Title	QAC1	QAC2	QAC3	QAC4	Index
P35	Ng (2015)	*New Digital Technology In Education*	1	1	0.5	1	3.5
P36	Oh & Reeves (2014)	Generational differences and the integration of technology in learning, instruction, and performance	1	1	1	1	4
P37	Othman et al. (2014)	Improving the quality of technology enhanced learning for computer programming courses	1	0.5	0.5	0.5	2.5
P38	Wild et al. (2013)	*Advances in Technology Enhanced Learning*	1	1	1	1	4
P39	Cober et al. (2015)	Teachers as participatory designers	1	1	0.5	0	2.5
P40	Fischer et al. (2013)	Examining the potential for tablet use in a higher education context	1	0.5	0.5	0.5	2.5
P41	García-Peñalvo & Conde (2015)	The impact of a mobile personal learning environment in different educational contexts	1	1	0.5	0.5	3
P42	Gikas & Grant (2013)	Mobile computing devices in higher education	1	0.5	0.5	0.5	2.5
P43	Holotescu & Grosseck (2012)	An empirical analysis of the educational effects of social media in universities and colleges	1	1	0.5	0.5	3
P44	Hwang & Wu (2014)	Applications, impacts and trends of mobile technology-enhanced learning	1	0.5	0.5	0.5	2.5
P45	Khaddage et al. (2015)	A model driven framework to address challenges in a mobile learning environment	1	1	1	1	4
P46	Kitsantas et al. (2016)	College students' perceptions of positive and negative effects of social networking	1	1	0.5	0.5	3
P47	Lytras et al. (2014)	Advances of scientific research on technology enhanced learning in social networks and mobile contexts	1	1	1	0.5	3.5
P48	Mang & Wardley (2012)	Effective adoption of tablets in post-secondary education	1	0.5	0.5	0.5	2.5
P49	Mayisela (2013)	The potential use of mobile technology	1	1	1	1	4
P50	Nguyen et al. (2015)	iPads in higher education	1	0.5	0.5	0.5	2.5
P51	Oldfield & Herrington (2012)	Mobilising authentic learning	1	1	0.5	0.5	3
P52	Pérez-Sanagustín et al. (2012)	Discovering the campus together	1	1	0.5	0.5	3
P53	Rambe & Ng'ambi (2014)	Learning with and from Facebook	1	1	0.5	0.5	3
P54	Stickel & Hum (2008)	Lessons learned from the first-time use of tablet pcs in the classroom	1	0.5	0.5	0.5	2.5
P55	Webb (2014)	Pedagogy with information and communications technologies in transition	1	0.5	0.5	0.5	2.5

A.4 Academic publications with attributes – final selection of 55 articles

ID	Author(s)	Abbreviated Title	Article Type	Strategy	LM	Source	Methodology	Participants	Analysis
P01	Inglis (2005)	Quality Improvement, Quality Assurance, and Benchmarking	Journal Article	Theoretical	EL	FW	Comparative review	-	Content
P02	Marshall (2010)	Change, technology and higher education	Journal Article	Theoretical	EL	FW	Position paper	-	Benchmarking
P03	Schoonenboom (2014)	Using an adapted task-level technology acceptance model to explain	Journal Article	Empirical	EL	FW	Survey research	Practitioners	Exploratory
P04	Alrasheedi & Capretz (2015)	Determination of Critical Success Factors Affecting Mobile Learning	Journal Article	Theoretical	ML	FW	Systematic literature review	-	Content
P05	Botha *et al.* (2012)	Towards a Mobile Learning Curriculum Framework	Conference Proceedings	Theoretical	ML	FW	Design-based Research	-	Iterative
P06	Cochrane *et al.* (2014)	Emerging Technologies in New Zealand	Chapter	Empirical	ML	FW	Case study	Students, Lecturers, Researchers	Discourse
P07	Farley & Murphy (2013)	Developing a framework for evaluating the impact and sustainability of mobile learning initiatives in higher education	Conference Proceedings	Theoretical	ML	FW	Systematic literature review	-	Study
P08	Fetaji & Fetaji (2011)	Devising M-learning Usability Framework	Conference Proceedings	Empirical	ML	FW	Case study	Students	Case -based
P09	Harpur & de Villiers (2015)	MUUX, a framework for evaluating the usability, user experience and learning features of m-learning environments	Journal Article	Empirical	ML	FW	Design-based Research	Students, Experts	Evaluation
P10	Harpur & de Villiers (2014)	Design Guidelines for Technology-Enhanced Learning via Mobile Devices in a Tertiary Education Context	Chapter	Empirical	ML	FW	Survey research	Students, Experts	Thematic
P11	Khaddage *et al.* (2015)	A model driven framework to address challenges in a mobile learning environment	Journal Article	Mixed	ML	FW	Case study	Students	Contextual
P12	Koole *et al.* (2010)	Mobile Learning in Distance Education	Journal Article	Empirical	ML	FW	Survey research	Students	Evaluation
P13	Laurillard (2007)	Pedagogical Forms of Mobile Learning	Chapter	Theoretical	ML	FW	Position paper	-	Evaluation
P14	Mileva *et al.* (2008)	A Framework for Mobile Learning Pedagogy	eResource	Theoretical	ML	FW	Position paper	-	Content

ID	Author(s)	Abbreviated Title	Article Type	Strategy	LM	Source	Methodology	Participants	Analysis
P15	Park (2014)	A Pedagogical Framework for Mobile Learning	Chapter	Theoretical	ML	FW	Comparative review	-	Conceptual
P16	Vavoula & Sharples (2009)	Meeting the Challenges in Evaluating Mobile Learning	Journal Article	Theoretical	ML	FW	Position paper	-	Project-based
P17	Casanova *et al.* (2011)	Technology Enhanced Learning in Higher Education	Conference Proceedings	Mixed	TEL	FW	Literature review	Practitioners	Evaluation
P18	Mhlanga *et al.* (2013)	Embedding Quality Improvement in Online courses	Chapter	Empirical	TEL	FW	Case study	Practitioners	Content
P19	Mishra & Koehler (2006)	Technological Pedagogical Content Knowledge	Journal Article	Theoretical	TEL	FW	Position paper	-	Theoretical
P20	Tedre *et al.* (2011)	Towards a systemic view of educational technology in developing regions	Conference Proceedings	Theoretical	TEL	FW	Systematic literature review	-	Content
P21	Venkatesh *et al.* (2016)	Unified Theory of Acceptance and Use of Technology	Journal Article	Theoretical	TEL	FW	Literature review	-	Theoretical
P22	Wong *et al.* (2015)	A Framework for Effectiveness of Institutional Policies on Technology-Enhanced Learning	Conference Proceedings	Theoretical	TEL	FW	Systematic literature review	-	Content
P23	Graham *et al.* (2012)	A framework for institutional adoption and implementation of blended learning in higher education	Journal Article	Empirical	BL	FW	Case study	Institutions	Content
P24	Lai *et al.* (2013)	Blending student technology experiences in formal and informal learning	Journal Article	Theoretical	BL	FW	Position paper	-	Theoretical
P25	Wang *et al.* (2015)	Revisiting the Blended Learning Literature	Journal Article	Theoretical	BL	FW	Systematic literature review	-	Content
P26	Bennett *et al.* (2012)	Implementing Web 2.0 technologies in higher education	Journal Article	Empirical	EL	AS	Case study	Students	Project-based
P27	McGill *et al.* (2014)	Critical success factors for the continuation of e-learning initiatives	Journal Article	Empirical	EL	AS	Quasi-experimental Research	Authors	Evaluation
P28	Teräs & Herrington (2014)	Neither the Frying Pan Nor the Fire	Journal Article	Theoretical	EL	AS	Survey research	-	Evaluation

ID	Author(s)	Abbreviated Title	Article Type	Strategy	LM	Source	Methodology	Participants	Analysis
P29	Alrasheedi *et al.* (2015)	A systematic review of the critical factors for success of mobile learning in higher education	Journal Article	Theoretical	ML	AS	Systematic literature review	-	Study
P30	Bird & Stubbs (2015)	It's Not Just the Pedagogy	Conference Proceedings	Empirical	ML	AS	Case study	Institutions	Case based
P31	Brown & Mbati (2015)	Mobile learning: moving past the myths and embracing the opportunities	Journal Article	Theoretical	ML	AS	Critical reflection	-	Content
P32	Terras & Ramsay (2015)	The Psychological Challenges of Mobile Learning	eResource	Theoretical	ML	AS	Literature review	-	Content
P33	Bozalek *et al.* (2013)	Transforming teaching with emerging technologies	Journal Article	Empirical	TEL	AS	Survey research	Practitioners	Empirical
P34	Kukulska-Hulme (2012)	How should the higher education workforce adapt to advancements in technology for teaching and learning?	Journal Article	Empirical	TEL	AS	Position paper	Practitioners	Evaluation
P35	Ng (2015)	Affordances of New Digital Technologies in Education	Chapter	Theoretical	TEL	AS	Literature review	-	Technological
P36	Oh & Reeves (2014)	Generational Differences and the Integration of Technology in Learning, Instruction, and Performance	Chapter	Theoretical	TEL	AS	Literature review	-	Theoretical
P37	Othman *et al.* (2014)	Improving the Quality of Technology Enhanced Learning for Computer Programming Courses	Journal Article	Empirical	TEL	AS	Design and Development	Students, Experts	Evaluation
P38	Wild *et al.* (2013)	Advances in Technology Enhanced Learning	eResource	Theoretical	TEL	AS	Case study	-	Content
P39	Cober *et al.* (2015)	Teachers as participatory designers	Journal Article	Empirical	MTEL	AS	Case study	Practitioners	Empirical
P40	Fischer *et al.* (2013)	Examining the Potential for Tablet Use in a Higher Education Context	Conference Proceedings	Empirical	MTEL	AS	Survey research	Students	Exploratory
P41	Garcia-Peñalvo & Conde (2015)	The impact of a mobile Personal Learning Environment in different educational	Journal Article	Theoretical	MTEL	AS	Survey research	-	Content
P42	Gikas & Grant (2013)	Mobile computing devices in higher education	Journal Article	Empirical	MTEL	AS	Survey research	Students	Thematic

ID	Author(s)	Abbreviated Title	Article Type	Strategy	LM	Source	Methodology	Participants	Analysis
P43	Holotescu & Grosseck (2012)	An Empirical Analysis of the Educational Effects of Social Media in universities and colleges	Conference Proceedings	Empirical	MTEL	AS	Survey research	Students	Empirical
P44	Hwang & Wu (2014)	Applications, impacts and trends of mobile technology-enhanced learning	Journal Article	Theoretical	MTEL	AS	Systematic literature review	-	Content
P45	Khaddage *et al.* (2016)	Advancing Mobile Learning in Formal And Informal Settings via Mobile App Technology	Conference Proceedings	Theoretical	MTEL	AS	Literature review	-	Theoretical
P46	Kitsantas *et al.* (2016)	College Students' Perceptions of positive and negative effects of social networking	Chapter	Empirical	MTEL	AS	Survey research	Students	Exploratory
P47	Lytras *et al.* (2014)	Advances of Scientific Research on Technology Enhanced Learning in Social Networks and Mobile Contexts	Journal Article	Theoretical	MTEL	AS	Position paper	-	Comparative
P48	Mang & Wardley (2012)	Effective Adoption of Tablets in Post-Secondary Education	Journal Article	Empirical	MTEL	AS	Intervention	Students	Contextual
P49	Mayisela (2013)	The potential use of mobile technology	Journal Article	Empirical	MTEL	AS	Case study	Students, Lecturers	Empirical
P50	Nguyen *et al.* (2015)	iPads in higher education	Journal Article	Theoretical	MTEL	AS	Systematic literature review	-	Content
P51	Oldfield & Herrington (2012)	Mobilising authentic learning	Conference Proceedings	Theoretical	MTEL	AS	Design-based Research	-	Theoretical
P52	Pérez-Sanagustín *et al.* (2012)	Discovering the campus together	Journal Article	Empirical	MTEL	AS	Case study	Students	Exploratory
P53	Rambe & Ng'ambi (2014)	Learning with and from *Facebook*	Journal Article	Empirical	MTEL	AS	Case study	Students	Thematic
P54	Stickel & Hum (2008)	Lessons Learned From The First-time Use of Tablet PCs in the Classroom	Conference Proceedings	Empirical	MTEL	AS	Survey research	Students	Empirical
P55	Webb (2014)	Pedagogy with information and communications technologies in transition	Journal Article	Theoretical	MTEL	AS	Literature review	-	Conceptual

Note: LM = Learning Modality, FW = Framework source, AS = Additional source

Appendix B Exploratory Case Study

B.1 Institutional ethical clearance

Cape Peninsula
University of Technology

P.O. Box 652 • Cape Town 8000 South Africa •Tel: +27 21 469 1012 • Fax +27 21 469 1002
80 Roeland Street, Vredehoek, Cape Town 8001

Office of the Research Ethics Committee	Faculty of Informatics and Design

The Faculty Research Ethics Committee, on 11 June 2014, granted ethics approval to Ms PA Harpur, student number 21401937 for research activities related to the DTech: Information Technology in the Faculty of Informatics and Design, Cape Peninsula University of Technology.

Title of thesis:	Towards a framework for technology-enhanced learning via mobile devices in a higher education context in South Africa

Comments

Research activities are restricted to those detailed in the research proposal.

Signed: Faculty Research Ethics Committee	11 June 2014 Date

RESEARCH ETHICS COMMITTEE
INFORMATICS AND DESIGN
ETHICS APPROVAL GRANTED
11 JUN 2014
Cape Peninsula
University of Technology

B.2 Case study protocol – activities linked to thesis sections

Activities	Sections
1. An overview of the research design summarises purpose of the study; discusses data and document storage and publication. Laptop devices facilitate local storage of data in Microsoft Excel and Microsoft Word files. Secure online storage occurs via cloud storage facilities and the institutional library repository.	2.2
2. A dual strategy comprises theoretical and empirical sequentially implemented components, addressing two main and five secondary research questions underpinning the study and focusing on topics linked to research design and methodology activities.	2.3
3. The study includes a review of tools used during the research process.	2.4
4. The theoretical component comprises a systematic literature review that collects secondary data in four phases: • Phase 1 Planning • Phase 2 Selection • Phase 3 Extraction • Phase 4 Execution	2.5
5. The empirical component incorporates a single case, exploratory case study, and encompasses: • A natural context in a higher education environment – an architectural technology domain. • Case selection and respondent sampling was purposive – a sample of convenience.	2.6.1
6. Empirical data that is essentially qualitative, is collected: • Data collection occurred over a 4-month period between October 2014 and January 2015. • Instruments include interview protocols, custom-designed lecturer and student questionnaires. • Gatekeepers managed data collection via survey instruments • Methods comprise unstructured and semi-structured interviews, survey questionnaires, and document analysis – institutional repository.	2.6.2
7. The empirical design incorporates data sources defined by three phases and six studies, as follows: • Phase 1: Preamble – domain expert, faculty experts, institutional repository. • Phase 2: Cohort – part-time, distance-learning, architectural technology students. • Phase 3: Faculty – architectural technology lecturers and the faculty head.	2.6.3
8. Qualitative data analysis consists of several procedures, such as: • Initial concurrent data collection and analysis followed by an iterative and evolutionary thematic analysis, culminating with the finalisation of themes. • Application of ATLAS.ti V8.0 as a CAQDAS tool, used for the analysis of qualitative data emanating from both primary and secondary data sources. • Qualitative data analysis leading to the emergence of constructs, categories, sub-categories and items. • Quantitative data analysis incorporating basic descriptive statistics. • Network maps and diagrammatic charts illustrating findings. • An evolving codebook of theoretically based and empirically determined codes.	2.7.2 and 2.7.3
9. Reporting of findings communicates via: • Future-based academic publications e.g. conference papers and journal articles; examiners; higher education institutions; academic conversations with a target audience of faculty members and departmental leaders in the domain of digital education; and other doctoral students; • A contribution to the body of knowledge, concerning use of ad hoc mobile technology-enhanced learning in higher education environments; • A formal and structured postgraduate report comprises five chapters as follows: Chapter 1 Introduction; Chapter 2 Research Design and Methods; Chapter 3 Towards A Framework: Theoretical Perspectives; Chapter 4 Framework Augmentation: Empirical Contribution; and Chapter 5 Contributions of the Study. The contents of the chapters are supplemented by a set of Appendices; and • Journal articles, accepted for publication.	2.7.4
10. Ethical issues are addressed – informed consent, anonymity, confidentiality, right to withdraw.	2.7.5
11. Trustworthiness measures review: • Credibility • Transferability • Dependability • Confirmability	2.8
12. Limitations and delimiters include: • Limitations – researcher bias, Internet-based surveys, sample size. • Delimiters.	2.9

B.3 Informed consent email

Greetings <<Respondent Name>>

I am a first-year doctoral student, registered in the Faculty of Informatics and Design at CPUT and researching mobile technology-enhanced learning in a higher education context in South Africa. Prof. Johannes Cronjé is my supervisor.

If you decide to respond, it is important that you complete the necessary ethical consent section included in the online questionnaire worded as follows:

> Please read and select EACH of the ethical consent items below, before completing the questionnaire which follows. Tick each item that applies:
>
> ☐ I agree to be a participant in the study;
> ☐ I have read the information above; I understand the nature of the research and my role in it;
> ☐ I understand I may ask questions about the study and request additional information;
> ☐ I understand that I may withdraw from the study at any time; and
> ☐ Please keep me informed about the findings of the study prior to publication.

Thereafter, please complete the online questionnaire that addresses dimensions of ad hoc mobile technology-enhanced learning in six sections: context, usage, experiences, expectations, networks and ad hoc mobile technology-enhanced learning. Your feedback is invaluable and will contribute to a deeper understanding of technology-enhanced learning supported by mobile devices.

Thank you in advance for your participation and feedback.

To complete the survey, follow the URL with any of your mobile devices or your PC: http://goo.gl/forms/w8FZB2U9pK

Patricia Harpur
Email: abc@digilearning.co.za **Cell: 083 730 8540**

B.4 Study 1.1 Domain Expert – unstructured interview protocol

Probing Conversational Questions
1. General questions associated with the context of the case
• Age, gender, fulltime or part-time study, employment status of your students?
• How many students are in the 2014 cohort?
• Do they work in groups with team-based assignments or as individuals doing project work?
• Academic level of the 2014 cohort? Undergraduate level?
• Number of students enrolled in the 2014 cohort?
• Number of lecturers dedicated to the 2014 cohort?
• Digital capabilities of students?
2. Pedagogical strategy aligned with mobile technology
• How do you use digital technology to enhance teaching and learning?
• Do students experience any face-to-face time? What is the ratio of face-to-face time and online activities?
• You say these are distance-learning students. Where do your students live?
• What is your Vision for educational technology in the 21st century?
• How do students use their digital technology and mobile devices for educational purposes?
• Is there a structured BYOD initiative in place? If yes, how? If no, what happens? Or are devices not an issue or factor? If devices are worth discussing, what can you tell me? What should I know?
• Do you make use of digital technologies and social networking media to support communication and collaboration e.g. Facebook and Skype? Any other technologies?
3. Structure of the part-time BTech: Architectural Technology programme
• Can you share an outline of the curriculum content?
• What kind of virtual learning environment do you use? E.g. do you make use of Blackboard? Issues?
• How do you carry out assessment?
• How does your team like to keep in touch and collaborate with the students?

B.5 Study 3.2 Faculty Head – semi-structured interview protocol

Specific Questions
1. Thinking back to beginnings of discussions, what strategic institutional issues were being addressed with the implementation of the part-time, blended-learning, architectural technology programme?
2. What, in your opinion, has worked really well?
3. What, do you believe, still needs to be addressed, can be improved?
4. Looking at a bigger picture, under what circumstances would you implement a similar project within other departments in your faculty?

B.6 Study 2.1 Architecture Students – survey questionnaire instrument

SECTION 1: CONTEXT

Q1 Age Bracket
Select only ONE option.

☐ <20 ☐ 20 – 25 ☐ 26 – 30 ☐ >30

Q2 Gender
Select only ONE option

☐ Male ☐ Female

Q3 Architectural Role in the Workplace
Select only ONE option

☐ Permanent position ☐ On contract ☐ Freelancing ☐ Other:

Q4 Years of Work Experience in an Architectural Firm
Select only ONE option

☐ <1 year ☐ 1 – 2 years ☐ 2 – 3 years ☐ > 3 years

Q5 Mobile technology skills are valuable in a work environment
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q6 Use of mobile Technology in the Workplace
Select EACH relevant option

☐ Collaborate in teams on *Facebook* via mobile devices
☐ Keep project notes on my tablet
☐ *Twitter* to keep track on colleagues and clients
☐ Other:
☐ Research current work assignments while on-the-move

Q7 How have you experienced the blended learning-whilst-earning way of studying?
Offer a few BRIEF thoughts on issues and benefits you have experienced in the space below:

Q8 The *OpenArchitecture* blended learning model worked for me
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q9 Which aspects of *OpenArchitecture* worked for you?
Share your positive your experiences in the space below:

Q10 Which aspects did not work so well and could be improved?
Offer a few BRIEF ideas suggesting how improvements could be made in the space below:

Q11 How can mobile technology improve your studies?
Offer a few BRIEF suggestions in the space below:

Q12 How can mobile technology improve your practical work?
Offer a few BRIEF suggestions in the space below:

Q13 Advances in mobile technology have made my studies in 2014 possible
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q14 I would have struggled to adjust from classroom-based learning without using my mobile devices and applications
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q15 Practical and theoretical activities are possible using online technologies
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q16 Effective wireless connectivity and bandwidth are essential for Internet access via my mobile devices
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q17 How do you connect to the Internet for study purposes while being on-the-move?
Select EACH relevant option

☐ I have a monthly-paid contract with 3G capability
☐ I have wireless ADSL at home, used for all devices
☐ I purchase prepaid data bundles regularly, when necessary
☐ I use the wireless network in the local library
☐ I connect at the nearest coffee shop
☐ I have a serious problem connecting due to financial constraints
☐ I make sure I am near the McDonalds hotspot
☐ Other:

Q18 How do you use your mobile devices when working?
Offer a few BRIEF thoughts on your mobile habits in the space below:

Q19 Being off-campus and mobile has saved time as I can work easily in my own way from anywhere via the Internet
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q20 My working life is pressured so I rely on mobile technology to multitask work and educational activities
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q21 I connect and collaborate with other *OpenArchitecture* students when I am ...
Select EACH relevant option

☐ On the bus, train or taxi
☐ Having a lunch break
☐ Other:
☐ Watching TV
☐ Getting a lift
☐ At home, relaxing
☐ Having dinner
☐ Shopping
☐ On campus

Q22 I connect and collaborate wirelessly with other *OpenArchitecture* students when I am ...
Select EACH relevant option

☐ On the bus, train or taxi
☐ Having a lunch break
☐ Other:
☐ Watching TV
☐ Getting a lift
☐ At home, relaxing
☐ Having dinner
☐ Shopping
☐ On campus

SECTION 2: USAGE

Q23 Mobile devices and applications supported my B.Tech studies
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q24 My *OpenArchitecture* activities were made possible by social networking technologies
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q25 I used social networking technologies for educational purposes in the following ways ...
Offer a few BRIEF thoughts on your social networking habits in the space below:

Q26 Members of my class have used mobile technology creatively to connect and collaborate with each other
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q27 Group members have shared unique ways of using mobile technology to be productive, learning from each other
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q28 How have you used mobile technology to improve your way of studying to meet Open Architecture deadlines ...
Offer a few BRIEF thoughts on your use of mobile technology for studying in the space below:

Q29 Which mobile devices have you used to support your studies?
Select EACH relevant option

☐ Smartphone ☐ Tablet ☐ Netbook ☐ Laptop ☐ Other:

Q30 I use my mobile devices for … ?
Select EACH relevant option

☐ Learning on-the-move
☐ Learning at home
☐ Learning at the office
☐ Note-taking
☐ Internet research
☐ Problem-solving
☐ Practical work
☐ Accessing educational apps
☐ Other:

Q31 I think the weaknesses of using mobile technology for educational purposes include …
Select EACH relevant option

☐ Devices specifications
☐ Limitations of the learning portal
☐ Too many apps
☐ Poor digital skills
☐ Attitude to technological change
☐ eCourseware
☐ University policies
☐ Connectivity and bandwidth
☐ Cost
☐ Other:

Q32 For EACH EDUCATIONAL activity, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Library access	☐	☐	☐	☐	☐
Learning portal	☐	☐	☐	☐	☐
Admin	☐	☐	☐	☐	☐
Teaching/Learning	☐	☐	☐	☐	☐
Assignments	☐	☐	☐	☐	☐
ReVision	☐	☐	☐	☐	☐
Projects	☐	☐	☐	☐	☐

Q33 For EACH EDUCATIONAL activity, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Twitter	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
YouTube	☐	☐	☐	☐	☐
Research	☐	☐	☐	☐	☐
Web browsing	☐	☐	☐	☐	☐
Collaboration	☐	☐	☐	☐	☐

Q34 For EACH COMMUNICATION activity, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
WeChat	☐	☐	☐	☐	☐
SMS	☐	☐	☐	☐	☐
Email	☐	☐	☐	☐	☐
WhatsApp	☐	☐	☐	☐	☐
Skype	☐	☐	☐	☐	☐

Q35 For EACH SOCIAL NETWORKING activity, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Facebook	☐	☐	☐	☐	☐
LinkedIn	☐	☐	☐	☐	☐
Discussion	☐	☐	☐	☐	☐
Chatroom	☐	☐	☐	☐	☐
Blog	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐

Q36 How would you rate your current mobile technology-in-education skills?
Rate your skills selecting ONE option

	1	2	3	4	
Superb	☐	☐	☐	☐	Poor

Q37 Q14 In what ways could mobile devices and applications be used for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q38 What changes are needed in your course for effective use of mobile devices and applications for learning?
Offer a few BRIEF suggestions in the space below:

Q39 In your opinion, what are the potential BENEFITS of using mobile devices and applications for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q40 Select EACH of the options below that you believe is a potential LIMITATION of using mobile devices and applications for educational purposes
Select EACH relevant option

☐ Device specifications	☐ Electronic course content	☐ Network capabilities
☐ Learning portal	☐ Limited digital skills	☐ Assessment requirements
☐ Lack of integration	☐ Faculty policy	☐ Safety and privacy
☐ Bandwidth	☐ Other:	

Q41 Any additional LIMITATIONS of using mobile devices and applications for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q42 In your opinion, which of the following digital technologies could support teaching/learning activities?
Select EACH relevant option

☐ Learning portal	☐ Moodle	☐ *Skype*
☐ *Facebook*	☐ *Twitter*	☐ *Google Drive*
☐ Dropbox	☐ *WhatsApp*	☐ TedEd
☐ Socrative	☐ Edmodo	☐ *SharePoint*
☐ SMS	☐ *Mendeley*	☐ Pinterest
☐ *Instagram*	☐ Other:	

Q43 Support for the use of mobile devices and applications for learning purposes would be beneficial to studying architecture
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q44 Students would benefit from workshops focusing on mobile devices and applications in educational contexts
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q45 How would you categorise your "digital personality" (adapted from Horrigan, 2010)?
Select the MOST relevant option

☐ Distant: Not interested in mobile technology enhanced learning at all

☐ Hopeful: Would like to introduce mobile technology enhanced learning but lack the resources

☐ Uncomfortable: Have the resources for mobile technology enhanced learning but do not have the right mix of skills

☐ Aware: Have the skills for mobile technology enhanced learning via but am limited by financial constraints

☐ Committed: Have the skills, resources and finance for mobile technology enhanced learning

Q46 Explain your choice of "digital personality" in Q45?
Offer a few BRIEF suggestions in the space below:

SECTION 3: EXPERIENCES

Q47 I receive university support for mobile technology enhanced learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q48 The learning portal facilitates learning via any chosen device type
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q49 The introduction of tablets to support our studies would be a big success
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q50 Course material is integrated for m-learning across all platforms
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q51 The quality of learning is enhanced when mobile devices are used to access course content
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q52 University decisions influence technology-enhanced projects outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q53 Issues emerging from technology are addressed quickly leading to improvements
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q54 Distance between lecturers and students presents challenges
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q55 Success of the B.Tech Architectural Technology degree is influenced by technology choices
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q56 Rapid changes in technology match changes we find at our university
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q57 Campus-wide rollouts of mobile technology are triggered by competition
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q58 In your opinion, which aspects of technology worked satisfactorily in your *OpenArchitecture* programme in 2014?
Offer a few BRIEF suggestions in the space below:

Q59 In your opinion, which aspects of technology did not work satisfactorily in your *OpenArchitecture* programme in 2014?
Offer a few BRIEF suggestions in the space below:

Q60 Based on your experiences in 2014, which changes in the use of mobile technology would you suggest for new students in 2015?
Offer a few BRIEF suggestions in the space below:

Q61 In your opinion, which changes in the use of mobile technology will you make for yourself in 2015?
Offer a few BRIEF suggestions in the space below:

SECTION 4: EXPECTATIONS

Q62 An *ad hoc* mobile technology-enhanced learning initiative may not meet the expectations of students
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q63 Additional training in the use of mobile technology would improve my teaching/learning style
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q64 Mobile learning involves skills I do not yet have so training is needed
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q65 I have already adjusted the way I teach/learn to include the creative use of mobile devices
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q66 A positive attitude to the use of mobile devices is necessary for success of blended learning in the future
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q67 The lecturer's role is becoming more motivational than instructional
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q68 The cost of using my own mobile devices for learning is too much for my budget
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q69 I prefer to use my own mobile devices for educational purposes rather than devices being supplied as part of my B.Tech course
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q70 Expectations for mobile technology enhanced learning have been met in 2014
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q71 What changes are needed to meet your expectations for mobile technology enhanced learning in 2015?
Offer a few BRIEF suggestions

SECTION 5: NETWORKS

Q72 Which technologies do you use to connect with others for educational reasons?
Select the OPTIONS that resonate with you

☐ Email	☐ SMS	☐ *Facebook* postings
☐ *WhatsApp*	☐ *Twitter*	☐ *Google Drive*
☐ Dropbox	☐ *WhatsApp*	☐ Learning portal notifications
☐ Word-of-mouth	☐ WeChat	☐ Phone calls
☐ *Twitter*	☐ Other:	

Q73 Which additional technologies do you use to connect with your lecturers?
Offer a few BRIEF suggestions in the space below:

Q74 Do you consistently use the same approach to establish lines of communication and collaboration with other students?
Select the OPTION that resonates with you

☐ Yes ☐ No ☐ It depends …

Q75 What have you noticed about the way students use mobile devices and applications to connect with other students?
Offer a few BRIEF suggestions in the space below:

Q76 What have you noticed about the way students use mobile devices and applications to work on projects with each other?
Offer a few BRIEF suggestions in the space below:

Q77 The future of education is changing to a more mobile, flexible, boundary-free conversation between students
Select the MOST relevant option

☐ The rapidly changing nature of mobile technology causes chaos and confusion

☐ No single student influences the mobile usage patterns of the group

☐ There are endless ways that networked students can access course content

☐ Students are constantly creating innovative ways of using technology

☐ A break in the thread of an online discussion does not mean the conversation is over

Q78 The mobile phone, originally a means of communication, has become a tool for the enhancement of learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q79 How has teaching and learning been evolving due to the influence of mobile technology?
Select ONE option that resonates BEST with you

☐ Learning style should adapt, involving student-centred digital tools

☐ Students are encouraged to guide the learning process; lecturers are the students these days

☐ Learning in this networked generation is demanding and complex there are too many blockages

☐ Advances in mobile technology enhanced learning only benefit student-student collaboration

☐ When lecturers and students encounter each other each is influenced and changed by the other

Q80 How has the influence of mobile technology caused adjustments to way we learn?
Select ONE option that resonates BEST with you

☐ Education does not really change: syllabus, notes and techniques are the same

☐ Adjustments are necessary but digital recreation of templates is too time-consuming

☐ To a greater extent, changes made to way academics work with students has been forced

☐ Devices and skills of academics are too out-dated to cope with the pace and direction of change

☐ The Internet is a distraction, offering no great prospects for the development of 21st century skills

Q81 Mobile technology-enhanced learning is characterised by the emergence of alternate and resourceful ways of teaching and learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

SECTION 6: TECHNOLOGY AND EDUCATION

Q82 Mobile technology choices directly influence learning outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q83 Educational results are still the most important consideration, technology is just the mechanism of delivery
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q84 There should be an equal balance between what technology can achieve and expected educational outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q85 A blended learning context incorporates the use of mobile devices and applications offering a more "natural" learning environment
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q86 A blended learning context supported by mobile devices and applications is vastly different from a traditional face-to-face learning environment
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q87 Which features of mobile technology support B.Tech Architectural Technology?
Offer a few BRIEF suggestions in the space below:

B.7 Study 3.1 Architecture Lecturers – survey questionnaire instrument

SECTION 1: CONTEXT

Q1 Age Bracket
Select only ONE option

☐ <21 ☐ 21 – 30 ☐ 31 – 40 ☐ 41 – 50 ☐ 51 – 60 ☐ >60

Q2 Gender
Select only ONE option

☐ Male ☐ Female

Q3 Academic Role
Select the MOST relevant option

☐ Professor ☐ Senior Lecturer ☐ Lecturer ☐ Facilitator ☐ Post Grad Student ☐ Administrator

Q4 Type of teaching environment
Select the MOST relevant option

☐ Face to face ☐ Online ☐ Blended ☐ Other:

Q5 Type of student enrolment
Select the MOST relevant option

☐ Fulltime ☐ Part-time ☐ Other:

Q6 Responsibility for which group of students?
Select EACH relevant option

☐ First year ☐ Second year ☐ Third Year ☐ Fourth Year ☐ Post Grad ☐ Other:

Q7 The use of mobile devices and mobile applications for educational purposes may enhance teaching practice and learning experiences
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

SECTION 2: USAGE

Q8 Which mobile device types do you use to support your academic role?
Select EACH relevant option

☐ Smartphone ☐ Tablet ☐ Netbook ☐ Laptop ☐ Other:

Q9 For EACH EDUCATIONAL activity, select the mobile device you may use
Select the MOST OFTEN used device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Library access	☐	☐	☐	☐	☐
Learning portal	☐	☐	☐	☐	☐
Admin	☐	☐	☐	☐	☐
Teaching/Learning	☐	☐	☐	☐	☐
Assignments	☐	☐	☐	☐	☐
ReVision	☐	☐	☐	☐	☐
Projects	☐	☐	☐	☐	☐

Q10 For EACH EDUCATIONAL activity, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Twitter	☐	☐	☐	☐	☐
Facebook	☐	☐	☐	☐	☐
YouTube	☐	☐	☐	☐	☐
Research	☐	☐	☐	☐	☐
Web browsing	☐	☐	☐	☐	☐
Collaboration	☐	☐	☐	☐	☐

Q11 For EACH COMMUNICATION activity with your students, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
WeChat	☐	☐	☐	☐	☐
SMS	☐	☐	☐	☐	☐
Email	☐	☐	☐	☐	☐
WhatsApp	☐	☐	☐	☐	☐
Skype	☐	☐	☐	☐	☐

Q12 For EACH SOCIAL NETWORKING activity with your students, select the mobile device you may use
Select the MOST LIKELY device option per activity

	Smartphone	Tablet	Netbook	Laptop	N/A
Facebook	☐	☐	☐	☐	☐
LinkedIn	☐	☐	☐	☐	☐
Discussion	☐	☐	☐	☐	☐
Chatroom	☐	☐	☐	☐	☐
Blog	☐	☐	☐	☐	☐
Twitter	☐	☐	☐	☐	☐

Q13 How would you rate your current mobile technology-in-education skills?
Rate your skills selecting ONE option

	1	2	3	4	
Superb	☐	☐	☐	☐	Poor

Q14 In what ways could mobile devices and applications be used for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q15 What changes are needed in your department for effective use of mobile devices and applications for learning?
Offer a few BRIEF suggestions in the space below:

Q16 In your opinion, what are the potential BENEFITS of using mobile devices and applications for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q17 Select EACH of the options below that you believe is a potential LIMITATION of using mobile devices and applications for educational purposes
Select EACH relevant option

☐ Device specifications	☐ Electronic course content	☐ Network capabilities
☐ Learning portal	☐ Limited digital skills	☐ Assessment requirements
☐ Lack of integration	☐ Faculty policy	☐ Safety and privacy
☐ Bandwidth	☐ Other:	

Q18 Any additional LIMITATIONS of using mobile devices and applications for educational purposes?
Offer a few BRIEF suggestions in the space below:

Q19 In your opinion, which of the following digital technologies could support teaching/learning activities?
Select EACH relevant option

☐ Learning portal	☐ Moodle	☐ *Skype*	☐ *Facebook*
☐ *Twitter*	☐ *Google Drive*	☐ Dropbox	☐ *WhatsApp*
☐ TedEd	☐ Socrative	☐ Edmodo	☐ *SharePoint*
☐ SMS	☐ *Mendeley*	☐ Pinterest	☐ *Instagram*
☐ Other:			

Q20 Institutional support for the use of mobile devices and applications to enhance learning would be beneficial to teaching practice
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q21 Academics would benefit from workshops focusing on potential of mobile devices and applications in educational contexts
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q22 How would you categorise your "digital personality" (adapted from Horrigan, 2010)?
Select the MOST relevant option

☐ Distant: Not interested in mobile technology enhanced learning at all

☐ Hopeful: Would like to introduce mobile technology enhanced learning but lack the resources

☐ Uncomfortable: Have the resources for mobile technology enhanced learning but do not have the right mix of skills

☐ Aware: Have the skills for mobile technology enhanced learning via but am limited by financial constraints

☐ Committed: Have the skills, resources and finance for mobile technology enhanced learning

Q23 Explain your choice of "digital personality" in Q22?
Offer a few BRIEF suggestions in the space below:

SECTION 3: EXPERIENCES

Q24 The faculty receives support for mobile technology enhanced learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q25 The learning portal facilitates learning via any chosen device type
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q26 The implementation of a mobile learning initiative will be a big success
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q27 Course material is integrated for m-learning across all platforms

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q28 The quality of learning is enhanced when mobile devices are used to access course content
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q29 University decisions influence technology-enhanced projects outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q30 Issues emerging from technology are addressed quickly leading to improvements
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q31 Distance between lecturers and students presents challenges
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q32 Mobile technology choices directly influence learning outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q33 Rollouts of technology enhanced learning projects are mapped to industry benchmarks
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q34 Campus-wide rollouts of mobile technology are triggered by competition
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q35 In your opinion, which aspects of technology worked satisfactorily in your teaching context during 2014?
Offer a few BRIEF suggestions in the space below:

Q36 In your opinion, which aspects of technology did not work successfully in your teaching context during 2014?
Offer a few BRIEF suggestions in the space below:

SECTION 4: EXPECTATIONS

Q37 An *ad hoc* mobile technology-enhanced learning initiative may not meet the expectations of students
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q38 Additional training in the use of mobile technology would improve my teaching/learning style
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q39 The implementation of m-learning initiatives should not necessarily require the acceptance of digital innovation
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q40 I have already adjusted the way I teach/learn to include the creative use of mobile devices
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q41 A positive attitude to the use of mobile devices is necessary for success of blended
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q42 The lecturer's role is becoming more motivational than instructional
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q43 The cost of using my own mobile devices for learning is too much for my budget
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q44 Bring-Your-Own-Device (BYOD) initiatives save money and scaffold the use of mobile technology to enhance teaching and learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q45 Expectations for mobile technology enhanced learning have been met in 2014
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q46 What changes are needed to meet your expectations for mobile technology enhanced learning in 2015?
Offer a few BRIEF suggestions in the space below:

SECTION 5: NETWORKS

Q47 Which technologies do you use to connect with others for educational reasons?
Select the OPTIONS that resonate with you

☐ Email ☐ SMS ☐ *Facebook* postings ☐ *WhatsApp*

☐ Learning portal notifications ☐ Word-of-mouth ☐ WeChat ☐ Phone calls

☐ *Twitter* ☐ Other:

Q48 Which additional technologies do you use to connect with your students?
Offer a few BRIEF suggestions in the space below:

Q49 Do you consistently use the same approach to establish lines of communication and collaboration with your students?
Select the OPTION that resonates with you

☐ Yes ☐ No ☐ It depends …

Q50 What have you noticed about the way students use mobile devices and applications to connect with lecturers?
Offer a few BRIEF suggestions in the space below:

Q51 What have you noticed about the way students use mobile devices and applications to work on course-related assignments?
Offer a few BRIEF suggestions in the space below:

Q52 What have you noticed about the way students use mobile devices and applications to work on projects with each other?
Offer a few BRIEF suggestions in the space below:

Q53 The future of education is changing to a more mobile, flexible, boundary-free conversation between students
Select the MOST relevant option

☐ The rapidly changing nature of mobile technology causes chaos and confusion

☐ No single student influences the mobile usage patterns of the group

☐ There are endless ways that networked students can access course content

☐ Students are constantly creating innovative ways of using technology

☐ A break in the thread of an online discussion does not mean the conversation is over

Q54 The mobile phone, originally a means of communication, has become a tool for the enhancement of learning
Select the MOST relevant option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q55 How has teaching and learning been evolving due to the influence of mobile technology?
Select ONE option that resonates BEST with you

☐ Teaching style should adapt, involving student-centred digital tools

☐ Students are encouraged to guide the learning process; lecturers are the students these days

☐ Teaching in this networked generation is demanding and complex, there are too many blockages

☐ Advances in mobile technology enhanced learning only benefit student-student collaboration

☐ When lecturers and students encounter each other each is influenced and changed by the other

Q56 How has the influence of mobile technology caused adjustments to teaching strategy?
Select ONE option that resonates BEST with you

☐ Education does not really change: syllabus, notes and techniques are the same

☐ Adjustments are necessary but digital recreation of templates is too time-consuming

☐ To a greater extent changes made to way academics work with students has been forced

☐ Devices and skills of academics are too out-dated to cope with the pace and direction of change

☐ The Internet is a distraction, offering no great prospects for the development of 21st century skills

Q57 Mobile technology-enhanced learning is characterised by the emergence of alternate and resourceful ways of teaching and learning
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

SECTION 6: TECHNOLOGY AND EDUCATION

Q58 First make the technology choices as technology decisions directly influence outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q59 Educational results are still the most important consideration, technology is just the mechanism of delivery
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q60 Education enhanced by technology is successful when there is an equal balance between affordances of technology and the expected outcomes
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q61 From the student's perspective, a blended learning context incorporates the use of mobile devices and applications offering a more "natural" learning environment
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q62 A blended learning context supported by mobile devices and applications is vastly different from a traditional face-to-face learning environment
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q63 A blended learning context scaffolded by mobile technology should demonstrate alignment between learning outcomes, teaching methods and digital skill competencies
Rate the statement selecting ONE option

	1	2	3	4	
Strongly Agree	☐	☐	☐	☐	Strongly Disagree

Q64 Under what circumstances do you think learning outcomes, teaching methods and technologies would be out of alignment in a mobile learning initiative?
Offer a few BRIEF suggestions in the space below:

Appendix C Empirical Data

Raw data collected from faculty academics, architecture students and architecture lecturers via survey questionnaires respectively during Studies 1.3, 2.1 and 3.1, may be accessed via the university repository.

C.1 Study 1.1 Domain Expert – transcript

Interviewer: Myself – referred to here as PAH

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: I established an appointment with the domain expert, an Architectural Technology facilitator. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

PAH	Comments of the domain expert
1 General questions	
• Academic level of the 2014 cohort?	…they are working apprentices, mature … part-time, Open Architecture students from around the country … 4th year BTech students, got one more year – 2015…
• Number of enrolled students in the 2014 cohort?	…initially twenty-four … but there will ultimately be dropouts…
• Number of dedicated lecturers during 2014?	…three...
• Digital capabilities of students?	…unexpected, almost no training was necessary on SharePoint for students...
2 Strategic aspects	
• Implementation and scaffolding?	…we provide links to course items to encourage discussion and deeper research…
• Mobile technology?	…I do not know how they do what they do…
• Social networking technologies?	…a closed Facebook group … postings: students and lecturers… students have another Facebook place where they do their own thing…
3 Programme structure	
• Curriculum content?	…TedEd lessons, MCQs, open questions… students receive course content from SharePoin*t*...
• VLE - Blackboard?	…not an LMS…we do not use Blackboard – too much hassle getting support … use SharePoint
• Assessment mechanisms?	…crits are done regularly … they work on projects, upload online to SharePoint...
• Communication and collaboration?	…on-campus block sessions, get-togethers in November … we leave discussion items on SharePoint … sometimes we Skype...

Note: the domain expert agreed to review custom-designed survey questionnaire instruments and to facilitate the data-collection process by filling the role of gatekeeper and linking me to respondents.

C.2 Study 3.2 Faculty Head – transcript

Interviewer: Myself – referred to here as PAH

Date of the interview: Monday 23rd March 2015 at 11:45

Interview environment: four interview questions had been sent to the faculty head via WhatsApp the day before the planned interview which was conducted digitally via smartphone at a designated timeslot. I adopted this approach as the faculty head was travelling between campus site A and B. The interview was recorded using a mobile app, Record My Call.

PAH: Let's look at the first question … Question 1: Thinking back to beginnings of discussions, what strategic institutional issues were being addressed with the implementation of the part-time, blended-learning, architectural technology programme?

Faculty Head: I suppose you sent me email that I did not read! OK, I'm fine. So we are talking about Open Architecture initiative from my perspective. I am on-board now.

PAH: Yes, reasons for version of OA … your view, from executive perspective?

Faculty Head: Came about if I remember correctly when the champion et al. talked about an office-based BTech, thinking about expanding for future using technology, so they could actually meet students when they are not on campus. Now, we already had something similar with 2nd-year students. So I thought it could be useful if we did the same with BTech. Second years are off campus for a year but come in on a Friday; they were at that stage supported through Blackboard, although not that well. Model was there, thought the model would be useful, useful to work according to that model.

PAH: I see …

Faculty Head: Idea was two-fold … extend reach of campus, lower the amount of teaching that we were doing and amount of floor space that was necessary. Don't need students on campus if they can do their work at the office. Has to do with a feeling I had that we tend to teach way too much, way too little getting students to learn. So majority of the work I have been doing has been mainly for pedagogical rather than economical purposes.

PAH: Let's review the next question … Question 2: What, in your opinion, has worked really well?

Faculty Head: Think what has worked really well is the creation of a virtual community of students … think that's what we have done. Students talk to each other even before class, amazing what Facebook does in creating hype and so the vibe on campus when these students arrive is almost electric. They come there very much motivated to work. Find experience completely different from regular "Yes, OK, we are coming to class".

PAH: From a differing perspective, now to third question … Question 3: What, do you believe, still needs to be addressed, can be improved?

Faculty Head: OK. Organisationally, firstly I think that the effort of trying to get this thing off the ground and having to the signing of… memos of understanding and that sort of stuff, that was hectic! In the organisation, the university needs to put structures in place to understand how these things work … so that would be the first change that needs to be done. But from our own perspective, I think that what needs to be done is that firstly we need to have a re-look at our current studio-based BTech and whether it needs to continue the way it does or should also hybridise itself or maybe we should start an office for students who do not have an office … and run the whole thing the way we are currently doing it. And then joining to our physical infrastructure doesn't accommodate social life of students well enough. There isn't a proper cafeteria, a way for students to feel "this is my space" … there needs to place, even on a temporary basis, they could call home.

PAH: Thanks for that feedback, now for the final question … Question 4: Looking at a bigger picture, under what circumstances would you implement a similar project within other departments in your faculty? From what you have experienced can this concept be rolled out in other departments? What are your recommendations going forward?

Faculty Head: Yes, absolutely. Already in negotiations with the champion to choose a model for BTech nights that I believe is ready for this kind of thing but lecturers just do not have self-assurance.

Faculty Head: Think that what needs to be said too and I don't whether it's said in your research, is that there's a whole lot to be said of the actual person driving, typical example of a course driven by champion who puts in way more effort than what could be required of a regular lecturer. We always have a problem of scaling. When we take it to the others, are others going to put in the same amount of enthusiasm? So for the next step let's start scaling. There's another next step, let's start practising it. Let's start a recipe for lecturers who want to do the same, indicating these are things you need to be in a studio. An example is the studio in Bellville. The facilitator should have her own space, be at home, no need to come in, put Internet in her house. That's the sort of things that should be done. I think that's what the champion says BTech should be about. How do you convert this? If you look at what … other guy, design guy who wrote about design thinking? A design model! A design funnel!

Faculty Head: What needs to be done now? The champion is working on heuristics but she needs to write the algorithm. If you have so many students in a class, then you need so many exercises that need to be done, with so many hours spent working. You don't need to be an e-learning expert or enthusiast. It just becomes part of your regular job, things to be done.

PAH: I had this feeling a year and a half or so ago, about the need for success factors, best practices. Feel what's coming out, is that there are certain holes, e.g. the champion. If you remove the champion you remove the project; should be a stand-alone in order to multiply itself.

Faculty Head: Ja, two ways of doing that: 1) by appointing co-champions whom it would rub off on, 2) writing doctorates!

PAH: Thanks – just what I was looking for; this was the last piece of the puzzle, looking at top level of the pyramid. Thank you.

Faculty Head: Oh … excellent! It's all over bar the shouting.

Appendix D Synthesised Codebook

The final codebook that evolved during the study is provided as Appendix D. It comprises categories of theoretically based codes with prefix 'T' and empirically determined items with the prefix 'E'. In addition, each code incorporates an associated category reflecting five differing perspectives, namely: A. Enablement (Table D.1.1), B. Environment (Table D.1.2), C. Interactivity (Table D.1.3), D. Dynamics (Table D.1.1.4) and E. Mobility (Table D.1.5). For example, code TA01 represents the theoretically based code for 'Change management' whereas EA13 represents the empirically determined code for 'Access to information', both of which are associated with Category A. Enablement. The final column suggests guidelines for best practices, associated with each of the items.

D.1 Category A. Enablement

Code	Theoretically based items	Guidelines for best practices
TA01	Change management	Adapt to needs for ongoing adjustment and refinement.
TA02	Competition	Respond to digital trends and market pressures in education.
TA03	Design and development	Formulate activities, courseware and assessment.
TA04	Evaluation	Provide estimation of maturity, capability, effectiveness.
TA05	Implementation	Delineate a strategy for deployment, maintenance and migration.
TA06	Inclusiveness	Incorporate transparency, seamlessness and integration.
TA07	Logistics	Define proximity, procurement, co-ordination and operations.
TA08	Quality	Emphasise effectiveness, enhancement and excellence.
TA09	Strategy	Formulate tactics, procedures, planning and direction of initiatives.
TA10	Sustainability	Maintain endurance, resolution and strength of digital projects.
TA11	Time orientation	Combine scheduling, timeliness, currency and prevalence.
TA12	Training	Facilitate upliftment of digital skills and awareness.
Code	**Empirically determined items**	**Guidelines for best practices**
EA13	Access to information	Grant timeous access by permissions and privileges.
EA14	Bandwidth	Maximise transmission speed and data transfer capacity.
EA15	Campus WiFi	Ensure wireless network availability.
EA16	Ethics	Define privacy, principles, actions, rights and rules.
EA17	Focus on the user	Embrace user-centricity and profiles.
EA18	Internet connectivity	Support Internet-based course requirements and research.
EA19	Wireless connectivity	Afford off-campus performance based on network allowances.

Note: Category A. Enablement comprises twelve theoretically based and seven empirically determined codes

D.2 Category B. Environment

Code	Theoretically based items	Guidelines for best practices
TB01	Acceptance	Assimilate the benefits of technology use in education.
TB02	Adoption	Incorporate the participative use of pedagogical technology.
TB03	Affordability	Assess cost considerations.
TB04	Big picture	Include technology holistically into education.
DB05	Impact	Involve the influence and challenges of a mobile milieu.
TB06	Innovation	Provide novelty, improvement, re-invention and uniqueness.
TB07	Personal learning environments	Consider contextually enabled personal learning via mobile devices.
TB08	Roles	Define educational functions and responsibilities.
TB09	Socio-cultural factors	Incorporate diversity of groups, beliefs and patterns of society.
TB10	Stakeholder involvement	Consult the institution, administrators, educators and students.
TB11	Support	Scaffold digitally enhanced teaching and learning.
TB12	Technology	Establish a digital milieu conducive to educational effectiveness.
Code	**Empirically determined items**	**Guidelines for best practices**
EB13	Cloud facilities	Incorporate Internet-enabled, web-based tools and applications.
EB14	Off-campus benefits	Describe benefits afforded by being off-campus and mobile.
EB15	Off-campus issues	Highlight digital problems encountered away from campus.
EB16	Ubiquity	Permeate all mobile, social and educational pathways.

Note: Category B. Environment consists of twelve theoretically based and four empirically determined codes.

D.3 Category C. Interactivity

Code	Theoretically based items	Guidelines for best practices
TC01	Collaboration	Encourage project team participation and co-operation.
TC02	Communication	Enable exchange of information, via Web 2.0 applications.
TC03	Compatibility	Support working in teams via a network of diverse technologies.
TC04	Connectivity	Enable seamless interactivity for users.
TC05	Digital platforms	Provide data channels via mobile-enabled applications.
TC06	Internet access	Maintain access to web-based sites for educational purposes.
TC07	Learning portal	Mediate bi-directional educational dialogue.
TC08	Social networking	Include social media, social technologies and social networking tools.
TC09	Web 2.0 tools	Support user-interoperability, distinct from social networking.
Code	**Empirically determined items**	**Guidelines for best practices**
EC10	Information sharing	Encourage a team-culture of mutually supportive members.
EC11	Interconnectivity	Define an orientation towards a holistic and rhizomatic system.
EC12	Interpersonal contact	Describe an exchange between people making connections.

Note: Category C. Interactivity is made up of nine theoretically based and three empirically determined codes.

D.4 Category D. Dynamics

Code	Theoretically based items	Guidelines for best practices
TD01	Accreditation	Review officially certified qualifications and courseware.
TD02	Approach	Specify pedagogical processes and attitudes.
TD03	Assessment	Define methods for evaluation of levels of achievement.
TD04	Curriculum	Detail qualification subject matter and course content.
TD05	Digital content	Deliver digitised resources and course material.
TD06	Digital skills	Outline required and acquired digital literacies
TD07	Domain	Describe an instructive subset in a particular educational discipline.
TD08	Informal social learning	Incorporate socially oriented learning strategies.
TD09	Interventions	Include exploratory steps aimed at evaluation and improvement.
TD10	Learning activities	List course-related events underpinning pedagogy-in-action.
TD11	Models	Propose a selection of approaches to teaching and learning.
TD12	Outcomes	Present end-results and consequences of educational experiences.
TD13	Policies, principles	Define philosophies underpinning techniques and tools.
TD14	Tools	Support teaching and learning via digital mechanisms.
Code	**Empirically determined items**	**Guidelines for best practices**
ED15	BLearning	Propose a mix of differing teaching and learning modalities.
ED16	BYOD	Design personal mobile device initiatives for educational purposes.
ED17	Efficiency learning	Embrace casual and lifelong learning experienced off-campus.
ED18	MLearning	Incorporate mobile technology into teaching and learning.
ED19	Multi-tasking	Facilitate the simultaneous performance of differing digital tasks.
ED20	Resources	Include VLEs, multimedia, e-literature, devices and applications.
ED21	TEL	Outline a technology-enhanced learning plan.

Note: Category D. Dynamics includes fourteen theoretically based and seven empirically determined codes.

D.5 Category E. Mobility

Code	Theoretically based items	Guidelines for best practices
TE01	Applications	Include software packages, mobile apps and web-enabled systems.
TE02	Attitude	Review attitude to technology use in educational contexts.
TE03	Device specifications	Consider attributes of devices used by educational stakeholders.
TE04	Device types	Represent types of devices used in higher education.
TE05	Digital preferences	Accommodate idiosyncratic choices of devices and applications.
TE06	Expectations	Suggest anticipated opportunities offered by mobile devices.
TE07	Mobile productivity	Offer educational potential for on-the-move efficiency.
TE08	Motivation	Encourage users to accept and adopt mobile technology.
TE09	Perception	Indicate awareness of technological potential.
TE10	Satisfaction	Consider user happiness, enjoyment and approval.
TE11	Usability	Determine effectiveness and efficiency in mobile contexts.
TE12	Usage patterns	Define patterns of mobile technology use for teaching and learning.
TE13	User experience	Acknowledge hedonistic responses to mobility.
Code	**Empirically determined items**	**Guidelines for best practices**
EE14	Alignment	Associate mobile technology transparently with educational needs.
EE15	Confusion	Avoid many pathways of Internet-based information.
EE16	Convenience	Provide mobile accessibility for lecturers and students.
EE17	Digital difference	Suggest the difference between digitally skilled and unskilled users.
EE18	Digital divide	Refer to the gap between technological advantage and deprivation.
EE19	Distractions	Support user concentration, avoiding focus loss in cyberspace.
EE20	Encouragement	Campaign for innovative technological decisions and processes.
EE21	Flexibility	Enable access to educational content at any time and in any place.
EE22	Immediacy	Characterise instantaneous availability of information.
EE23	Mobile discussion	Involve forms of synchronous and asynchronous communication.
EE24	Mobile research	Achieve exploration of web-based resources via mobile devices.
EE25	On-the-go	Support mobile users and their mobile habits.
EE26	Portability	Accommodate diverse platforms, devices and applications.
EE27	Safety and security	Protect user privacy and data integrity.

Note: Category E. Mobility comprises thirteen theoretically based and fourteen empirically determined codes.

Appendix E Descriptive Statistics – Likert-Type Data

E.1 Study 1.3 – Categories, sub-categories, codes and items

Cat.	Sub-category	SQ	Code	Item	Likert	SD	D	A	SA	WTD Ave.	Med.
A.	Competitive advantage	SQ1.1	TA02	Competition	Q32	0	0	3	2	85%	3
		SQ1.1	TA06	Inclusiveness	Q25	1	3	1	0	60%	3
		SQ1.1	TA07	Logistics	Q29	0	2	3	0	70%	3
		SQ1.1	TA09	Strategy	Q27	0	0	2	3	90%	4
	Continuous improvement	SQ1.1	TA08	Quality	Q26	0	1	4	0	75%	3
		SQ1.1	TA12	Training	Q36	0	0	2	3	90%	4
B.	External elements	SQ1.2	TB03	Affordability	Q41	0	1	3	1	80%	3
		SQ1.2	TB08	Roles	Q40	0	0	4	1	80%	3
	Vibrant evolution	SQ1.2	TB06	Innovation	Q38	0	0	3	2	85%	3
C.	Learning-management system	SQ1.3	TC07	Learning portal	Q23	1	2	2	0	60%	3
D.	Decision-making trends	SQ1.4	TD02	Approach	Q50	1	0	2	2	75%	3
	Educational preferences	SQ1.4	TD14	Tools	Q48	0	1	2	2	85%	3
	On-the-move education	SQ1.4	TD11	Outcomes	Q30	0	1	3	1	75%	3
	Mobile champions	SQ1.5	TE02	Attitude	Q39	0	1	0	4	95%	4
E.	Quality-focused considerations	SQ1.5	TE05	Expectations	Q35	0	1	3	1	80%	3
		SQ1.5	TE10	Satisfaction	Q28	0	2	1	2	75%	3

Note: Likert-type question key: SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree, WTD AVE. = Weighted Average, Med. = Median

E.2 Study 2.1 – Categories, sub-categories, secondary questions, codes and items

Cat.	Sub-category	SQ	Code	Item	Likert	SD	D	A	SA	WTD Ave.	Med.
A.	Competitive advantage	SQ1.1	TA02	Competition	Q57	1	5	7	1	64.3%	3
		SQ1.1	TA06	Inclusiveness	Q50	0	3	7	4	76.8%	3
		SQ1.1	TA07	Logistics	Q54	4	6	2	2	53.6%	2
		SQ1.1	TA09	Strategy	Q52	0	1	4	9	89.3%	4
	Continuous improvement	SQ1.1	TA08	Quality	Q51	0	2	4	8	85.7%	4
		SQ1.1	TA12	Training	Q63	1	3	2	8	80.4%	4
B.	External elements	SQ1.2	TB03	Affordability	Q68	0	8	6	0	60.7%	2
		SQ1.2	TB08	Roles	Q67	1	4	4	5	73.2%	3
	Vibrant evolution	SQ1.2	TB06	Innovation	Q65	0	1	5	8	87.5%	4
C.	Learning-management system	SQ1.3	TC07	Learning portal	Q48	2	6	4	2	60.7%	2
D.	Decision-making trends	SQ1.4	TD02	Approach	Q81	0	2	5	7	83.9%	3.5
	Educational preferences	SQ1.4	TD14	Tools	Q78	0	1	3	10	91.1%	4
	On-the-move education	SQ1.4	TD11	Outcomes	Q82	1	5	4	4	69.6%	3
	Mobile champions	SQ1.5	TE02	Attitude	Q66	0	0	2	12	96.4%	4
E.	Quality-focused considerations	SQ1.5	TE05	Expectations	Q62	6	5	2	1	46.4%	2
		SQ1.5	TE10	Satisfaction	Q53	1	1	5	7	82.1%	4

Note: Likert-type question key: SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree, WTD AVE. = Weighted Average, Med. = Median

E.3 Study 3.1 – Categories, sub-categories, codes and items

Cat.	Sub-category	SQ	Code	Item	Likert	SD	D	A	SA	WTD Ave.	Med.
A.	Competitive advantage	SQ1.1	TA02	Competition	Q34	0	3	0	0	50%	3
		SQ1.1	TA06	Inclusiveness	Q27	0	2	1	0	58%	2
		SQ1.1	TA07	Logistics	Q31	2	0	1	0	42%	1
		SQ1.1	TA09	Strategy	Q29	0	0	1	2	92%	4
	Continuous improvement	SQ1.1	TA08	Quality	Q28	0	0	2	1	83%	3
		SQ1.1	TA12	Training	Q38	0	0	1	2	92%	4
B.	External elements	SQ1.2	TB03	Affordability	Q43	0	2	1	0	58%	2
		SQ1.2	TB08	Roles	Q42	0	0	1	2	92%	4
	Vibrant evolution	SQ1.2	TB06	Innovation	Q40	0	0	3	0	75%	3
C.	Learning-management system	SQ1.3	TC07	Learning portal	Q25	0	0	3	0	75%	3
D.	Decision-making trends	SQ1.4	TD02	Approach	Q57	0	0	1	2	92%	4
	Educational preferences	SQ1.4	TD14	Tools	Q54	0	1	0	2	83%	4
	On-the-move education	SQ1.4	TD11	Outcomes	Q32	0	0	2	1	83%	3
	Mobile champions	SQ1.5	TE02	Attitude	Q41	0	0	0	3	100%	4
E.	Quality-focused considerations	SQ1.5	TE05	Expectations	Q37	2	0	1	0	42%	1
		SQ1.5	TE10	Satisfaction	Q30	0	1	2	0	67%	3

Note: Likert-type question key: SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree, WTD AVE. = Weighted Average, Med. = Median

Appendix F Framework Elements

Tables F.1 to F.5 describe the categories of a framework for the ad hoc use of mobile technology to enhance teaching and learning in higher education contexts and define its nature and structure. The tables result from the extraction and synthesis of theoretical outcomes – Tables 3.9 to 3.13 – aggregated as 3.14 and 3.15 and empirical findings – Tables 4.3, 4.5, 4.7, 4.9 and 4.11, consolidated as Tables 4.13 and 4.14. Components of the finalised framework comprise 19 constructs, five categories, 24 sub-categories and 95 items.

F.1 Category A. Enablement – sub-categories, items and constructs

Sub-category	Item	Construct
A1 Preparedness and maintenance	TA03 Design & development	CO02 Approach
	TA04 Evaluation	CO09 Measurement
	TA05 Implementation	CO06 Execution
A2 Continuous improvement	TA01 Change management	CO08 Maturity
	TA08 Quality	CO07 Excellence
	TA12 Training	CO11 Social media
	TA10 Sustainability	CO09 Measurement
	TA11 Time orientation	CO07 Integration
A3 Competitive advantage	TA02 Competition	CO09 Measurement
	TA06 Inclusiveness	CO11 Social media
	TA07 Logistics	CO09 Measurement
	TA09 Strategy	CO10 Pedagogy
AI4 User-centricity	EA13 Access to information	CO14 Information
	EA16 Ethics	CO19 Rights
	EA17 Focus on the user	CO12 Centricity
AI5 Digital facilitation	EA14 Bandwidth	CO18 Provisioning
	EA15 Campus WiFi	CO18 Provisioning
	EA18 Internet connectivity	CO18 Provisioning
	EA19 Wireless connectivity	CO18 Provisioning

Note: Category A. Enablement comprises five sub-categories, nineteen items and twelve constructs.

F.2 Category B. Environment – sub-categories, items and constructs

Sub-category	Item	Construct
B1 Personal responses to mobile technology	TB01 Acceptance	CO03 Approval
	TB02 Adoption	CO01 Application
	TB07 Personal learning environments	CO11 Social media
	TB10 Stakeholder involvement	CO01 Application
B2 External elements	TB03 Affordability	CO03 Approval
	TB05 Impact	CO09 Measurement
	TB08 Roles	CO10 Pedagogy
	TB09 Socio-cultural factors	CO09 Measurement
	TB11 Support	CO06 Execution
B3 Vibrant evolution	TB04 Big picture	CO06 Execution
	TB06 Innovation	CO02 Approach
	TB12 Technology	CO06 Execution
BI4 Dealing with distances	EB13 Cloud facilities	CO18 Provisioning
	EB14 Off-campus benefits	CO15 Milieu
	EB15 Off-campus issues	CO15 Milieu
	EB16 Ubiquity	CO15 Milieu

Note: Category B. Environment consists of four sub-categories, sixteen items and nine constructs.

F.3 Category C. Interactivity – sub-categories, items and constructs

Sub-category	Item	Construct
C1 Learning-management systems	TC01 Collaboration	CO11 Social media
	TC02 Communication	CO04 Enthusiasm
	TC07 Learning portal	CO05 Excellence
C2 Technological requirements	TC03 Compatibility	CO03 Approval
	TC04 Connectivity	CO03 Approval
	TC06 Internet access	CO08 Maturity
C3 Socially driven mobile education	TC05 Digital platforms	CO09 Measurement
	TC08 Social networking	CO11 Social media
	TC09 Web 2.0 tools	CO11 Social media
CI4 Relationships with others	EC10 Information sharing	CO14 Information
	EC11 Interconnectivity	CO17 People
	EC12 Interpersonal contact	CO17 People

Note: Category C. Interactivity consists of four sub-categories, twelve items and eight constructs.

F.4 Category D. Dynamics – sub-categories, items and constructs

Sub-category	Item	Construct
D1 Educational preferences	TD06 Digital skills	CO03 Approval
	TD08 Informal social learning	CO11 Social media
	TD14 Tools	CO01 Application
D2 On-the-move education	TD03 Assessment	CO06 Execution
	TD04 Curriculum	CO10 Pedagogy
	TD05 Digital content	CO05 Excellence
	TD09 Interventions	CO10 Pedagogy
	TD10 Learning activities	CO01 Application
	TD12 Outcomes	CO09 Measurement
D3 Decision-making trends in mobile education	TD01 Accreditation	CO03 Approval
	TD02 Approach	CO10 Pedagogy
	TD07 Domain	CO10 Pedagogy
	TD11 Models	CO02 Approach
	TD13 Policies, principles	CO02 Approach
DI4 Productivity	ED17 Efficiency learning	CO12 Centricity
	ED19 Multi-tasking	CO15 Milieu
	ED20 Resources	CO14 Information
DI5 Digital designs	ED15 BLearning	CO16 Models
	ED16 BYOD	CO16 Models
	ED18 MLearning	CO16 Models
	ED21 TEL	CO16 Models

Note: Category D. Dynamics has five sub-categories, twenty-one items and twelve constructs.

F.5 Category E. Mobility – sub-categories, items and constructs

Sub-category	Item	Construct
E1 Hardware and software dimensions	TE01 Applications	CO05 Excellence
	TE03 Device specifications	CO09 Measurement
	TE04 Device types	CO01 Application
E2 Patterns of personalisation	TE05 Digital preferences	CO03 Approval
	TE07 Mobile productivity	CO11 Social media
	TE12 Usage patterns	CO03 Approval
E3 Mobile champions	TE02 Attitude	CO02 Approach
	TE08 Motivation	CO04 Enthusiasm
	TE09 Perception	CO03 Approval
E4 Quality-focused considerations	TE06 Expectations	CO09 Measurement
	TE10 Satisfaction	CO09 Measurement
	TE11 Usability	CO09 Measurement
	TE13 User experience	CO08 User experience
EI5 Affective factors	EE14 Alignment	CO15 Milieu
	EE15 Confusion	CO17 People
	EE16 Convenience	CO17 People
	EE19 Distractions	CO17 People
	EE21 Flexibility	CO12 Centricity
	EE22 Immediacy	CO12 Centricity
	EE25 On-the-go	CO12 Centricity
	EE26 Portability	CO15 Milieu
	EE27 Safety and security	CO19 Rights
EI6 Embracing differences	EE17 Digital difference	CO13 Diversity
	EE18 Digital divide	CO13 Diversity
	EE20 Encouragement	CO17 People
	EE23 Mobile discussion	CO15 Milieu
	EE24 Mobile research	CO14 Information

Note: Category E. Mobility has six sub-categories, twenty-seven items and fourteen constructs.

Appendix G Framework Constructs

G.1 Eleven theoretically based constructs

Construct	Supportive examples from literature sources
CO01 Application	Graham et al. (2013) propose criteria that guide application of blended learning, suggest necessity of clarification of institutional purpose and nature of blended courses and aim to achieve success of initiatives.
CO02 Approach	An approach to the design of m-learning environments addresses improved user experiences (Harpur & De Villiers, 2015a). The framework enhances the potential of accelerating educational innovation offered by mobile devices and applications.
CO03 Approval	An adapted task-level technology acceptance model (Schoonenboom, 2014) determines approval for the use of technology in e-learning contexts. The model measures intentional use, usefulness and ease-of-use, guiding the recommendation of specific technological tools.
CO04 Enthusiasm	The Motivational Framework concerns the design of learning processes, guiding lecturers to ensure enthusiastic student participation in m-learning contexts (Laurillard, 2007).
CO05 Excellence	Inglis (2005) compares two quality-oriented frameworks suited to e-learning excellence. A framework that guides process-centric quality improvement may support design of technology-enhanced learning courseware (Mhlanga et al., 2013).
CO06 Execution	Khaddage et al. (2015) recommend a framework of guidelines that inform the implementation of m-learning projects, where project execution considers both the learning context and goals.
CO07 Integration	The TCPK framework for the integration of technology into teaching is proposed by Mishra and Koehler (2006). It assimilates the complexity of technology-enhanced learning and in situ knowledge. A framework that motivates student engagement aims at integrating formal and informal m-learning (Lai et al., 2013).
CO08 Maturity	The eMM framework determines and informs organisational change aligned to maturity of e-learning initiatives (Marshall, 2010).
CO09 Measurement	A toolkit that evaluates m-learning is posited, reviewing needs of mobile lecturers and students (Farley & Murphy, 2013). While Fetaji and Fetaji (2011) propose a framework of usability guidelines for m-learning, Harpur and De Villiers (2015b) catalogue a framework of criteria for both usability and UX for assessment of m-learning applications (MUUX). Tedre et al. (2011) suggest practical measurement guidelines for technology-enhanced learning designers.
CO10 Pedagogy	Botha et al. (2012) propose a curriculum framework for m-learning, systematically exploring ways that mobile technology could be used in educational contexts while a pedagogical model for e-learning best practices is proposed by Mileva et al. (2008).
CO11 Social Media	A framework presents support for the utilisation of mobile social media enabling pedagogical change within higher education situations (Cochrane et al., 2015).

G.2 Eight empirically determined constructs

Constructs	Supportive examples from empirical sources
CO12 Centricity	A focus on the user (EA17) supports efficient (ED17) and flexible learning opportunities (EE21), affording immediate responses (EE22).
CO13 Diversity	Digital differences (EE17) and divides (EE18) signify diversities that exist between institutional, academic, student and lecturer stakeholders.
CO14 Information	Access to information (EA13) provided as compatible mobile resources (ED20) allows research for educational purposes while being on the move (EE24).
CO15 Milieu	Ubiquitous mobile technology (EB16) provides both off-campus benefits (EB14) and issues (EB15) emanating from multitasking (ED19) in a mobile context. This environment depends on both alignment (EE14) and portability (EE26) of devices and technologies.
CO16 Models	Digital design incorporates a range of learning modalities and their hybrid models, namely: BLearning (ED15), BYOD (ED16), MLearning (ED18) and TEL (ED21).
CO17 People	Mobile stakeholders interconnect (EC11), enjoy interpersonal contact (EC12) and benefit from the convenience of being mobile (EE16). However, they also report feeling confused (EE15) and distracted (EE19) by mobile chatter.
CO18 Provisioning	Educational institutions are charged with the responsibility and cost of providing sufficient bandwidth (EA14) and cloud-based facilities (EB13) via an effective campus WiFi infrastructure (EA15) that ensures satisfactory Internet access (EA18) and wireless connectivity (EA19).
CO19 Rights	Ethical issues (EA16) include safety and security (EE17) where stakeholder privacy is respected and course-related content and assessment outcomes are protected.