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A FRAMEWORK FOR TEACHING DIGITAL BUSINESS INNOVATION SKILLS TO SOUTH AFRICAN INFORMATION SYSTEMS STUDENTS

BY

CAROLIEN VAN DEN BERG

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SUPERVISORS: DR JOHAN BREYTENBACH
: PROF VIVIENNE BOZALEK

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ABSTRACT

The diffusion of the digital infrastructure is opening up multiple opportunities for innovations to transform business and society. The overall purpose of Information Systems (IS) education is to equip students to use technology to improve business, the environment and society, and digital innovation lies at the heart of this transformation. IS students are instructed in both Information Technology (IT) and business and therefore can be taught to identify the value of technology advances to meet an unmet organisational or societal need. IS students ought to play a leading role as the innovators of the future. Their teaching and learning environment needs to prepare them for this uncertain, complex and ambiguous world. They have to move beyond the current horizons of knowledge and skills within a specific discipline and develop a "sense of self" in order to be adaptable which requires a curriculum that is "future proof". The aim of this research study is to develop a framework to teach digital business innovation to South African students in Information Systems (IS).

There is consensus in the literature that the alignment of IS graduate attributes to industry requirements has been a contentious issue for more than a decade. A more future-focused approach in the development of IS students will have to be applied as a result of looming changes presented by digital innovation and transformation. A review of the literature reveals very little research in terms of how this can be enacted. Furthermore, the current and proposed updated curriculum contain limited guidance on digital transformation or digital innovation.

A design-based research (DBR) approach was applied in the study due to the merger of IS research with an educational setting. Within the IS field, DBR places a central focus on the application of human creativity in the construction of artefacts and for the study of wicked organisational problems typical to a digital environment. DBR in a teaching and learning environment is ideal for researching and designing a learning environment in which technology plays a major role. In DBR, the researcher collaborates with participants and other stakeholders to improve teaching and learning practices in an interactive, systematic, flexible and iterative way within real-world settings.

This study applied the four-phased model developed by Reeves (2006) which was an appropriate approach because it lends itself to customisation within a particular context. Phase 1 of this DBR study consisted of a review of the literature and consultation with industry partners, students and IS practitioners. The review in the first phase resulted in the design of a conceptual framework in Phase 2. The framework integrated authentic learning, the TPACK framework, 21st century learning and interventions that stimulate innovation. This enabled the creation of draft design principles that were tested and updated in Phase 3. Mixed-methods research was undertaken during three iterative cycles in 2016 and 2017. Phase 4 consisted of a reflection on the entire process to produce the updated design principles that enabled the development of competent digital innovators among IS students at a university in South Africa.

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KEY WORDS

Authentic learning

Business model innovation

Design-based research

Digital business innovation

Digital skills and competencies

Future work

Information Systems curriculum

Information Systems graduate development

Information systems pedagogy

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DECLARATION

I declare that *A framework to teach digital business innovation skills to South African Information Systems students* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Name: Carolien van den Berg Date: November 2017

Signed: CvdBerg

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LIST OF ABBREVIATIONS

Abbreviation	Description
AI	Artificial Intelligence
DBR	Design-Based Research
DBI	Digital Business Innovation
EQ	Emotional Intelligence
FTE	Full Time Equivalent
GDP	Gross Domestic Product
HE	Higher Education
HEIs	Higher Education Institutions
ICT	Information and Communication Technologies
IS	Information Systems
IT	Information Technology
LMS	Learning Management System
MOOC	Massive Open Online Course
MVP	Minimum Viable Product
NRF	National Research Fund
OECD	Organisation for Economic Co-operation and Development
SA	South Africa
SMME	Small, medium and micro-enterprise
TPACK	Technological Pedagogical Content Knowledge
UCT	University of Cape Town
UWC	University of the Western Cape
UX	Human Centred Design
WEF	World Economic Forum
21st CS	21st-Century Skills

LIST OF CONCEPTS

Concept	Description	Authors
Attitude	How we do it, or what we can do with what we know	(Cobo, 2013)
Attitude versus Knowledge	Where knowledge refers to what we know, attitude refers to how we do it or, what we can do with what we know	(Cobo, 2013)
Authentic learning	A framework that suggests that practical knowledge is best obtained in learning settings that have the following characteristics: an authentic context; an authentic task; expert performance; multiple perspectives; collaboration; reflection; articulation; coaching and scaffolding; assessment.	(Herrington, Reeves & Oliver, 2010)
Authentic task	Should be ill-defined, complex, comprehensive, and completed over an extended period of time, mirroring activities that are relevant to the kinds of problems to which knowledge is applied in the real world.	(Bozalek, Gachago, Alexander, Watters, Wood, Ivala & Herrington, 2013:630)
Business model	A system-level, holistic approach to explaining how firms do business. Explain both value creation and value capture. Therefore what customers want, how they want it, and how an enterprise can best meet those needs, and get paid for doing so.	(Zott, Amit & Massa, 2011)
Capstone Course	Assist students to assimilate and integrate the core competencies inherent in an information systems curriculum, particularly in the areas of technology and business, and to acquire practical knowledge. It is project-based and thus affords students a real-world experience through intensive teamwork and collaboration with other stakeholders.	(Gupta & Wachter, 1998)
Competence	Ability to apply knowledge, skills and attitudes in a habitual or changing situation. Competencies often serve as the basis for skill standards that specify the level of knowledge, skills, and abilities required for success	(Cobo, 2013)
Co-operation versus collaboration	Co-operation involves a division of labour in achieving a task and can be synchronous or asynchronous. Collaboration happens synchronously, providing social support and modelling and observing the contributions of each learner. Not just working together, but also solving a problem or creating a product that could not have been completed independently.	(Herrington, Reeves & Oliver, 2010)

Creativity	Creativity is the production of novel and useful ideas by an individual or a small group of individuals working together.	(Amabile, 1988:126)
Creativity versus innovation	Creativity is how we come up with new and useful ideas and innovation is the successful implementation of those ideas.	(Amabile, 1988:126)
Design-based research	"Design-based research is a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings."	(Wang & Hannafin, 2005:6)
Digitalisation	The practice of taking processes, content or objects that used to be primarily (or entirely) physical or analogue and transforming them to be primarily (or entirely) digital.	(Fichman, Dos Santos & Zheng, 2014)
Digital Innovation	A product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT.	(Fichman, Dos Santos & Zheng, 2014)
Design Principle	In this DBR study, design principles are "heuristic guidelines to help others select and apply the most appropriate knowledge for a specific design task in another setting"	(Nieveen, McKenney, & van den Akker, 2006:153)
Design Thinking	This is a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity.	(Brown, 2008)
Graduate	In this study, the term graduate refers to a student who has completed the prescribed duration and requirements for a bachelor's degree and/or honours degree in Information Systems.	(Van der Berg & Van Broekhuizen, 2012)
IT Artefacts	IT artefacts are broadly defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems). **Please note: artefact is spelt artifact in the United States**	(Hevner, March, Park & Ram, 2004)
Pedagogy	Activities of learning and teaching. Pedagogy is used to describe how we think and talk about, plan and structure those activities when we are not actually engaged in them.	(Beetham & Sharpe, 2007, 2013)
Reflection	Processes that individuals apply to explore their experiences in order to derive new understanding and appreciation. In DBR, "reflection is an active and thoughtful consideration of what has come together in both research and development (including theoretical	(Mezirow, 1990) (McKenney & Reeves, 2012:151)

	inputs, empirical findings and subjective reactions) with the aim of producing new (theoretical) understandings".	
Scaffolding	"A way of operationalizing Vygotsky's (1987) concept of working in the zone of proximal development". It includes three features: 1) the essentially dialogic nature of the discourse in which knowledge is co-constructed; 2) the significance of the kind of activity in which knowing is embedded; and 3) the role of artefacts that mediate knowing	(Wells, 1999:127)
Skills	The knowledge (what we know) and experience needed to perform a specific task or job (what we can do with what we know).	(Pop & Barkhuizen, 2010)

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CHAPTER 1: BACKGROUND TO THE STUDY

> *There is an intimate and necessary relation between the processes of actual experience and education*
>
> (John Dewey, 1938:20)

Background

The world is transforming as a result of technological changes dominated by a digital second machine age (Brynjolfsson & McAfee, 2014) and the global interconnection of the world's population. This digital infrastructure results in the emergence of new technologies, ranging from mobile, cloud, social media and analytics, to wearable devices, 3D printing and autonomous business systems, and the full digitisation of economies (Benkert & Van Dam, 2015; Fichman, Dos Santos & Zheng, 2014). The automation of work, new knowledge work tools, the emergence of intelligent processes, more precise analytical capabilities, a new age of artificial intelligence, consumer gadgetry, instant communication and boundless information will have a significant impact on organisations in South Africa.

Digital innovation demands fundamental change within a business that requires responsiveness and agility. These changes cause disruption and require innovation and profound transformations in work, business and the way we live.

The challenge to academic institutions is how to equip students for the roles needed in this changing business environment. The 2017 Horizon Report highlights a number of trends that will impact the higher education (HE) learning environment over the next couple of years (Adams Becker, Cummins, Davis, Freeman, Hall Giesinger & Ananthanarayanan, 2017). The long-term trends spanning five or more years include advancing cultures of innovation, and deeper learning approaches. A growing focus on measured learning and a re-design of learning spaces are considered medium term, and blended and collaborative learning have an immediate impact (Adams Becker et al., 2017:8). This study reviews the impact of the long-term trends on Information Systems (IS) education and argues that digital business innovation needs to be foregrounded in IS education.

This requires a framework to guide educators in the development of the necessary skills and competencies. The central question proposed by Dhar and Sundararajan (2007) for education in IS is how to instruct future leaders on the importance of digital innovation to facilitate business transformation. Fichman et al. (2014) express concern about the current curriculum not providing the necessary grounding to students and highlight the necessity to redesign IS core classes to adopt digital innovation as a "fundamental and powerful concept" (FPC)

It is becoming evident that individuals who are good at idea generation, creativity and innovation, as well as 'thinking outside the box', will find themselves in demand in the digital world. More focus needs to be placed on teaching the skills of ideation, pattern recognition, communication, collaboration, case-based and problem-based

learning and, where possible, to help create self-organising learning environments (Brynjolfsson & McAfee, 2014:88-90).

There is consensus in the literature that the alignment of IS graduate attributes with industry requirements has been a contentious issue for more than a decade (De Beer, 2010; Hirschheim & Klein, 2012; Schofield, 2014; Scott & Tanner, 2015). A more future-focused approach in the development of IS students will have to be applied as a result of looming changes presented by digital innovation and transformation. Pedagogical techniques that can facilitate the development of critical 21st-century skills to better prepare students for the global workforce need to be incorporated (P21, 2015).

The study took place at the University of the Western Cape (UWC) where a renewed emphasis is placed on the attributes of a twenty first century graduate such as scholarship, critical citizenship, lifelong learning and creative and collaborative problem solving in their updated first tier graduate attributes. A review of the literature revealed very little research in terms of how this can be achieved in IS. Furthermore, the current and the proposed updated IS curriculum contained limited guidance on digital transformation or digital innovation (Topi et al., 2010; Rosenthal & Dhariwal, 2015).

The importance of a study that investigates these changing requirements within the South African HE learning environment became evident in 2014 when IS student projects with industry partners were introduced in the curriculum. Students were unable to recognise potential technological improvements that could aid their industry partners in achieving certain outcomes. This was exacerbated by a perceived lack of the impact that the accelerated emergence of new technologies such as social media, cloud computing, mobile applications, big data and the interconnectedness thereof on business further motivated more investigation.

This prompted a study of the most conducive pedagogical approach to enable digital business innovation competencies among IS students in collaboration with educators, industry and students. Technological affordances were further investigated to align the use of ubiquitous technologies in the learning process within an ever-changing digital landscape.

The intention of this study was to design and develop a pedagogical intervention that could strengthen the capabilities of IS students to participate in, and ultimately orchestrate, digital transformation in business and society. This required the study of interventions within an authentic setting to enable evolving pedagogical goals, as well as the development of design principles that would lead to a new framework to teach digital business innovation (Koehler & Mishra, 2009). This process required the development of principles that were well researched and tested via a number of iterations using a design-based research (DBR) framework (Herrington & Reeves, 2011).

The purpose of DBR is to connect educational research with real-world problems via an iterative process that attempts to refine an innovation, and it is based on design principles that can guide similar research (Amiel & Reeves, 2008).

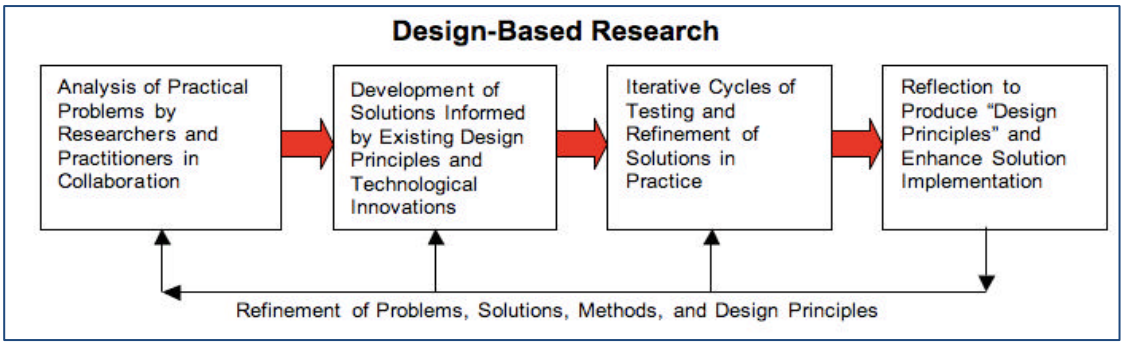

Figure 1: Predictive and design-based research approaches in educational technology research (Reeves, 2006)

A four-phased DBR approach, as depicted in Figure 1, was applied to the study.

The first phase commenced with the analysis of practical problems between practitioners, industry, students and the researcher to establish the research goals (Reeves, 2006). This partnership assisted the researcher to establish the research questions and identify the problems to investigate. The issues were further substantiated via a review of the literature. The next phase constituted draft principles for the design of the learning environment to address the concerns. These principles were tested and refined via three iterations during 2016 and 2017 in order to "re-define the problems, possible solutions, and the principles that might best address them" to develop "a set of design principles or guidelines derived empirically and richly described, which can be implemented by others interested in studying similar settings and concerns" (Amiel & Reeves, 2008:35).

Statement of research problem

As described in the section above, DBR took place in four interrelated phases. During the first phase, the research problem was analysed.

Much has been written about the requirement for more rigorous academic inquiry into the impact of digitisation and an understanding of the changing nature of business models (Osterwalder & Pigneur, 2010; 2013; Girotra & Netessine, 2013; Veit et al., 2014; De Jong & Van Dijk, 2015). The digital tsunami, coupled with questions posed by many about the skills gap of IS students to cope with the challenges of the real world, stresses the necessity to align and update the current curriculum. The debate concerning this gap between industry requirements and IS graduate attributes has been going on for more than a decade, as mentioned above, yet not enough has been done to address the issue (Schofield, 2008; de Beer, 2010; Lotriet, Matthee & Alexander, 2010; Hirschheim & Klein, 2012; Scott & Tanner, 2015).

A more future-focused approach in the development of IS students needs to be implemented as a result of looming changes presented by digital innovation and transformation (Lotriet, Matthee & Alexander, 2010; Schofield, 2014; Tanner & Scott, 2015). The diffusion of digital infrastructure is opening up multiple opportunities for innovations to transform business and society. IS students ought to be able to identify such opportunities and to play a leading role as the innovators of the future in business and society. The problem of how to teach the required skills to equip IS students to better perform their future roles in the digital economy is multifaceted.

A review of the literature reveals very little research in terms of how this can be done. A proposed update to the international Information Systems curriculum 2015, similar to the 2010 update, contains limited guidance on digital transformation or digital innovation (Topi et al. 2010; Rosenthal & Dhariwal, 2015). To approach this problem, an understanding of, and framework to instruct, specific methodologies and techniques to cultivate the skills required by the worker of the future are required.

South African higher education context

The majority of undergraduate students in South African higher education institutions (HEIs) were born after 1994 (often referred to as the “born-free” generation – the first generation born after the end of apartheid). In terms of size, there are now almost a million students in the public sector, up from half a million in 1994. Demographically, there has been a significant increase in access for black students, and most HEIs have a majority of black students in their student complements. However, the rates for black and white students who attend universities still differ drastically – at 55% for white and 16% for African students as measured in 2013 (CHE, 2016:7). Moreover, student success rates are sharply skewed by race, prior education, gender and poverty (ibid).

Funding for the HE sector is usually an indication of the ascribed importance to that sector, and although higher education in South Africa has been regarded as key to social and economic development, this is not reflected in the funding formula. The proportion of the entire education budget spent on HE is 12%, compared to 20% in Africa and 19.8% in the rest of the world. Furthermore, government funding per full-time equivalent enrolled student fell by 1.1% annually between 2000 and 2010, while student tuition fees increased by 2.5% per year (CHE, 2016:8).

The student protests of 2015, 2016 and 2017 highlighted the plight of HEIs in South Africa. This was initiated in the #RhodesMustFall protests at the University of Cape Town (UCT) in March 2015, calling for the decolonisation of the university. Racial inequality and the lack of transformation at the university were emphasised. These protests were followed by those objecting to an increase in student fees, #FeesMustFall, and these concerns spread to many other areas of discontent. At the heart of it lies the continued legacy of apartheid that has resulted in drastic inequalities in the South African society.

The #FeesMustFall movement started in October 2015 over university fee increases for 2016. Thousands of students, workers, parents and supporters marched to the Union Buildings in Pretoria and to parliament in Cape Town, forcing President Jacob Zuma to concede a zero percent increase in tuition fees for 2016 (Naicker, 2016). The protest action resulted in the revision of exam timelines for many HEIs, placing pressure on both students and staff. The protests continued in 2016 and became much more violent due to the presence of police and private security firms on campuses. HEIs across South Africa were forced to close their campuses and the academic year and exams were disrupted as a result.

The #FeesMustFall and #RhodesMustFall movements highlighted the importance of transformation in HEIs to more affordable, meaningful, flexible and supportive higher education opportunities. This requires new teaching and learning methods, as it has "initiated an irrevocable change to Higher Education not only in South Africa but globally" (Ng'ambi, Jameson, Bozalek & Carr, 2016:441).

At the University of the Western Cape, where this study took place, the students are very diverse in terms of their social backgrounds and also in terms of their expectations and knowledge of the world. The majority of students are first-generation students, and many are from rural areas.

Whilst most of the students come from working-class backgrounds, there are some who come from privileged homes and are armed with the latest gadgets. And then there are others, from the direst poverty, for whom paying fees and finding food and shelter are a challenge. This is mirrored in terms of their educational background, forcing lecturers to be mindful in the use of, for example, different types of technology in the classroom. These conditions present lecturers with pedagogical challenges in the design and delivery of accessible and meaningful teaching and learning experiences (Bozalek, Gachago, Alexander, Watters, Wood, Ivala, & Herrington, 2013).

Aim of the study

According to the National Development Plan, South Africa's competitiveness will rely on a national system of innovation. It needs to be infused in business and society by instilling innovation and learning in the national culture (National Planning Commission, 2011:110).

The aim of this research study was to develop a framework to teach digital business innovation to South African students in Information Systems (IS). The focus was to define the skills required by IS students to become competent digital business innovators in business and society, and further to develop design principles to define the design of the teaching and learning environment. The purpose was to ensure an industry informed curriculum design in IS that is future proof within a digital economy.

The overall purpose of IS education is to equip students to use technology to improve the effectiveness of business, the environment and society, and digital innovation lies at the heart of this transformation (Dhar & Sundararajan, 2006, 2007a; Fichman, Dos Santos & Zheng, 2014).

Research question

The study was guided by an overall research question and three secondary questions. The overall research question was:

How should digital business innovation skills be taught to South African Information Systems students?

In order to support the answering of the main research question, the following sub-questions were included to explore the learning environment required in more depth.

- What is the impact of global trends in digital innovation on the IS curriculum?
- What skills are required from IS students to develop the competency to be digital business innovators?
- What teaching and learning interventions are required to teach digital business innovation skills to IS students?

Research objectives

Phase 1: Consult industry partners, IS practitioners and IS students and review existing literature in Chapter 1 and 2 to:

- Investigate the impact of global industry trends in digital innovation on the IS curriculum.
- Establish the skills required for IS students to develop the competency to become digital business innovators.
- Investigate the best methodologies, tools and methods to equip students with the right skills to participate in digital business innovation.

Phase 2: Develop a conceptual framework and draft design principles to teach digital business innovation to IS students based on the literature review and the consultations with industry, students and academic practitioners.

Phase 3: Iterative cycles of testing and refinement. The course was implemented during the first semester in 2016 and evaluated to provide recommendations for improvement for the next iteration during the second semester in 2016. Two further iterations followed in 2017.

Phase 4: Design principles. The final phase consisted of the final recommendations for a framework and suggestions for future research.

Research approach

The method of inquiry and the researcher's underlying philosophical assumptions supported the application of an interpretivist paradigm in the study (Myers,1997). The study aimed to produce an understanding of the phenomena through the meanings that people assign to them, combined with a review of the literature towards an interpretive model. In this context there was a strong focus on human sense-making for the duration of the study (Kaplan & Maxwell, 1994).

A design-based research (DBR) approach was deemed as the most suitable for the study. Design activities are central in many applied disciplines, such as the arts, engineering, education, IS and psychology, because of a focus on the creation of innovative artefacts to solve real-world problems (Hevner & Chatterjee, 2010). The merger of IS research within an educational setting made this type of approach well suited for the study. Within the IS field, DBR places a central focus on the application of human creativity in the construction of artefacts and for the study of "wicked organisational problems" typical of a digital environment (Hevner & Chatterjee, 2010:11). DBR within a teaching and learning environment is ideal for the research and design of a learning environment in which technology plays a major role, as was the case in this study (Wang & Hannafin, 2004). The suitability of DBR is further supported by Amiel and Reeves (2008:30) in their argument that "design-based research provides an innovative proposal for research on innovation and education".

In DBR, the researcher collaborates with participants and other stakeholders to improve teaching and learning practices in an interactive, systematic, flexible and iterative way within real-world settings (Herrington & Reeves, 2011). It is important to start with a review of the literature and interaction with different stakeholders in order to base the initial design on sound theoretical principles. In the iterative cycles, the theory is enriched and updated based on the data collected in each cycle and the experiences of the designers (Herrington & Reeves, 2011).

The principles applied for DBR include:

- Develop theoretical goals and initial plans
- Conduct research in real-world settings
- Collaborate with participants
- Use research methods systematically
- Analyse collected data retrospectively and constantly

- Continuously refine the design for each iteration
- Report contextual and usable design principles
- Underscore the generalisability of the design continuously (Wang & Hannafin, 2004).

The application of the four phases within this study is depicted in Figure 2 below.

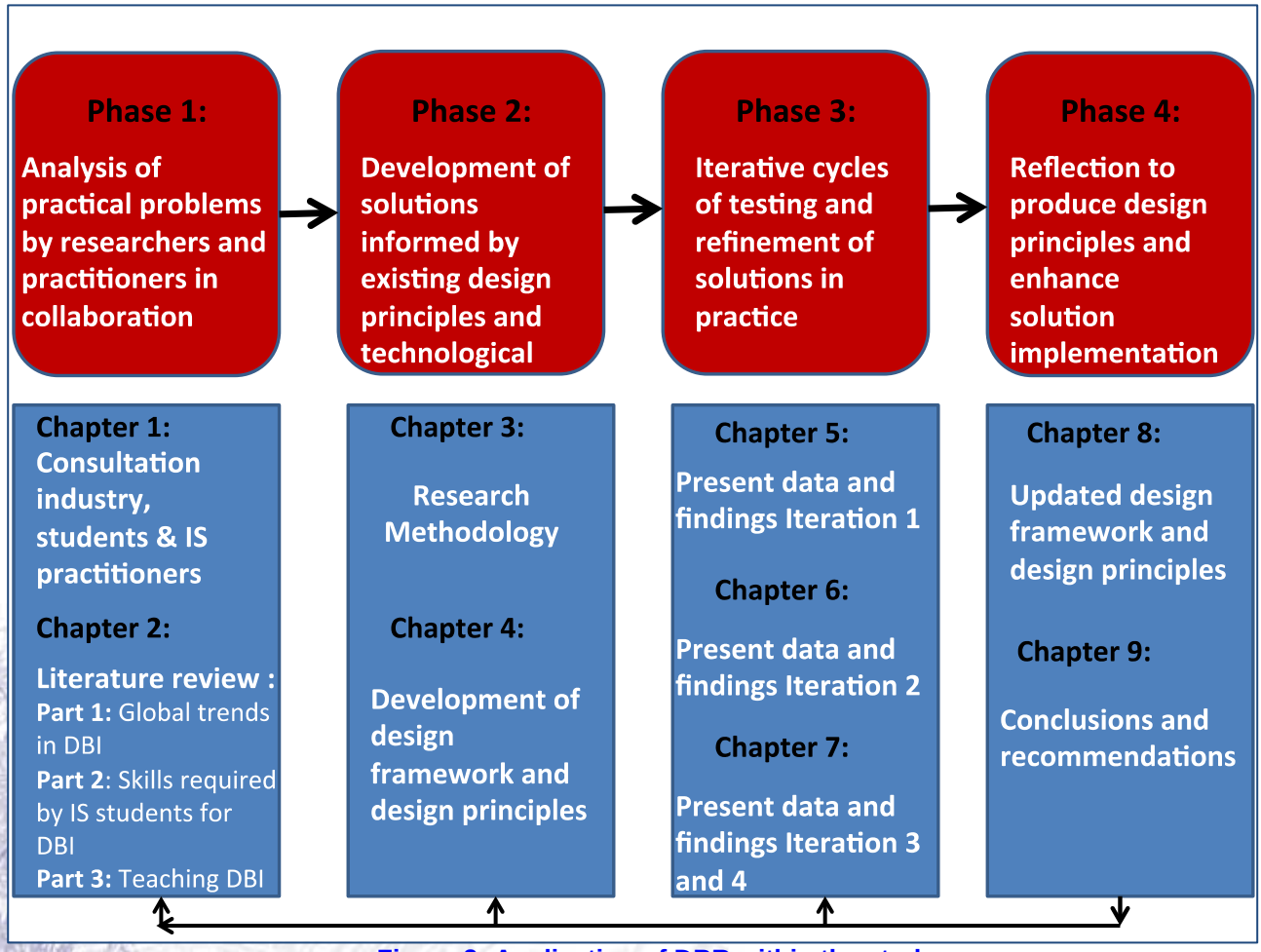

Figure 2: Application of DBR within the study

Data analysis

The researcher participated in the data-gathering efforts and ensured that the data remained as close as possible to the actual events. A Google Drive folder was used to store all information gathered from students during the semester. This included:

- Pre- and post-course surveys using Google Forms
- Questionnaires for industry partners on Google Documents

- All course work saved in folders per assignment (seven assignments with all responses, comments, rubrics and marks allocated)
- Link to blogs written by students in a central folder
- Link to digital stories by students in individual folders
- Field notes and reflections gathered by the researcher during the duration of the course

The following characteristics of a DBR approach were relevant to the study:

- Mixed methods were used in data gathering
- The analysis involved multiple iterations
- A collaborative partnership existed between the researcher and practitioners
- There was evolution in the design principles after each iteration
- The research had a practical impact on practice (Anderson and Shattuck, 2012).

Validity/reliability in data collection

Data collection requires creativity, sensitivity, flexibility and skill by the researcher and the elimination of a biased view (Morse, Barrett, Mayan, Olson & Spiers, 2002). The researcher played a vital role in determining the validity and reliability of the data collected.

The rigor of the study depended on the verification of the data to make sure that it was reliable and valid. The iterative nature of DBR assisted in this process because, after each iteration, the data was checked, verified, analysed and confirmed before it was used to inform the overall design. A process of correction and adjustment took place after each iteration. This verification assisted the researcher to identify which draft principles could continue or how they needed to be modified, changed or discontinued in the research process in order to achieve the reliability and validity and ensure rigor (Morse et al., 2002).

During the iterations, a process of triangulation was applied to the data sets (as mentioned above) in order to check, cross check and confirm information. Triangulation is defined as “a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study” (Creswell & Miller, 2000:126).

Ethical statement

The research was conducted in accordance with the ethical and professional guidelines as specified by the University of the Western Cape (UWC). A copy of the ethical clearance obtained can be viewed in Appendix 1. Research participants were requested to participate in the study through a letter that contained details about the study and confirmation of participation was done in writing (Appendix 2). Participation in the study was voluntary.

Students who participated in the study were informed about the research at the start of each iteration. Their participation was voluntary and they were informed that they could withdraw at any time with no negative consequences. All students signed consent forms at the beginning of the module, which stated that they had received enough information to enable them to make decisions about whether they wanted their work used as part of the research.

The rights and welfare of all participants in the research were protected via the protection of identities. The confidentiality of all data supplied to the researcher was respected. Participants were able to disengage from the study at any time.

Layout of the thesis

In Chapter 1 the introduction and background to the study are provided to explain the problem, aim and objectives of the research. The reader is further introduced to the research methodology applied in the study. Chapter 1 also contains Phase 1 of this educational design-based research (DBR) study and a summary of the consultations with students, industry and practitioners.

The literature review is presented in three parts in Chapter 2. The first part reviews the impact of global industry trends in digital innovation on the Information Systems curriculum. The second part analyses the literature to determine the skills required in the digital economy, and the third part analyses the teaching and learning environment necessary to teach the skills required by IS students to become competent digital innovators in a digital economy.

In the third chapter, the application of a mixed-methods DBR approach as the research methodology for the study is justified. The target group and data collection and analysis methods are also described.

Chapter 4 describes the draft principles employed to guide the design of the learning environment to create a framework for teaching digital business innovation skills to IS students. The findings from the data gathered during the first iteration in 2016 are presented and discussed in Chapter 5, including the recommended improvements to the next iteration. The outcomes of the second iteration, conducted in the second semester of 2016, are presented in Chapter 6. Chapter 7 contains the findings of the third and fourth iterations, and the results of the findings in Chapters 5 to 7 are integrated to produce an update to the design framework in Chapter 8, followed by conclusions and recommendations in Chapter 9.

Consultation with practitioners

The research problem was formulated and refined by the researcher with input from industry partners, students and academic practitioners. Consultation and collaboration with practitioners are important building blocks for design-based research in order to identify teaching and learning problems (Reeves, 2006:59, Herrington, Reeves & Oliver, 2010). Inputs were obtained via face-to-face discussions with students and lecturers, and through informal conversations and engagement with industry practitioners during 2014 and 2015. The reflections from these conversations were recorded by the researcher in an electronic journal. The aspects deemed to be most pertinent by the respondents were highlighted and followed up by more formal interviews to test certain notions. These initial discussions and a review of the literature, as documented in Chapter 2, resulted in the draft design principles documented in Chapter 4.

Industry input

The focus of the discussions with industry was generally on the perceived impact of digital innovation on organisations in South Africa, and further on the type of skills that this requires of IS students. Industry stakeholders with whom partnerships were entered in IS student projects during 2014 and 2015 were consulted. These included financial services such as Sanlam, MMI and Old Mutual, as well as consultancies such as PwC, Accenture and the Qbit Group. Stakeholders from NGOs in the health and education field were also consulted.

All conversations highlighted the potential impact of the digital economy on their current business models and their unease about the changes in the world of work as a result. Apprehension about the digital readiness of their businesses could also be detected. Findings from a report that tested the competitiveness of large companies in South Africa in the digital economy support these initial findings (Craffert, Ungerer, Visser, Morrison & Claassen, 2014). Concerns expressed included the lack of business agility, digital skills and e-leadership. In larger organisations, the adaptability of their organisational cultures to a digital economy was also mentioned as an area of concern.

Uncertainty about the impact of digital transformation could also be detected in conversations about the required skills that students need in a digital economy. Concerns about the mismatch between education and labour needs are not new (Aken & Michalisin, 2007; Scholtz, Cilliers & Calitz, 2010; Cobo, 2013; Schofield, 2014) and not limited to a specific industry, but uncertainties around digital transformation seem to intensify the unease expressed by industry. Initial discussions highlighted the following:

- Students need to develop better social intelligence to be able to work in groups and collaborate with others from diverse backgrounds.
- Creative thinking was also emphasised as a requirement and something that ought to be encouraged in employee development and training.

- Students need to be more innovative in the manner in which they approach problems, find solutions and implement the solutions.
- Students in IS need to have the ability to understand the applications of new technology within business processes.
- Critical thinking skills were highlighted as another core skill that IS students require when they graduate.
- The importance of both oral and written communication skills was highlighted by industry as an area of development as many graduates seem to lack the ability to communicate effectively. Interestingly, some mentioned that students should also be able to use different communication tools, including videos, blogs, podcasts and social media in their work environment.
- The requirement that graduates need to have the ability to filter, discriminate and manage information to screen for importance through the use of various tools and techniques.

Industry participants valued students who have been exposed to a "real work" environment via, for example, internships or projects in collaboration with industry. They felt that real experience affords students the ability to get a better understanding of professional conduct, responsibility and accountability. It also exposes them to the type of skills required. The importance of technical skills and work readiness were also strongly emphasised.

Input from lecturers

Six lecturers in the IS department at the University of the Western Cape (UWC) were consulted during 2015 and again in 2016 to test their views on the impact of digital innovation on IS students. Practitioners expressed their concern about what exactly digital skills entailed and how to prepare students for a digital economy. Limitations in the current IS curriculum were also highlighted as an issue to address. The practitioners expressed their concerns about their own practice and how this meets the requirements of a changing landscape because of the struggle to "create innovative and radical courses to meet the evolving requirements of students and society" (Herrington, Reeves & Oliver, 2010:3).

The pace of change in the teaching environment was also mentioned as a cause of concern to them. Aspects mainly cited included:

- Expanding class sizes coupled with an increased diversity of student needs.
- Rapid changes in technology and the effective use of technology in teaching and learning.

- Global competitiveness and preparing students for 21st-century workforce needs, coupled with questions about their own knowledge to adapt to this changing world, and the adoption of different learning approaches.

The #FeesMustFall student protests at the end of 2015 and in 2016 had a big impact on higher education institutions (HEIs) in South Africa. Protests resulted in the countrywide closure of campuses and required lecturers to move all learning and assessments online in an attempt to salvage their academic year. Aspects mentioned by the practitioners in terms of the protests and the impact on them included:

- Lack of support from the institution for academics and the lack of communication from the top down. This aspect improved during the 2016 protests because more contingency plans were in place.
- The necessity of new skills and techniques in teaching via blended learning, online learning and the use of digital open content.
- They also expressed concern about the quality of their online content versus face-to-face engagement with students. They were concerned that students were not reading instructions and taking responsibility for their own learning in an online environment.
- There was an overall perception among practitioners that they lacked experience in the design of online assessments for IS courses.

Lecturers were aware of the type of learning environment that would be conducive to the training of IS students who are industry ready. What did not come out strong enough was the importance of a more "holistic education" with a focus on lifelong learning. Lecturers tend to focus on their area of speciality and desperately trying to meet the targets set for them, pointing to the difficulties experienced at present as a result of the turmoil in HE.

Feedback from students

In surveys conducted with students in the IS department, the students were asked: "Do you believe that you have been taught the right skills to assist you to find work in your field?" If they answered no, they were asked to name the skills that they may need in the future.

The first survey took place in 2015 with 200 students taking IS courses at the end of their second year. The findings were presented at the Graduate Women International Conference. The gender was split equally, with 100 male and 100 female students to test if gender had an impact. In total, 80% of the students felt that they had not been taught the right skills. The question related to their perception of skills they would require was open-ended and answers were coded and tabulated into the categories listed in the figure below.

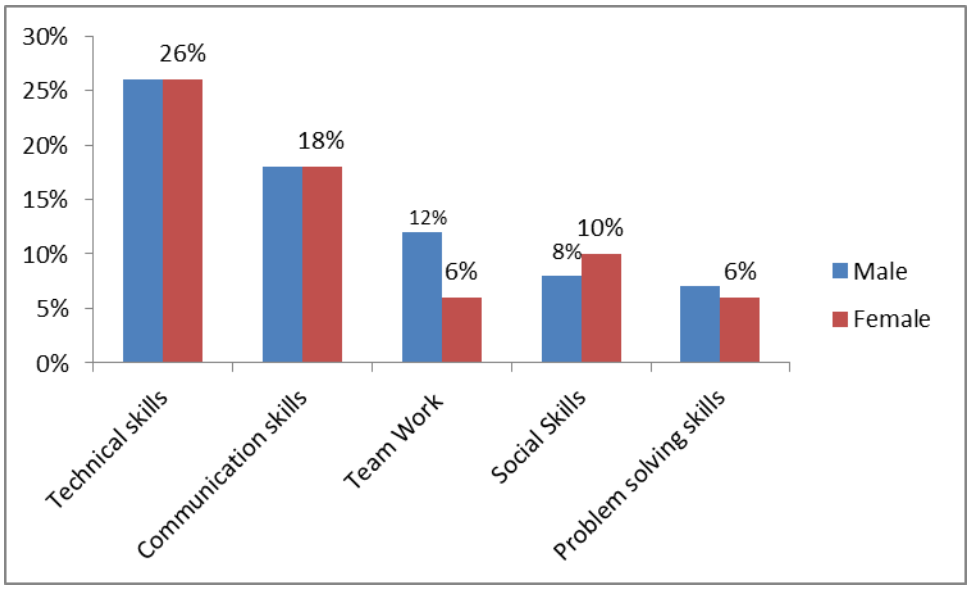

Figure 3: Findings from student skills perceptions – second years

This exercise was repeated to test the perceptions of third-year students who took an elective course in Information Systems during the same year. Of the third-year students, 50% felt that they had been taught the right skills. The 50% who answered no could select from a list of skills that they felt would be required. The results are presented in the figure below.

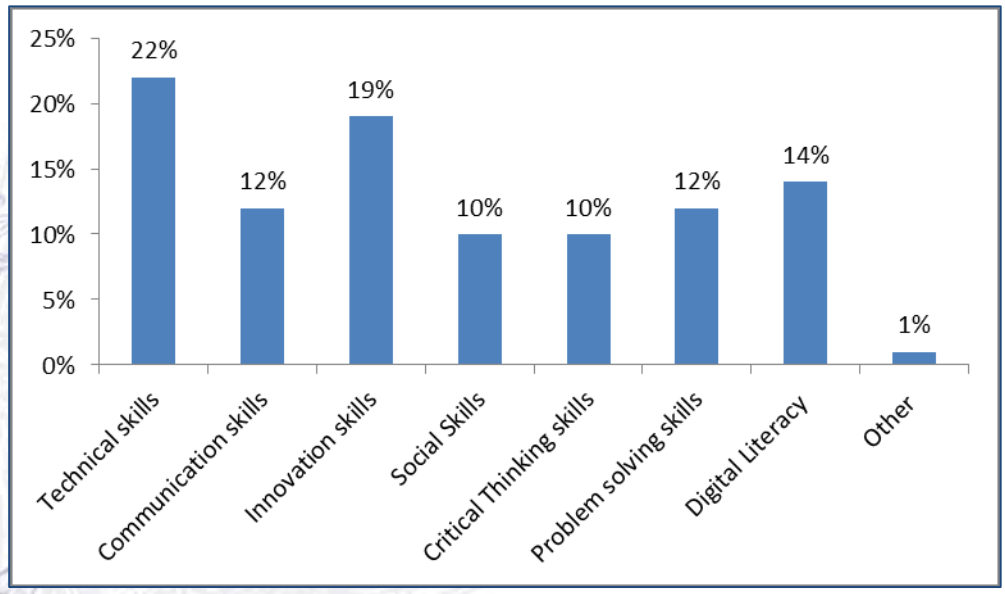

Figure 4: Findings from student skills perceptions – third years

The surveys were followed up with personal interviews with a sample of 20 students to ask them what they would like to change. The students felt that they required more exposure to technical competencies to enable

them to become more technically flexible. A number of students cited the difficulty of working in teams and the requirement to learn the skills to better manage within a team environment, particularly in terms of time management and personality clashes. They also expressed the requirement to have more exposure to industry and working on projects that deal with real-world problems.

> *I think it will be valuable if students will have a guest lecturer to tell them about the working world, what skills they need to have and how they can acquire those skills. I think that will be valuable to have more practical modules in IS.* (SS 3rd year)
>
> *I think it would be good if our lecturers had a team they work with, who maybe would come in some of our lectures and give us a practical lecture where we would work with them. Rather than hearing one voice all the time.* (M 2nd year)
>
> *I want to experience what really takes place in an organisation for example the real experience on how to work with clients, and handling a project of a client.* (DB 3rd year)
>
> *I want to learn more about technology and be given guidelines on how to approach problems in the workplace regarding IS.* (ZM 3rd year)

The challenges faced by the different stakeholders are depicted in Figure 5 below.

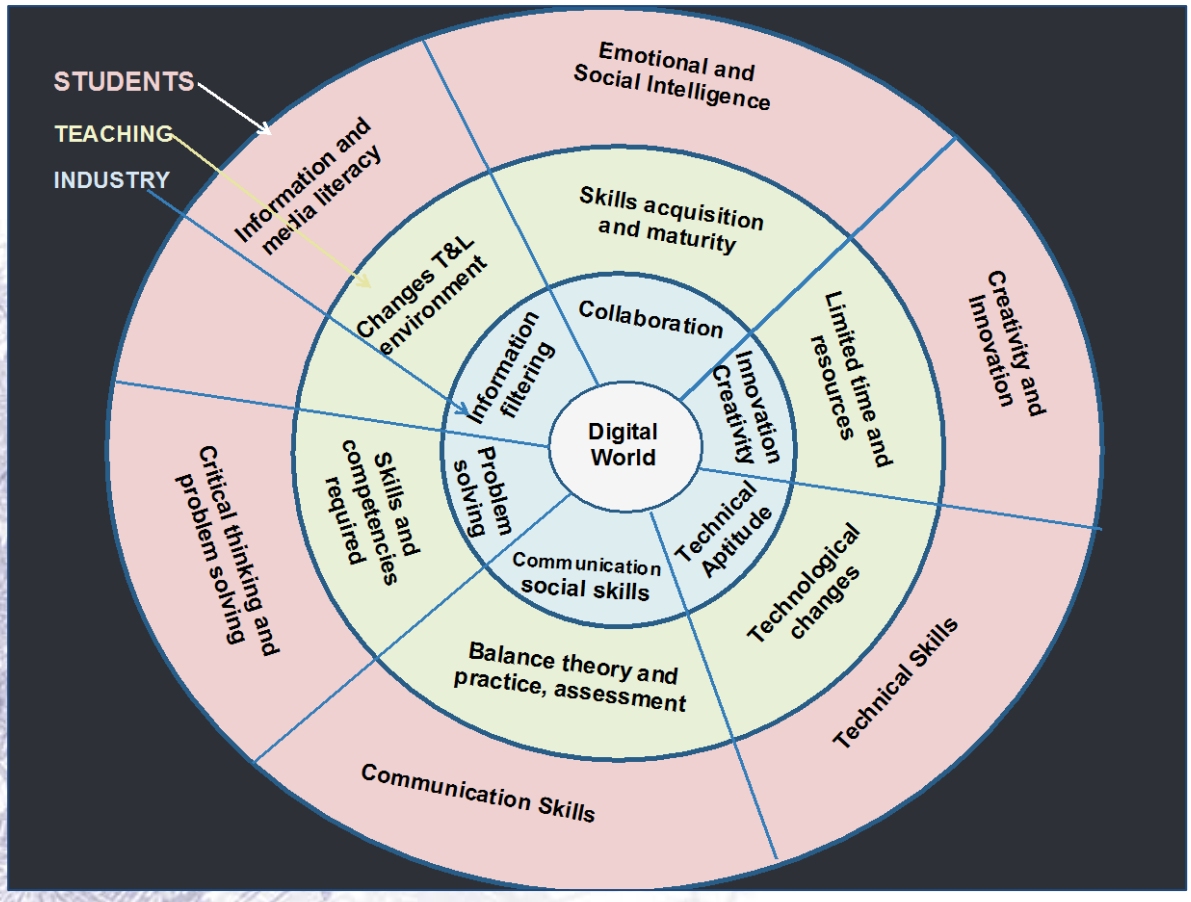

Figure 5: Challenges identified by students, teachers and industry

Conclusion

In this introduction to the thesis, the researcher provided relevant background information on the study via an introduction to the research problem and the relevance of the study in IS discourse. An overview of the design of the overall study is provided to guide the reader through the thesis. The first chapter also commences the first phase of this DBR study to analyse the problem in collaboration with practitioners, industry stakeholders and students.

In the next chapter, Chapter 2, the researcher presents an overview of the literature in three parts to discuss each objective formulated in Chapter 1. Chapters 1 and 2 form part of Phase 1 in the DBR study and culminate in the development of a draft framework and design principles to teach digital business innovation to IS students.

UNIVERSITY of the WESTERN CAPE

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

A literature review, as well as consultations with industry partners and practitioners, constitutes the **first phase** of a DBR study. The key findings from consultations were described in Chapter 1. Chapter 2 discusses the concepts identified from a review of the literature. The review of the literature is critical in design-based research because it supports the formulation of draft design guidelines for the design of an intervention to address the identified problem (Herrington, McKenney, Reeves & Oliver, 2013).

The chapter is presented in three parts to explore each of the sub-questions posed in Chapter 1. The first part explores the current global industry trends in digital innovation and how these have an impact on the IS curriculum. This section provides a brief background to digital business innovation, and thereafter the technology trends that may have an impact on digital business innovation. A discussion of the future of work forms part of the analysis on the impact of digital business innovation on education. Part 1 concludes with a discussion of the current IS curriculum and potential gaps.

In Part 2, the potential skills and competencies required from IS students to participate in the digital economy are identified and explored via a review of the literature on 21st-century learning. The key skills to develop the necessary competencies for digital business innovation are highlighted at the end of this section.

The final section of the chapter, Part 3, reviews the teaching and learning of the skills and competencies for IS students to effectively participate in and contribute to the digital economy via digital business innovation. The technology affordances as well as the pedagogy and content to effectively teach digital business innovation skills are subsequently discussed. This section concludes with a high-level summary of the potential learning environment required to effectively teach the right skills to IS students to enable them to become competent in digital business innovation.

Part 1: The impact of global industry trends in digital innovation on the IS curriculum

> *Someone needs to prepare the managers and business leaders of tomorrow to thrive in and contribute to this golden age of digital innovation, and it would be a shame if we in IS did not stand up, seize this opportunity, and lead the way forward*
>
> *(Fichman, Dos Santos & Zheng, 2014:349)*

The first sub-question is explored in Part 1 of the literature review, namely **what is the impact of global trends in digital innovation on the IS curriculum?** To answer this question, the impact of digital business innovation

on people and work is discussed to determine what it is, what is driving it (new technologies on the radar), what it means for us (work and life) and what it means for in IS education?

Background to digital business innovation

Digital transformation is being driven by a range of new technologies that are blurring the boundaries between people, the Internet and the physical world. This transformation causes disruption in economies and creates new challenges, but also opportunities for economic growth (Castro & Andes, 2009). New strategies, ideas, products and markets are required in order to transform the way we live, work and relate to one another (Montresor, 2016).

A question that can be posed is “what does digital innovation really mean?” Digital technologies can be defined as the blending of information, computing, communication and connectivity technologies (Bharadwaj, El Sawy, Pavlou & Venkatraman, 2013). Innovation is an idea, practice or object perceived as new (Rogers, 1995). A digital innovator has the ability to join two things together, such as knowledge of technological advances and their possibilities and an astute insight into some unmet organisational or societal need (Fichman, Dos Santos & Zheng, 2014).

Within business, industry leaders have different perspectives on digital innovation. For some it is about technology, whilst others view it as a new way of customer engagement, or new processes, or even an entirely new way of doing business (Dörner & Edelman, 2015). These diverse perspectives point to the lack of alignment in where business needs to go in the digital economy. The result is often piecemeal initiatives and missed opportunities.

A good place to start is a review of the Digital Transformation Framework developed by the MIT Centre for Digital Business in collaboration with CapGemini Consulting. These organisations conducted a three-year study that investigated the elements of effective digital transformation. The key areas include customer experience, operational processes and the business model of an organisation, as depicted in the figure below.

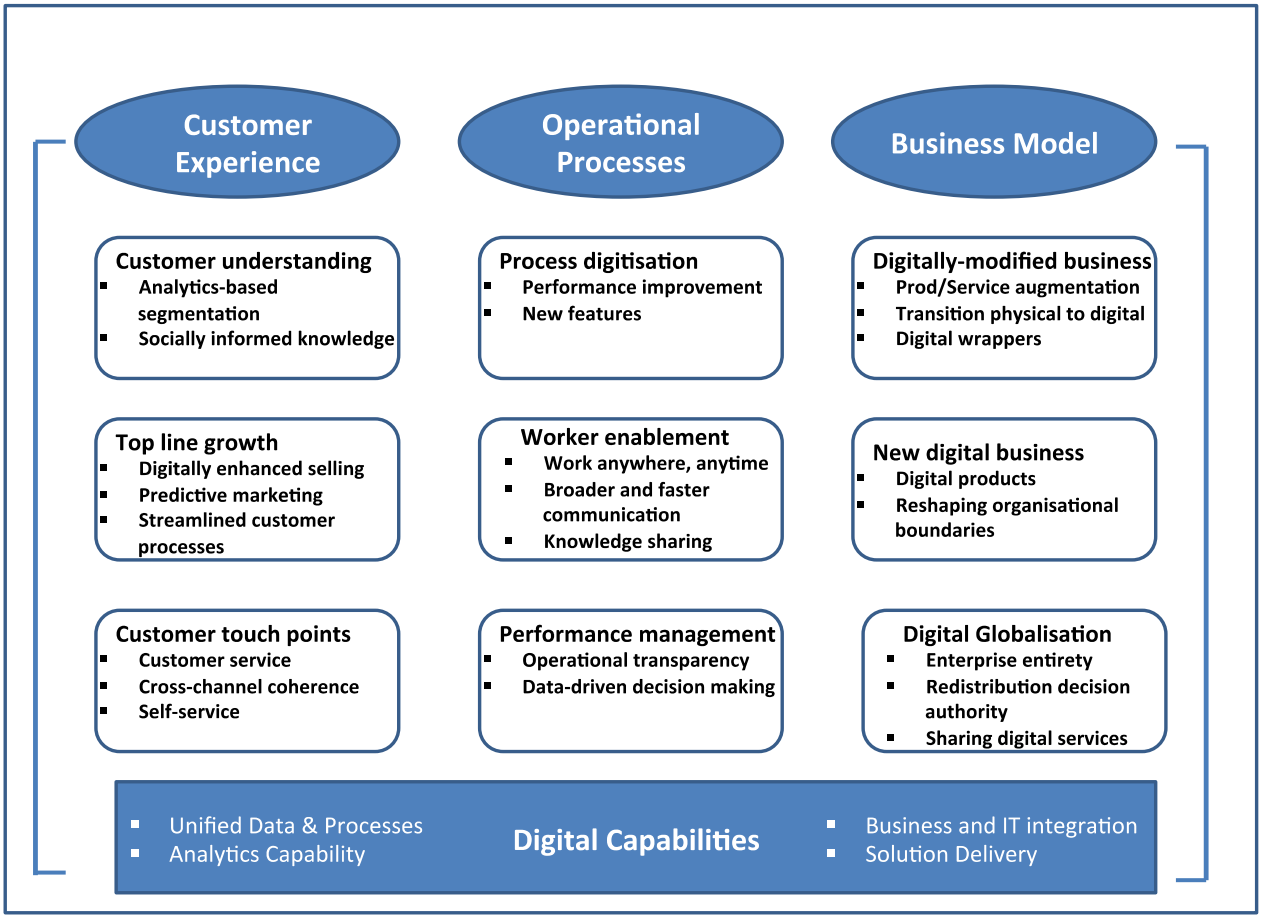

Figure 6: Digital transformation framework (McAfee & Welch, 2013)

According to Dörner and Edelman (2015:1), digital transformation can be broken down into three attributes: "creating value at the new frontiers of the business world, creating value in the processes that execute a vision of customer experiences, and building foundational capabilities that support the entire structure". The components to be reviewed by organisations in their quest to become a digital enterprise can include: strategy and innovation, business agility, the customer decision journey, process automation, technology, and data and analytics (Desmet, Duncan, Scanlan & Singer, 2015).

The next section takes a brief look at the impact of technology trends on organisations to obtain a snapshot of what digital innovation may entail from a technological perspective.

Technology trends and the impact on organisations

One can argue that technology, from the printing press to the steam engine to the Internet, has always disrupted the status quo, but the difference today is the speed at which this is happening. Whilst previous technological inventions were each impressive, none had the on-going level of continuous improvement seen in digital technologies (Brynjolfsson & McAfee, 2012). Although there may be slight differences in the literature as to

which technology will be the next big thing, one aspect that all agree upon is that the furious pace of technological innovation is forcing organisations to be more flexible in adopting changes and making decisions (McAfee & Welch, 2013; Olanrewaju, Smaje & Willmott, 2014; Dobbs, Manyika & Woetzel, 2015; Gast & Lansink, 2015). Organisations therefore need to become more responsive, agile, creative and innovative. This will require a culture that encourages continuous business model innovation as enabled by digital technology.

A strong understanding of trends in technology and the impact thereof on business models is therefore necessary. In the book by Morabito (2016), *The Future of Digital Business Innovation*, the technological trends identified predominantly feature intelligent computers and advanced IT platforms, for example wearables, machine-to-machine communication, digital currencies and data visualisation and security. The challenges to organisations in terms of digital management trends delve into aspects such as neuro-information systems, IT ambidexterity, and the IT business alignment evolution. A study by Accenture stresses the impacts of artificial intelligence (AI), internet of things capabilities and big data analytics insofar as the unlimited processing and algorithmic power of quantum computing is concerned (Nanterme & Daugherty, 2017). McKinsey Digital highlighted mobile computing devices and Internet connectivity, the automation of knowledge work, the internet of things, cloud technology, AI, autonomous and near-autonomous vehicles, next-generation genomics, 3D printing and renewable energy as trends to watch (Manyika, Chui & Bughin, 2013). Another source is the annual Gartner Hype Cycle for emerging technologies, which illustrates those technological innovations that an organisation ought to monitor, as depicted in Figure 7 (Gartner, 2017).

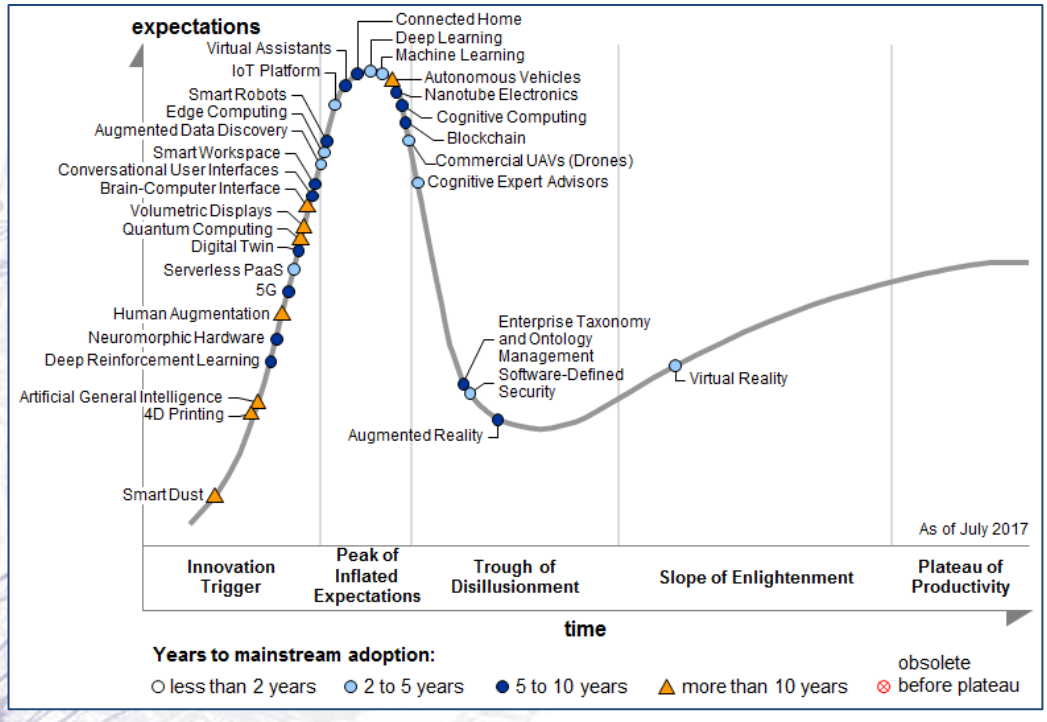

Figure 7: Hype cycle of emerging technologies (Gartner, 2017)

The next big thing in terms of technology may differ slightly from one source to the next, but all studies point to the ubiquitous nature of new technology and the speed at which things are changing. In a global study measuring responses from executives in more than 2000 companies, McKinsey & Co. found that few executives are responding appropriately to this digital disruption. Whilst 90% indicated that they were engaged in some form of digitisation, only 16% responded with a bold digital strategy (half of whom had a fully integrated digital strategy), and only 30% were looking at new customer segments or re-segmenting their markets to capture the value of digitisation (Bughin & van Zeebroeck, 2017:80). To respond effectively to digitisation, companies need to develop new customer segments and not just defend existing business lines via cost cutting, automation, or service improvements. This requires new business models and a re-definition of value chains (Bughin & van Zeebroeck, 2017:86).

The role of higher education in equipping students for this uncertain world needs to be emphasised. It is recommended that greater attention should be given to emerging technologies that are in the earlier phases of diffusion among early adopters because students find this more interesting and thought provoking (Fichman, Dos Santos & Zheng, 2014).

Universities must further explore the adoption of new technologies, such as virtual-reality equipment, advanced digital-editing software, and 3D printers. HEIs ought to reorganise their learning spaces to include spaces that encourage skills like designing and coding, and also build innovation hubs that connect learning with real-world opportunities and encourage students to network and assist them to secure funding (Adams Becker et al., 2017:16).

The next section reviews this emerging digital world in terms of the impact thereof on employment. The section further elaborates on the impact of digitisation to help prepare students for the future.

The evolution of employment

The workplace has evolved from labourers using ad hoc processes to the Industrial Revolution, where processes became more standardised and integrated. The explosion of digital technologies now enables intelligent processes that disrupt current business models and change the employment landscape. Flexibility and speed, which promote collaboration between people and technology to drive experimentation and rapid iteration, are becoming essential (Malone, 2004).

Whilst standardised and integrated processes accommodate low-skilled workers, the digital revolution creates employment opportunities for highly skilled workers in entirely new occupations and industries. Many jobs, now in high demand, did not exist a couple of years ago, and children entering the school system today will probably embark on jobs that do not yet exist. This digital revolution requires businesses, governments and individuals to anticipate trends and prepare for future skills requirements (Montresor, 2016). The digital economy will require a

flexible workforce with the ability to change and adapt within a complex global economic environment. This flexibility requires skills such as “problem solving, communication in different media, team working and ICT skills, management and leadership, multicultural openness, adaptability, innovation and creativity and learning-to-learn” (Redecker et al., 2011).

The economist Joseph Schumpeter (1942:84) used the term “creative destruction” to describe the evolution of economies. Creative destruction can be applied to digital innovation, whereby continuous product and process innovation replaces outdated business models. Schumpeter’s theory is based on Karl Marx, but Schumpeter saw entrepreneurship as the key to economic value as opposed to labour per se. For Schumpeter, innovation means progress, but it also means destabilisation in capitalism, resulting in job losses and the decline of companies or industries. However, this is part of the system and the loss will result in fundamental shifts and, ultimately, a more productive outcome. One can view digital innovation as both the “creator” and the “destroyer”, altering the entire landscape, creating new markets and industries, whilst other industries will become redundant (Schumpeter, 1942; Manyika et al., 2013). The creative destruction of the information society, in the words of Castells (2004:2), “has profound consequences: shaking institutions, transforming cultures, creating wealth and inducing poverty, spurring greed, innovation, and hope, while simultaneously imposing hardship and despair. It is indeed, brave or not, a new world”.

Erik Brynjolfsson and Andrew McAfee (2014) refer to the creative destruction of digital innovation in *The Second Machine Age*. They describe current technological advances as merely a warmup for what is to come due to the exponential growth of digitisation in two important areas: real, useful artificial intelligence (AI) and the interconnectedness of people, places and things via a common digital network. The impact of this will be much bigger than anything since the Industrial Revolution in terms of the way we work. They make a case for the importance of entrepreneurship and innovation to create jobs and new opportunities due to the inevitable impact of automation. Schumpeter (1942) argued that innovation is not merely an invention but can also be the market introduction of a technical or organisational novelty in a market. Schumpeter, Brynjolfsson and McAfee all argue that innovation is more likely to happen in start-ups. This is also advocated by other authors, who argue the case for a start-up mentality to drive digital innovation (Osterwalder & Pigneur, 2010; Ries, 2011; Blank, 2013; Osterwalder, Pigneur, Bernarda & Smith, 2014).

The importance of collaboration among individuals, organisations and even industries is another requirement for future business that is strongly emphasised in the literature. Collaboration gives rise to the sharing of ideas, innovation and the ability to make changes faster, all essential components in the second machine age (Bughin, Chui & Manyika, 2013; Dewhurst & Willmott, 2014; The Economist, 2014; Gast & Lansink, 2015). Knowledge exchange will need to occur between colleagues and peers, and also between older and younger, experienced and inexperienced workers. Intergenerational learning enables younger workers to tap into the tacit knowledge of more senior workers while, at the same time, allowing more senior workers to update themselves with fresh knowledge from younger people (Koulopoulos & Keldsen, 2014).

The digital future requires a new type of employee who is able to work in unstructured and unpredictable circumstances that are often complex and involve constant change. Futurists predict that people are likely to change their professions more frequently throughout their life (Malone, 2004; Koulopoulos & Keldsen, 2014; Marchant, Stevens & Hennessy, 2014; Tulgan, 2015). Furthermore, demographic changes will result in an ageing workforce and it will become necessary to continuously update skills in all careers via relevant training opportunities. Lifelong learning opportunities via a range of sophisticated and adaptive learning tools and programmes will be available for skills upgrades and professional development of the skills, and to drive the professional careers of the workforce (Redecker et al., 2011). Figure 8 illustrates the shifts that are taking place within the world of work.

Figure 8: The evolution of the employee (Morgan, 2014)

As depicted in Figure 8, a digital workplace requires flexibility to work anywhere and anytime using any device because the focus is on work outputs. Hierarchies are broken down and collaboration platforms are created to share information. Organisations will need to incentivise this via, for example, internal incubators, crowd design, hack days, intrapreneur and open innovation programmes. This will facilitate a culture of idea generation, where

any employee can have an idea that can turn into a new product, service or opportunity. For employees in the future, knowledge is not the most important factor, but rather the ability to filter knowledge and use it to learn and apply learnings to new situations and scenarios. Digitisation enables democratised learning and teaching via, for example, Massive Open Online Courses (MOOCS), video sharing, wikis or blogs (Morgan, 2014).

A strong trend for the future is on-demand labour platforms, where organisations will source the skills they require, at that time, from a large pool of available talent. Organisations without legacy (hierarchical) employment models will thrive because they will be able to match the supply and demand for people and skills. Platforms such as Freelancer and Gigster are already widely utilised to acquire, for example, skilled software developers and product managers. This model enables organisations to become extremely agile in the design and development of programmes and to radically reduce the time to completion. Online work-management solutions will enable a blended workforce of both internal and external workers (Nanterme & Daugherty, 2017).

In a study by the Institute for the Future (IFTF) and the University of Phoenix Research Institute (UPRI), 10 vital skills for the future workforce were identified. These are illustrated in Table 1 below.

Table 1: Future workforce skills

Skill	Description
Sense-making	The ability to determine the deeper meaning or significance of what is being expressed
Social intelligence	The ability to connect to others in a deep and direct way, and to sense and stimulate desired reactions and interactions
Novel and adaptive thinking	Proficiency at thinking and coming up with solutions and responses beyond those that are rule based
Cross-cultural competence	The ability to operate in different cultural settings in a truly globally connected world. Depending on a worker's skill set, s/he could be posted in any number of locations
Computational thinking	The ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning
New media literacy	The ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication
Transdisciplinarity	The ability to understand concepts across multiple disciplines
Design mindset	The ability to represent and develop tasks and work processes for desired outcomes
Cognitive load management	The ability to discriminate and filter information by importance, and to understand how to maximise cognitive functioning using a variety of tools and techniques
Virtual collaboration	The ability to work productively, drive engagement and demonstrate presence as a member of a virtual team

Source: Davies, Fidler and Gorbis (2011)

The previous sections provided an overview of changes to the future world of work as a result of digital technology. In the next section, the impact thereof on education is discussed and, more specifically, the importance of teaching digital innovation to equip IS students for this uncertain world. IS students are in the fortunate position that they are instructed in both IT and business and therefore can be taught to identify the value of technology advances to meet an unmet organisational or societal need.

Teaching digital innovation

The above sections highlight the importance of changes in the content and methods of education to keep pace with evolving technology and digital innovation. We are at a turning point that requires collaboration between different actors within the system to find a way to best approach this. The teaching of digital innovation requires an understanding and integration not only of the subject matter, but also of how students develop their skills, habits, practices and conceptions of learning in a digital age. The mode of learning needs to reflect the experience of learning in a digital age (Sharpe, Beetham & De Freitas, 2010:86).

In an interview with Perry (2014), Professor Barry Dwolatzky from the Johannesburg Centre for Software Engineering highlighted the high unemployment among the youth, saying “there are two and a half times more youth unemployed than adults in South Africa, and 60% in total on the continent. We’re at risk of losing an entire generation if vital steps aren’t taken”. He advocates the need for Africa to become a leading developer and innovator of digital technology over the next few decades to help curb unemployment and capitalise on the opportunities presented in a digital economy (Schofield, 2014). The development of a digital innovation agenda in schools, universities and via internships must therefore be prioritised. This changing landscape and requirement for new skills and competencies in a digital age require educational institutions to adapt quickly in response. Some directions for change might include:

- Placing additional emphasis on developing higher-order thinking skills such as critical thinking, insight, and analysis capabilities;
- Integrating new-media literacy into education programmes;
- Including experiential learning that gives prominence to soft skills such as the ability to collaborate, work in groups, read social cues, and respond adaptively; and
- Integrating interdisciplinary training that allows students to develop skills and knowledge in a range of subjects (Davies et al., 2011)

Students need to be prepared for the digital economy through the design of a participative, digitally enabled, collaborative learning environment. Higher education institutions (HEIs) are forced to experiment with new formats and strategies for learning and teaching to be able to offer relevant, effective and high-quality learning experiences in the future. This will require more flexibility to support both individual and industry needs in order

to better align supply and demand via information and communication technologies (ICTs) (Redecker et al., 2011). Figure 9 depicts a conceptual map of what this future may entail.

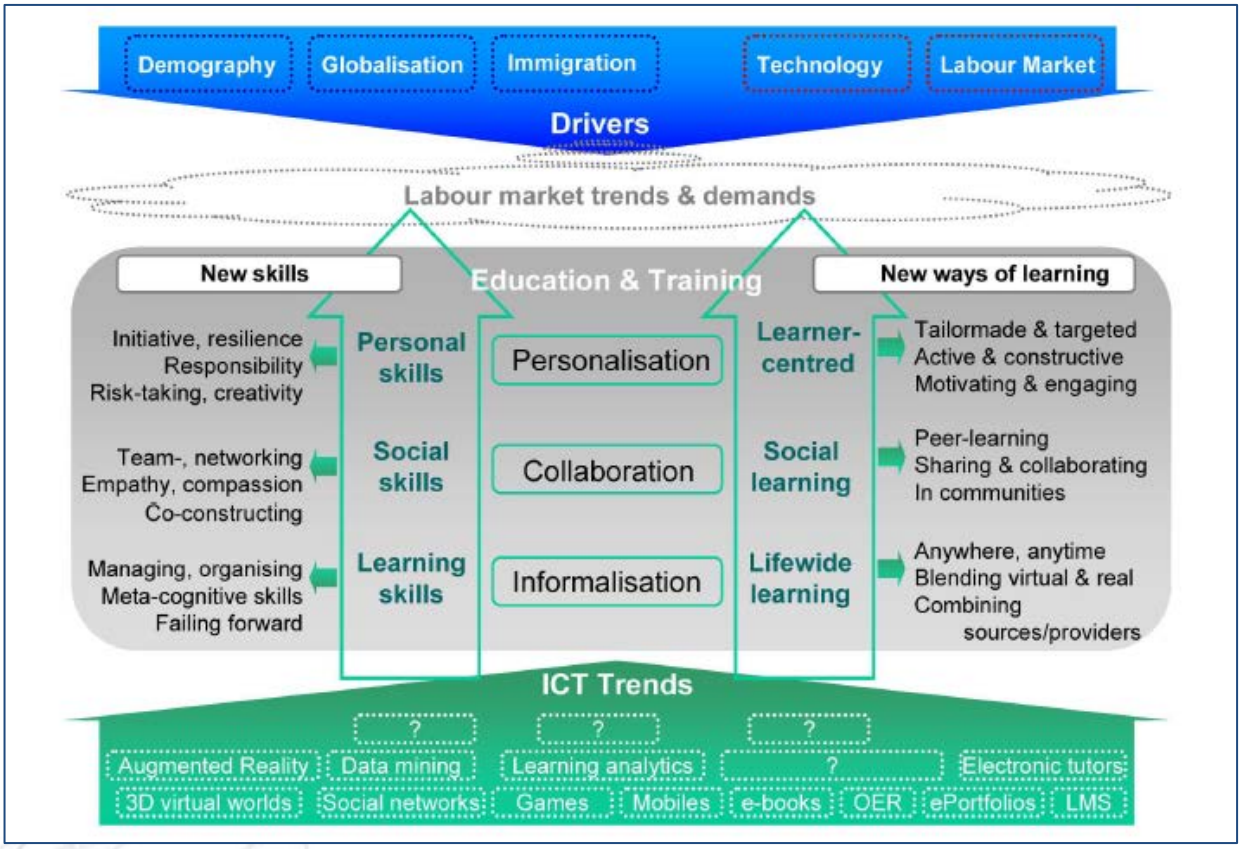

Figure 9: Conceptual map of the future of learning (Redecker et al., 2011)

Teaching digital innovation will not only require teaching about technology (content), but importantly also teaching with technology (pedagogy). Students need to be prepared for a new culture of learning in the 21st century, and this requires the integration of knowledge from different domains: knowledge of student thinking and learning, knowledge of subject matter, and knowledge of technology (Koehler & Mishra, 2009).

IT innovation has been studied in Information Systems for decades, dealing with aspects relating to the adoption and diffusion of innovation (Swanson, 1994; Fichman & Hill, 2004; Tumbas, Tumbas, Matkovic & Sakal, 2014). The speed of change brought on by digital technology is opening up the market to a relatively cheap and easy-to-use worldwide digital infrastructure, thus reducing the barriers that prevented ordinary people from becoming innovators. As discussed, a digital innovator has the ability to see new possibilities created by advances in technology that meet an organisational or societal need. The wide diffusion of cheap digital infrastructures enable businesses to develop new organisational processes, products and business models (Fichman, Dos Santos & Zheng, 2014). It is the recombination of something that already exists within the business with new technology and follows a nonlinear pattern of innovation diffusion. The innovators can be located in various

departments, stressing the importance of collaboration to find new and novel ways to do things better (Tumbas et al., 2014).

Knowledge about the content will be reliant on the subject matter of digital business innovation, and the required models, tools and techniques to adequately prepare students are tested and refined after each iteration of this DBR study.

The knowledge about student thinking and learning or pedagogical knowledge encompasses the processes and practices or methods of teaching and learning (Koehler & Mishra, 2009). Pedagogical knowledge of teaching digital innovation requires a deep understanding of how students construct knowledge and acquire skills (Koehler & Mishra, 2009). It requires the teacher to interpret the subject matter and find the ways to best tailor it to the subject and to students' prior knowledge and experience (Shulman, 1986; 1987).

Knowledge of technology needs to take into account the impact of technological change on the subject matter and how this will influence the pedagogy. Furthermore, it needs to consider how technology can be utilised in student teaching and learning for the development of a 21st-century learner, skilled in understanding and implementing digital business innovations. The second and third parts of this chapter analyse such skills and the instruction thereof in further detail.

The previous sections discussed the impact of digital transformation and the impact of this on the worker of the future, and thus the importance of preparing students for this via the instruction of digital business innovation. In the next section the implications that this may have for the IS curriculum are reviewed.

Information Systems curriculum

The current IS curriculum needs to be reviewed to establish if it allows for the effective instruction of digital business innovation. As mentioned before, there is consensus in the literature that the alignment of IS graduate attributes to industry requirements has been a contentious issue for more than a decade (Schofield, 2008; De Beer, 2010; Lotriet, Matthee & Alexander, 2010; Hirschheim & Klein, 2012; Scott & Tanner, 2015). The impact of digitisation, coupled with the questions posed by many about the skills gap, stresses the necessity of potential changes to the current Information Systems curriculum.

The sections above have foregrounded the importance of instructing students in IT and digital innovation to enable them to become leaders in the digital economy because digital innovation is becoming the primary driver of innovation (Fichman, Dos Santos & Zheng, 2014). Moreover, continuous improvement in the IS curriculum has become a necessity due to changes in the business environment as a result of digitisation, pressure from industry for students with the required skills, and changes in higher education.

The question of how to equip students to assess the threats to business models, and realise the opportunities enabled by emerging information technologies, is not new (Dhar & Sundararajan, 2007). From the literature

reviewed and interaction with industry, the necessity of equipping IS students to become digital innovators is evident. IS students should have a strong grounding in technology and be able to detect the emergence of potential digital innovations and the challenges and opportunities thereof for organisations (Fichman, Dos Santos & Zheng, 2014).

Curriculum guidelines for under graduates in Information Systems (IS) have been developed by the Association for Computing Machinery (ACM) and the Association for Information Systems (AIS) (Topi et al., 2010). These guidelines have not been updated since 2010 and contain very limited guidance on course design insofar as digital business innovation is concerned.

Digital business innovation needs to form part of the IS curriculum via the adjustment of all IS courses to include a greater innovation orientation. It can be phased in via the introduction of electives in digital business innovation. There ought to be a focus on instruction in techniques to actively involve students in the innovation process, such as prototyping, agile development and design thinking, along with the exposure of students to real-world problems (Fichman, Dos Santos & Zheng, 2014).

This section has introduced the importance of the teaching of digital business innovation to IS students. More detail in terms of the creation of a potential framework to achieve this is provided in Part 3 of this chapter. Prior to a discussion regarding the required content and pedagogy, a review of the types of skills required by students to become digital innovators needs to take place. The next section will discuss the skills required by 21st-century graduates and isolate those that may be more pertinent for IS students to become digital innovators.

To summarise Part 1, the world is changing as a result of digital technology at a speed never seen before, and this has far-reaching consequences for society that can be perceived as positive or negative. IS students are in the fortunate position that they are instructed in both IT and business and therefore can be taught to identify the value of technology advances to meet an unmet organisational or societal need. This requires flexibility and the ability to collaborate, which requires skills such as problem solving, communication, team working, multicultural openness, adaptability, innovation and creativity, the ability to filter knowledge, and to use it to learn and apply learnings to new situations and scenarios. The importance of entrepreneurship and innovation to create jobs and new opportunities due to the inevitable impact of automation are also stressed as critical components within the digital economy.

The teaching of digital innovation requires an understanding and integration of not only the subject matter, but also how students develop their skills, habits, practices and conceptions of learning in a digital age. The mode of learning needs to reflect the experience of learning in a digital age. This requires additional emphasis on developing higher-order thinking skills such as critical thinking, integrating new-media literacy into education programmes, and including experiential learning that gives prominence to soft skills such as the ability to collaborate, work in groups, read social cues and integrate interdisciplinary training. Students need to be

prepared for the digital economy through the design of a participative, digitally enabled collaborative learning environment.

Part 2: Skills for the digital economy

> *"Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution."*
>
> (Albert Einstein, 1929)

Background

Part 2 reviews the literature to help answer the second sub-question posed in Chapter 1, namely **what skills are required from IS students to develop the competence to be digital business innovators?**

In this study, skills are defined as "the knowledge and experience needed to perform a specific task or job" and competence as the "ability to apply knowledge, know-how and skills in a habitual or changing situation" (Cobo, 2013:68).

"For the previous historic innovations in history, businesses had the ability to be late adopters", and many of them were. They waited to see what would happen before charting their course. Due to the advancement of digital technologies at an exponential rate, disruption and changes in the demand for certain skills sets are rapidly growing, when it comes to the future of work, a late adopter is the same thing as being out of business (Morgan, 2014:18).

The review of what the digital economy entails in Part 1 emphasised the importance of a changing landscape that requires a radical new way of looking at skills requirements and the instruction thereof. The digital economy will require "T-shaped" workers, who bring a deep understanding of at least one field (vertically), but have the versatility to understand and participate in a broader range of disciplines (horizontally). This concept of T-shaped people was first introduced by the design consultancy IDEO, which emphasised the importance of both a deep expertise in a given field and a broad understanding of other fields (van Dijk, 2010). This requires T-shaped learning that provides a broad level of basic understanding that is complemented with a deeper, more specific and detailed understanding of a particular subject (House of Lords, 2015). The future workforce will have to become lifelong students who will be exposed to multiple industries and disciplines over the span of their careers, emphasising this T-shaped quality (Davies, et al., 2011).

HEIs will have to adapt by placing additional emphasis on the integration of digital literacy into education programmes. They will further need to include experiential learning and interdisciplinary training that allows students to develop skills and knowledge in a range of subjects (Davies, et al., 2011). Students need to be prepared for an uncertain, complex and ambiguous world and be given the opportunity to practise skills. Students need to move beyond the current horizons of knowledge and skills within a specific discipline and

develop a "sense of self" in order to be adaptable, which requires a curriculum that is "future proof" (Laurillard, 2012:17).

An information-transmission model of teaching can no longer be sufficient because it limits the skills and competencies required in the digital age (Bates, 2015:415). It is becoming evident that individuals who are good at idea generation, creativity and innovation, 'thinking outside of the box,' will find themselves in demand in a digital world. More focus needs to be placed on teaching skills of ideation, pattern recognition and communication and, where possible, to help create self-organising learning environments (Brynjolfsson & McAfee, 2014:88-90).

21st-Century learning

The umbrella term used to describe the type of skills that students will need to develop in the digital economy is "21st-century skills" (21st CS). These skills are very different to the skills required in the 20th century due to changes in the world of work, as discussed in Part 1. These generic skills for 21st-century employment and citizenship are applicable across different disciplines and are a vital aspect of formal learning (Laurillard, 2012:18).

During the 1990s, many countries started referring to 21st CS in their curriculum documents (Partnership for 21st Century Learning, 2015). Increased pressure from industry and government was placed on educators to develop 21st CS in pedagogy, curriculum and assessment, resulting in a number of different frameworks for 21st CS. Table 2 compares summaries of some of the frameworks.

Table 2: Comparison of 21st-century skills frameworks

Teaching of 21st-century Skills (ATC21S)	European Union: Key Competences for Lifelong Learning (2008)	Partnership for 21st Century Skills (P21)	Finnish National Curriculum 2004: Cross-curricular themes (C) and working methods (W)
WAYS OF THINKING Creativity and innovation Critical thinking Problem solving Decision making Learning to learn, metacognition	Learning to learn	Creativity and innovation Critical thinking Problem solving	Human growth (C) Skills for thinking, learning and problem solving (W)
WAYS OF WORKING Communication	Communication in the	Communication	Working skills (W)

Collaboration (teamwork)	mother tongue Communication in foreign languages	Collaboration	Social skills (W) Active participation (W)
TOOLS FOR WORKING Information literacy ICT literacy	Mathematical competence and basic competences in science and technology Digital competence	Information literacy, media literacy ICT literacy	Media skills and communication (W) Human technology (W) ICT literacy (W)
LIVING IN THE WORLD Global and local citizenship Life and career Personal and social responsibility, including cultural awareness and accountability	Cultural awareness and expression Social and civic competences Sense of initiative and entrepreneurship	Flexibility and adaptability Initiative and self-direction Social and cross-cultural skills Productivity and accountability Leadership and responsibility	Cultural identity and global awareness (C) Participatory citizenship and entrepreneurship (C) Responsibility for the environment, wellbeing and a sustainable future (C)

Source: Adamson and Hammond (2014)

Many other frameworks also exist, such as "the Metiri Group and NCREL (2003), the American Association of Colleges and Universities (2007), and the Organization for Economic Cooperation and Development (2005)" (Dede, 2010:4). In another study, 15 more frameworks were compared to identify the common elements of 21st-century frameworks in order to identify the types of knowledge claimed to be integral to a 21st CS (Kereluik, Mishra, Fahnoe & Terry, 2013). In the review conducted in Part 1, the necessary skills that are predominant for digital business innovation were explored. The review enabled a comparison between the different frameworks, and the framework of Kereluik et al. (2013) was deemed to be the most appropriate for this study, as it was found to be the most comprehensive (see the findings in Figure 10).

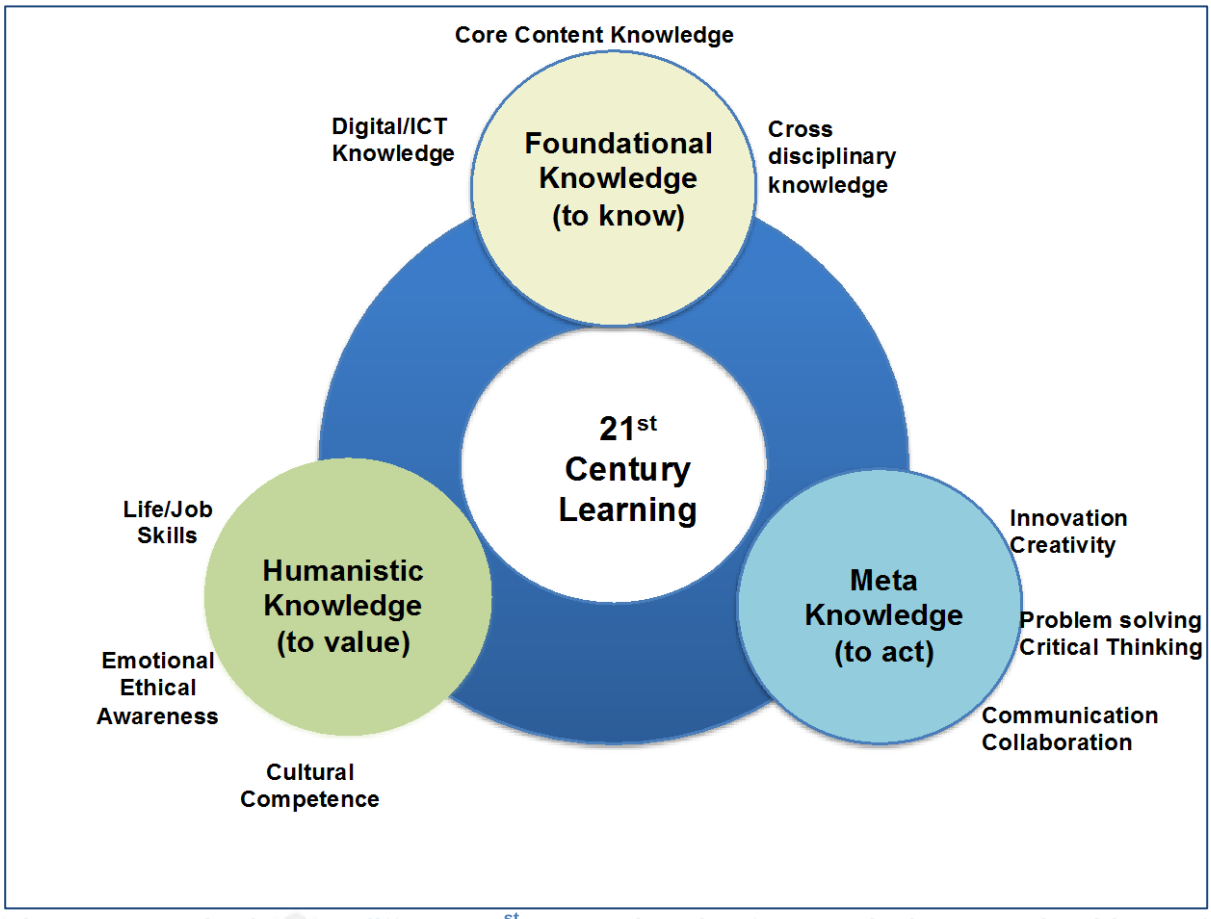

Figure 10: Synthesis of 15 different 21st-century learning frameworks into one visual image (Kereluik et al., 2013)

The three-by-three synthesis of the framework aligns with declarative, procedural and conditional knowledge, as defined by cognitive psychologists (Mishra & Mehta, 2017).

Changes to knowledge acquisition in a digital world

In Figure 10, **foundational knowledge** consists of core content, cross-disciplinary and digital knowledge. One can argue that content knowledge will continuously change in an IS curriculum due to the rapid advancement of technology. Furthermore, the methods and techniques of obtaining, expressing and manipulating knowledge will also continue to evolve. This does not imply that students do not need deep disciplinary knowledge, merely that more authentic disciplinary inquiry needs to take place (Kereluik et al., 2013). Teachers need to facilitate a process of developing broader disciplinary lenses to make transdisciplinary real-world connections (Cain & Henriksen, 2017; Mishra & Mehta, 2017).

The development of T-shaped individuals requires deep knowledge of an area, with the added ability to think outside of the disciplinary confines. IS students need to be completely confident with the use of digital technologies and have a broad understanding of the available technology. Students need to be able to track

changes in technology and be familiar with the applications of new technology within a business environment. Digital knowledge requires a deep understanding of the entire digital environment and the ability to quickly adopt new technology and co-create content. Students also need to master online communication etiquette and digital rights and responsibilities (Adams Becker et al., 2017).

Meta-knowledge is knowledge "to act" using creativity, innovation, problem solving, critical thinking, communication and collaboration. These skills are not unique to the 21st century, but have been amplified by digital transformation because of the large amounts of information available and the ability to distinguish the reliability thereof, as well as open communication and collaboration across a wide variety of platforms (Kereluik et al., 2013). Meta-knowledge requires students to develop skills such as ideation, large-frame pattern recognition and complex communication (Brynjolfsson & McAfee, 2014; Cain & Henriksen, 2017). In order to develop these skills in students, authentic tasks and assessments are required to enable them to learn and demonstrate such outcomes (Herrington, Reeves & Oliver, 2010). In order to develop creativity and innovation skills, deep cognition is required via immersion in an authentic learning environment to allow students to experience the process and reflect upon it, which requires time (Hartman & Darab, 2012). Creativity is often emphasised in organisations, but what needs to be pursued actively is innovation. Innovation requires creativity to be effective, and creativity requires innovation to be effected (Briggs, 2013).

Globalisation, digital transformation, extreme longevity and AI will all have an impact on **human knowledge**. Students need to develop the skills to become lifelong learners in an ever-changing world and have a future-focused mindset. A deep understanding of human emotions and human interactions will become more and more important as we march towards the "second machine age" (Kereluik et al., 2013; Brynjolfsson & McAfee, 2014; Nanterme & Daugherty, 2017).

The next section takes a deeper look at innovation skills and begins to introduce the type of learning environment that will stimulate such skills.

Innovation skills

As discussed in Part 1, the diffusion of digital technology is opening up opportunities to innovate (implementation of ideas) and innovation is increasingly being regarded as the skill that separate students who are prepared for the challenges of increased complexity in the digital world from those who are not (P21, 2015). Furthermore, individual innovativeness is no longer viewed as a trait and studies have proven that it can be learned via effective training in innovation skills (Brown, 2008; Wagner, 2012; Celuch, Bourdeau & Smothers, 2014). Although the enhancement of innovation and creativity in oneself and others comprises foundational skills in the IS 2010 curriculum, literature containing explicit guidance on how to instruct IS students to achieve this is limited (Topi et al., 2010).

Learned behaviour, including the ability to question, observe, experiment and network, can enhance the ability to be more innovative (Dyer, Gregersen & Christensen, 2009). In the process of learning to innovate, students need to be prepared to think creatively, work creatively with others, learn to implement innovations, reason effectively, use systems thinking, make judgements and decisions, solve problems, communicate clearly, and collaborate with others (Partnership for 21st Century Learning, 2015). In a more simple description, one might say that innovation skills cover three basic areas: thinking (customer-focused thinking and problem solving), telling (getting others on board and storytelling), and doing (learning through experimentation).

Cobo (2013) explores this further to identify the elements necessary for an innovative society and stresses the criticality of developing skills for innovation in education. These include:

- The mismatch between what is taught in formal education versus what is required by an innovative society such as multi-disciplinary thinking. This is echoed by Wagner (2012), who claims that education is neither adding value nor teaching the skills that matter most in the marketplace.
- The shift from what we learn to how we learn to better understand how knowledge is co-created and re-constructed. Furthermore, the ability to filter information to develop the skills to think scientifically.
- The fluctuating relationship between digital technologies and content to assist students in how to think and not to tell them what to think.
- Education needs to be participative and utilise technology to digitally enable collaboration.
- The changing conceptions of space-time and the emphasis on lifelong learning. These aspects talk to what Castells (2004:36) terms “timeless time”, shaped by the “space of flows”. In the digital economy, work becomes much more flexible and unstable, transforming space and time.
- The development of soft skills or social behavioural skills such as those depicted in Table 1, and skills such as critical thinking, communication, creativity, innovation and self-direction.

Part 3 of the chapter reviews the pedagogy and content to teach digital business innovation as supported by the use of technology within the teaching environment. In concluding this section, it must be emphasised that as “much attention needs to be given to skills development as to content acquisition to ensure that students graduate with the necessary knowledge and skills for a digital age” (Bates, 2015:16).

To summarise Part 2, different frameworks to define the skills sets required in a digital world were reviewed and the framework deemed to be most appropriate was identified. This framework requires students to acquire foundational, meta- and human knowledge.

Those skills sets more prominent in the teaching of digital business innovation emerged as cross-disciplinary knowledge to develop T-shaped individuals, digital skills, problem solving, communication and collaboration, as well as innovation and creativity. The other aspects cannot be excluded for example setting the foundation with the correct core content, students obtaining life and job skills as well as the importance of cultural and ethical knowledge.

The following section will analyse the teaching and learning environment that needs to be created to teach these skills.

PART 3: Skills for teaching digital innovation to IS students

Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand.

Confucius

Background

Part 3 reviews the literature to explore alternatives to answer the third sub-question posed in Chapter 1, namely w**hat teaching and learning interventions are required to teach digital business innovation skills to IS students?**

As discussed in the previous sections, skills such as problem solving, creativity, critical thinking, innovation, collaboration and entrepreneurship will become essential in the future. To teach digital innovation to IS students, the changing learning landscape is considered and, via an iterative approach using design research, new formats and strategies for learning and teaching in IS are explored. This is required for relevant, effective and high-quality learning experiences in the future that allow for flexibility in terms of learner needs and industry requirements (Redecker et al., 2011). This section explores the teaching and learning interventions required to teach the skills identified in Part 2 via an analysis of the content, pedagogy and technology affordances required.

The importance of deeper learning approaches found in 21st-century learning was emphasised in the previous section. The fostering of active learning experiences emerged in the previous century, when educational theorists began to analyse what it means to learn, away from the tell, practise, test model. Theories such as experiential learning, social learning, inquiry-based learning, constructivism, problem-based learning, situated learning or learning through doing emerged. To learn is more than simply being told; however, the mode of teaching has not changed radically and the potential of the technology to be applied to meet learner needs must be explored further (Laurillard, 2008).

In order to cultivate such knowledge, students need to understand the real-world relevance of their coursework to foster more active learning experiences, both inside and outside the classroom (Johnson et al., 2016:8). This requires classrooms to move away from the traditional to resemble real-world work and social settings that encourage transdisciplinary problem solving (Green, 2015:35; Adams Becker et al., 2017).

For 21st-century learning to be effective, the active involvement of students in their learning is paramount. The design of learning based on how human beings think and learn has been influenced for decades by cognitive psychologists like Vygotsky (1978). Their work has been taken forward and literature on the nature of thinking, problem solving and reasoning is in abundance but to actively involve students, the importance of an authentic learning environment emerges (Herrington, 1997). In this study, the application of authentic learning principles is explored to enable the cultivation of the type of skills required by IS students to become digital business innovators.

Teaching Technological Pedagogical Content Knowledge (TPACK)

This section of the study investigates Technological Pedagogical Content Knowledge (TPACK) within an authentic learning environment to teach digital business innovation effectively. When exploring how to teach digital business innovation to IS students, it is necessary to examine the learning designs to integrate content, pedagogy and technology. The notion of pedagogical content knowledge (PCK), which describes how to teach a concept successfully using the integration of knowledge of content with knowledge of pedagogy, was customary in the past (Shulman, 1986). This idea, deriving from Schulman (1986), was extended to incorporate how technology can be integrated into effective pedagogy to teach a certain concept (TPACK) due to rapid advances in information and communication technology (Mishra & Koehler, 2006).

TPACK is knowledge that goes beyond all three components (content, pedagogy and technology). “TPACK represents a class of knowledge that is central to teachers’ work with technology. This knowledge would not typically be held by technologically proficient subject matter experts, or by technologists who know little of the subject or of pedagogy, or by teachers who know little of that subject or about technology” (Mishra & Koehler, 2006:1029) The integration of technology in teaching requires all three concepts to be looked at as an integrated system.

The general application of the model across different contexts, however, can be debated and the issue of how technology affordances can transform content and pedagogy is not adequately addressed in the model. Moreover, factors other than content, pedagogy and technology are not taken into account. As argued by Angeli and Valanides (2009:157), this generalisation “may lead to possible erroneous, simplistic, and naïve perceptions about the nature of integrating technology in teaching and learning”. In this thesis, the elements of TPACK are applied, but a new framework that incorporates TPACK and other elements that relate to the teaching of digital innovation needs to be created.

Aspects surrounding pedagogy, content and technology are discussed in the sections below as they relate to the teaching of digital business innovation skills to IS students. The theoretical constructs of these elements are explored further to construct potential design principles and a design framework.

Pedagogy

An analysis of the pedagogy in the framework assists teachers and students with the design of a digital business innovation environment that develops the skills required for competent workers of the future. One ought to question the impact of digital technology and changes in the educational sphere on our understanding of pedagogy. Will theoretical pedagogical concepts still rely on Dewey, Vygotsky, Bruner, Papert, Lave and Wenger (Beetham & Sharpe, 2013)? What will be the best way to guide learning in the instruction of digital business innovation? Any pedagogical endeavour involves interactions between the teacher and students and, in this uncertain, constantly changing environment, collaboration and sharing among practitioners and other stakeholders will be highly beneficial (Sharpe et al., 2010; Bozalek et al., 2013). This study explores the pedagogy via collaboration between practitioners, students and industry partners to test the design of the best way to instruct digital business innovation.

This collaborative learning can be achieved by placing students at the centre, continuously emphasising interaction, group work and the development of solutions based on real-world challenges via the creative use of emerging technology (Adams Becker et al., 2017). Students need to be active participants in their own process of learning, and the educator ought to provide the necessary scaffolding and guidance to facilitate this process. Vygotsky (1978) refers to this as the Zone of Proximal Development, whereby students are guided from what they can learn independently to what they can achieve with guidance from a more experienced individual in order to move to a level of deeper understanding. This study reviews the learning framework that could best cultivate the higher-order thinking skills required to teach digital business innovation.

Philosophers and cognitive scientists have for centuries explored the manner in which people learn. The linking of knowledge and experience was extensively explored by educators such as John Dewey and Jean Piaget. David Kolb recognised these factors and combined the work of Dewey and Piaget with the psychology of Kurt Lewin to develop the experiential learning cycle. This cycle consists of concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Kolb, 1984).

A typical staged process in experiential learning can be described as follows:

- Experience and explore: doing;
- Sharing and reflecting: what happened?
- Processing and analysing: what's important?
- Generalising: so what?
- Applying: what works for me? (Brown, Roediger & McDaniel, 2014).

In experiential learning, students must try to accomplish a task and solve problems through the use of creativity and stored knowledge. Students are more likely to learn if they have to find the solutions using the help of experts, texts or the Web, as opposed to somebody trying to teach them. Learning is best facilitated via dynamic, interactive sessions by lecturers with subject-matter expertise and practical knowledge (Brown, Roediger & McDaniel, 2014:160).

Project-based, experiential learning contains a learning environment that can be conducive to teaching digital business innovation skills. However, from a review of the literature, the best framework to apply is authentic learning.

Authentic learning

Learning designs to promote situated learning are often applied to professional and vocational education, where there is a clear incentive to develop certain skills and competencies within a profession (Beetham & Sharpe, 2013). Brown, Collins and Duguid (1989) developed one of the first models of *situated cognition* or *situated learning* to provide a theoretical perspective for successful learning in order to improve methods of teaching. Their model suggests that learning needs to take place as it would in real life. Their notion of apprenticeship was punted as particularly successful. However, merely viewing situated learning as "learning by doing" was cautioned as being too restricted by Lave and Wenger (1991). McLellan (1994) subsequently summarised situated learning as: apprenticeship, collaboration, reflection, coaching, multiple practice, and articulation of learning skills. In 1997, Herrington expanded these concepts further and identified nine critical elements of situated learning and developed a model for authentic learning that could successfully be applied to educational practice.

The development of certain 21st-century skills to teach digital business innovation has a natural affinity towards an authentic learning environment in which students must be "engaged in an inventive and realistic task that provides opportunities for complex collaborative activities" (Herrington, Reeves & Oliver, 2010:1). The principles of authentic learning as outlined in Herrington, Reeves and Oliver (2010) are described below.

1. Provide **authentic contexts** that reflect the way the knowledge will be used in real life. The argument is made that students ought to be challenged via realistic levels of complexity in the learning environment and guided in this, as opposed to the oversimplification of complex issues. This will mirror the real-life situation that students will encounter in the workplace and prepare them to function successfully in the digital economy. There is a big difference between real-life and in-school problem solving, where problems need to have depth, complexity and duration and not seem artificial, with little relevance to students. Moreover, real-life problem solving is not an individual task but involves collaboration and a shared consequence (Lebow & Wager, 1994). The design ought to be nonlinear and students should have a large number of resources available to them.

2. Provide **authentic task/s** to enable students to interact with the learning environment and demonstrate their skills and competencies. These need to have real-world relevance, be ill defined, continue over an extended period and be integrated across subject areas. This is the central element in the design of the authentic learning environment, as discussed in further detail in the next section.

3. Provide access to **expert performances** and the **modelling of processes** by allowing students access to experts within the industry, collaboration with other students and facilitation by the lecturer.

4. Provide **multiple roles** and perspectives to move away from a linear method of instruction and expose students to different perspectives on the topic and come in from different angles using a variety of interpretations.

5. Support the **collaborative construction of knowledge tasks** in which group work is required to complete tasks and the appropriate assessment is in place to emphasise whole-group achievement.

6. Promote **reflection** to enable abstractions to be formed by students whilst they are working within the authentic context completing authentic tasks. They need to be able to go back to any element and reflect on the outcomes thereof and compare themselves to experts and the other learners, both during the completion of tasks and afterwards.

7. Promote **articulation** to enable tacit knowledge to be made explicit. Students need to have continuous opportunities to discuss their learnings as their understanding grows within their collaborative groups and via presentations during class.

8. Provide **coaching and scaffolding** by the teacher **at critical times** to support students in their learning by playing the role of facilitator who guides students and provides resources.

9. Provide for **integrated assessment of learning** within the tasks to provide the opportunity for students to demonstrate their acquired knowledge as the learning progresses until the final product is delivered. Assignments need to allow enough time for students to collaborate with others. Educators widely acknowledge that assessment is a key driver of student behaviour and therefore can play an important role in teaching innovations (Osborne, Dunne & Farrand, 2013; Bates, 2015:467). The teaching of digital innovation cannot rely on traditional forms of assessment, as authentic assessment that incorporates group work, problem-based, collaborative and portfolio assessment will be far better suited (Allen & Coleman, 2011).

Educators differ on whether an authentic learning environment requires industry partnerships to create a real-world environment. It is, however, emphasised that the importance of authenticity is for the experience to make sense to the students. The exposure to complex, ill-defined real-world problems can create an authentic

environment for students. Such an environment, coupled with the affordances of the right technology, can foster deeper thinking skills that support 21st-century learning (Parker, 2015) .

Herrington (2006) emphasises the focus on authentic tasks as a critical component of authenticity in authentic learning environments, and as a result this component is described in further detail below in order to explore the effectiveness thereof in the creation of an environment for the effective instruction of digital innovation skills.

Authentic Tasks

In formal education, tasks are required via demands of the curriculum and activities are engaged in by students in response to the demands of a task (Beetham & Sharpe, 2013). Table 3 contains a breakdown of the requirements of authentic tasks and guidance on the mapping thereof to course design.

Table 3: Authentic tasks

Authentic tasks	Mapping to course design
Real-world relevance	Activities match as nearly as possible the real-world tasks of professionals in practice rather than decontextualised or classroom-based tasks.
Ill-defined activities	Problems inherent in the activities are ill defined and open to multiple interpretations, rather than easily solved by the application of existing algorithms. Students must identify their own unique tasks and subtasks in order to complete the major task.
Complex tasks investigated over a period of time	Activities are completed in days, weeks and months, rather than in minutes or hours, requiring a significant investment of time and intellectual resources.
Examine tasks from different perspectives, using a variety of resources	The task affords students the opportunity to examine the problem from a variety of theoretical and practical perspectives, rather than a single perspective that students must imitate to be successful. The use of a variety of resources rather than a limited number of pre-selected references requires students to distinguish relevant from irrelevant information.
Opportunity to collaborate	Collaboration is integral to the task, both within the course and the real world, rather than achievable by an individual learner.

Opportunity to reflect	Activities need to enable students to make choices and reflect on their learning, both individually and socially.
Integration of different subject areas	Activities encourage interdisciplinary perspectives and enable diverse roles of expertise, rather than a single, well-defined field or domain.
Integration with assessments	Assessment of activities is seamlessly integrated with the major task in a manner that reflects real-world assessment, rather than separate, artificial assessment removed from the nature of the task.
Creation of a polished product	Activities culminate in the creation of a whole product rather than an exercise or sub-step in preparation for something else.
Allow for competing solutions and a diversity of outcomes	Activities allow a diversity of outcomes open to multiple solutions of an original nature, rather than a single correct response obtained by the application of rules and procedures.

Source: Herrington (2006)

Research suggests that the use of authentic tasks supports self-directed and independent learning because the focus is on educating the student and not focusing on the content. Teachers need to re-condition students in terms of expectations for defined readings, well-structured tasks, well-defined problems, and receiving information in a timeous manner (Herrington, 2006).

The pedagogy must include the course design criteria, the properties of the teaching and learning tasks, and the capabilities of the conventional and digital tools and technologies being used (Laurillard, 2012:214). In the following section, the content-specific aspects to teach digital business innovation are discussed.

The relevant content to teach digital business innovation

The importance of teachers to have content knowledge within their given field cannot be disputed (Shulman, 1986). As discussed, the pressure to develop the skills required in a digital economy requires changes in the way we teach. This is also applicable to course design and the application of new, ever-changing technology and applications.

The availability of content and courses is exploding, with more to learn and more ways to do so. What we teach is changing, but how we do it is the key to preparing students for an uncertain future (Bowen, 2012). The content can be flexible, based on the experience of the students or as new knowledge emerges; however, the core skills to be developed will remain constant. What needs to be emphasised is not to do the same things better with technology, but to obtain outcomes that are different and relevant for teaching in a digital world (Bates, 2015:139).

In the design of the course, there are some core design principles pertaining to an authentic learning environment to be adhered to, as described in the section above. The key, however, is to be agile in the design to adequately prepare students for an uncertain future and incorporate changes quickly within the course (Bates, 2015:139). The application of DBR enables this because principles are tested in each iteration and updated according to the findings.

In a review of the content, the primary concepts that need to be taught are discussed, as well as the reasons for selecting these concepts as the primary drivers of course content.

Business model innovation

In the past, the primary focus of IS scholars was on process innovation, but the digital explosion requires a refocus on product, process and business model innovation in IS teaching and research going forward (Fichman, Dos Santos & Zheng, 2014). This is supported by Veit et al. (2014), who emphasise that business model innovation is largely under-researched in IS. Contrary to research on business models, where 1 741 journal articles with the title “business model” are listed on the Scopus database, only 156 articles on “business model innovation” are listed for the period 2005 to 2016. The literature on BMI only started increasing from 2013, pointing to the relative newness of the research area. Foss and Saebi (2016) substantiate this, as they found that the literature exhibits many of the characteristics of an emerging research stream, with a lack of clearly articulated research models.

Digital process innovation focuses on adoption and when and why organisations adopt new technologies, whether supplied by the market or internally developed. Product and business model innovation focuses on the supply side of innovation and is mostly grouped together (Fichman, Dos Santos & Zheng, 2014). In the development of content, the focus is on business model innovation (including product innovation) because it requires a more holistic view of the entire value chain of a business.

A business model provides a framework to strategically review how a business is structured to create, deliver and capture value (Osterwalder & Pigneur, 2010; Veit et al., 2014). Business model innovation (BMI) can assist one to examine future value and also provides an overview of the entire system, in contrast to process innovation. Osterwalder and Pigneur (2013) describe a Business Model as an overarching framework with which novel approaches in the digital era can be strategically structured, analysed and designed to be a competitive tool that can translate into a sustainable advantage for an organisation (Amit & Zott, 2012).

In a review of available BM frameworks, the one that was deemed the most appropriate to teach the concepts of BMI to IS students was the business model canvas designed by Osterwalder and Pigneur (2010). It provides a clear conceptual framework that facilitates both the understanding and the design of business models. This framework can assist students to conceptualise a business and understand the impact of digital innovation on the entire BM. Figure 11 provides an overview of this canvas.

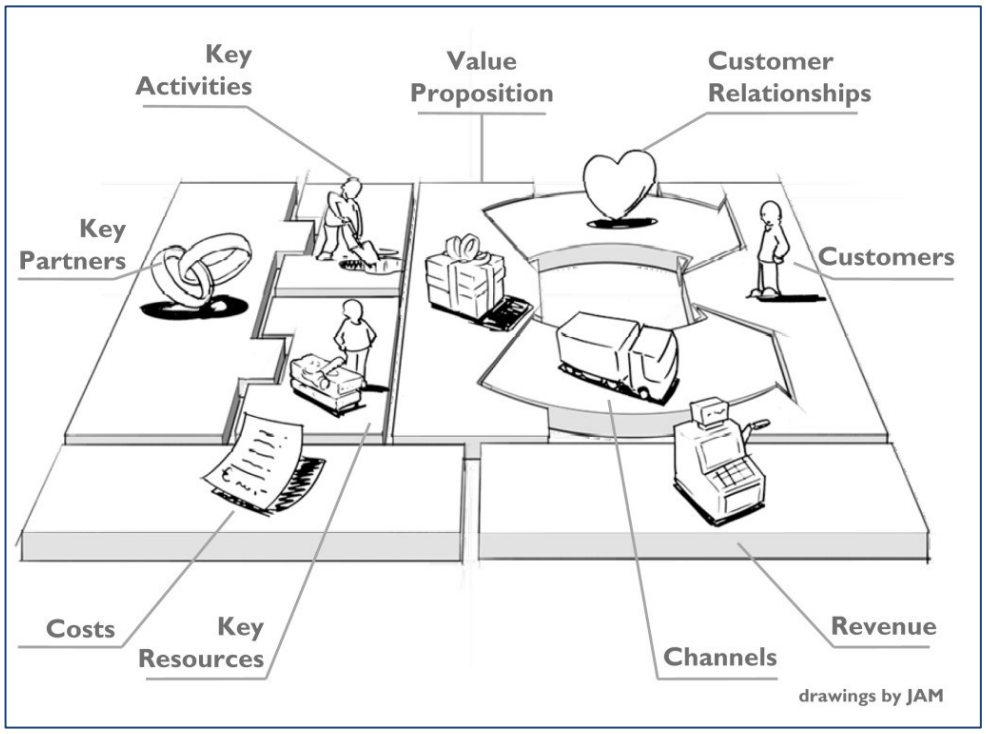

Figure 11: Business model canvas (Osterwalder & Pigneur, 2010)

Business model innovation is crucial to yield the benefits of a new technology, and excellent business models have as much value as excellent technologies, or even more, because if outside firms uncover a business model more suited for a given technology they will capture the value and not the firm that originally discovered the technology (Chesbrough, 2010). Students need to understand the concepts in a business model and business model innovation to harness the benefits of digital business innovations. This will enable them to understand disruption and how traditional ways of doing business can constrain new modes of value creation (De Jong & Van Dijk, 2015).

The next section describes how to go about the process of digital business innovation by discussing the process of design thinking, including prototyping, and exploring alternative solutions to implement digital business innovations.

Design Thinking

"Thinking like a designer can transform the way you develop products, services, processes and even strategy."

(Tim Brown, 2008:1)

The previous section discussed the importance of incorporating business model innovation into the IS curriculum in order to teach digital business innovation. The inability to apply design thinking has been cited as a core issue

faced by many organisations in designing new and viable business models (Johnson, Straker, Wrigley & Buccolo, 2013; Osterwalder & Pigneur, 2013). According to Checkland and Poulter (2010, as cited in Osterwalder & Pigneur, 2013), IS may be the best suited field to combat this due to its body of knowledge specifically related to design process and methodology. Utilising a design thinking framework as popularised by IDEO can be a useful technique in this process (Brown, 2008).

There is a strong correlation between design thinking and the cultivation of skills identified in the previous sections as essential for IS students to become digital business innovators. Design thinking is increasingly recognised for its ability to cultivate creativity and innovation because of the connection between innovation skills and design thinking elements, such as empathy, listening, collaboration and experimentation (Wagner, 2012). By following a design thinking approach, students are involved in a process of collaboratively solving complex, real-world or wicked problems. A further advantage of this approach is the strong focus on collaboration and teamwork, as well as the cultivation of empathy and social interaction within the rollout of the design process (Koh, Chai, Wong & Hong, 2015:10-11).

The process of digital innovation consists of four stages, namely:

- Discovery of new ideas for potential development into a process, product or business model innovation via invention or the selection of an innovative technology in the external environment.
- Development of an idea for a core technology into a usable innovation.
- Diffusion to spread an innovation across a population of potential users to adopt and use the innovation.
- Impact (intended and unintended) that digital innovations, once diffused, have on individuals, organisations, markets and society (Fichman, Dos Santos & Zheng, 2014).

The phases of design thinking vary, but ultimately support these four stages by going through the process of definition and research, ideation, prototyping, choosing, implementation and learning. This cycle is iterative, with the end point of a previous cycle becoming the beginning of the next iteration. It is noted that the circular nature of the process enables managers to engage in continuous learning in the changing environment of digital innovation (Lee Chong & Benza, 2015).

To complement the elements of design thinking, further aspects to be included in the course development need to be a suitable project methodology to help guide the process from ideation to implementation. The next section highlights the benefits of using an agile project methodology.

Agile methodology

During design thinking, students are focusing on getting to know the organisation and its clients and generating ideas for the implementation of a digital business innovation. A project methodology needs to be introduced to

help guide the process to final implementation. The strength of agile projects is the focus thereof on multifunctional teams that work together and implement solutions through early prototyping, quick feedback and incremental development to support an iterative process. The benefit of agile projects is that they enable one to meet customer needs in a shorter time and more cost effectively than through traditional approaches (Gurusamy, Srinivasaraghavan & Adikari, 2016).

Agile methodology emerged as a project management methodology in software development as an alternative to the traditional Waterfall, V or stage gate methodologies. It was formalised via the Agile Manifesto in 2001 (Edin Grimheden, 2013). The manifesto consists of 12 steps that outline the approach of agile methods, which include aspects such as customer satisfaction, competitive advantage, frequent delivery, collaboration, team work, design excellence, simplicity, self-organising teams and reflection (ibid).

The course design introduces students to agile methods but refines the process by using Scrum, one of the most popular processes within agile methodology. Scrum has the benefit of applying certain principles that boost collaboration and accountability within teams (Opt & Sims, 2014). Scrum prescribes four formal events, namely sprint planning, daily scrum, sprint review and sprint retrospective. Students need to be exposed to the rules of each using a source such as the Scrum Guide (Schwaber & Sutherland, 2013).

The benefits of using Scrum for student projects have been cited by a few authors (Sanders, 2007; Pope-Ruark, 2012; Edin Grimheden, 2013; Opt & Sims, 2014). The author's personal experiences in different project methodologies also contributed to the recommendation of using Scrum as the best method to roll out digital innovations and accomplish the implementation of a workable solution within an organisation.

The pedagogy and content were discussed in the previous sections. The following section discusses the technology affordances to teach digital business innovation to IS students.

Technology

There is little dispute in the literature that technology must support effective learning experiences, but where the challenge comes in is in relation to the question of how digital technologies are changing the landscape of education (Beetham & Sharpe, 2013:3). Due to the host of potential improvements that digitisation and data analytics can offer, educators need to reassess how to teach and develop the skills required in a digital world (Brynjolfsson & McAfee, 2014:96).

The literature stresses the importance of fostering a culture of innovation and entrepreneurship in higher education (Friedman & Deek, 2003; Beetham, McGill & Littlejohn, 2009; Cobo, 2013; Fichman, Dos Santos & Zheng, 2014; Adams Becker et al., 2017). Technology opens up many opportunities to be more creative and innovative in teaching students what they need to know, and in how to find, evaluate and apply information (Bates, 2015). This necessitates courses to be structured to allow flexibility and to drive creativity and

entrepreneurial thinking to actively train students to become digital innovators (Tumbas, et al., 2014). Technology plays a dual part in this process – both learning with technology (pedagogy) and learning about technology (content).

Educators are faced with a wide variety of new technological tools and applications and challenged by new ways of engaging with students and colleagues, requiring them to employ new learning methodologies (Adams Becker et al., 2017). It is no longer sufficient to simply know your subject matter, you also need to know the manner in which your subject matter can be changed by the application of technology (Mishra & Mehta, 2017). The South African higher education landscape is shifting to a cloud-based ICT infrastructure, opening up multiple educational opportunities in teaching and learning (Kilfoil, 2015:5). However, because technology and digital tools have become so ubiquitous, a clear direction in terms of how they are integrated into the teaching and learning process is required (Adams Becker et al., 2017). Technology needs to match materials and assignments in an authentic learning environment to give students control over their engagement with a subject, enable idea generation and implement solutions in their communities (Johnson, Adams Becker, Estrada & Freeman, 2016:8).

Teachers will remain the experts of their content and pedagogy and need to incorporate technology to design the best learning experiences for the transformation of information into knowledge (Johnson et al., 2016). Technology gives students access to multiple explanations of a concept, but the onus is still on the teacher to make the conceptual narrative clear to the learner for it to be understood. Technology cannot bypass the responsibility of teachers to work out how to “structure an intelligible presentation of a difficult idea” (Laurillard, 2012:119). This is also emphasised by Herrington (2006), who cautions against the use of technology to merely house course information rather than engaging students in active learning. Therefore, “digital models of teaching and learning are required and not just a technology overlay on old modes of teaching and learning” (Venkant, cited in Brynjolfsson & McAfee, 2014:96). The creation of an authentic learning environment supported by the correct technology, pedagogy and content can mitigate this and encourage the cultivation of the right skills for a digital economy.

Because technology is changing so fast, it becomes difficult to remain up to date on the latest software, hardware and terminology for teaching and learning. The key is in leveraging technology in creative ways to allow for adaption and innovation in teaching (Adams Becker et al., 2017). The emphasis ought to be on inquiry, creativity and experimentation to realise the full potential of technology. The findings of a study on the use of emerging technologies by 262 South African higher educators shows that there is a “symbiotic, rather than a simple cause-effect relationship between emerging technologies and transformative teaching and learning approaches like authentic learning” (Bozalek et al., 2013:8).

For the purpose of analysing the best match between technologies and learning outcomes, the affordance classification of a system needs to take place. Kirschner et al. (2004, as cited in Bower 2008:6) provide a

framework that incorporates not only technological but also social and educational affordances to support the collaborative design of learning tasks. Affordances can be classified according to the possibilities offered to the user in order to select the technology that best matches the learning tasks. Classification of affordances can be functional and non-functional from an educational point of view. For the functional classification of affordances, the emphasis will be on what can be accomplished with the educational design and not the usability of the system, as is the case with non-functional affordances (Bower, 2008). The steps to follow are firstly to define educational goals or outcomes in order to derive the learning design, and thereafter to create the relevant tasks to enable the achievement of learning outcomes. The affordance requirements of tasks can then be determined to find a suitable technology/tool (Bower, 2008). This process needs to be applied in determining the technological affordances for teaching digital business innovation.

Students need to become the co-designers in the new framework and, through a DBR approach, the affordances of different technologies can be tested and improved upon. Technology needs to support the development of a higher-order-skills or conceptual understanding by becoming a tool for understanding (Laurillard, 2008).

In Table 4, different applications are analysed to test their affordances from an educator and student perspective.

Table 4: Matching technology solutions and user requirements

User	Requirement	LMS	Google Drive	Wikis	Haiku	Edmodo	Ever-note	Facebook	Dropbox	Socrative	Twitter
Lecturer and Student	Write-ability										
	View-ability										
	Draw-ability										
	Listen-ability										
	Speak-ability										
	Watch-ability										
	Resize-ability										
	Move-ability										
	Accessibility										
	Search-ability										
	Browse-ability										
	Share-ability										

	Permission-ability										
	Multi-platform										
Lecturer	Record-ability										
	Link-ability										
	Analytics										
	Combine-ability										
	Integrate-ability										
	Real-time Feedback										
Students	**Familiar**										
	Free										
	Fast										
	Flexible										
	Assessment										
	Co-creation and Ideation										

Source: Adapted from Brown (2008)

The review of the affordances of different technologies to assist with the instruction of students pointed to the use of both learning management systems (LMS) and Google Drive. The LMS at the university where the study was conducted is sophisticated enough to allow for such affordances, but all LMS systems are not as robust. A review of the different affordances needs to take place to test the LMS system at each site. The LMS system and Google Drive were tested during the different iterations to make further recommendations.

Factors such as a teachers' epistemological beliefs (how students learn), practical experiences about what can and what cannot work, educational outcomes and goals are all factors that come into play in determining how technology is infused in the learning process (Angeli & Valanides, 2009). Laurillard (2012:9) makes the plea that teachers implement design science as part of their professional practice in order to continuously improve practice by collaboratively building on the work of others. Furthermore, education needs to stop following and start leading innovation in the use of technology, which requires clarity about the principles of designing good teaching and learning with technology.

To summarise the third part of the review, the creation of an **authentic learning** environment supported by the correct technology, pedagogy and content can assist in cultivating the right skills for a digital economy.

In order to create a framework for teaching digital business innovation, the objectives of the study were to determine the skills required by IS students to become competent in the digital economy and subsequently to review the type of teaching and learning environment that will be conducive to this.

The table below contains the potential elements that were deemed to be appropriate to be included in the conceptual framework from the review of literature and consultation with practitioners, industry and students.

Table 5: Elements to include in the conceptual framework

Framework for teaching DBI skills	Findings from consultations with industry	Findings from consultation with students	Findings from practitioners	Findings from the literature
Digital innovation skills	Industry requires: communication and collaboration skills, networking and ICT skills, the ability to think critically and solve real-world problems, and the ability to filter information and embrace diversity	Students felt that they lacked communication and collaboration skills. They were unsure of their ability to solve real-world problems. They were not confident about their technical skills and their ability to adapt to new technology	Teachers were uncomfortable about the constant changes within the teaching environment as a result of new technology, and changes in industry requirements for the perfect graduate. Diversity of student needs. The lack of support that they receive was also cited	Digital and ICT knowledge Core content knowledge Cross-disciplinary knowledge Life and job skills Ethical and emotional awareness Cultural competence Innovation and creativity skills Problem-solving and critical thinking skills Communication and collaboration skills
How to teach digital innovation skills	Students need to be exposed to a "real work" environment via, for example, internships or projects in collaboration with industry. Need real experience to understand professional responsibility and accountability	Projects that deal with real clients and real-world problems are perceived as more beneficial. They feel that they learn the skills required by industry, and the exposure enables them to be more ready for the working world	Awareness of the teaching and learning environment to cultivate the required skills to teach students to operate in the real world. What content, pedagogy and technology affordances are required to create the correct learning environment	Provide authentic contexts Provide authentic tasks Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives Support collaborative learning Promote reflection to enable abstractions to be formed Promote articulation to enable tacit knowledge to be made explicit Provide coaching and scaffolding by the teacher at critical times Provide for authentic assessment

Conclusion

A review of the literature helped to clarify the concepts that support the formulation of draft design guidelines and concludes Phase 1 of the DBR process. The chapter was structured into three parts.

In the first part, current global industry trends in digital innovation and the impact thereof on the IS curriculum were explored. The speed of change that we are facing as a result of the digital economy and the impact thereof on people, work and life are substantiated by the literature. This stresses the importance of different actors to collaborate to find the best way forward in terms of how to equip our students for this uncertain future. Furthermore, an understanding is required of the integration of skills habits, practices and conceptions of learning in a digital age. The first part concluded with findings on the inability of the current IS curricula to cultivate the type of graduate who will be equipped to become a digital innovator. This section of the literature review was conducted to answer the research question: ***What is the impact of global trends in digital innovation on the IS curriculum?*** These trends helped to inform the design of the overall solution.

In Part 2, skills required from IS students to participate in the digital economy were reviewed by analysing different frameworks for 21st-century learning. The specific requirements for innovation and the teaching of innovation were outlined on the basis of the literature.

The final part of the chapter reviewed the teaching and learning requirements for instructing IS students in digital business innovation. The technology affordances as well as the pedagogy and content to effectively teach digital business innovation skills were outlined to assist with the course design.

The following chapter describes the methodology employed for this design-based research study.

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CHAPTER 3: RESEARCH METHODOLOGY

Introduction

In Chapter 1, the aim of the research was defined as the development of a framework to teach digital business innovation to South African students in Information Systems (IS). The focus is to define the skills required by IS students to become competent digital business innovators in business and society, and further to develop design principles to define the design of the teaching and learning environment. This chapter explains the research methodology to ensure the attainment of the goals and objectives set out in Chapter 1.

The chapter commences with an exploration of the research philosophy applied, followed by a discussion on DBR and its relevance to this research. To achieve this, the different aspects related to DBR are explored and the choice of a specific layout is justified. The chapter concludes with a discussion of the four phases followed during the rollout of this DBR study.

Table 6: Summary of research methods

Research context	A framework to teach digital business innovation skills to Information Systems (IS) students at the University of the Western Cape (UWC) to strengthen their skills and capabilities to participate in, and ultimately orchestrate, digital innovation in business and society
Research paradigm	Interpretivism
Research design	Educational design-based research
Data collection methods	Consisted of qualitative and quantitative archival and data gathered from an honours course and a capstone course in one university during 2016 and 2017, using different methods: Student surveys/observations/course documentation/reflective blogs/interviews/rubrics/course and peer evaluations/course marks/industry survey
Qualitative/quantitative	Mixed
Data analysis	Theoretical lenses were used to develop research outcomes. Thematic analysis techniques were applied to illustrate the themes and to create a deeper understanding Microsoft Excel was used to aid the analysis process

Research philosophy

The philosophical position determines the paradigm in which a study functions. At the most general level, a list of such paradigms – or worldviews – includes positivism, interpretivism, constructivism, realism, pragmatism and postmodernism. Each paradigm represents very different ideas about reality (ontology) and how we gain knowledge of it (epistemology) (Maxwell, 2012:42). Having an epistemological perspective helps in the clarification of the research design by informing the overarching structure of the research, including the gathering and interpretation of data. An understanding of the research philosophy assists the researcher to recognise the designs that will work for the research objectives and those that will not (Gray, 2004:17).

Because every researcher has certain prior assumptions about his/her research topic within a specific worldview and how the topic can be examined, decisions about paradigm are not entirely a matter of free choice (Maxwell, 2012:44). Four main sources to help centre the framework [to assist in defining a study's paradigm] are suggested, namely experiential knowledge, existing theory and research, pilot and exploratory research, and thought experiments (Maxwell, 2012).

These aspects were considered to determine the most appropriate research paradigm to frame this research. The thesis proposes the design of a learning environment and researches how this environment enables certain aspects whilst certain human actors interact with it. Using the classification of Orlikowski and Baroudi (1991), the ontological beliefs in terms of the phenomena under investigation will either be objective (independent of humans) or subjective, whereby the actions of humans will create and recreate our reality. Furthermore, epistemological assumptions will be constructed via our beliefs on how valid knowledge about a phenomenon may be constructed and evaluated. For a positivist worldview, for example, theory is only true if it is repeatedly not falsified by empirical events (Orlikowski & Baroudi, 1991). These aspects, in combination with the classification of Maxwell (2012:44), helped to direct the research paradigm, and the most appropriate paradigm was deemed to be interpretivist research.

In interpretivism, reality and our knowledge thereof are social products, and the social actors are all linked to them. The aim of interpretivist research is to "understand how members of a social group, through their participation in social processes, enact their particular realities and endow them with meaning, and to show how these meanings, beliefs and intentions of the members help to constitute their social action" (Orlikowski & Baroudi, 1991:14). This is an approach that aims to understand people (Babbie & Mouton, 2008:28). Although interpretivist research stems from the social sciences, it is also used in educational research (Herrington, 1997; McKenney & Reeves, 2012) and in IS (Myers, 1997; Klein & Myers, 1999; Walsham, 2006; Dhar & Sundararajan, 2007).

Design research

As clarified above, the method of inquiry and the researcher's underlying philosophical assumptions support the application of an interpretivist paradigm because the aim was to produce an understanding of the phenomena through the meanings that people assign to them. In this context there was a strong focus on human sense making throughout the duration of the study (Kaplan & Maxwell, 1994).

Design activities are central in many applied disciplines, such as arts, engineering, education, IS and psychology, because of a focus on the creation of innovative artefacts to solve real-world problems (Hevner & Chatterjee, 2010). The merger of IS research within an educational setting makes an interpretivist stance well suited for the study. Within the IS field, design-based research places a central focus on the application of human creativity in the construction of artefacts and the study of wicked problems in digital environments (Hevner & Chatterjee, 2010). DBR within a teaching and learning environment is ideal for the research and design of a learning environment in which technology plays a major role, as is the case in this study (Wang & Hannafin, 2004). However, design research differs for the different disciplines, and different terminologies, methodologies and practices apply even within disciplines.

A design science contributes to theoretical science, but it builds design principles rather than theories. The study uses the premise that teaching is a design science because it uses what is known to accomplish a certain outcome in terms of student learning, and implements designs to test them and keep on improving upon them (Laurillard, 2012:16).

Design science led to design research, which aims to address real-world problems by generating and evaluating innovative artefacts to solve them. This approach acknowledges multiple states and incorporates various paradigms and research methods, therefore both positivist and interpretivist stances can apply (De Villiers & Harpur, 2013).

The differences between Design Science Research in IS (DSRIS) and Design-Based Research (DBR) in educational settings are addressed next.

Design science research

DSRIS is gaining popularity and increasingly being recognised as equal in stature to behavioural science research (De Villiers & Harpur, 2013). Behavioural science aims to develop and verify theories to explore or predict human or organisational behaviour, and design science aims to create new and innovative artefacts to extend the boundaries of human and organisational capabilities (Hevner et al., 2004). The founding father of design science research was Dr Herbert E. Simon, a professor in the Economics department at Carnegie Mellon University's Business School, who wrote the phenomenal book, "The Sciences of the Artificial" (Simon, 1996). The mainstream adoption thereof in IS was after the Hevner et al. (2004) publication in MIS Quarterly, which drew inspiration from Simon (Chatterjee, 2015).

Hevner et al. (2004), present seven guidelines for DSRIS practice:

1. Design and produce an innovative and viable artefact to address an identified problem.
2. The solution must address a relevant problem, although it need not be fully operational.
3. Appropriate evaluation methods, including observational, analytical, experimental, descriptive and testing techniques, must be employed to demonstrate utility, quality and efficacy in the artefact's context.
4. The research contributions ought to be clear, verifiable, new, innovative and interesting.
5. Rigour is necessary, and should not reduce relevance. Metrics ought to be related to the evaluation criteria and also address human aspects.
6. The design is a process of iterations and cycles of generating prototypes and testing the design methods. The problem can be simplified and decomposed, followed by expansion, i.e. a 'satisficing' approach that seeks satisfactory solutions while sacrificing exhaustive searches through all possibilities.
7. Results should be presented to end users and to professional or technological audiences.

Baskerville, Kaul and Storey (2015) summarise these steps by classifying a DSR project as the design and development of an artefact that results in the production of new knowledge and the creation of reports or articles describing this design-science research project. Such projects are iterative and incremental, and the artefacts can include constructs, models, methods and instantiations.

DSR contrasts with natural and social sciences due to a focus on the development of improvement solutions to problems that are of a particularly complex nature, so-called "wicked problems", and solutions manifesting in a variety of forms (Baskerville, Kaul & Storey, 2015).

A review of the typology of DSR artefacts did not include aspects around e-learning systems or educational technology with the functions of teaching and learning support (De Villiers & Harpur, 2013). Because the outcome of this thesis is a framework to teach digital business innovation skills to IS students, the most appropriate design framework is therefore in educational design-based research (DBR). In the next section, the use of this design methodology is justified because it enables the design of learning environments and the development of theories of learning.

Research approach: Design-Based Research

The process of normal teaching can often skew the actual implementation of an innovative teaching method or intervention from the intended design. This results in development design research that is not experimental but

iterative, whereby the initial theory gets progressively refined as it is implemented (Laurillard, 2012:5). Collins (1999, in Laurillard, 2012:5) characterises such design experiments as messy situations requiring flexible design revision, social interaction, the development of a profile as opposed to hypotheses testing and, most importantly, using co-participant design and analysis and not experimental design. It differs from action research (AR) in that it is informed, at the onset, by theory that guides both the design of the learning process and the technologies used to inform and support these practices. However, it has similarities with AR in that the researcher/s seeks to investigate and improve his or her practice through iterative systematic cycles of action and reflection on action to improve practice.

DBR can create novel learning and teaching environments, develop contextually based theories of teaching and learning, consolidate design knowledge, and increase the capacity for educational innovation (DBR Collective, 2003).

The principles applied for DBR include:

- Develop theory goals and initial plans
- Conduct research in real-world settings
- Collaborate with participants
- Use research methods systematically
- Analyse collected data retrospectively and constantly
- Continuously refine the design for each iteration
- Report contextual and usable design principles
- Underscore the generalisability of the design continuously (Wang & Hannafin, 2004).

Design research in education is described under various names, the most common of which are design-based research, development research, design experiments and educational design research (McKenney & Reeves, 2012:19). The term used in this thesis is design-based research (DBR), although an argument can be made that it ought to include the term educational design research (McKenney & Reeves, 2012) to avoid confusion with other strands. However, DBR is widely accepted within the educational milieu and must not be confused with, for example, DSRIS, as a result of the artefact produced in this research study.

There are a number of different models that apply to educational design research – some visual, and others as frameworks. The purpose of this study was to determine the most useful model or framework to teach digital innovation. Models are appropriate for framing ideas, and frameworks for understanding specific elements or

phases of educational design research (McKenney & Reeves, 2012:74). The latter is more applicable to this research study, and the level of detail varies in the different frameworks that describe different phases.

The model of Reeves (2006) is more minimalist due to its focus on four main, iterative phases as opposed to, for example, the Integrative Learning Design Framework (Bannan-Ritland, 2003). Although the model of Reeves offers less detail, it lends itself to better customisation within a particular context because it is less prescriptive. Reeves's (2006) model was updated in McKenney and Reeves (2012:76) to include three phases, but the original model was deemed to be the most suitable to this study because the final phase of the later model requires multiple actors for implementation. The articulation of design principles is also not that clear in the later model (Parker, 2015).

The design was informed by design principles derived from the existing literature, existing products and interventions and consultations with practitioners (Reeves, 2006). A phase of reflection to produce design principles and enhance solution implementation was built into the model. This model consists of four iterative phases, as illustrated in Figure 1 and Figure 2.

Phase 1: Analysis of the problem

The problem investigated created a purpose for the research, and the creation and evaluation of a potential solution to this problem formed the focus of the entire study. The initial phase consisted of consultation with stakeholders, a literature review and the formulation of the research questions.

Researchers, practitioners and other stakeholders collaboratively explore the problem not only from an academic perspective, but also from the perspective of the people who deal with the problem on a day-to-day basis. Consultation can take a variety of forms, such as participant observation and conversation, interviews, focus groups interviews or reflective journals and blogs. Written questionnaires and surveys ought to be avoided, because in-depth reflective data is required (Herrington, Reeves & Oliver, 2010; Herrington & Reeves, 2011). Consultations with industry participants, students and higher education practitioners in IS were conducted. In Chapter 1, the significant findings from the initial consultations are described, as well as the research questions and objectives of the study.

A literature review was conducted in Chapter 2 to further elaborate on the research problem and to inform draft design principles for the design of the course.

Phase 2: Development of solutions

The second phase articulated a solution to the problem identified during the initial phase. During this phase the initial literature review was extended to find additional theory that could guide the theory. Existing design principles that may address a similar problem were also expanded upon during this phase. The creation of draft

design principles for the planned intervention required an analysis of relevant learning theories, input from the stakeholders and the exploration of existing principles (Herrington, Reeves & Oliver, 2010; Herrington & Reeves, 2011).

The recommendation is to have design principles that are specific and that relate to an action or activity within the learning environment (Van den Akker, 1999, as cited in Herrington & Reeves, 2011). The draft principles inform the development of the proposed solution, and the technological affordances identified also form part of the process for drafting design principles.

A mapping of the design principles to the actual learning environment should subsequently take place to illustrate how each principle will be implemented or operationalised (Herrington, Reeves & Oliver, 2010).

Draft design guidelines were formulated from the research conducted in Phase 1, as well as from a follow-up literature review. These are discussed in further detail in Chapter 4 of this study.

Phase 3: Iterative cycles of testing and refinement

In Phase 3, the solution designed in Phase 2 was implemented and evaluated in iterative cycles. In a DBR study, a single implementation is rarely sufficient to gather enough evidence about the success of the intervention (Herrington & Reeves, 2011). The study comprised three full iterations and one iteration to test some principles over a period of two years. After each iteration, changes were made to improve the design in order to better address the problem in the subsequent iteration. The implementation of the solution, data gathering, analysis and recommendations for improvements per iteration are discussed in Chapters 5 to 7.

Important aspects to consider during the rollout of a DBR study are:

- The importance of collaboration between stakeholders during the different iterations
- The ability of the researcher to walk the narrow line between objectivity and bias
- Formative evaluation, which plays a significant role, and this methodology incorporates both evaluation and empirical analyses and provides multiple entry points for various scholarly endeavours
- DBR can use a variety of research tools and techniques that usually evolve through the creation and testing of prototypes
- The length of time to conduct DBR studies may be restrictive to an agile environment in which technology changes rapidly

- Design-based interventions are rarely if ever designed and implemented perfectly and there always seems to be room for improvement (Anderson & Shattuck, 2012)

During the different iterations, interventions were tested to study several aspects to determine potential improvements. Interventions can be formative (how to improve a design) whilst also testing how well it is working to prompt a desirable outcome (summative) (McKenney & Reeves, 2012:138).

Testing each intervention can take the form of alpha, beta and gamma testing, for example:

- Alpha testing: Collect data to ascertain the soundness of the design (requirements or propositions) and the application and feasibility thereof. Test the robustness of design principles and potential changes that can increase the plausibility and probability to meet the goals.
- Beta testing: Test the performance of an intervention within a setting and how well it integrates within an environment. Include aspects relating to perceived relevance by stakeholders.
- Gamma studies are mostly used to determine whether the intervention meets its goals and brings about measurable change in the target setting (McKenney & Reeves, 2012:139).

Participants

The research and innovation were conducted with third-year and Honours students in the Information Systems Department of the University of the Western Cape (UWC) in Cape Town, South Africa. The first iteration was conducted with the IS full-time Honours group in the module End User Practical. There were a total of 43 students registered for the module and all students gave their informed consent to be part of the study.

The second iteration took place with third-year IS students during the second semester of 2016. The module was specifically designed to teach digital business innovation. There were a total of 40 students registered for the module and all students gave their informed consent to participate in the study.

The third iteration was merely a test of the quantitative skills on a group of third-year IS students during the first semester of 2017 to test the principles. No qualitative analysis took place because the researcher did not facilitate the class. The fourth iteration took place with third-year IS students who enrolled in the Digital Business Innovation capstone course during the second semester of 2017.

The diversity of students at UWC prompted a demographic analysis of the student profiles during the four iterations. Students were requested to complete a survey at the start and end of each iteration to gather information about age, gender and home language. Internet connectivity and where students connect to the Internet were also questioned to determine the application of technology during each course. The table below depicts details of participant profiles during the four iterations.

Table 7: Participant profile

	Iteration 1	Iteration 2	Iteration 3	Iteration 4
Female	59%	49%	31%	31%
Male	41%	51%	69%	69%
Age 16-24	81%	87%	77%	92%
Age 25-34	19%	13%	23%	8%
Home language English	56%	35%	42%	46%
Home language IsiXhosa	32%	48%	31%	31%
Home language IsiZulu	5%	5%	4%	4%
Home language Afrikaans	7%	5%	4%	8%
Home language other	0%	7%	19%	11%
Connect to internet on cell (Prepaid)	64%	61%	54%	54%
Connect to internet on cell (Contract)	24%	17%	42%	35%
Connect to the internet via ADSL	26%	11%	7%	31%
Connect to the internet publicly via Wi-Fi	92%	95%	92%	97%
Connect from Internet café	12%	11%	7%	7%
Do not have internet access	0%	0%	0%	0%
Connect most to the internet at home	48%	50%	65%	58%
Connect most to the internet at UWC	79%	76%	73%	77%
Connect most to the internet at work	5%	0%	15%	4%
First-generation student at university	61%	72%	58%	54%
Total number of respondents	40	39	26	30

The gender breakdown assisted the researcher to gage perceptions about skills development particularly in terms of technical competencies and collaboration in teams. The majority of students were within the 16-24 year age group and age was therefore not a significant indicator. Home language provided guidance in terms of written and oral communication skills and potential interventions required during iterations.

Access to the Internet and the way in which students connect were analysed to assist in online teaching interventions and online assessments.

Data collection methods

DBR supports the collection of qualitative and/or quantitative data in cycles of several weeks, semesters or years. Due to the wide variation of possible interventions and the range of direct and/or indirect interventions,

certain indicators for success should be considered (Van den Akker, 1999, cited in Herrington et al., 2010). The study used multiple data sources to ensure that evidence on the success of the solution was collected from multiple angles. Data sources included pre- and post-course surveys conducted on Google Forms with all students to test skills development as it pertained to the first research question (Appendix 3). Questionnaires to industry partners to test the outcome of each group's digital business innovation on their business and their views in terms of skills requirements for students were also conducted (Appendix 4). Formal student reflections via weekly online blogs were analysed. Other forms of data collection included student assignments and results from the online assessment submissions and field notes.

Both qualitative and quantitative data were collected in a mixed-methods design, following the Triangulation Design: Convergence Model by Creswell and Plano Clark (2007), this allows different but complementary data to be collected and analysed. By combining both qualitative and quantitative methods, one can address both exploratory and confirmatory questions in the same research inquiry (Venkatesh, Scott & Barrett, 2013). Creswell and Plano Clark (2007) suggest four major types of mixed-methods designs:

- Triangulation, in which qualitative and quantitative data are merged to understand a research problem
- Embedded designs, where either qualitative or quantitative data are used to answer a research question within a largely quantitative or qualitative study
- An explanatory design, where qualitative data explain or elaborate on quantitative results
- Exploratory designs that collect quantitative data to test and explain a relationship found in qualitative data

The application of mixed-methods research can result in rich insights into various phenomena to develop novel theoretical perspectives (Venkatesh, Scott & Barrett, 2013). The researcher collected and analysed quantitative and qualitative data separately and then triangulated both sets of data to understand the outcome of the course. Quantitative data were collected through survey questionnaires before and after the course. The qualitative data emerged from reflections, observations, semi-structured interviews and document analyses during and after the course.

Data analysis

Using the design-based research approach, data analysis progressed through a number of iterative cycles and processes. It was informed by the key design principles relating to the pedagogical activities, the content and the use of technology to teach digital innovation skills to IS students within an authentic learning environment. Research aims and key questions guided the analysis of the data, supported by the key theoretical principles informing the design of the intervention. The principles of hermeneutics were applied in the interpretation and analysis of data during the research process.

Analysis of quantitative data

Quantitative data were analysed in Excel to perform both regression analysis and an ANOVA test on the outcomes of student surveys prior to and after each iteration.

The analysis tested the reliance on certain skills during an initial assessment and again at the end of the course. The multiple regression equation estimated the relationship between a dependent variable (Y) (student assessment scores) and the nine independent variables (X) (the skill sets identified).

When implementing a multiple regression model, the overall quality of the results may be checked with a hypothesis test. In this case, the null hypothesis is that all the slope coefficients of the model equal zero, with the alternative hypothesis being that at least one of the slope coefficients is not equal to zero. The hypothesis is rejected if at least one of the independent variables explains the value of the dependent variable by reviewing the p-value. If the p-value is less than the level of significance, the null hypothesis that the coefficient equals zero is rejected; the variable therefore is statistically significant (Anderson, 2014).

The analysis helped to identify the skills that were statistically significant using the p-value to test the null hypothesis. If a variable has a low p-value (< 0.05) it indicates that the null hypothesis can be rejected and the variable therefore is a meaningful addition to the framework.

The second statistical test applied was a one-way ANOVA to test the difference between the students' scores for their initial skills survey and the scores obtained for the second survey upon completion of the module. The purpose of one-way ANOVA is to test whether the means of different groups are common or different.

Analysis of qualitative data

Qualitative analytic methods can stem from a particular theoretical or epistemological position, such as conversation analysis or interpretative phenomenological analysis, with relatively limited variance in how this method ought to be applied. Grounded theory, discourse analysis and narrative analysis also apply a broad theoretical framework (Braun & Clarke, 2006). The other alternative is methods that can be applied across a range of theoretical and epistemological approaches because they are more independent of theory (Braun & Clarke, 2006). Thematic analysis forms part of this camp and provides a flexible and useful research tool, which potentially can provide a rich and detailed, yet complex, account of the data. It is important to include the "how" when doing qualitative research, and the process followed is detailed below (Attride-Stirling, 2001).

The researcher was actively involved in the data gathering in order to keep the data as close as possible to the actual events. The steps prescribed by Miles and Huberman (1994) to systematically organise the data were applied in the qualitative data analysis.

Step 1: Reflection on the data received, organise data systematically, and try to discover emerging patterns. This step requires immersion in the data, whereby the researcher repeatedly reads through the data and searches for

meanings and patterns. It is recommended to read through the entire dataset at least once prior to the coding thereof (Braun & Clarke, 2006).

Step 2: Interpreting the data collected against the key principles informing the design. This would include coding the data in relation to the key pedagogical and design principles identified in the literature, as well as identifying new and emerging principles from the implementation process. Coded data differ from the units of analysis (themes), which are often broader (Braun & Clarke, 2006). When all data have been coded, codes are sorted into potential themes and the use of visual representations may be useful here (Braun & Clarke, 2006).

Step 3: Follow the data analysis phases indicated in the DBR approach through the iterative cycles. This iterative process enables the researcher to become more grounded in the data and to develop a deeper understanding of the phenomenon as richer concepts emerged.

The analysis of qualitative data can provide richer descriptions and explanations that will support the findings from the quantitative analysis. Words from the research participants can provide a more convincing argument than mere pages of numbers, providing a certain 'undeniability' (Braun & Clarke, 2006). However, qualitative analysis can be criticised for lacking in methodological rigour and can increase researcher subjectivity (Gray, 2004:320). The process of analysis has to address the representativeness and the trustworthiness of the data. This requires the quality to be assessed and weighted (McKenney & Reeves, 2012:101). All datasets were analysed to look for patterns and similarities in the responses to ensure that they represented the views of the entire group.

The data analysis was required to inform a decision on whether the authentic learning elements, pedagogical strategies and technologies employed were effective in facilitating participant learning, and whether any improvements could be made for future implementations.

Aspects of the process applied in the qualitative data analysis are illustrated in Figure 12 below.

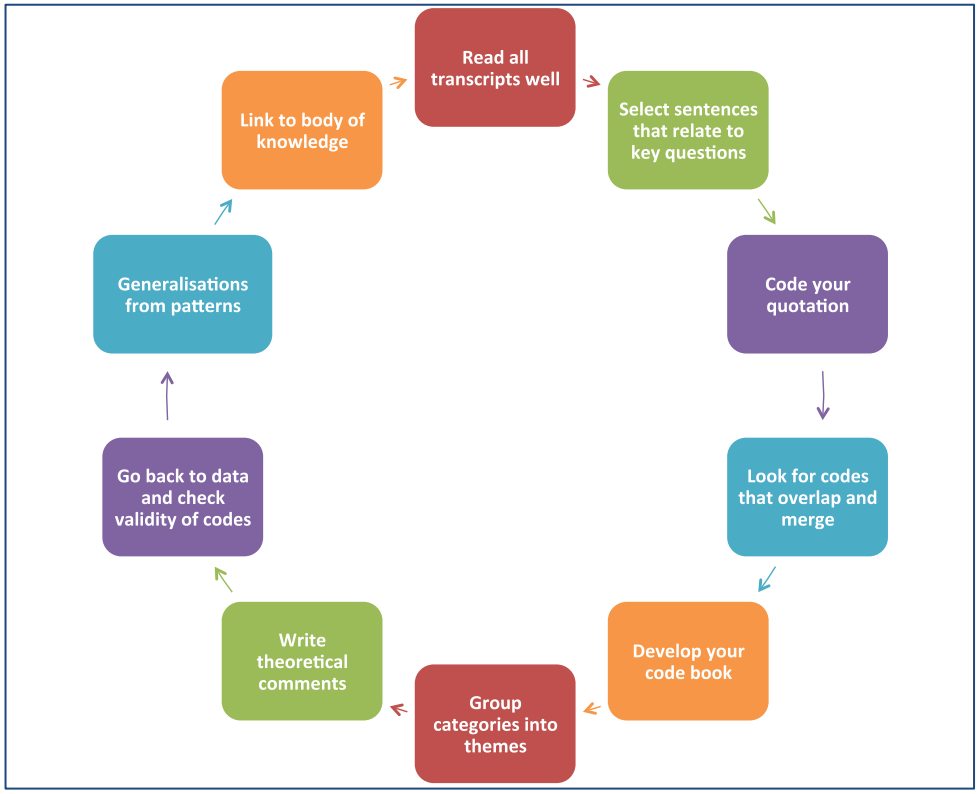


Figure 12: The process of thematic analysis (Braun & Clarke, 2006)

The table below contains the data elements and the tools for analysis within the study.

Table 8: Datasets and analysis

Dataset iteration 1	Code	Documentation	Analysis tool
Survey 1 and 2 analytics	S01-4.1	Google Forms	Quantitative in Excel using regression and ANOVA
Survey 1 and 2 open-ended questions	S01-4.2	Google Forms	Qualitative in Excel
Weekly reflective blogs submitted monthly	B01.1-3	Url per blog in Google Drive	Qualitative in Excel and Word
Project documentation	PD01-3	Google Documents	Qualitative in Excel
Project Artefacts	PA01-3	Google Documents	Picture Editor
Facilitator reflections	FR01-3	Reflection journal	Qualitative in Word
Industry survey	IS01-3	Google Documents	Qualitative in Excel

Student survey

Students were asked to fill in a survey on Google Forms at the start of the semester to test their perceptions prior to the course (Survey 1) and again at the end of the course to test the outcome of the intervention (Survey 2). The survey questions were adapted from the Student Success Toolkit (George, 2015). A sample of the survey can be viewed in Appendix 3. All survey and reflection responses were transferred from Google into Excel spreadsheets.

Each closed-ended question was rated on a five-point Likert scale using the following criteria:

5 The statement is always or almost always true for you (around 100%)

4 The statement is often true for you (around 75%)

3 The statement is sometimes true for you (around 50%)

2 The statement is rarely true for you (around 25%)

1 The statement is never or almost never true for you (around 0%)

In the design of the survey, aspects were considered as suggested by Saunders, Lewis and Thornhill (2009)

1. Collect data at the right level of detail to answer the investigative question.
2. Ensure respondents have the necessary knowledge to answer the question.
3. Use familiar words that all respondents understand in the same way, and avoid jargon, abbreviations and colloquialisms.
4. Ensure that no words are used that may cause offence, as these might result in biased responses or a lower response rate.
5. Make questions as short as possible.
6. Avoid questions with a negative or double negative, because the word 'not' is sometimes difficult to understand.
7. Ensure questions are unambiguous with statements that are easy to understand.
8. Avoid words that have a double meaning or sentences that lead the respondent in a particular direction.
9. Answers to closed questions must be written so that at least one will apply to every respondent.
10. Provide clear instruction on how each question needs to be answered.

The survey gave respondents a clear indication of their progress and limited the number of open-ended questions. Students had the option to participate in the survey, with no consequences if they selected the option not to participate.

Student blogs

Students were required to subscribe to a blog and submit three blogs during the semester. They could use any open source blogsites, or alternatively the LMS (iKamva) blog facility. Suggestions were made to them, such as

- http://wordpress.com/
- http://iblog.co.za/
- http://blog.com/
- http://www.blogger.com/

The blog posts were used as a space where they could reflect on their own progress during the semester, and they were also encouraged to share their experiences with other students, who could give feedback to them. The blog posts also included additional aspects such as a personal inventory of their own strengths, weaknesses, opportunities and threats. They were also asked to reflect on their journey in the next few years once they leave the university and what they wanted to achieve in the future. All these additional aspects were included to help prepare them for future interviews with prospective employers.

Students were encouraged to include images, videos and photographs in the blogs to develop multimedia skills and to encourage creativity. Some of the front pages of the blog posts are depicted in the figure below.

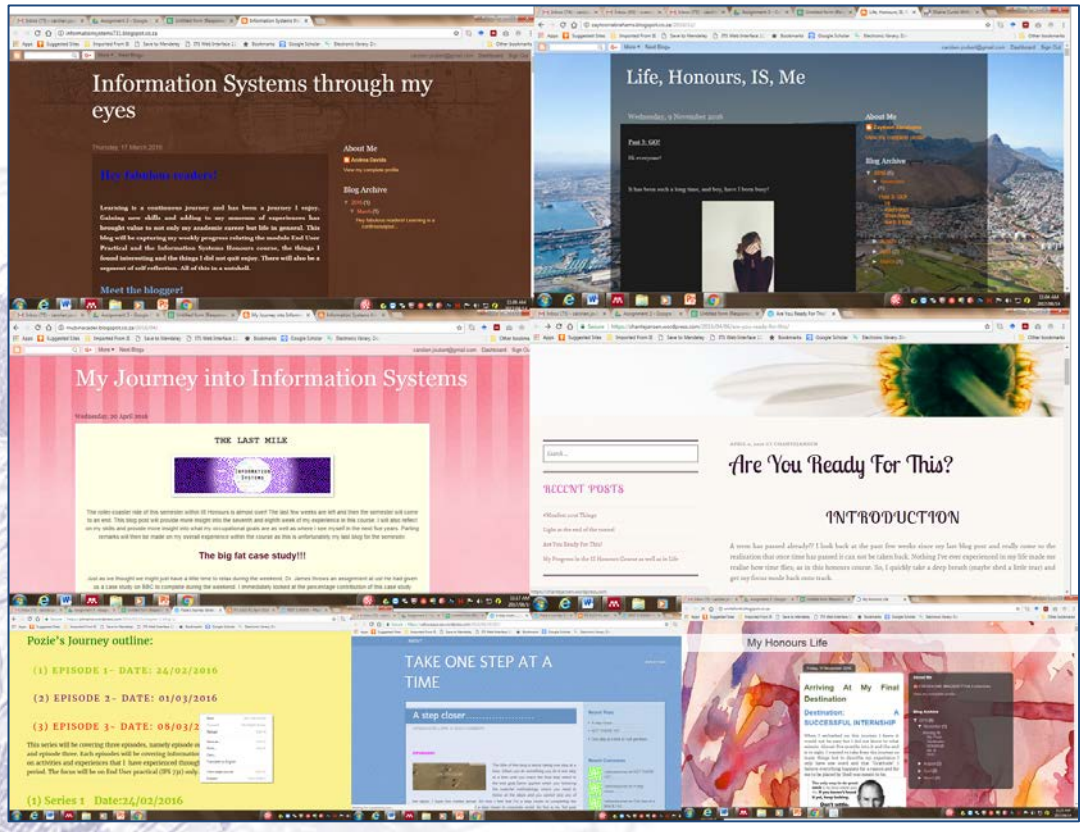
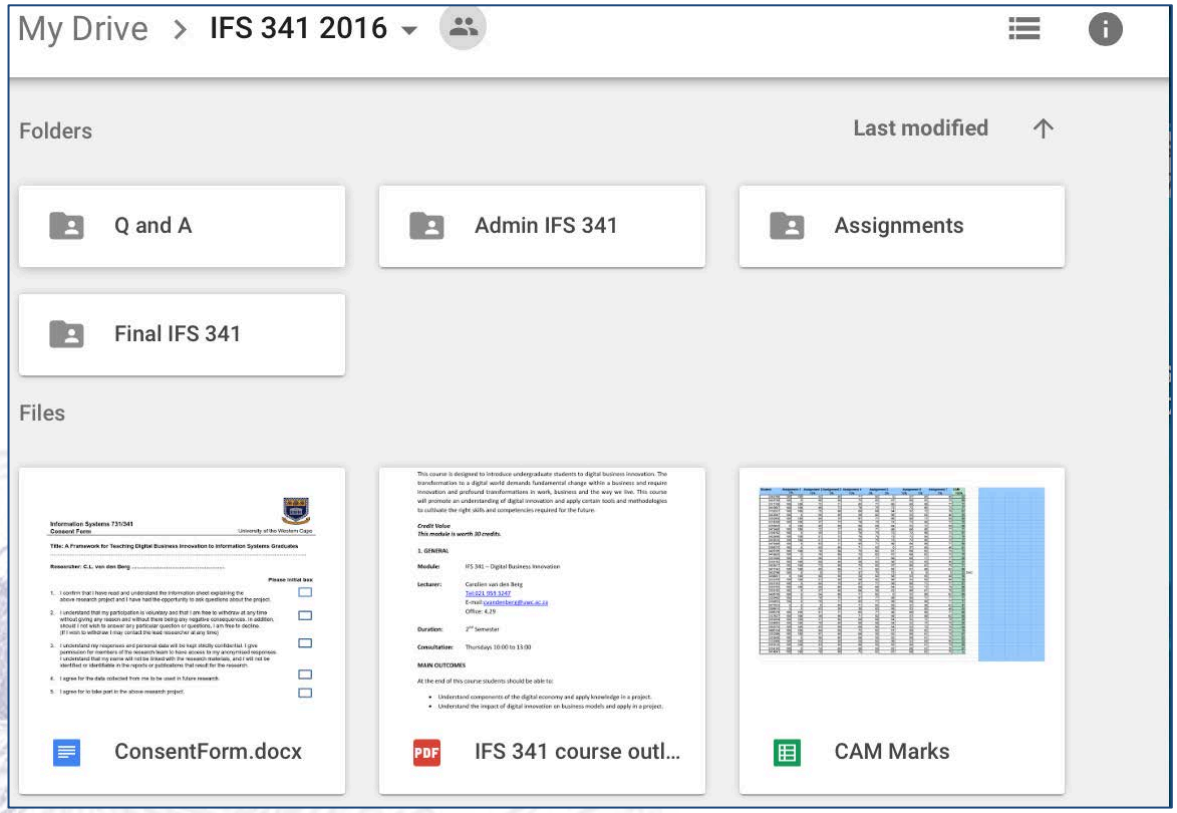


Figure 13: Example of student blogs

Project documentation

All project documentation was kept on a Google Drive and shared with the students. Students were tasked to complete a number of assignments per iteration that all added up to the final project implementation. The assignments provided valuable information on the skills development during the semester. Assignments consisted of group presentations on project progress, peer reviews, individual digital stories on a topic of choice covered during the semester, and final project documents detailing the rollout of the entire digital innovation project.

An example of the layout of the Google Drive and individual folder per group on Google Drive can be viewed below.



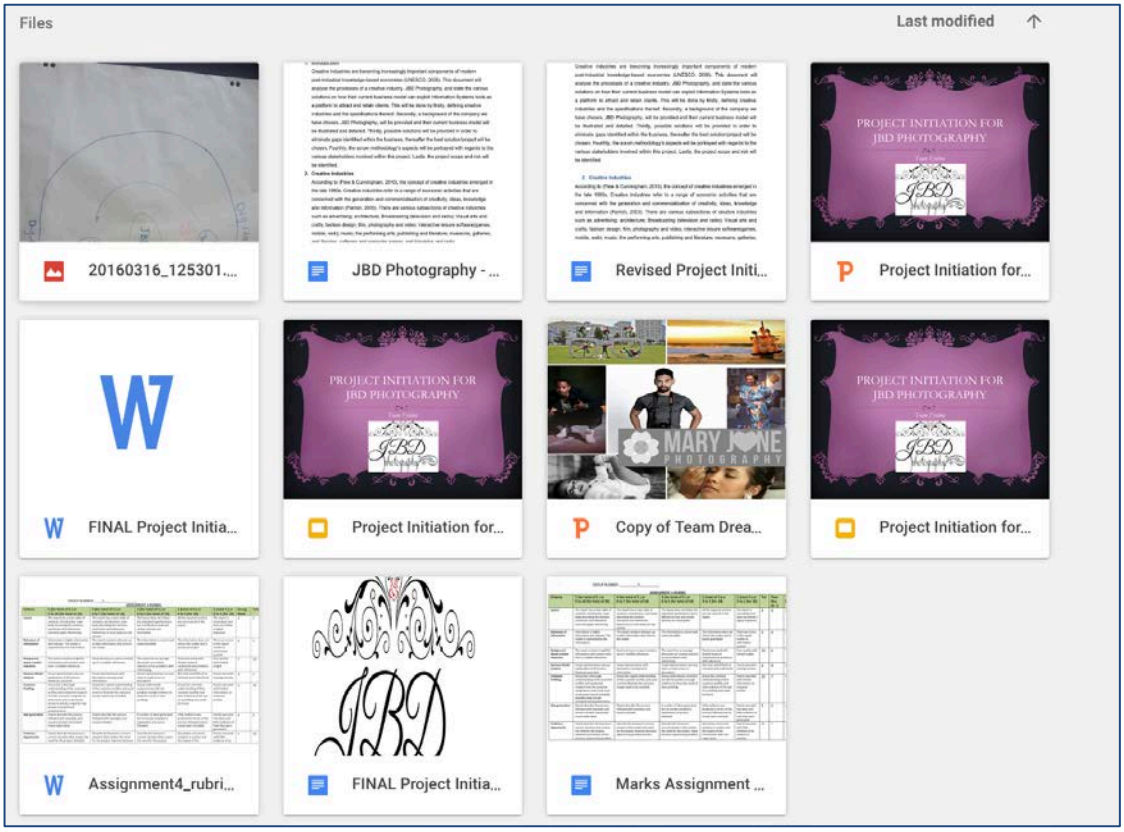


Figure 14: Project documentation

Project artefacts

Students were required to implement a digital innovation for an industry partner and, in the process, they had to produce a number of outputs and a final solution. The aspects reviewed were:

- Business model canvasses consisting of the original and the updated canvas that showcases the digital innovation
- Customer profiles (including empathy maps and personas)
- Requirement analysis, including user stories, functional and non-functional requirements and a decision matrix
- Business benefits and opportunities
- Ideation process, project prototypes, testing and final implementation
- Project scope, implementation phases (sprints), project risk matrix and lessons learned
- Project communication and training plan, as well as feedback from clients

The emphasis was not solely on the final product that the teams could implement (websites, mobile applications, social media profiles), but on the entire process that they followed. An example of a final product review can be viewed at the following link: https://goo.gl/55nvvi

Facilitator reflections

DBR builds design principles through a process of iterative design, reflection and design to refine the principles according to the findings from each iteration. In a DBR study, the researcher takes on an active role as one of the participants in the study and needs to reflect on the process throughout. For this purpose, a reflection journal was kept to capture the process as it progressed in each iteration. The presence of authentic learning elements was strongly foregrounded in the reflections to establish what went well and what was missing.

Throughout the process, the researcher had to remain aware of her own presence as an active participant and the influence thereof on other participants. For this purpose, the other participants were instructed on their own role in the study and were given the option to be included or not. They had to provide written consent and could withdraw at any stage without any consequences for them or their team. The researcher's own presence and interactions with the students were also reflected upon in the reflection journal (Gray, 2004:252).

Industry survey

The industry partners participating in each iteration were asked to complete a survey (available in Appendix 4) after the implementation to test their overall satisfaction. A six-point Likert scale was used, ranging from extremely poor to excellent, and the results were converted into percentages. The questions measured industry satisfaction in terms of the conduct of the student teams in their engagement with them, as well as their overall satisfaction with the digital innovation implemented in their business. Questions were also asked to measure their business models and degree of digital sophistication.

Ethical considerations

The research was conducted in accordance with the ethical and professional guidelines as specified by the University of the Western Cape (UWC), with ethical approval registration number 15/7/193 (Appendix 1). Students who participated in the research were informed about the research at the start of each iteration and were updated as required during the semester.

The students were informed that the module would be studied as part of a research project, and that their reflective blogs, online and classroom interactions, project documents and digital artefacts may be part of the data gathered. All students signed informed consent forms at the beginning of the module, which stated that they had received enough information to enable them to make decisions about whether they wanted their work used as part of the research (Appendix 2). Their participation was voluntary and they were informed that they could withdraw at any time with no negative consequences.

For all online surveys, students again had to provide informed consent that they were willing to participate in the questionnaire (Appendix 3). The rights and welfare of all participants in the research were protected via the protection of their identities, as pseudonyms were used. The students were notified at the start that the surveys would not be for marks and that their rights would be respected throughout, and they were not subjected to any harm in any way. To ensure confidentiality, access to the original data was confined to the researcher, and no information that could identify the participants was included in the research report.

Once the data were collected, the information was kept in a password-protected file in a secure location on Google Drive. Hard copies were kept in a locked filing cabinet and archived per iteration.

The researcher was cognisant of researcher bias and aimed to use open and honest narrative by including both positive and negative findings that occurred during the different iterations. Data were transcribed verbatim to ensure that the participants' true reflections were recorded.

Phase 4: Design principles

Once a learning design or intervention had been implemented, evaluated and refined in cycles, the last phase was to reflect on the entire process to produce design principles that could inform future development and implementation decisions. The design principles developed as part of Phase 4 of the study are documented in Chapter 8. There are potentially at least three useful outcomes of design-based research:

• The design principles

• Designed products or artefacts: the physical representations of the learning environment

• Societal outputs, such as professional development and learning (Herrington et al., 2013).

Conclusion

This chapter commenced by identifying and motivating the research philosophy and choice of paradigm for this study. It then framed the choice of research method by exploring design research and motivating the choice of educational DBR as the research method. It further explained the main phases in a DBR study and how each phase is rolled out within the study. Table 6 provides a summary of the chapter.

The design principles that were identified from a review of the literature in Chapter 2 and via consultation with practitioners, industry partners and students are described in the next chapter as Phase 2 of the study.

The second phase of design research proposes a solution to teach digital business innovation skills to IS students by describing a design framework and design principles to be applied in the study.

CHAPTER 4: DEFINING THE DESIGN PRINCIPLES

Introduction

Chapter 1 of the study provided background to the research problem and identified challenges expressed by students, industry partners and practitioners to further frame the research. A literature review was conducted in Chapter 2, highlighting the aspects that need to be considered for designing a framework and identifying the design principles that had to be applied in the study. The research method and rollout of the phases during the DBR study was outlined in Chapter 3.

In Chapter 4, the second phase of DBR is outlined to propose a solution to the research problem and the implementation thereof within the educational setting. The chapter defines the draft design guidelines and conceptual framework that were formulated following an inductive process. During the second phase, literature was consulted again to help guide the thinking on the development of design principles. As depicted in Chapter 1, an outline of the phases and corresponding chapters are presented in Figure 2.

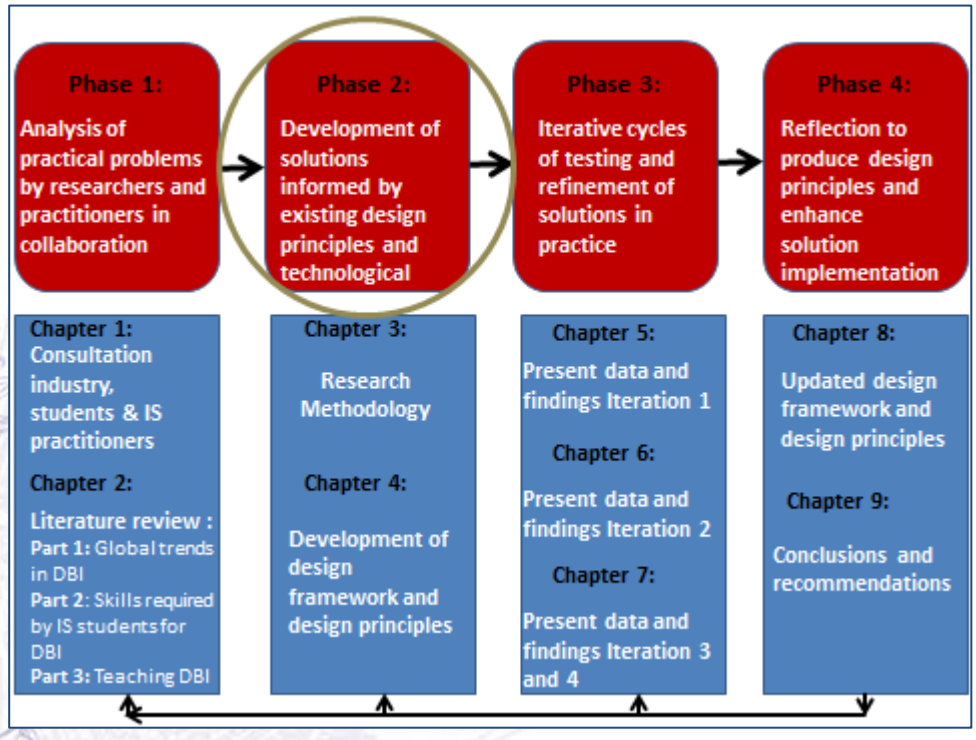


Figure 2: Application of DBR within the study

Review of findings from Phase 1 and analysis of the literature

In the first phase, the acute challenges that a changing, digital world pose to individuals, educators, industry and society as a whole were outlined. The lack of current IS curricula to adequately prepare students for this uncertain world was also discussed. This necessitated the development of a solution to prepare IS students for the digital economy via the design of a participative, digitally enabled collaborative learning environment that integrates pedagogy, subject matter and technology. Such an environment will help cultivate digital innovation skills to enable the ability to meet some unmet organisational or societal need via the innovative use of technology.

Practitioners, industry partners and students were interviewed to identify the current constraints and challenges that are plaguing HEIs insofar as the creation of a teaching and learning environment that cultivates digital innovation skills for IS students. These challenges were explored to analyse potential solutions in the literature to guide the design of design principles.

Conceptual Framework

The first phase culminated in the design of a conceptual framework to help guide the study. The framework incorporates a number of existing frameworks, such as authentic learning (Herrington, Reeves & Oliver, 2010), the TPACK framework (Mishra & Koehler, 2006; Koehler & Mishra, 2009), the development of 21st-century students (Kereluik et al., 2013), and a teaching and learning environment to stimulate innovation (Briggs, 2013; Markham, 2013; Lang, Craig & Casey, 2016).

The conceptual framework was designed to guide the design of draft principles to include in the design of a framework to teach digital business innovation skills to IS students, namely **the business innovation skills for Information Systems (BISIS) framework** as depicted below. The initial set of design principles emerged from a review of the literature and discussions with the relevant stakeholders. A process was followed to systematically review the findings and extract the information.

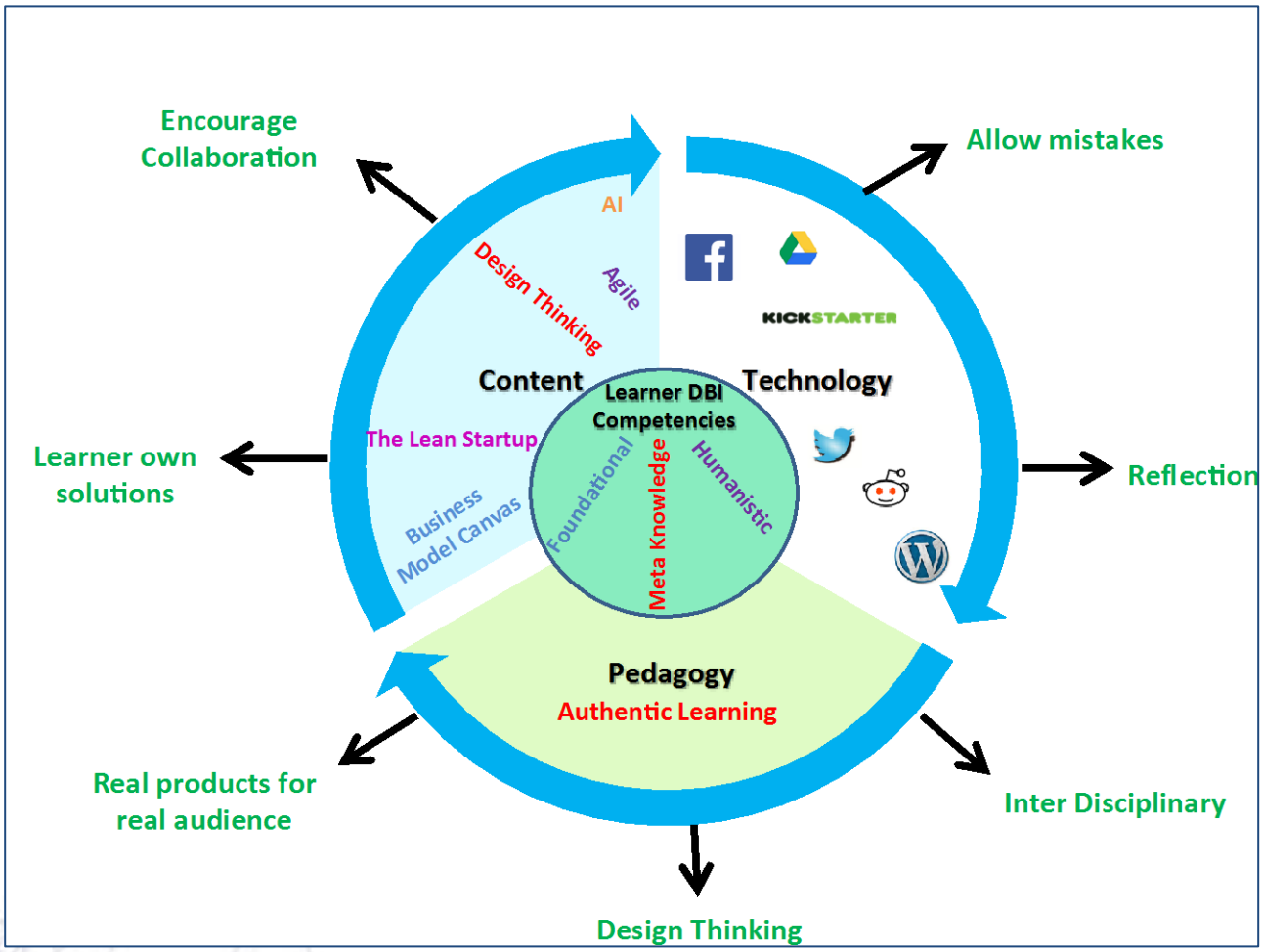


Figure 15: BISIS conceptual framework

Design principles to develop a framework to teach digital business innovation to IS students

In this section, the elements in the BISIS framework are analysed further to enable the design of a digital business innovation course for IS students. The literature was consulted again to fill in areas that required more detail. The analysis took place to define the aspects required in order to answer the secondary research questions.

In the BISIS framework, students need to cultivate certain skills sets in order to become competent digital business innovators. These skills sets need to be present in the design in order to achieve the principles of teaching digital business innovation to IS students. Furthermore, the learning environment to achieve the cultivation of such competencies needs to be defined and tested via a number of iterations within this DBR study. The components within the learning environment include the pedagogy that utilises authentic learning, the content to be taught and the application of technology.

Skills required to develop competent IS digital business innovators

Foundational knowledge consists of core content, digital/ICT and cross-disciplinary knowledge.

Core content knowledge, coupled with academic achievement, is cited frequently as an essential skill in the 21st century (Kereluik et al., 2013:130). The content required to teach digital business innovation was discussed in Chapter 2, Part 3 and was analysed during the different iterations to test the validity thereof.

- *Digital and information literacy* is also an essential skill for students, and more so for students in IS. Therefore this area was transformed to digital and ICT knowledge for the purpose of this study. Some of the aspects relevant to this area are detailed in Table 1 and include, for example: Computational thinking, or the ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning,
- New media literacy, to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication,
- Cognitive load management, or the ability to discriminate and filter information by importance and to understand how to maximise cognitive functioning using a variety of tools and techniques, and
- Virtual collaboration, to work productively, drive engagement and demonstrate presence as a member of a virtual team (Davies et al., 2011).

Cross-disciplinary knowledge integrates information across different fields or domains, thus the ability to understand, organise and connect vast amounts of information (Kereluik et al., 2013:130).

Course design enabled students to apply the core content knowledge to a practical project, to create tasks and assessments that facilitate the application of cross-disciplinary knowledge that they had obtained within the broader framework of their overall studies. IS students need to be completely confident with the use of digital technologies and have a broad understanding of the available technology. Students need to be able to track changes in technology and be familiar with the applications of new technology within a business environment. Students had to develop a digital innovation using a variety of potential technological solutions within an organisation.

Although foundational skills remain essential, a more complex set of competencies is required that goes beyond being technically competent to being able to “get things done, demonstrate ethics and integrity, and [work] well with others” (Lombardi, 2007:10). As confirmed by industry, the most important skills in newly hired graduates include teamwork, critical thinking and reasoning, the ability to disseminate information, and creativity and innovative thinking.

Meta-knowledge is knowledge "to act" using creativity, innovation, problem solving, critical thinking, communication and collaboration. This is the process of working with foundational knowledge. The definitions of these skills as defined by the Partnership for 21st Century Skills were applied to the design (Partnership for 21st Century Learning, 2015).

Creativity and innovation can be encouraged via a wide range of ideation exercises such as brainstorming. The application of design thinking also encouraged this, as the steps followed in design thinking encourage such activities. Students had to create a number of new ideas that could be useful, and then follow a process to analyse and refine the ideas to those that are appropriate for the client's business.

The students collaborated to develop, implement and communicate new ideas within teams and share this with other teams. It is important to encourage students to be open and responsive to new and diverse perspectives and to incorporate input and feedback. Assessments had to be designed to facilitate this process and to reward originality and inventiveness in work, whilst simultaneously testing for the feasibility of the project to make a tangible and useful contribution to the business partners. Mistakes during the process had to be accommodated, because failure is an opportunity to learn. Creativity and innovation are often a long-term, cyclical process of small successes and frequent mistakes (Partnership for 21st Century Learning, 2015).

Problem solving and critical thinking can be interpreted as the ability to make informed decisions based on information to resolve a specific problem or to achieve a specific end goal (Kereluik et al., 2013:130). This involves the ability to apply systems thinking to understand how parts of a whole interact with each other to produce overall outcomes in complex systems. In order to achieve this, students need to be able to analyse and evaluate evidence, understand alternative points of view and make connections between information and arguments. Conclusions need to be drawn based on the best analysis, and students need to reflect critically on learning experiences and processes. The learning environment needs to encourage different, non-familiar problems to be solved in both conventional and innovative ways (Partnership for 21st Century Learning, 2015).

Communication and collaboration can be seen as the ability to clearly express oneself via oral, written, nonverbal and digital means, and to interact respectfully with diverse audiences. Collaboration further requires flexibility, willingness to participate, and recognition of group and individual efforts and success (Kereluik et al., 2013:130).

In order to develop these skills in students, authentic tasks and assessments must be developed to demonstrate that skills have been acquired. Skill sets need to be measured at the onset and at the end of the course to determine improvements.

Human knowledge includes life and career skills, emotional and ethical awareness, as well as cultural awareness.

Life and career skills encompass aspects such as flexibility and adaptability to change in terms of varied roles, jobs or responsibilities. Students need to develop initiative and self-direction in order to function in a climate of ambiguity. The future world of work as discussed in Chapter 2 requires a commitment to lifelong learning (Partnership for 21st Century Learning, 2015).

Emotional and ethical awareness requires individuals to be able to imagine themselves in someone else's position and to engage in ethical decision making (Kereluik et al., 2013:131). Individuals will require the ability to form a deep understanding of human emotions and to be able to interact successfully with other humans in the future world of work, where autonomy, machine learning, artificial intelligence etc. will become part of daily life, hence stressing the importance of interpersonal skills (MacCrory et al., 2014).

Cultural competencies expand with effective communication and collaboration to include an appreciation of ideas and emotions of all types of individuals (Kereluik et al., 2013:131). The diversity of the South African cultural landscape, coupled with the impact of globalisation on the workforce, requires these competencies in our future workforce.

The course requires students to work in teams that are pre-selected based on criteria such as diversity, mixed genders and mixed cultures in order to expose students to real-life situations. Students need to work with a real organisation to roll out a real-life project to implement a digital business innovation. The course encourages continuous feedback, reflection and peer review to cultivate humanistic knowledge.

The development of the skills required to become digital innovators must be facilitated within the correct learning environment, as discussed in the following section.

Teaching and learning interventions to teach digital business innovation skills in IS

Pedagogy

The literature attests to the fact that the abstract knowledge taught in universities is seldom retrievable in real-life problem-solving contexts due to the absence of the interdependence of situation and cognition. Learning and context should not be separated, because knowledge becomes the final product of education for learners, as opposed to a tool to be used in problem solving (Herrington, Reeves & Oliver, 2010:6). The enablement of an authentic learning environment in the course design can circumvent this, and the elements of what this entails are described below.

Provide authentic contexts that reflect the way knowledge will be used in real life

In the design of a course to teach digital business innovation, simply using examples from real-world situations to illustrate the concept will not be sufficient. In the planning of an authentic context, the following questions need to be considered:

- What knowledge, skills and attitudes will students ideally have after completing the course?
- Where and how would students apply this knowledge in real life?
- What context might be possible and appropriate to enable students to do this (Herrington, Reeves & Oliver, 2010:17)?

Provide authentic tasks

The table below illustrates how authentic tasks were incorporated in the course design.

Table 9: Mapping of authentic tasks to course design

Authentic task	Mapping to course design
Real-world relevance	Run projects with organisations within industry (2016 Creative Industries) and (2017 88 BC)
Ill-defined activities	Brief to implement a digital innovation within the organisation using certain tools to guide the process
Complex tasks investigated over a period of time.	Project lasts for the whole semester and sometimes beyond
Examine tasks from different perspectives, using a variety of resources	Design thinking, business model canvas, sprint, lean startup, scenario planning, training plans, communication plans
Opportunity to collaborate	Group work, peer reviews, online collaboration
Opportunity to reflect	Weekly individual blogs about experience and weekly presentations
Integration of different subject areas	Project management, business analysis, IS strategy, technical skills, communication skills, client management and change management
Integration with assessments	Weekly presentations, project documentation, business models, prototypes developed, digital stories, blogs
Creation of a polished product	Implement a final solution with clients at end of the course
Allow for competing solutions and a diversity of outcomes	Different organisations, different approaches and implementing different solutions

Provide access to expert performances and the modelling of processes

In the design of the digital innovation course, students need access to expert or professional knowledge, skills and attitudes in real-world problem solving. The role of the lecturer/facilitator in the course is to provide some of this, and additional “guest speakers” need to be considered. Students at various levels of expertise can also support each other within groups and within peer review situations. An additional element to build in would be the opportunity for the sharing of narratives and stories (Herrington, Reeves & Oliver, 2010:24)

Provide multiple roles and perspectives

The key perspectives within digital business innovation need to be identified, as well as the different controversies, debates and discussions that subject matter experts are engaged in. The course further needs to enable students to engage with the different perspectives and to form their own opinions of what is relevant in their given situation and project (Herrington, Reeves & Oliver, 2010:26).

Support collaborative learning

Collaboration transcends cooperation because it is not merely about working together, but about solving a problem or creating a product together that could not have been completed independently. In collaborating, students provide social support and modelling to one another. The students need to work as a team to roll out their team projects and form their own project environment for communication. Tasks need an appropriate 'incentive structure' that rewards the performance of the group (Herrington, Reeves & Oliver, 2010:27).

Promote reflection to enable abstractions to be formed

In reflecting on progress, the recommendation is that students need to recollect the experience and narrate it to others. Furthermore, they need to express feelings related to the experience (positive and negative), and finally to re-evaluate the experience in order to identify new knowledge and integrate this into their conceptual framework.

Reflection is a social process enhanced by collaboration on tasks that require decision making. In the design of the course, students must be able to return to any element, if desired, to integrate knowledge. Comparing themselves to experts and other students at various stages of accomplishment is also important (Herrington, Reeves & Oliver, 2010:30).

Promote articulation to enable tacit knowledge to be made explicit

Psychological practice is rooted in 'I learn what I believe as I hear myself speak' (Herrington, Reeves & Oliver, 2010:32). Articulating enables one to form awareness, and to develop and refine thoughts. Vygotsky has had a profound influence on how educators see the role of articulation in learning, thought undergoes many changes as it turns into speech. Vygotsky further believes that intellectual development occurs between people before it becomes internalised (cited in Herrington, Reeves & Oliver, 2010:32).

Articulation ought to occur within collaborative groups to enable social, and then individual, understanding, and it should further consist of the public presentation of arguments to enable the understanding of a concept and the defence of learning (Herrington, Reeves & Oliver, 2010:32).

Provide coaching and scaffolding by the teacher at critical times

The development of digital business innovation skills requires some coaching and scaffolding from the facilitator at critical times. The facilitators need to monitor the rollout of the tasks and provide some support in terms of skills, strategies and links that the students are unable to provide to complete the task. This level of support (scaffolding) needs to be reduced over time until the students can complete the tasks unassisted (Herrington, Reeves & Oliver, 2010:33).

Provide for authentic assessment of learning within the tasks

Students ought to perform authentic tasks and be assessed on their effective performance to craft a polished final product in collaboration with others (Herrington, Reeves & Oliver, 2010:35). Assessments need to be integrated with the activities being performed, and should be varied. Multiple forms of evidence to measure student performance are included in the course design to test student collaboration during the rollout of the project, as well as the different artefacts produced to complete each task.

These elements are summarised in Table 10 to illustrate the overall mapping to the course design.

Table 10: Authentic assessments mapped to course design

Authentic assessment	Mapping to course design
Direct examination of student performance in worthy intellectual tasks	A completed project with full project documentation, supplemented with a variety of other assessments such as individual blogs, presentations, client feedback, progress reports, peer reviews of project progress, design artefacts, photo stories and scenarios
Require students to be effective performers with acquired knowledge	Provide content and context, and students define problem and implement a solution
Present the student with a full array of tasks	Have a number of assignments that build on one another and provide the opportunity for students to improve on their performance prior to the final assessment. Use multiple iterations to test their ideas in different contexts
Attend to whether the student can craft polished, thorough and justifiable answers, performances or products	Students can produce different end products and justify their answers to be correct, and produce entirely different digital innovation that works within the context of their organisation
Achieve validity and reliability by emphasising and standardising the appropriate criteria for scoring varied products	Rubrics are set up to guide the scoring of assessments but each assessment will be reviewed upon its merits and not on a standardised set of criteria
'Test validity' ought to depend in part upon whether the test simulates real-world 'tests' of ability	Test whether a solution was implemented within the chosen organisation that meets the client's requirements and improves the overall business. Teams can adapt their designs based on experience, evaluation and feedback from industry and peers
Involve ill-structured challenges that help	Authentic tasks will form the basis of the assessments and

students rehearse for the complex ambiguities of professional life	students will be required to perform real-world challenges within an organisation. Students will further be required to conduct class simulations of a project office and make regular presentations. Need to use contemporary technological solutions and designs

Source: Wiggins (1990, as cited in Herrington, Reeves & Oliver, 2010:3)

The table below depicts the elements of authentic learning and the implementation thereof in the course design.

Table 11: Implementation of authentic learning environment in course design

Authentic learning environment elements	Implementation in course design
Provide authentic contexts that reflect the way knowledge will be used in real life	Working with organisations to identify problems/solutions and implement a real, workable digital solution
Provide authentic tasks	More detail under authentic tasks in Table 9
Provide access to expert performances and the modelling of processes	Lecturer facilitation in class, peer reviews during class presentations and online
Provide multiple roles and perspectives	Group work on projects. Recommended readings provide different perspectives about the concepts. Source own information, reflect on it and share their perspective with their peers via their blogs, discussions on Google Drive
Support collaborative learning	Work in teams and with clients, online collaboration, peer reviews, rubrics to assess whole group collaboration
Promote reflection to enable abstractions to be formed	Personal blogs with weekly reflection on learning outcomes and experience, with added exercises for personal development. Digital stories to reflect on the outcomes. Peer reviews on blogs and online comments
Promote articulation to enable tacit knowledge to be made explicit	Weekly presentations during class time and individual check-ins to discuss the growing understanding of topics covered. Facilitation during face-to-face and online collaboration
Provide coaching and scaffolding by the teacher at critical times	Weekly analysis, feedback ability to improve, online guidance
Provide for authentic assessment of learning within the tasks	Refer to the detail in Table 9 to indicate the mapping

Content

The content requirements were discussed in Chapter 2, Part 3 (The relevant content to teach digital business innovation). The course outline for the first iteration is depicted in Table 12 below. The content had to be reviewed per iteration to test the validity thereof in terms of skills development, and the required changes that took place are discussed in Chapters 5 to 7.

Table 12: Content development focused on digital innovation, iteration 1

Subject	Assessments and requirements
Course overview Effective communication Creative industry specification Agile meets Design Thinking	
Quiz Show-and-tell Design Thinking Digital innovation The Business Model The Business Model Canvas	Pre-reading and podcast on iKamva (LMS) and Google Drive **Individual questionnaire 1**
Team presentations	**Team presentation of current business model and your digital innovation idea**
The Lean Startup Scrum versus Lean The worker of the future Class exercise	Pre-reading and podcast on iKamva and Google Drive **Individual blog 1**
Team presentations	**Project initiation document and presentation**
Peer review feedback presentation Team progress and plans	**Peer review report** **Individual blog 2**
Quiz Team progress and plans The future of work	Pre-reading and podcast on iKamva and Google Drive
Team progress and plans Individual presentation 1	**Individual blog 3** **Individual presentation photo story**
Team progress and plans Individual presentation 2	**Individual presentation photo story**
Final presentation	**Final presentations** **Final report** **Individual questionnaire 2** **Client feedback report**

Technology

The affordance of different technological solutions to enable the digitisation of course content in line with the requirements of both teachers and students was illustrated in Table 4. Technology needs to enhance an authentic learning environment to teach digital business innovation skills to IS students. Moreover, the use of technology needs to stimulate the cultivation of the 21st-century skills required by IS students to become competent digital innovators.

Google Drive was deemed to be the most useful application in terms of the affordance thereof for the type of teaching and learning environment required in the design of the course. All course materials were available on Google Drive and on the internal learning management system (LMS), iKamva. The iKamva platform is a Sakai open source platform available to all students at the University of the Western Cape. Students were required to upload all their coursework onto Google Drive in specified folders. Google Drive was also utilised as an online environment for discussion and feedback.

Students need further exposure to technology in order to develop their digital and ICT knowledge and therefore were required to create personalised blogs and digital stories using a choice of different applications. Open

source was encouraged and the choice of applications was not prescribed to the students, thereby encouraging them to explore different options to test the viability thereof. This further encourages the more individualised approach to teaching and learning afforded by technology.

In order to develop an innovative course, the designer needs to think outside the box in terms of technological applications and allow for a more fluid approach to experimentation and testing. A very participatory approach should be applied, in which students and the lecturer can experiment together to determine which applications are more suitable for specific tasks. According to Herrington, Reeves and Oliver (2010:8), "mobile technologies and emerging technologies of 'participatory culture' on the Web comprise powerful cognitive tools for authentic learning environments".

Draft design principles

The elements contained in the conceptual framework that pertain to the probable skills required by IS students to develop the competence to become digital innovators, and the type of learning environment required to teach such skills were proposed in the section above. The section below attempts to outline the draft design principles and the required skills and authentic learning elements required to support the achievement thereof. The design principles are tested, refined and updated in each iteration according to the outcome of the qualitative and quantitative data analysis.

The outcome of this chapter ought to be an articulation of a potential solution to the problem identified in Chapter 1. The initial literature review was extended to find additional theory to guide the development of draft design principles for the planned intervention in the first iteration. Herrington, Reeves and Oliver (2010) stress the importance of continuously updating the literature review as the study progresses.

This process was repeated in each iteration to update the design principles in order to derive the principles that will address the research question:

How should digital business innovation skills be taught to South African Information Systems students?

It is recommended that the design principles are specific and relate to an action or activity within the learning environment (Van den Akker, 1999, as cited in Herrington & Reeves, 2011). The draft principles inform the development of the proposed solution, and the technological affordances identified also form part of the process for drafting design principles.

A mapping of the curriculum design principles to the actual learning environment, including the skills sets and authentic learning elements required, are depicted in Table 13 below. The aim is to illustrate the aspects that ought to be evident to implement and operationalise each principle, as described by Herrington, Reeves and Oliver (2010).

Table 13: Initial set of draft design principles with authentic learning elements and skills sets

Draft design principle	Description	Skills sets required by principle	Authentic learning elements to support	References for design principles
Encourage collaboration	• Students need to perform tasks in teams • Ensure that students collaborate to solve problems in class and in projects • Use peer reviews	Collaboration and communication Digital/ICT	Authentic tasks – opportunity to collaborate Support collaborative learning Promote articulation to enable tacit knowledge to be made explicit	Dede, 2010; Herrington, Reeves & Oliver, 2010; Sharpe, Beetham & De Freitas, 2010; Kereluik et al., 2013; Koppi et al., 2013; Brynjolfsson & McAfee, 2014; Tumbas et al., 2014b; Celuch, et al., 2014; MacCrory et al., 2014; Koh et al., 2015; Sharples et al., 2016; Adams Becker et al., 2017
Allow students to find their own solutions	• Encourage innovation by letting students take their own initiative • Do not put too much structure in place, use some scaffolding when required	Creativity and innovation Problem solving and critical thinking	Authentic contexts Authentic tasks – ill-defined activities Provide coaching and scaffolding by the teacher at critical times	Herrington, 2000; 2006; Herrington & Reeves, 2011; Reeves, McKenney & Herrington, 2011
Have students produce real products for a real audience	• Require students to do a team-based project with organisations within their community where they are required to implement a real solution • Work within a specific industry that needs assistance with digital innovation	Problem solving and critical thinking Life/job skills Emotional intelligence (EQ) and ethics	Authentic contexts Authentic tasks – create a polished product with real-world relevance Provide access to expert performances and the modelling of processes Authentic assessment	Janicki, Fischetti & Burns, 2007; Reeves, Herrington & Oliver, 2002:564; Herrington, Reeves & Oliver, 2010:35; Hevner & Chatterjee, 2010; Bozalek et al., 2013; Gill & Ritzhaupt, 2013; Inder & Withell, 2013; Kereluik et al., 2013; Barber, King & Buchanan, 2015
Use design thinking	• This is a structured approach to	Core content Creativity and	Authentic tasks – examine from	Brown, 2008; Maier & Fadel, 2009; Van

	generating new ideas • The stages involve students in discovering a challenge, interpreting the context of the challenge, forming ideas, building prototypes, testing the ideas and developing a solution	innovation	different perspectives with a variety of resources Provide access to expert performances and the modelling of processes Authentic assessment	Dijk, 2010; Razzouk & Shute, 2012; Inder & Withell, 2013; Baskerville & Myers, 2015; Fichman, Dos Santos & Zheng, 2014; Koh et al., 2015; Lee Chong & Benza, 2015; Sharples et al., 2016
Cultivate an interdisciplinary mindset to create T-shaped students	• To understand problems, students need to combine different academic disciplines • Innovation requires flexibility; it demands experience and knowledge that is both broad and deep	Cross-disciplinary Collaboration and communication	Provide authentic contexts Authentic tasks – integrate different subject areas Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives	Perryman, 2010; Van Dijk, 2010; Davies et al., 2011; Craffert et al., 2014
Encourage reflection	• There is usually too much material to cover in too short a time and the tendency is to try to speed things up • Allocating enough time for students is necessary to stimulate creativity and innovation	Digital/ICT Life/job skills	Authentic tasks – opportunities to reflect Promote reflection to enable abstractions to be formed Provide for authentic assessment	Vaishnavi & Kuechler, 2004; Gupta & Bostrom, 2009; Herrington, Reeves & Oliver, 2010; McKenney & Reeves, 2012; Pope-Ruark, 2012; Matkovic, tumbas, Sakal & Pavlicevic, 2014; Iivari, Molin-Juustila & Kinnula, 2016
Allow for mistakes	• Innovation requires the willingness to fail • A course needs to be designed in which students are encouraged to try different approaches and, when something fails, they	Creativity and innovation Problem solving and critical thinking	Authentic tasks – competing solutions and a diversity of outcomes Provide coaching and scaffolding by the teacher at critical times	Herrington, Reeves & Oliver, 2010; McKenney & Reeves, 2012; Pope-Ruark, 2012; Briggs, 2013; Green, 2015; Barber, et al., 2015; Wagner & Molloy, 2016; Keenan & Henriksen,

	need to try another approach without being penalised for it			2017
Apply project-based learning to combine inquiry with accountability	• Involve students in projects that are based on real-world, authentic problems that are meaningful and engaging	Cross-disciplinary Collaboration and communication Life/job skills	Authentic contexts Authentic tasks – complex tasks performed over a period of time Provide for authentic assessment	Beetham & Sharpe, 2007; Mehlenbacher, 2010; Sharpe, Beetham & De Freitas, 2010; Markham, 2013; Saltz, Serva & Heckman, 2013; Sharples et al., 2016; Adams Becker et al., 2017

Conclusion

This chapter described the draft framework that was developed to help guide the design of the course. The different components of the framework and the importance thereof to the overall design of a course to teach digital business innovation skills to IS students were summarised.

By the end of Phase 2 of this DBR study, a learning environment had been designed and created based on consultations with practitioners, students and industry, as well as an analysis of the literature and theory. In Phase 3, the solutions are implemented, tested, evaluated and refined to provide an updated framework. The next three chapters outline the four iterations that took place during 2016 and 2017 to test and refine the principles.

CHAPTER 5: PRESENTATION AND DISCUSSION OF FINDINGS, ITERATION 1

Introduction

The first two chapters of this study described the **first phase** of this DBR study to identify the proposed intervention to answer the research question:

How should digital business innovation skills be taught to South African Information Systems students?

In order to support the answering of the main research question, the following sub-questions were included to explore the learning environment required in more depth.

1. What is the impact of global trends in digital innovation on the IS curriculum?
2. What potential skills are required from IS students to become competent digital innovators?
3. What teaching and learning interventions are required to teach digital business innovation skills to IS students?

The first sub-question was addressed in Chapter 2, which reviewed the literature, and the trends identified helped to draft the principles required in the design and provided the necessary grounding for the subsequent sub-questions. In the following chapters, the second and third sub-questions were addressed via an analysis of the data per iteration of the teaching and learning interventions to test and refine the draft principles developed in Chapter 4. In this chapter, Chapter 5, the first iteration is discussed, followed by a discussion of the second iteration in Chapter 6 and the last two iterations in Chapter 7.

In Chapter 4, the second phase of DBR was concluded to develop a conceptual framework for teaching digital business innovation to IS students. The design principles were drafted based on the literature review and the consultations with industry and academic practitioners.

In Chapters 5 to 7, the data gathered during the four iterative cycles are analysed to report on the **third phase** of this study, namely iterative cycles of testing and refinement. The findings obtained in each iteration are discussed and updates to the course are suggested for subsequent iterations. The potential skills required by IS students to become competent innovators to participate in the digital economy, and the teaching and learning interventions to teach digital business innovation skills to IS students, are explored to conclude the third phase of this DBR study.

In Chapter 8, the **final phase** is presented to recommend the framework that needs to be in place to teach digital business innovation skills to South African IS students.

Data Collection and evaluation process

In this study, a DBR approach was followed to improve the intervention via iterative cycles of data gathering, testing and verifying. After each iteration, the design was updated according to the findings. The approach that was followed to collect and analyse data in responding to the research questions was firstly to test the skills sets acquired by learners, and thereafter to test the presence of authentic learning elements in the course. The content presented and technology applied were subsequently analysed to determine the overall outcome of the draft design principles. The principles were updated and refined after each iteration to improve the overall intervention and refine the framework. The figure below provides an overview of this process.

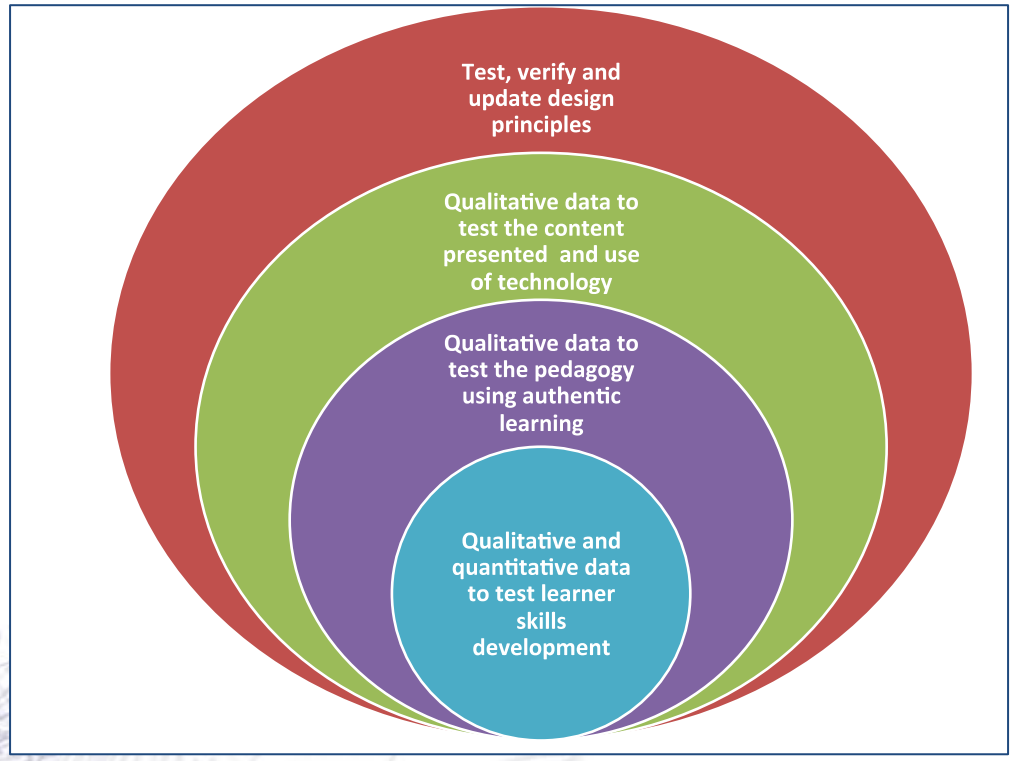


Figure 16: Data collection and evaluation process

Iteration 1: participants

The first iteration took place during the first semester of 2016 with a group of 40 Information Systems students during their Honours year at the University of the Western Cape. All students gave written consent to take part in the study. A sample of the consent letter can be viewed in Appendix 2. The participant profiles are depicted in Table 7 in Chapter 3.

Data collection, iteration 1

Table 14 illustrates the data collection approach followed.

Table 14: Summary of data collection

Data	Collection	Analysis method	Purpose	Expected outcome
Quantitative	Student online survey prior to course commencement and upon completion of the course	Regression analysis of skills perceptions ANOVA to test skills perceptions prior to and after course	Test the potential skills required by IS students to be competent digital business innovators	Test, confirm and update the design principles and update the course accordingly
Qualitative	Student survey Student blogs Student assignments Facilitator reflections Industry survey	Text analysis with Excel and Word as tools of analysis	Complement quantitative data with rich qualitative data and test teaching and learning interventions required to teach digital business innovation skills to IS students	Test, confirm and update the design principles and update the course accordingly

A mixed-methods approach was used in the collection and evaluation of data, based on a convergent parallel design model (Creswell & Plano Clark, 2011:77). In a mixed-methods research study, both quantitative and qualitative data are collected, analysed and integrated. The notion is that the combination will enable a better understanding of the research problem.

In the study, quantitative and qualitative data were collected concurrently and compared for confirmation or cross-validation (Creswell, 2007:213). The advantage of this method is well-validated and substantiated findings, and the disadvantage is the complexity inherent in comparing two different datasets, particularly where discrepancies occur in the findings (Creswell, 2007:214).

The data collection approach employed in the first iteration is illustrated in Figure 17 below.

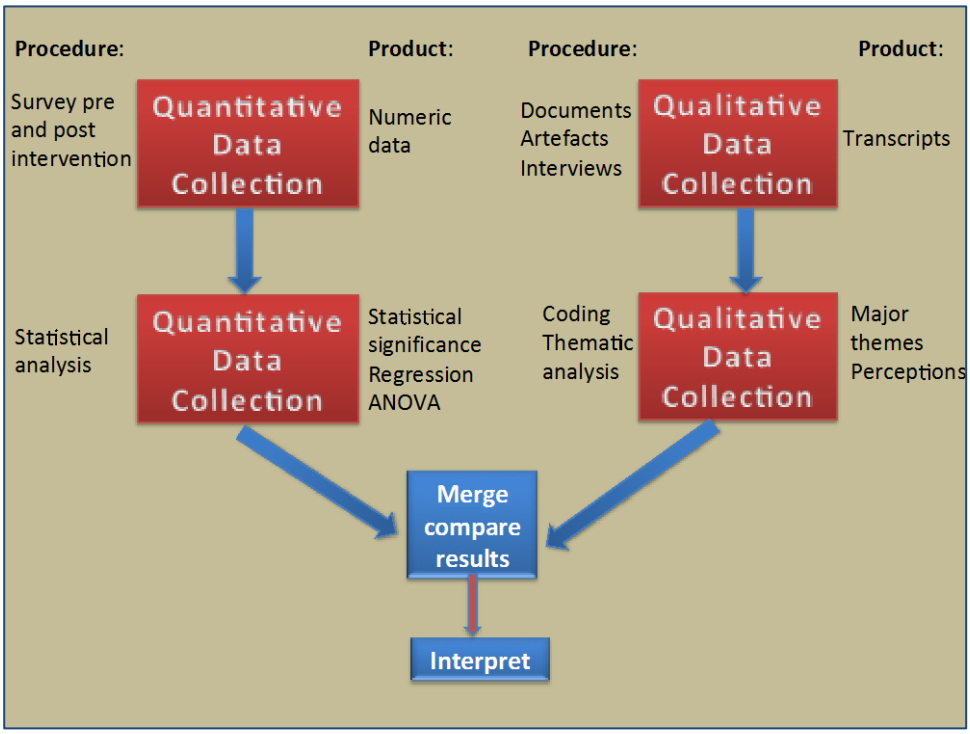


Figure 17: Concurrent design (adapted from Creswell, 2007)

Results pertaining to skills required for digital business innovation

The first section reviews the results obtained from the data analysis in the first iteration that addressed the second sub-question, namely: What skills are required by IS students to become competent digital business innovators?

Students were asked to fill in a survey on Google Forms at the start of the semester to test their perceptions prior to the course (Survey 1), and again at the end of the course to test the outcome of the intervention (Survey 2). The survey questions were adapted from the Student Success Toolkit (George, 2015). A sample of the survey can be viewed in Appendix 3. All survey and reflection responses were transferred from Google to Excel spreadsheets. Table 15 illustrates the mapping of the survey questions to the skills sets tested.

Table 15: Mapping survey questions to skills

21st-century skill	Mapping of question from pilot survey
Core content	1, 2, 3, 5, 6, 7, 9
Cross-disciplinary	24, 31, 43
Digital/ICT knowledge	22, 23, 26, 27
Communication/collaboration	8, 11, 12, 16, 17, 18, 19, 22
Problem solving/critical thinking	28, 29, 30, 32

Innovation/creativity	29, 44, 45, 46
Life/job skills	10, 34, 35, 36, 37, 38, 40, 43
EQ and ethics	15, 33, 39, 47, 48,
Cultural competencies	19, 20, 21

Each question was rated on a five-point Likert scale using the following criteria:

5 The statement is always or almost always true for you (around 100%)

4 The statement is often true for you (around 75%)

3 The statement is sometimes true for you (around 50%)

2 The statement is rarely true for you (around 25%)

1 The statement is never or almost never true for you (around 0%)

Using the mapping in Table 14, a percentage per skill was calculated for each student to conduct the statistical analysis.

Quantitative data from student surveys, iteration 1

Regression analysis

A regression analysis was conducted to determine the relationships between the variables (skills) obtained in the survey results. The regression analysis was done in Excel using the student assessment scores as the dependent variable to test the importance of the different skills, as identified in the literature, that are required for IS students to participate in the digital economy. The analysis tested the reliance on certain skills during an initial assessment and again at the end of the course. This multiple regression equation estimated the relationship between a dependent variable (Y) (student assessment scores) and the nine independent variables (X) (the skill sets identified).

When implementing a multiple regression model, the overall quality of the results may be checked with a hypothesis test. In this case, the null hypothesis is that all the slope coefficients of the model equal zero, with the alternative hypothesis being that at least one of the slope coefficients is not equal to zero. The hypothesis is rejected if at least one of the independent variables explains the value of the dependent variable by reviewing the p-value. If the p-value is less than the level of significance, the null hypothesis that the coefficient equals zero is rejected; the variable is therefore statistically significant (Anderson, 2014).

The analysis helped to identify the skills that were statistically significant using the p-value to test the null hypothesis. If a variable has a low p-value (< 0.05), it indicates that the null hypothesis can be rejected and the variable therefore is a meaningful addition to the framework.

Below are the results obtained from the first iteration survey that was conducted with students before the course commenced. For a detailed analysis of the entire result set, please refer to Appendix 5.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.74779172	0.102730979	7.27912581	5.12841E-08	0.537683277	0.957900164	0.537683277	0.957900164
Core Content	-0.206756226	0.092984647	-2.22355231	0.034128785	-0.396931182	-0.01658127	-0.396931182	-0.01658127
Digital/ICT	0.098401292	0.080483141	1.222632353	0.231312368	-0.066205214	0.263007798	-0.066205214	0.263007798
Cross Diciplinary	-0.285763933	0.139739302	-2.044978965	0.050026282	-0.571562896	3.50295E-05	-0.571562896	3.50295E-05
Communication/Collaboration	0.139710783	0.138141677	1.011358674	0.320209162	-0.14282067	0.422242236	-0.14282067	0.422242236
Problem Solving/critical thinking	0.064557047	0.068061179	0.948514966	0.350705191	-0.074643694	0.203757789	-0.074643694	0.203757789
Creativity/Innovation	-0.202929586	0.12582365	-1.612809564	0.117616861	-0.460267844	0.054408673	-0.460267844	0.054408673
Life/Job Skills	0.113459921	0.163407149	0.694338784	0.492995172	-0.220745224	0.447665067	-0.220745224	0.447665067
EQ/Ethics	0.223530794	0.151920601	1.471365912	0.151961328	-0.087181723	0.534243312	-0.087181723	0.534243312
Cultural	-0.071724536	0.091111152	-0.78722016	0.437539811	-0.258067766	0.114618694	-0.258067766	0.114618694

Figure 18: Regression Results Iteration 1: Survey 1

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.648443	0.075916	8.541567	2.07E-09	0.493176691	0.80370849	0.493176691	0.80370849
Content	-0.03364	0.111081	-0.30282	0.76419	-0.260823311	0.193548614	-0.260823311	0.193548614
Digital/ICT	-0.04042	0.104196	-0.38791	0.700914	-0.253523778	0.172685996	-0.253523778	0.172685996
Cross Dicipline	-0.09113	0.108358	-0.84105	0.407201	-0.312750335	0.130481716	-0.312750335	0.130481716
Comm/Collaboration	0.019057	0.148432	0.128386	0.89873	-0.284520337	0.322633349	-0.284520337	0.322633349
Problem Solving /Critical T	-0.05213	0.136827	-0.38097	0.706004	-0.331970322	0.227716749	-0.331970322	0.227716749
Innovation/Creativity	0.24601	0.129414	1.90095	0.067289	-0.018671819	0.510692464	-0.018671819	0.510692464
Cultural competencies	-0.06634	0.101042	-0.65655	0.516645	-0.272994824	0.140315287	-0.272994824	0.140315287
Life/Job Skills	0.087042	0.176885	0.492081	0.626366	-0.274729379	0.448813493	-0.274729379	0.448813493
EQ/Ethics	-0.03262	0.135068	-0.24148	0.810885	-0.308860048	0.243628704	-0.308860048	0.243628704

Figure 19: Regression Results Iteration 1: Survey 2

In a regression analysis you typically would like to produce a high R^2 value, thus a low p-value with a high R^2 will indicate that the results explain the response variability. However, when one predicts human behaviour, lower R^2 values are acceptable because humans are harder to predict (Anderson, 2014). For this analysis, the p-value therefore was examined more closely.

The initial assessment consisted of a number of tasks pertaining to the build-up of the capstone project. At least two values stood out in the initial survey – those of core content and cross-disciplinary skills. These skills were therefore statistically significant for results obtained during the initial assessment of the students. This shows that the students had an accurate perception of the skills required in the initial assessment pertaining to core content and cross-disciplinary skills, and furthermore that those skills were being assessed in the initial assessment.

This was to be expected, as one can argue that foundational knowledge (to know) needs to be drawn upon at the onset of a course. The other skills set that forms part of foundational knowledge is digital or ICT knowledge. The fact that this did not come out stronger can be questioned in terms of whether the students perceived that they somehow lacked digital/ICT knowledge, or if they simply did not rely on it strongly.

The skills sets that pertain to meta-knowledge (to act) would be those that ideally need to be developed during the semester. The correct content, pedagogy and use of technology need to be utilised to assist in the cultivation of these skills.

When the survey was repeated at the end of the semester to test the outcome of the intervention, the only skills set that produced a statistically significant outcome was creativity and innovation. Students therefore had an accurate perception about the requirement for creativity and innovation in the final assessment, and creativity and innovation skills were tested in the final assessment. One can argue that this will be the knowledge required primarily for digital business innovation, but ideally other skills sets ought to be featured to make for a more balanced course design. The course will have to be updated to include more of a balanced assessment that draws on skills sets from all three categories.

Considering that foundational knowledge ought to be embedded by the end of the semester, it therefore would not make a statistically significant difference in the outcome. The results obtained from the qualitative data ought to be reviewed in conjunction with each other to gain a deeper understanding of this outcome.

ANOVA analysis

The second statistical test applied was a one-way ANOVA to test the differences between the students' scores for their initial skills survey and the scores obtained for the second survey upon completion of the module. The purpose of one-way ANOVA is to test whether the means of different groups are common or different. A detailed outline of the results obtained per skills set for the pre- and post-intervention surveys is depicted in Appendix 6, and a summary of the results is displayed in the table below.

The results indicate that there was a significant positive difference ($p < 0.01$) and ($p < 0.05$) between the pre-test and post-test results regarding perceived skills development.

Table 16: ANOVA results Iteration 1

Skills set tested	F-value	P-value
Core content knowledge	57.79	8.46E-11**
Cross-disciplinary knowledge	9.47	0.003**
Digital/ICT knowledge	27.49	1.51E-06**
Communication/collaboration	17.94	6.66E-05**
Creativity/innovation	12.06	0.001**
Problem solving/critical thinking	7.98	0.006**
Life/job skills	6.09	0.016*
EQ/ethical skills	5.89	0.018*
Cultural competence	3.55	0.06 ns

(**p < 0.01; *p < 0.05; ns = not significant)

The results showed a statistically significant difference in foundational knowledge, with a perceived improvement in their core content knowledge [F=57.8, P=8.46E-11], an improvement in their digital or ICT knowledge [F=27.4, P 1.51E-06], and a result of [F=9.5, P=0.002] for the improvement in cross-disciplinary skills. These results are indicative that the skills sets for foundational knowledge were highly influential in the course outcome. This is consistent with findings from the literature, which pointed to the type of graduate who would be in demand in the future – T-shaped individuals who require a deep knowledge of an area, with the added ability to think outside of disciplinary confines. Students in IS should not only be able to track changes in technology, but also be familiar with the applications of new technology within a business environment. The design principle to create an interdisciplinary mindset is supported in this evidence.

Digital knowledge requires a deep understanding of the entire digital environment and the ability to quickly adopt new technology and co-create content. Teachers need to have the necessary expertise, not only in content knowledge, but also in pedagogy and technology to facilitate the process whereby information is transformed into knowledge. This requires the need to move beyond facts to help students to develop broader cross-disciplinary lenses to act in a digital world (Mishra & Mehta, 2017).

The findings obtained in the analysis of meta-knowledge also resulted in a statistically significant difference in the students' perceptions of learning during the course. The improvements in their knowledge pertaining to communication and collaboration resulted in [F=17.9, P=6.66E05], for problem solving and critical thinking the outcome was [F=7.9, P=0.006], and for creativity and innovation it was [F=12.1, P=0.0009]. The research shows that creativity and innovation require a deep knowledge of a discipline, combined with the ability to apply cross-disciplinary learning and to reconstruct knowledge (Mishra & Mehta, 2017). As discussed in the literature, the development of meta-knowledge is becoming more prominent due to the impact of technology and globalisation. The more complex problems become, the more the reliance on creativity and innovation (Keenan & Henriksen, 2017).

The importance of cultivating communication and collaboration is essential in this domain, because research shows that creativity in an organisational context is mostly cultivated via the interactions of interdisciplinary teams (Keenan & Henriksen, 2017). The cultivation of meta-knowledge not only requires the right information and knowledge, but also the right space or an authentic learning environment to experience the process of learning.

The thinking process regarding creativity can be trained via the facilitation of a process of idea generation around a problem, and thereafter the funnelling of ideas to narrow them down to those that are viable to implement (Keenan & Henriksen, 2017). This requires communication, collaboration, problem solving and critical thinking skills. This will have to be foregrounded within the next iteration, and more scaffolding and coaching in terms of the development of such skills as they pertain to idea generation need to take place.

The results from the one-way ANOVA pertaining to humanistic knowledge showed a statistically significant difference in the perceived knowledge of students at the onset versus after the course for both life and job skills [F=6.1, P=0.02] and EQ and ethics [F=5.9, P=0.02]. However, the results obtained for cultural competencies remained indifferent [F=3.5, P=0.06]. These results show that the development of life and job skills was perceived to be more pertinent, followed by EQ and ethics; cultural competencies did not have a significant impact. Aspects to better develop cultural skills have to be foregrounded, and these can include interventions in terms of teams and also the type of industry partners that teams work with.

The results obtained from the qualitative analysis will be compared with these results to obtain deeper insights into the overall findings from the first iteration.

Qualitative data

Qualitative data approach

The steps prescribed by Miles and Huberman (1994) to systematically organise the data were applied in the qualitative data analysis.

Step 1: Reflecting on the data received, organise data and find emerging patterns. Repeatedly read through the data and searches for meanings and patterns (Braun & Clarke, 2006).

Step 2: Code data in relation to the key pedagogical and design principles identified in the literature and identify new and emerging principles from the implementation process. When all data have been coded, codes are sorted into potential themes (Braun & Clarke, 2006).

Step 3: The data analysis phases indicated in the DBR approach are followed through the iterative cycles. This iterative process enables the researcher to become more grounded in the data and to develop a deeper understanding of the phenomenon as richer concepts emerge.

The steps prescribed by Brown and Clark (2006), as illustrated in Figure 12, were further applied to form the deeper thematic analysis. The researcher was actively involved in the data gathering, and all data were captured on a Google Drive to enable the researcher to access the data at any time. The intended outcomes and the design principles guided the analysis of the data in organising themes and lists of associated concepts, or basic themes that characterise a particular organising theme.

The table below provides further details about the qualitative data collection and analysis steps followed during the first iteration. The table is a high-level summary. For further information about the data, please refer to Appendix 7.

Table 17: Qualitative analysis form

Specific datasets	Process steps	Decision rules	Analysis operations (enter codes)			Research comments
			Data for analysis	Conclusions	Confirm conclusions	
S02.1	Analyse S01.2 and use themes and subtheme codes	Survey 2 Question 10: analysis of perceived skills development	S01.2 in Google Forms	Chapter 5	Chapter 5 update principles	Triangulate skills tested
	Analyse S01.2 themes from open-ended questions	Survey 2 Question 50 and 51 Outcome of course	S01.2 in Google Forms	Chapter 5	Chapter 5 update principles	Themes identified in responses and open-ended quotes
B01.1-3	Analysis of blogs to identify codes and themes	Analysis of Blogs 1 to 3 and identify relevant quotes per theme	B01.1-3 urls captured on Google Drive using Doctopus to create individual documentation	Chapter 5: discussion of process and quotes	Deeper discussion of findings and conclusions in Chapter 5	Substantiate findings with quotations from students per theme
PD01	Analysis of project documentation	Overview of results to identify responses and progress	Documentation on Google Drive	Review outcome of online environment	Chapter 5: integrate findings	Findings to update iteration 2
FR01	Facilitator reflections	Reflections per week on student progress and constraints experienced	Documentation in reflective journal in Word	Review results to update next iteration	Chapter 5 to update the draft design principles	
DS01	Digital stories review facilitator notes	Review necessity for course	Google Drive with Doctopus to create individual folders and links	Results were not relevant to the overall findings	No data included from digital stories	
IS01	Industry survey at end of course to measure success of implementation	Survey results	Survey in project documentation and hard copies to clients	Results captured to test validity of implementations in Chapter 5	Review and update industry liaison for future iterations	

Source: Miles and Huberman (1994)

The table below includes the codes and themes for the analysis of the qualitative data as per step two in Miles and Huberman (1994), as described above.

Table 18: Qualitative data codes and themes

Principle	Code	Description
Skills	**S01**	Core content
	S02	Cross-disciplinary
	S03	ICT/digital knowledge
	S04	Communication/collaboration
	S05	Creativity/innovation
	S06	Critical thinking/problem solving
	S07	Life/job skills
	S08	EQ/ethics
	S09	Cultural competencies
Authentic Learning	**A01**	Authentic contexts
	A02	Authentic tasks
	A03	Expert performances and the modelling of processes
	A04	Multiple roles and perspectives
	A05	Collaborative learning
	A06	Reflection to enable abstractions to be formed
	A07	Articulation to enable tacit knowledge to be made explicit
	A08	Coaching and scaffolding by the teacher
	A09	Authentic assessment

Survey 2: Open-ended questions

Student answers from the survey were coded according the above and tabled per student using numbers from the first response (St01) to the final response received (St40). Students were asked to name five skills that they believed they had gained that would be beneficial to their future employer. The question was open ended and the answers were mapped to the nine skills identified in the literature. The genders were further split in the answers to look at the difference in male versus female perspectives among the students.

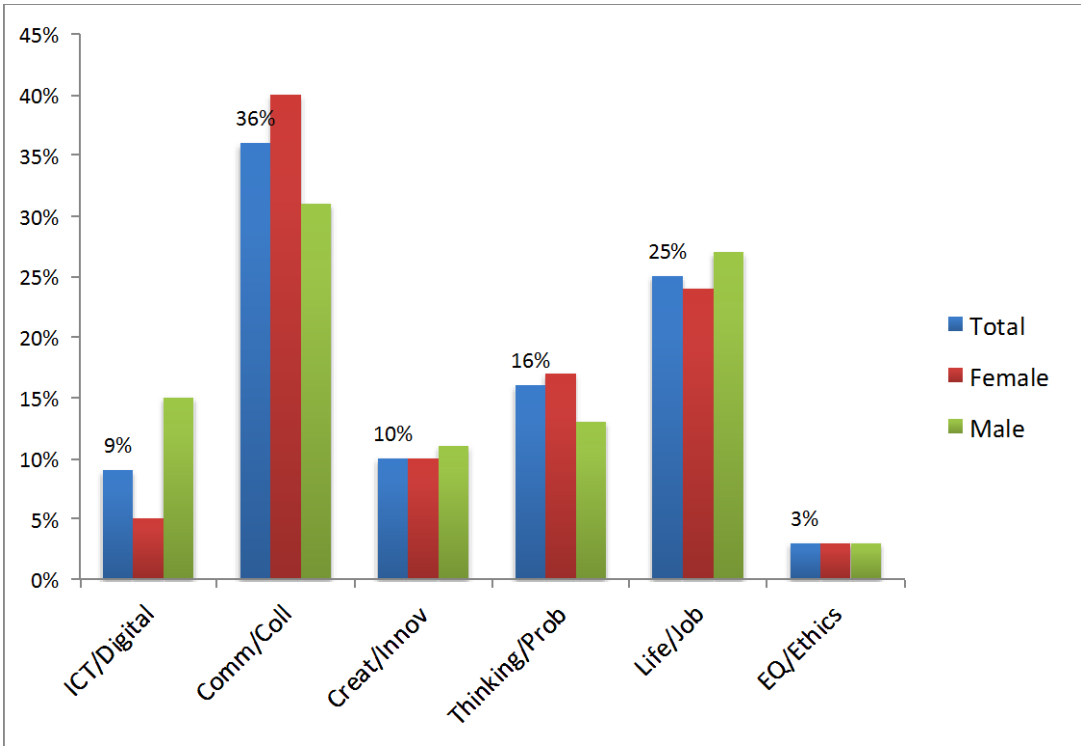


Figure 20: Valuable skills for future employer

The overall outcome showed that students perceived the development of their communication and collaboration skills to be the most significant, at 36%, followed by life and job skills at 25%, problem solving and critical thinking at 16%, creativity and innovation at 10%, closely followed by ICT and digital skills at 9% and, lastly, EQ and ethics at 3%. These results point to the impact of the learning environment, where students were required to work in teams to implement a project in a business in the creative industries sector. Students therefore spent the majority of class time in their teams, working on problems requiring them to communicate and collaborate, not only in teams but also with their clients in industry as well as with their peers. Teams were required to conduct feedback presentations on the status of their projects during class times and were reviewed by their peers in terms of progress. This authentic learning environment therefore also cultivated the development of job skills, hence the high score obtained for this category.

The categories for core content, cross-disciplinary and cultural competencies obtained very limited responses and were therefore excluded. The development of core content and cross-disciplinary skills would probably fit with what ought to happen, and would not be perceived as something that will necessarily add additional value to their future employers. The results from the ANOVA tests showed that cultural skills were not seen as skills that were significant during the course. An intervention in the next iteration is required to lift the development of cultural skills.

The difference in gender was not that significant, with the exception of ICT and digital skills, where male students felt that they could offer more, in contrast to communication and collaboration, which were scored higher by the female students. Female students in IS need to be boosted in terms of their technical skills and may require additional scaffolding to increase their confidence. This is consistent with observations that showed that teams often relied on male students to be the technical leads, whereas the female students played the role of communicators.

The second question tested the overall outcome of student perceptions in terms of the five areas that made a positive impact on their overall learning.

The results were ranked and coded according to the themes that emerged in the answers. The results are displayed in Table 19 below.

Table 19: Results of positive student perceptions of course

Code	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Total overall
A01	13%	11%	10%	11%	17%	12%
A02	0%	5%	3%	0%	0%	2%
A03	0%	0%	3%	4%	4%	2%
A05	13%	16%	13%	14%	13%	14%
A06	5%	5%	3%	21%	8%	8%
A07	26%	18%	8%	18%	13%	17%
A08	5%	5%	8%	4%	13%	7%
A09	13%	13%	8%	14%	4%	11%
S01	8%	3%	13%	7%	8%	8%
S02	15%	10%	16%	4%	13%	13%
S05	0%	11%	16%	0%	8%	7%
Responses	39	38	39	28	24	

The skills that featured the most prominently were the development of ICT and digital knowledge, which 13%, the core content taught, which scored 8%, and the development of creativity and innovation skills, at 5%. Student feedback included aspects such as:

> *I got an opportunity to learn new digital platforms such as creating a blog and photo story*. (St21)
>
> *I increased my technical skills* (St19)
>
> *Additional skills learnt like communication and writing skills* (St08)
>
> *The fact that we were not given strict guidelines on how to do our assessments because most of the time strict guidelines limit or [sic] creativity.* (St39)

However, the use of technology was not only seen in a positive light, as some students were finding it hard to adapt to the digital platforms, whilst others felt that more technical content ought to be included in the course.

> *Creating a website as I do not have technical skills and the time to learn*. (St28)
>
> *The only challenge at times were constructing video presentations and incorporating media*. (St30)
>
> *Lack of technical content that was learnt.* (St08)

The majority of answers to these two questions were on the learning environment, and not on the cultivation of new skills and competencies. In subsequent iterations, it was possible to review this again to investigate whether a similar pattern emerged when students were more focused on the environment and not on the learning per se. The previous question pertinently asked about skills development, and the results obtained from this section should not be seen as problematic because so little mention was made of skills development.

Qualitative data from student blogs

Students were required to write weekly blogs and update what they had learned during the week, and also to perform some self-evaluation exercises. The findings from the blogs were analysed to identify the themes and coded according to the nine skills sets under foundational, meta- and human knowledge. The first letter of student names and the first letter of their surnames were used as pseudonyms to record student answers and the number (1) was added to indicate that this was the first iteration.

The establishment of foundational knowledge is through the content taught, the establishment of a cross-disciplinary focus, and ICT and digital knowledge creation. The student feedback obtained confirmed the transfer of these skills during the course. The content knowledge was popular insofar as both technical and non-technical skills development were concerned.

> *I have accomplished so much in a short space of time. I have gained technical and non-technical skills that could take me anywhere in future in terms of my career.* (MM1)
>
> *In the same lecture, each group was then required to do a presentation based on all of the work covered thus far in the module. It was during preparation for this presentation that something clicked and I better understood how all of the pieces of the puzzle (i.e. business model canvas, design thinking, agile and Lean) fit together and relate to one another.* (MK1)

The foundational content taught techniques that students had been exposed to before, such as business models, agile project management and lean methodology. They had not been exposed to the process of design

thinking before and found this extremely beneficial in the process of identifying and implementing innovative digital solutions.

> *What really interested me was the design thinking process. I personally took in design thinking as it made me look at how to be creative or incorporate creativity when thinking about things from a business and IT perspective. It showed me how [to] address problems from a new point of view and be more liberal when it came to finding solutions to problems.* (FA1)

> *Since the start of my honours years there are so many new topics that have been taught which has increased my interests in the study of Information technology as a whole. One of the key skills that come to mind is DESIGN THINKING, it opens your mind to new ideas and a different perspective of how to do things.* (Seth1)

> *It was the first time I heard about the concept design thinking and it gripped me like I would grip the handles of a roller coaster ride. The delicate manner of how design thinking is incorporated in the three IS components that are used to define Information Systems are [sic] mesmerising.* (FF1)

The incorporation of cross-disciplinary knowledge in the curriculum during the first iteration was not an easy feat, and the reliance was more on content to provide a foundation for students to become digital business innovators. The majority of students in the class came from a number of different disciplines within the Economic and Management Sciences (EMS) faculty at the university, which ensured cross-disciplinary knowledge within the teams. The teams were further selected by the IS department to enable some diversity between members, and this could also have impacted positively on the incorporation of cross-disciplinary knowledge.

> *I have also been able to align my knowledge that I have learned over the years relating to information systems which I thought I had forgotten. I am curious what the next few weeks hold for me.* (LR)

> *I have learnt the necessary procedures, tools and skills to utilise for IS in the business environment when piloting a project. This is vital for me, because as much as I am in the IS field, the business environment is where I will execute IS projects and implement my knowledge and skills.* (TZ1)

The students in the Honours group included some students who come from BCom Information Systems, others from the BCom general group who opted to take Information Systems subjects, and also some from Computer Science. The students from BCom Information Systems and Computer Science had technical experience, but most students from the BCom group did not select the specialised technical courses during their second and third years. In the course, students were tasked to design and implement a digital innovation to improve the business that they worked with. Some students found this challenging because they felt that they lacked the technical know-how to develop a system. There were six students per team and the idea was that at least one of the team members came from Computer Science or BCom IS and would have more advanced technical skills. Working in a team and being tasked to develop a system exposed the students to more advanced digital and ICT knowledge. Comments from students showed that they improved their knowledge in this area.

> *I had no prior technical experience when developing an actual system just theoretical knowledge, the main assignment has helped me to develop some programming and developing skills with regards to a system.* (SM1)

Communication and collaboration were seen as an area that challenged and inspired the students during the course, and many teams went through phases from finding their feet to conflict and finally working together as a united front. Online collaboration was a further aspect included in the course, and teams transformed the practical work into documents on Google Drive, where they were required to give one another feedback on progress. This was also a vehicle used by the instructor for feedback and suggestions to groups.

> *Doing these tasks with my group, made this experience very enjoyable and full of fun. We managed to do the work through constant collaboration and lots of laughter!* (ZA1)

> *What was interesting for me to find out how information systems as a discipline greatly involve the interaction of technology with people. This entails that a large part of this discipline involves the social aspect. As it largely involves people one has to master the skill of interacting with not only the technology and processes involved in technology but the people aspect as well.* (LB1)

> *Throughout this course I've had to be in countless group meetings, consultation with peers and the lecturer as well as people outside of this course such as the client for our project. This has also helped be [sic] to handle people better, I have realised that my opinions are not always right and have learnt to listen more. Conflict management skills are definitely one that has been improved on!* (SS1)

> *The past three weeks has [sic] taught me a lot of myself and about others. The knowledge regarding academics was not nearly as rich as the knowledge I gained about working with others and staying true to who I am. We are learning how to accept each other's personalities and communicating better.* (AD1)

Cultivating creativity and innovation was a vital component of the course and students were encouraged to explore, test, refine and experiment with different options. They were furthermore not penalised when an intervention did not work, but rather encouraged to keep on trying and experimenting with different options. Students were required to prepare their lessons before lectures, and lecture times were used to conduct practical tasks based on the theory learned. Students worked in their teams and class times consisted of lots of white paper, sticky notes, coloured pens, brainstorming, mind mapping and lateral thinking quizzes.

Figure 21: Getting creative in class, iteration 1

Teams were given the time to prepare tasks and then tasked to present their work to the other teams, who gave constructive feedback. Figure 21 above is an example of a presentation in class.

> *This module allows us to be creative and to be innovative. What was more interesting to me was to see that there are other ways of doing things. In presentation for instance we do not have to spend a lot of time doing slides. As we can do voice over slides, do a video and present it in class, do a show or act.* (VT1)

> *I have enjoyed all the lectures and tasks done in this course so far. What I enjoy more is that we are doing practical work, which prepares us for life after this course; the tasks done in this course help us to be more creative/ innovative and help us to gain some technical skills that will work to our advantage in the workplace.* (ND1)

> *The lecturer provided the class with a quiz involving a number of riddles. A similar quiz was given to the class in the beginning of course. The lecturer executed this exercise to determine if our thinking and train of thought has changed throughout the course. From my perspective, I feel that my thinking has changed or improved. Answering the questions seemed much easier than before, and the results certainly indicated that.* (LR1)

Limited evidence was found in the student reflection on humanistic knowledge, with the exception of life and job skills. The intention was to create an authentic learning environment to enable “real-world” problems to help students with the transition from university to a work environment upon graduation.

It has not been easy for almost all of us here; we have all got our share of hardships, obstacles, failures, and painful experiences. But in all of that for us to be here that means we managed to pick ourselves up, dust off and continued with the journey. (JM1)

I am also gaining knowledge and experience in personal and social skills, which will help me as a person in the working environment. (TZ1)

I have learnt so much skills and knowledge. I am confident about the things I have learnt and I am confident that I could apply these in the "big world" now. (SM1)

Table 20: Summary of skills data obtained in iteration 1

Code	Description	Regression	ANOVA	Survey skills audit	Reflection	Comments
S01	**Core content**	1 survey 1	1		✓	More design thinking upfront
S02	**Cross-discipline**	2 survey 1	5		✓	Need more evidence of development
S03	**Digi/ICT**		2	5	✓	Problem for some, more upfront work
S04	**Comm/coll**		3	1	✓	Good evidence of development
S05	**Create/innovate**	1 survey 2	4	4	✓	Good evidence of development
S06	**Problem/critical**		6	3		Need some more evidence
S07	**Life/job**		7	2	✓	Good evidence of development
S08	**EQ/ethics**		8	6		Limited evidence
S09	**Cultural**					No evidence
Comments		Statistical significance of skills in assessments	Rank on F value for skills develop-ment	Rank skills for future employer	Significant responses for skills applied in course	

The summary of findings in the table above were used in conjunction with the findings from the next iterations to obtain certainty on the significant skills to be included for students to become competent digital innovators. The skills highlighted were tested during assignments in the next iteration to see the results obtained versus the perceptions of students regarding important skills sets applied during the course.

Results for teaching and learning interventions

The following section reviews the results from the data analysis that pertain to the third sub-question, namely: What teaching and learning interventions are required to teach digital business innovation skills to IS students?

From the literature, the establishment of an authentic learning environment emerged as paramount, and evidence of the nine aspects that define authentic learning were analysed in the data. The data gathered for this section included only qualitative feedback from the students during the final survey, student reflective blogs, student assessments, reflections by the facilitator and industry feedback.

Qualitative data from student survey

An open-ended question in the survey tested the overall outcome of student perceptions in terms of the course at the end. Students were asked to name up to five areas that made a positive impact on their overall learning during the course. The results were ranked and coded according to the themes that emerged in the answers, as displayed in Table 18. The aspect that students found most beneficial was the promotion of articulation to enable tacit knowledge to become explicit. This was achieved through weekly presentations by teams during class time and individual check-ins to discuss the growing understanding of topics covered. Facilitation during face-to-face and online collaboration further assisted students to become familiar with concepts.

> *Having regular presentations where feedback was given for improvement to be done.* (St20)
>
> *The fact that we could also grade each other's presentations. This made me see what other groups expect from us.* (St39)
>
> *Taking criticism as a lesson for improvement.* (St29)

The students viewed the collaborative learning as the second most positive aspect of the course. The development of communication and collaboration skills was discussed in the previous section, and a learning environment that encourages this is crucial. Positive student feedback in terms of this aspect is therefore very encouraging.

> *Activities that encouraged collaboration worked for me.* (St6)
>
> *Collaborating with the team was better in the sense that we could see how far each other are on Google Drive.* (St13)
>
> *Working in groups helped me learn how to work with other people that have different backgrounds and personalities. This helped me prepare for my career when I am obligated to work with other people.* (St35)

Authentic contexts and assessments were also positively perceived by the students in the final survey due to the format of the course, in which students had to engage with businesses to implement a real, workable digital innovation.

> *The initiation and final document provided me with clear and concise knowledge on the way in which projects could be implemented for other businesses, which I believe, would really assist me in the working world.* (St18)

> *Better understanding of methodologies learnt because of a more hands-on experience* (St08)

Assessments were structured to test the rollout of tasks in a continuous manner. An area that could be improved upon in the next iteration was the quality of feedback provided to students to assist them to improve their overall performance. Google Drive needs to be utilised better and students need to be encouraged to post their work in progress online.

> *The continuous assignment work helped to keep the group on track and fully understand where to progress to.* (St37)

> *The practicality of assignments and being able to apply what was learnt in the real world.* (St18)

> *Having assignments broken up into different sections.* (St15)

The use of student blogs to do reflection was not received positively at the start, but as the course continued students started to see the value thereof.

> *The introspective element of the course that allowed me to gauge my own skills and personality.* (St31)

> *Web blogs, helped me to express myself and my thoughts and opinions.* (St32)

> *The use of different methods of teaching. Before this class I was not use [sic] to working online.* (St35)

The negative feedback provided included aspects on teamwork that caused conflict. In the following iterations, more work had to be done on the team-work aspects and students need to be assisted with areas that may cause discontent and guided in terms of good behaviour in teams.

> *Working in groups that you did not choose for yourself was not good.* (St6)

> *Working in a large group was challenging when it came to delegating work and producing quality and cohesive work.* (St24)

> *Teams were not equal which made the groups uneven in terms of capabilities.* (St25)

Another aspect that was seen as a challenge was the complexity of tasks that had to be investigated over a period of time.

> *There were some moments that I felt there were too many small projects that needed to be handed in. Those weeks that something was due every week.* (St16)

> *The fact that I had to submit something every week at first I did not get it right but thinking back now, it taught me on how to work under pressure. I had a problem with that but now I see it as a challenge I had to overcome.* (St19)

> *What did not work is the fact that we were doing presentations every week, no break.* (St21)

> *The limited time given to complete tasks.* (St26)

The use of technology provided constraints for some students, whilst others objected to the lack of technical training provided.

> *The use of Google drive was not convenient.* (St06)
>
> *Creating a website as I do not have technical skills and the time to learn.* (St28)
>
> *The only challenge at times were constructing video presentations and incorporating media.* (St30)
>
> *Lack of technical content that was learnt.* (St08)

Qualitative analysis of student reflections

Students were tasked to subscribe to a blog and submit three blogs during the semester, as described above. They were not restricted in terms of the specific blog site and used a variety, including WordPress, iblog, blogger and the blog available on the LMS system. They had to write about their progress per week and what they learned during the week, what they found interesting and what they did not enjoy. In addition, they had to perform certain tasks, such as personality analyses, skills audits and reflection on their goals and aspirations. The overall results obtained from the blogs during the first iteration can be viewed in Appendix 7.

The blogs were analysed to determine whether the principles of authentic learning were present during the course and how students experienced them and what their learnings were.

The first aspect analysed was whether an **authentic context** that reflects the way knowledge is used in real life was established. The emphasis ought to be on the development of digital innovation competencies and the ability of students to apply these skills in real life.

Feedback from the students provided some evidence of this taking place. This was reviewed in conjunction with other data to determine the success of and potential areas to improve on during the next iteration.

> *I enjoyed this exercise when it was done in class, but even more once we applied it to our chosen business as it helped to actually show progression with something that we had learnt.* (PA1)
>
> *The interaction for our assignments with the owners of companies was particularly interesting as it gave us the opportunity to solve a real-world problem. Throughout the project life cycle one should not just give focus on the technology aspect of it, but also the human interaction as well. This entails communicating to the users, whether it is the business owner, employees or customers.* (LB1)
>
> *The first thing I've learnt is how to apply my current knowledge to the real world. It is of utmost importance that we be able to apply the theory that we have learnt to real life situations.* (SI1)

The second aspect to test was the presence of **authentic tasks** and, to achieve this, the process in Table 9: Mapping of authentic tasks to course design was applied. Some feedback in terms of the success included:

> *I have enjoyed the fact that I am becoming aware my own strengths through these tasks that we find ourselves challenged with.* (CS1)

> *I have enjoyed that the conducting of the tasks has allowed for us to actually gain practical experience for once. It has allowed me to develop a new set of skills and knowledge and it has been fun to actually go out there, identify a digital opportunity and develop a system that will change a business.* (SS1)

To provide **access to expert performance** and the modelling of processes, the use of peer reviews was tested in the course. Some students found this challenging in the beginning and only started feeling more comfortable to voice their opinions towards the end of the course. They required more scaffolding with regard to the giving and receiving of feedback. A solution was to encourage them to make it a fun and playful environment in which they could all learn from one another and all ideas were welcomed.

> *One is constantly interacting between groups, other colleagues, guest speakers and the lecturer. I enjoy this interaction as I gain insight into others opinions and views. I found that this is also when I learn most.* (SM1)

> *We then turned our attention to peer review presentations where we reviewed another group's assignment for IFS 731. This was absolute fun. We enjoyed being able to help another group improve their work and at the same time it taught us how to spot and fix our own errors.* (SW)

> *In future I do not think it is a good idea for students to review each other because sometimes we can be biased and also unfair.* (PM1)

> *The peer review was probably one of the most interesting and yet challenging task I have ever had to complete with my group members.* (KH1)

> *The interesting part that stood out for me was that we might be doing group assignment and activities, but at the end we need the help and advice from our other fellow course members in aspects where we as a group might lack.* (CJ1)

A number of students did not enjoy the peer review and found it confusing and challenging. More effort needs to be made in future iterations to assist students in this process.

> *There was confusion of the instructions [sic] for assignment five. Also it was difficult to think of a creative way to present assignment five since we were critiquing a other [sic] group's work.* (BB1)

> *I didn't want to seem unbiased when reviewing the group, my group members and I had to look at the direction of the group 5 project [sic]. Choosing the cons wasn't easy for me, I didn't want to penalize my classmates and be so critic although it came with their benefit [sic].* (MM1)

The provision of **multiple roles and perspectives** is an aspect that requires more attention during the second iteration. Students relied heavily on what was more familiar to them and had a hard time to come up with different perspectives and to form their own opinions of what is relevant in their given situation and project. They tended to go for the familiar and all ended up doing similar interventions in their chosen business. Much more effort during the second iteration is required to improve the ideation exercises.

The creation of a collaborative learning environment was successful during the first iteration, and a similar strategy was applied in the next iteration, in terms of a large portion of tasks being performed in teams. The online engagement had to be improved, as students did not give feedback online except when tested for it. It

ought to be encouraged as a normal process in which the team members interact with one another online and face-to-face. Students must also be encouraged to use other online applications that can aid them in their project rollout.

> *The fact that we were placed into groups with random people we did not know but have to work with throughout the course, gives you a real life experience of what it would be like in a place of work one day, where you have to be able to communicate and work efficiently with people from various backgrounds. It has allowed me to engage with class mates beyond the norm, criticizing their work openly allowing them as well as ourselves to recognize our mistakes and improve on it. It has also allowed me to better understand my personality and why I react to things the way I do.* (KH1)

> *Before the module I was that student who was an introvert, I was used to working individually most of the times and I really did not like public speaking, even in my undergraduate studies, I never answered a question in class voluntarily because I do not like public speaking. IFS731 made me to overcome my fears and got me out from my comfort zone of working individually.* (BK1)

> *Through the interactive lectures and ongoing group work, I have learnt new things about myself and ultimately new skills and knowledge pertaining to the content. I've enjoyed being able to interact with my peers and fellow colleagues and learn new things from them. Working in a team has also allowed me to identify my strengths and weaknesses and I have enjoyed how they help me balance it out or improve on it.* (SS1)

> *The course is very challenging as it requires a person to be disciplined, manage time very well and be able to work with diverse groups. It encourages participation during lectures and individual contribution in group work.* (VT1)

In **reflecting on progress**, the students wrote the blogs to recollect their experiences and narrate it to others. They were further required to express feelings related to the experience – both positive and negative. Although the perceptions provided by the students were very insightful, it took an enormous amount of time to read all the blogs and to provide feedback to the students. In future, peer feedback needs to be built into the process, with clear guidance in the rubrics provided. Another aspect that can be improved upon in subsequent iterations is to help students to re-evaluate their experiences in order to identify new knowledge and how this can be applied.

> *The writing of my blogs has helped me reflect on my student life and has been beneficial in a number of ways. It provided a platform to vent, and voice my opinions and feelings. The blogs helped me to learn a lot about myself, as writing about certain topics really made me question myself. Although they may have been briefly thought about, recording and blogging it makes it a bit more real.* (LB1)

> *I also enjoy the blogs so much, that when I am posting I forget that it's for marks. I think it is such a good idea for reflection even though I write too much instead of using models and fancy words. And it also helps me go back to what I have done already and see if I still remember.* (YM1)

> *Writing this blog gave me a sense of direction in that it has allowed me the ability to be able to evaluate where I currently am in life. It has made me aware of the things I have accomplished thus far. It puts everything into perspective and I now see exactly what I am and should be working towards.* (KD1)

> *In writing these blog posts I have enjoyed documenting my journey so far. Even in just three blog posts I can see the progression in the way I write, the way I think and my ability to turn an assignment into something enjoyable, in hope that others will also enjoy my story telling.* (TZ1)

> *There are various things that stood out for me in this course, not necessarily because I enjoyed it or because it was easy, but because it helped me grow and helped me learn.* (KH1)
>
> *Her class not only taught me a lot of new skills, but also allowed us to reflect on who we are, or who we thought we were by doing these blogs.* (AD1)

The course had to promote **articulation** to enable **tacit knowledge** to be made **explicit**. As suggested in the literature, articulation ought to occur within collaborative groups to enable social and then individual understanding, and should further consist of the public presentation of arguments to enable the understanding of a concept (Herrington, Reeves & Oliver, 2010:32).

> *The class consisted of a great deal of class interaction, group work, additional reading as well as students presenting presentations; with the lecturer providing facilitation and insight. This seems to be almost a contrast to my experience doing my undergraduate studies, which just involved the lecturer just providing the lecture, with minimal class interaction, and us the students studying the content afterwards in preparation for tests and examinations.* (LR1)
>
> *We took the learning experience away from sitting in the lab listening to theory based explanations, following slides and making notes. The module evolved away from that, to becoming a module filled with hands-on activities and presentations to help students to become mentally and physically involved in the lectures. I believe this to be a very effective method of teaching making it an easier and more comfortable environment to learn in.* (TZ1)
>
> *We got a canvas and were sent in our groups to practice the business model as Carolien explained it in her videos on iKamva, so she just briefly touched on them in class, after we were sent it groups we had to present our work to the whole class, which gave us a chance to work on our agile techniques and our logical thinking.* (LB1)

The lecturer needs to provide **coaching and scaffolding** at critical times to monitor the rollout of the tasks and to provide some support in terms of skills, strategies and links to complete the task. It was important to monitor the guidance required and to scale it down to enable students to form the links for themselves as the course progressed. This was challenging at times, because students tend to rely very heavily on the facilitator to guide and direct them. They are more used to this form of instruction and needed more support at the beginning to enable them to start functioning independently as the semester progressed. Some teams also required more guidance than others, as they felt that they lacked some skills to perform certain tasks individually. The strategy followed was to let them experiment and try different techniques during lecture times to make them more comfortable with the process.

This is an area that needed improvement in subsequent iterations and a better understanding of what it means to coach and provide scaffolding to the students was required. Once cannot merely instruct, and I needed to step away at times and allow the students to make mistakes in order for them to learn. It is not an easy task to learn where to provide help and where to allow the situation to unfold a little more before stepping in and providing assistance.

The positive aspects highlighted by students in terms of communication, feedback, guidance and instruction included aspects such as:

> *Our lecturer guides us and constantly reassures us that this is a platform where our mistakes can be corrected and where we are not judged. We are constantly put at ease, and that is something I cherish and am very much grateful for.* (ZA1)

> *The lecturer facilitates the class in such a way that one does not feel intimidated if they have to present. She guides you on how you should go about a task if your interpretation of it is veering off course.* (CS1)

> *I have learnt a lot throughout the course and it has given me the opportunity of doing things beyond my abilities. It has showed me that the way we grasp things makes it better for us rather than expecting the norm from what it requires.* (CJ1)

On the negative side, some students found the lack of explicit instructions confusing:

> *Sometimes I did not understand what I had to do to complete assignments*. (AM1)

> *There was confusion in the instructions for assignments*. (LB1)

How much communication and instruction should be given to students had to be carefully balanced in the next iteration.

Authentic assessment of learning within the tasks had to be present in the review of the course, whereby students had to perform authentic tasks and be assessed according to their performance to implement a final product in collaboration with others. In the design, multiple forms of evidence were included to measure student performance in order to test student collaboration and to measure the different artefacts produced to complete each task.

> *We gained project management skills through understanding the importance thereof and through practicing certain aspects on a daily basis. This empowered me to become a team player and to fit myself well within my group. My writing skills have made a great improvement, as I am able to ensure that everything written makes sense, and I am capable of changing sentence constructions if need be. The constant assignments assisted me in developing a skill to know when something is visually appealing. Additionally, my presentation skills have definitely improved since I have enrolled for this course.* (ZA1)

> *Ways in which our documents and presentations in the end user practical course were reviewed allowed for changes and improvement to be made. Feedback is essential when writing a document; this helps you to improve your writing skills.* (SH1)

> *I thoroughly enjoy these tests as it forces one to step away from the norm and think out the box. I feel tests like these are important as students are generally expected to cover large amounts of theory which is later regurgitated in an assessment. We are not encouraged to think outside of the proverbial box enough especially in a field such as Information Systems.* (MK1)

> *End User Practical has been exciting and challenging over the past couple of weeks however the module has taught me a lot about; firstly theory within IS and how it is applied within the real world, secondly about myself and others in terms of how to work as a team, take constructive criticism from others without taking offense and lastly it allowed me to challenge myself and go beyond limits I set for myself.* (KH1)

To enable authentic assessment, students were required to capture their assessments in an online environment using Google Drive. The Learning Management System (LMS) was used in conjunction with Google Drive, but a review of the technological affordances of different platforms proved that Google Drive supported all the requirements of the teacher and students (see Table 4).

Students were asked to complete a survey to test their response in terms of working in an online environment. The survey showed that 57% of students did not find it difficult to work in Google Drive, while 43% did, due to constraints of internet connectivity, confusion in terms of document format and layout, and adjustment to a new application.

Students were asked about the perceived benefits of working online and comments included the ease of collaboration and feedback. For example:

> *For Assignment 4 the lecturer was able to comment on our work, and give us suggestions on where we can improve in certain parts of the assignment. With regards to assignment 5 we were able to see where we can improve in assignment 4.* (SS1)
>
> *I enjoyed the ability to work as a team simultaneously, and able to see team members when they are working on a document you busy with as a team.* (MC1)
>
> *Collaborating and being able to do everything from a centralized place was good. The feedback also helped me and my group to achieve better marks.* (T1)
>
> *To be corrected by my mates before the lecturer [marks] the final work.* (PM1)
>
> *I found it useful even though my group was a bit sceptical in posting our work there for everyone to see. The collaboration was very useful because it allowed for simultaneous collaboration with the team and the lecturer. We were able to ask the lecturer questions and she responded as soon as she could and we were able to use her feedback to improve our document.* (TZ1)

In future iterations, the online collaboration needs to be instilled from the start of the semester and students need to be guided in posting their work online for review.

Documentation

An online environment using Google Drive was created for all assignments, and the students were required to document their progress using the folder shared with them. This enabled online collaboration between team members, with the facilitator and between groups. Students received clear guidelines via recordings that provided on-screen guidance as well as rubrics. An example of this is depicted below.

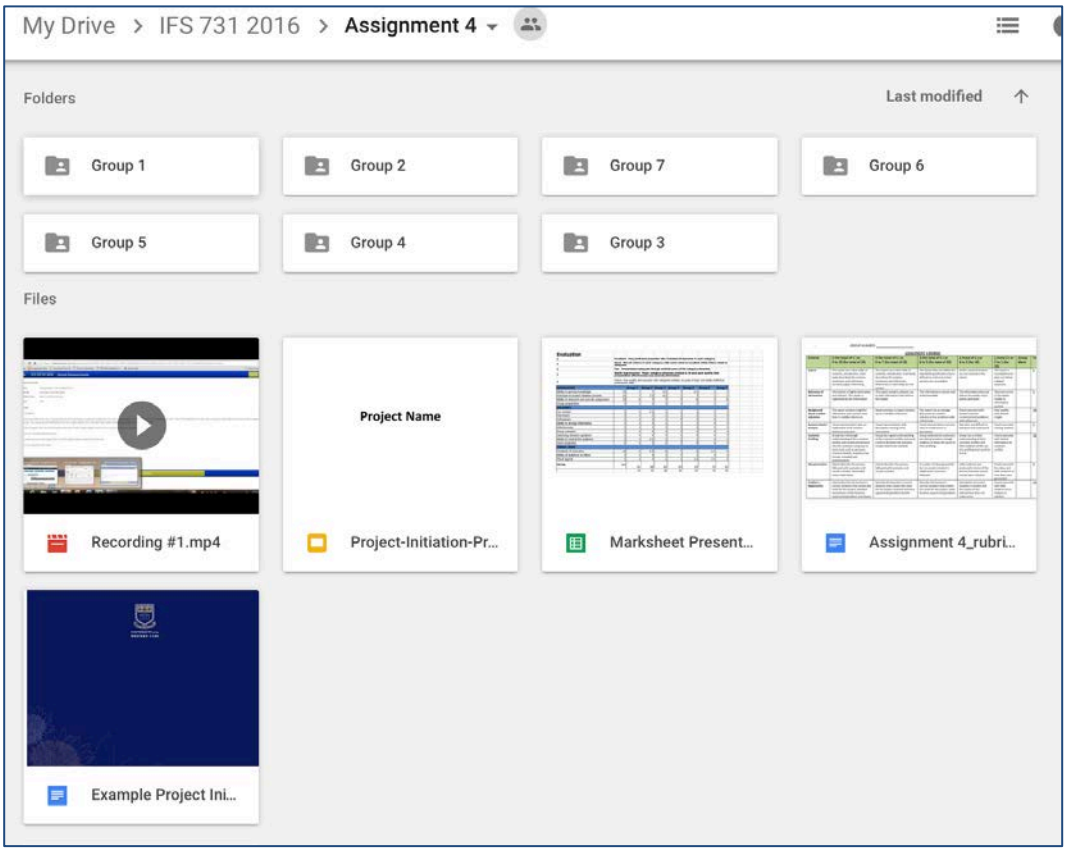


Figure 22: Project documentation

Industry results

The teams were required to engage with an industry partner to implement a digital business innovation in their business. Organisations within the creative industries could be selected due to the importance of this sector in Cape Town and the requirement to boost small businesses in our economy. A review of potential businesses included in this sector is depicted below.

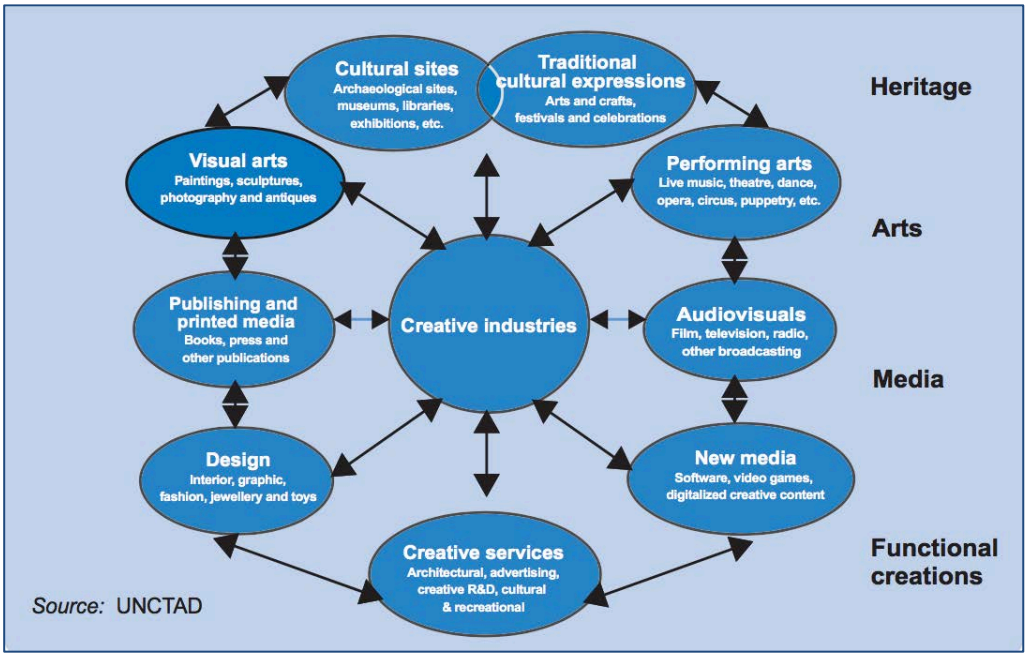


Figure 23: UNCTAD model of the creative industries (UNCTAD, 2008:14)

Groups worked with a variety of businesses, ranging from a radio station, clothing designers, photographers, music producers and graphic designers. The industry partners were asked to complete a survey (available in Appendix 4) after the implementation to test their overall satisfaction. A six-point Likert scale was used and the results were converted to percentages, as depicted in Table 21 below.

Table 21: Results from industry survey, iteration 1

Questions regarding student conduct	Result
How well did the group of students engage with you to determine your business needs?	76%
How well did the group of students consult you to analyse your current business model?	76%
What was the quality of feedback received by the group to illustrate your current business model?	67%
How well did the group of students communicate different ideas to improve your business?	74%
How well were you consulted to determine the best idea/s to improve your business?	74%
How well did the group explain the benefits of implementing a digital innovation for your business?	69%
What is the quality of the group's knowledge of your customers?	71%
How well did the group explain different techniques to analyse your customers to you?	76%
How well did the different members in the team work together to implement a solution for you?	69%
How effective was the overall communication and engagement from the students during the project?	64%
Questions on overall usefulness of new digital innovation implemented	
It helps me be more effective.	81%
It helps me to be more productive.	81%
It is useful.	81%
It gives me more control over the activities in my business.	83%
It makes the things I want to accomplish easier to get done.	83%
It saves me time when I use it.	75%
It meets my needs.	78%
It does everything I would expect it to do.	72%
It works the way I want it to work.	75%
It has been a useful exercise for me.	78%
Questions to test digital savvy of the industry partner	
I am comfortable with my current business model.	62%

I am aware of new technologies that can improve my business.	71%
I am comfortable to adopt new technology in my business.	76%
I would like to increase my awareness of potential digital improvements to my business.	81%
I believe that I can improve my customer relationship management	67%
It is easy to find technology to support my business needs.	64%
The digital economy will have a beneficial impact on my business	69%
It is essential that my business becomes more digitally savvy	83%
As the digital economy grows, so will my business	76%

The results displayed show that industry partners were 76% satisfied with the students' analysis of their business needs and business model, showing that the students grasped the core content.

The students found it more challenging to explain the potential digital innovation that can work in their clients' business, with a satisfaction level of 69%. They also performed less favourably in terms of their ability to provide quality feedback to their industry partners (67%). However, the overall digital solution implemented in their business was perceived as highly favourable by the majority of clients, with a satisfaction rate of over 80% for most aspects.

There was a lower satisfaction rating in terms of the solution meeting all the requirements set out by the clients, at an average of 75%. This may be as a result of inadequate communication between the clients and the students in terms of the management of expectations. This is an area in which the students require better coaching in the future, as there tends to be an "over-promise and under-deliver" scenario when pressure starts to build up.

> *Better training needs to be provided to employees and the system should be easier to use for customers* (IP1G5)

The survey showed that industry partners benefitted from the experience and that they became cognisant of the advantages of digital innovation for their businesses.

> *Thoroughly enjoyed working with them. They understood my needs and assisted us. Thanks for the excellent work conduct and enlightening us on the digital economy.* (IP1G3)

> *An excellent system, I would like to thank the students for their outstanding work. They have assisted me to improve my business they have a great future ahead!* (IP1G4)

After the interaction with the students the industry partners became aware that their current business model was outdated and that new technology could improve their business. They also said they would like to become more familiar with the benefits of digital innovation and therefore realised that they needed to become more digitally savvy. The primary constraint experienced in this area was the ease of finding the right technology to assist their business, and the intervention with the student teams assisted them in this regards.

A better selection process for industry partners needs to take place in future. The partners were all small companies or individuals and the overall impact of the innovations on the community can be questioned.

Facilitator reflections, iteration 1

As the designer, implementer and evaluator of this course, it was important to record how the researcher contributed both positively and negatively to the students' experiences of the course. These reflections were documented via a journal to record observations and issues expressed by the students and industry partners.

Content Specific

The aspects included in the content were all relevant to the tasks provided and the students had to grasp the concepts in order to progress with their digital innovations. One of the main obstacles for students was to integrate Agile and Design Thinking into their project planning, particularly how the phases of the design thinking process ought to fit in with the release strategies in their sprints. The benefit of Design Thinking and Agile Design is that both emphasise collaboration and communication, but how much time to spend on the design and testing the design, versus restlessness to get on with the job and start coding, caused conflict in the groups. Better facilitation has to take place in class to establish the process with the students upfront and to help them with their project planning. They also need to spend more time during class to test the concepts and present findings to one another in order to get better clarity. This could also help in improving problem solving and critical thinking skills in future iterations.

The content ought to incorporate the Value Proposition Canvas to help students to understand the client's business better (Osterwalder et al., 2014). The use of Empathy Maps and Personas via better facilitation in class should also be more prominent. Students found it hard to integrate concepts of Agile (Scrum) with Design Thinking.

The digital stories were very well executed but did not build on the project, and these can be excluded in future to rather incorporate scenario planning or something similar to guide students in future planning.

Pedagogy

The lack of creativity displayed in their ideation exercises and the tendency to stick to the familiar are further aspects that require more attention. In the next iteration, the first lecture ought to be on digital innovation to give students more ideas in terms of what can be done. They should be encouraged to go out and find more ideas, whether they are suitable or not, and to use a decision matrix to narrow down the ideas to those that are more plausible. This will require an update in the way that tasks are rolled out to ensure that the right concepts are presented at the correct times to enable knowledge to be embedded prior to the practical application thereof. The students need to be encouraged to experiment and have to be reassured that mistakes are allowed and are part of the process.

Both the lecturer and the students need to learn to embrace the uncertainties and open-ended nature of design problems and to learn to accept failure. A key learning was that the lecturer had to stress the importance of

productive failure and to continuously assist students to correct prototypes and encourage them to try new things and new ways of doing. This is a demanding process that requires the lecturer to have an in-depth understanding of student projects, and points to the importance of teamwork during lectures to unpack the different projects and provide collaborative feedback to teams in terms of progress and methods applied to solve problems. An effective way to encourage the development of meta-skills is to encourage students to articulate and share their findings about the content and the process applied via peer group learning discussions (Laurillard, 2012:77).

Technology

During the first iteration, a blended learning approach was applied to enable the instruction of learning material online via PowerPoint slides with a voiceover. The purpose was to free up time during the lecture sessions to practise practical concepts and to allow teams to work collaboratively on problems and present their solutions to the other teams.

The lecture videos were kept short and compact, and the idea was that students would find it easy to view and engage with the content. They were quizzed about their understanding during the lecture sessions and had to present practical findings based on the content provided. This posed a big problem during the first three sessions, as the students were not adequately prepared for the lectures and could not engage sufficiently. Team members became frustrated with their peers who had not prepared and this resulted in team conflict. A key constraint was that students did not have the opportunity to engage with each other online, within a forum, prior to the lecture to analyse and discuss content and to pose questions to the lecturer and their peers. The students required better coaching and scaffolding by the lecturer to enable them to become more familiar with an online environment in which they are encouraged to collaborate, and not to feel threatened and intimidated by the fact that they are being “watched” by their peers and instructor.

The course supported the development of meta-knowledge, but required more technical skills to be foregrounded. Technical knowledge is still perceived as a shortcoming in many students, particularly the women, who tend to shy away from getting into the “nuts and bolts”.

Reflection on draft design principles

At the end of the course, the facilitator reflected on the outcomes of the course in terms of the draft design principles. This section contains updates to principles in terms of the aspects to consider during the implementation of the course. The presence of the required skills sets and the elements that support the principles from an authentic learning perspective were also reviewed. This was not a scientific analysis, but a table was drawn up, similar to a project status report, to indicate the overall outcome. The areas that were perceived as satisfactory were highlighted in green, the areas that required improvement in amber, and the

areas that needed intervention and new strategies in the following iterations were highlighted in red. These reflections are summarised in Table 22 below.

The design principle that stipulated the application of project-based learning to combine inquiry with accountability was updated to be more specific. The new principle requires all tasks to be funnelled into a comprehensive capstone project that applies agile methods.

Table 22: Update to design principles from Iteration 1

Principle	Description and updates	Skills sets required by principle	Authentic learning elements to support
Ensure collaboration takes place	• Students need to perform tasks in teams • Ensure that students collaborate to solve problems in class and in projects • Use peer reviews that are assessed • Within class time, aim to be a facilitator in student learning and not the expert in the room, to encourage experimentation	Collaboration and communication Cultural competence	Authentic tasks – opportunity to collaborate Support collaborative learning Promote articulation to enable tacit knowledge to be made explicit
Provide opportunities for students to find their own solutions	• Encourage innovation by letting students take their own initiative • Do not put too much structure in place; use some scaffolding when required • Let the students discover their own answers by accessing several different sources and experimenting with different techniques to become comfortable with pivoting, adapting and changing	Creativity and innovation Problem solving and critical thinking	Authentic contexts Authentic tasks – ill-defined activities Provide coaching and scaffolding by the teacher at critical times
Implement a working digital innovation in a business	• Require students to do a team-based project with organisations within their community where they are required to implement a real solution	Problem solving and critical thinking Life/job skills EQ and ethics	Authentic contexts Authentic tasks – create a polished product with real-world relevance Provide access to expert performances and the modelling of processes Authentic assessment
Incorporate a design-thinking ethos	• The stages involve students in discovering a challenge, interpreting the context of the challenge, forming ideas, building prototypes, testing the ideas and	Core content Creativity and innovation	Authentic tasks – examine from different perspectives with a variety of resources Provide access to expert

	developing a solution • Integrate with agile methodology and provide clear guidance on the process to follow • Include value proposition canvas and guide students in process of empathising with customers via personas and empathy maps		performances and the modelling of processes Authentic assessment
Ensure that students utilise interdisciplinary skills	• Innovation requires flexibility; it demands experience and knowledge that are both broad and deep • To understand problems, students need to combine different academic disciplines in a capstone project • Incorporate this to test for different aspects in the assessment criteria	Cross-disciplinary Collaboration and communication	Provide authentic contexts Authentic tasks – integrate different subject areas Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives
Implement a formal process of reflection	• The use of reflection can assist to anchor learning and stimulate deeper thinking and understanding • Assess the reflection process using clear guidance in the rubric in terms of expected outcomes	Digital/ICT Life/job skills	Authentic tasks – opportunities to reflect Promote reflection to enable abstractions to be formed Provide for authentic assessment
Allow for mistakes to happen	• Innovation requires the willingness to fail • Students are encouraged to try different approaches and, when something fails, they need to try another approach without being penalised for it	Creativity and innovation Problem solving and critical thinking	Authentic tasks – competing solutions and a diversity of outcomes Provide coaching and scaffolding by the teacher at critical times
Ensure that tasks culminate in a capstone project	• Involve students in a project that is based on real-world, authentic problems • Projects ought to be structured to be longer term and interdisciplinary, and students need to provide their own structures • Apply agile methods	Cross-disciplinary Collaboration and communication Life/job skills	Authentic contexts Authentic tasks – complex tasks performed over a period of time Provide for authentic assessment

Conclusion

Chapter 5 commenced with a presentation of the data findings and analysis of the first iteration in the third phase of this DBR study. A quantitative and qualitative analysis of the data took place to review the draft design principles by answering the second and third sub-questions. The skills development was analysed first, followed by the teaching and learning environment. In the final section, the draft principles were reviewed to guide the implementation of the next iteration and to make the necessary changes required.

In the next chapter, the second iteration is discussed following a similar format to test the design principles and recommend updates to the subsequent iterations.

CHAPTER 6: ANALYSIS OF THE FINDINGS ITERATION 2

Introduction

This chapter is a continuation of the **third phase** of this DBR study, namely iterative cycles of testing and refining. In Chapter 5 the first iteration was discussed and updates to the course were suggested for the next iteration. The results of the second iteration are displayed and interpreted in this chapter. A similar method as applied in the first iteration was used for the data gathering and analysis in the second iteration. The chapter discusses the quantitative data analysis results obtained from a regression and ANOVA analysis, and thereafter discusses the results from the qualitative analysis. The data was analysed to interpret the findings from the second sub-question to suggest potential skills required by IS students to become competent digital innovators.

The qualitative analysis to answer the third sub-question, which suggests teaching and learning interventions to teach digital business innovation skills to IS students, is described thereafter. The chapter concludes with a discussion of and updates to the design principles.

The final iterations are interpreted in Chapter 7 and updates are suggested. The updated framework and design principles to teach digital business innovation skills to IS students are discussed in Chapter 8.

Data collection

Design-based research requires a number of iterations to verify and update the draft design principles to move beyond a draft design and gather evidence about the learning environment that addresses the research problem. As discussed in Chapter 3, the purpose of the third phase of DBR is the testing and refinement of the design. Chapter 5 described the first full implementation of the solution, the analysis of the data to infer suggestions to refine the learning environment and the updates to the design. These changes were implemented in the second iteration and again in the next iteration, to enable “continuous cycles of design, enactment, analysis, and redesign” (Design-Based Research Collective, 2003:5).

The approach followed to collect and analyse data was according to the research questions, firstly to test the skills sets acquired by the students and thereafter to test the presence of authentic learning elements in the course. The content presented and technology applied were subsequently analysed to determine the overall outcome of the draft design principles. The principles were updated and refined after each iteration to improve the overall intervention and refine the framework, as illustrated in Figure 16. A similar process was applied to collect, analyse, test and confirm the qualitative and quantitative data, as described in Table 15 in Chapter 5. The quantitative and qualitative data were collected concurrently as per the first iteration and compared for confirmation or cross-validation (Creswell, 2007:213).

Participants

The second iteration took place during the second semester of 2016 with a group of 42 Information Systems students in their final year at the University of the Western Cape. All students gave written consent to take part in the study as per the consent letter in Appendix 2. The participant profiles as depicted in Chapter 3, Table 7 provide breakdown of the demographic profile of the participants, as well as their ability to connect to the online learning environment and their preferred place to connect in order to build in any constraints that students may experience.

A more even gender distribution is evident from the first to the second iteration, with a slightly higher percentage of males (51%), probably as a result of the first iteration being conducted with IS Honours students and the second iteration with third-year IS and BCom students. The last four years have seen a significantly higher proportion of female students enrolling for IS Honours.

All students have access to the internet and the majority connect on campus (55%), whilst 45% of the students indicated that they can connect at home. This became significant during the second iteration due to student protests at the end of 2016, resulting in the closure of the campus and the requirement to present the course content and assessments solely online.

Results pertaining to skills required for digital business innovation

The first section reviews the results pertaining to the second sub-question: What skills are required by IS students to become competent digital business innovators? Students filled in the survey in Appendix 3 at the start of the semester to test their perceptions prior to the course (Survey 1), and again at the end of the course to test the outcome of the intervention (Survey 2). The mapping of questions to skills sets was duplicated from the first iteration to keep the data collection as consistent as possible between the iterations, as per Table 16. Responses were transferred from Google to Excel to calculate percentages in order to conduct the quantitative analysis. The open-ended questions were coded as per the first iteration.

Quantitative data from student surveys, iteration 2

Regression analysis

A regression analysis was again conducted in the second iteration to determine the relationship between the variables (skills) obtained in the survey results. Similar to the first iteration, the data analysis function in Excel was utilised with student assessment scores as the dependent variable. The detailed analysis of the entire result set is available in Appendix 5.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0,693542994	0,080340986	8,632492975	4,12457E-09	0,528399733	0,858686255	0,528399733	0,858686255
Core	0,077396987	0,077151029	1,003188003	0,325015827	-0,081189225	0,235983198	-0,081189225	0,235983198
Digital	-0,021535025	0,068633662	-0,31376768	0,756201095	-0,162613536	0,119543487	-0,162613536	0,119543487
Cross	0,232534317	0,071060376	3,272348545	0,003009465	0,086467623	0,378601011	0,086467623	0,378601011
Problem solving	0,022904143	0,096379207	0,237646108	0,814018341	-0,175206154	0,221014441	-0,175206154	0,221014441
Innovation	0,021148603	0,084332497	0,250776431	0,803958193	-0,152199327	0,194496532	-0,152199327	0,194496532
Comm/Coll	-0,04047238	0,047380799	-0,854193699	0,400799819	-0,137865007	0,056920247	-0,137865007	0,056920247
EQ	-0,023143698	0,086888636	-0,266360468	0,792062659	-0,201745846	0,155458451	-0,201745846	0,155458451
Life / Job Skills	-0,240322287	0,11120142	-2,161144042	0,040075104	-0,46890008	-0,011744494	-0,46890008	-0,011744494
Cultural	-0,035277259	0,074415105	-0,474060459	0,639413802	-0,188239698	0,11768518	-0,188239698	0,11768518

Figure 24: Regression Results, Iteration 2: Survey 1

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0,577936048	0,147305151	3,923393327	0,000471123	0,277098794	0,878773301	0,277098794	0,878773301
Core Content	0,335925307	0,168642772	1,991934204	0,055548933	-0,008489182	0,680339796	-0,008489182	0,680339796
Digital/ICT	-0,030420202	0,093509439	-0,325316917	0,747199282	-0,221391953	0,160551549	-0,221391953	0,160551549
Cross Diciplinary	-0,084997506	0,156668502	-0,542530916	0,591460756	-0,404957273	0,234962261	-0,404957273	0,234962261
Communication/Cc	-0,128333774	0,145693201	-0,880849434	0,385401917	-0,425878986	0,169211438	-0,425878986	0,169211438
Problem/Critical Th	0,207916182	0,204556545	1,016424001	0,317555182	-0,209844015	0,625676379	-0,209844015	0,625676379
Creativity/Innovatic	-0,318524599	0,162260013	-1,963050493	0,058970447	-0,649903755	0,012854557	-0,649903755	0,012854557
EQ/Ethics	-0,168579816	0,221358435	-0,761569423	0,452262687	-0,620654052	0,28349442	-0,620654052	0,28349442
Life/Job	0,2562964	0,209188868	1,225191392	0,230035749	-0,170924263	0,683517063	-0,170924263	0,683517063
Culture	0,066216233	0,080098531	0,826684735	0,414942771	-0,097366791	0,229799258	-0,097366791	0,229799258

Figure 25: Regression Results, Iteration 2: Survey 2

At least two values stand out in the initial survey – that of cross-disciplinary skills as well as life and job skills. These skills were therefore statistically significant for results obtained during the initial assessment of the students. This shows that, in the initial assessment, the students had an accurate perception of the skills required pertaining to cross-disciplinary and life and job skills.

The first iteration also showed a statistically significant result for cross-disciplinary skills during the first assessment. The students therefore relied on their ability to utilise their cross-disciplinary skills, and the initial assessments for the first and second iteration were designed to draw on the students' ability to use their interdisciplinary skills. In the first iteration there was a strong reliance by the students on core content, and the assessment was designed to incorporate the content-specific assessments. The findings from the first iteration showed that students required more scaffolding up-front to give them a better introduction to digital innovation and project planning, and that concepts around agile and design thinking should only be introduced thereafter. The reason was to try to circumvent the confusion experienced in iteration one pertaining to the processes to follow to merge the two concepts. In order to incorporate a design-thinking ethos, the students need to have a very clear picture in terms of the stages and rollout thereof and understand what aspects to bring in where within the overall rollout of the capstone project.

The other skills set with a statistically significant result was life and job skills. The reason for this can be that the assessment relied strongly on project planning skills and the students were required to commence with the capstone project and consult with their clients and team members from the onset of the course.

Although the students need to draw on their foundational knowledge (to know) at the onset of the course, the reliance on core content was less pronounced during the second iteration, for the reasons explained above. The other skills set that forms part of foundational knowledge is digital or ICT knowledge. Again, this did not come out strongly enough during the onset of the course, pointing to the fact that the students still perceive this as a problem area during their overall development at the undergraduate level. The skills sets that pertain to meta-knowledge (to act) were also not statistically significant at the onset and needed to be developed and assessed to ensure that the students developed the required competencies.

When the survey was repeated at the end of the semester to test the outcome of the intervention, the skill sets that produced a statistically significant outcome was core content and creativity and innovation. This is an improvement on the first iteration because core content was still a significant skill in the final assessment.

Students therefore had an accurate perception of the requirement for creativity and innovation in the final assessment using their core content knowledge. The fact that more skills sets did not show a statistically significant outcome points to the fact that the course design still required further refinement to balance the development of the required competencies.

ANOVA analysis

To test the difference between the scores for the first and second surveys, a one-way ANOVA test was performed in Excel. The detailed results obtained per skills set for the pre- and post-intervention surveys are in Appendix 6, and a summary of the results is shown below. The results indicate a significant positive difference ($p<0.05$ and $p<0.01$) between the pre-test and post-test results in terms of the students' perceived skills development.

Table 23: ANOVA results, Iteration 2

Skills sets tested	F-value	P-value
Core content knowledge	24.68	4.22E-06**
Cross-disciplinary knowledge	5.91	0.017*
Digital/ICT knowledge	4.14	0.045*
Communication/collaboration	8.73	0.004**
Problem solving/critical thinking	5.24	0.024*
Creativity/innovation	8.82	0.004**
Life/job skills	4.98	0.028*
EQ/ethics	1.81	0.182 ns
Cultural competence	4.52	0.037*

**p < 0.01;
*p < 0.05;
ns = not significant

The results show a statistically significant difference in the students' perceived skills improvement in their foundational knowledge. There ought to be an improvement in the content knowledge from the beginning to the end of the semester, hence the high values obtained in the test. Students relied on their cross-disciplinary knowledge to successfully complete the capstone project and showed that they felt confident in the improvement of their skills. There also was a perceived improvement in their digital skills due to the nature of the project, which required a digital intervention and all students were forced to participate in the outcome. This may be an area that still requires further coaching in future iterations because the result for the F-value was lower than the other skills areas, except for EQ and ethics.

The findings obtained in the analysis of meta-knowledge also resulted in a statistically significant difference in the students' perceptions of learning during the course. There was a specific focus to cultivate these skills during the course in the design of the authentic tasks and assessments. The development of meta-knowledge is critical for the successful attainment of the design principles. Results from the regression analysis point to the fact that students applied creativity and innovation in their final assessments; however, problem solving and collaboration did not have a statistically significant outcome. The assessments had to be tailored around the testing of meta-knowledge in the next iteration.

The results of the one-way ANOVA pertaining to humanistic knowledge showed a statistically significant difference in the perceived knowledge of students at the onset versus after the course for both life and job skills and cultural competencies. However, the results obtained for EQ and ethics were not significant. Specific tasks will have to be built into the course to strengthen the development of EQ and ethics. The previous iteration showed that cultural competencies were not significant and, in this iteration, this aspect was addressed via an intervention in the teams to provide more opportunity for engagement and collaboration. Specific exercises to make students aware of the importance of EQ, the testing of their own EQ scores and suggestions for the future could be included in the design.

The next section analyses the results obtained from the qualitative analysis to integrate the findings and obtain a clearer understanding of the overall outcome. This also enables the cross-validation of data and highlights areas where there may be potential discrepancies in the findings.

Qualitative Data

The steps prescribed by Miles and Huberman (1994) to systematically organise the data were applied in the qualitative data analysis for the second iteration (similar to the first iteration) (see Table 24 below).

Table 24: Qualitative Analysis, Iteration 2

Specific data sets	Process steps	Decision rules	Analysis operations (enter codes)			Research comments
			Data for analysis	Conclusions	Confirm conclusions	
S02.2	Analyse S02.2 and use themes and subtheme codes	Survey 2 Question 10: analysis of perceived skills development	S02.2 in Google Forms	Chapter 6	Chapter 6 to update the design principles	Triangulate skills tested
	Analyse S02.2 themes from open-ended questions	Survey 2 Question 50 and 51 Outcome of course	S02.2 in Google Forms	Chapter 6	Chapter 6 to update the design principles	Themes identified in responses and open-ended quotes
B02.1-3	Analysis of blogs to identify codes and themes	Analysis of Blogs 1 to 3 and identify relevant quotes per theme	B02.1-3 urls captured on Google Drive	Chapter 6: discussion of process and quotes	Deeper discussion of findings and conclusions in Chapter 6 to update the design principles	Substantiate findings with quotations from students per theme
FR02	Facilitator reflections during the course include the analysis of project documentation	Overview of results to identify responses and progress, areas for improvement, constraints experienced by students	Electronic journal in Work and data capture and analysis in Excel	Chapter 6	Chapter 6: integrate findings and update the design principles	Findings to update iteration 4
IS02	Industry survey at end of course to measure success of implementation	Survey results	Survey in project documentation and hard copies to clients	Discuss areas of concern in Chapter 6	Review to make changes to industry selection for iteration 4	Review the participation and areas of concern to ensure a more authentic experience for students in the next iteration.

Source: Miles and Huberman (1994)

Survey 2: Open-ended questions

Students were asked to name five skills that they believed they had gained that would be beneficial to their future employer. The question was open ended and the answers were mapped to the nine skills identified in the literature. The genders were further split in the answers to look at the differences in male versus female perspectives among the students. The outcome is depicted below.

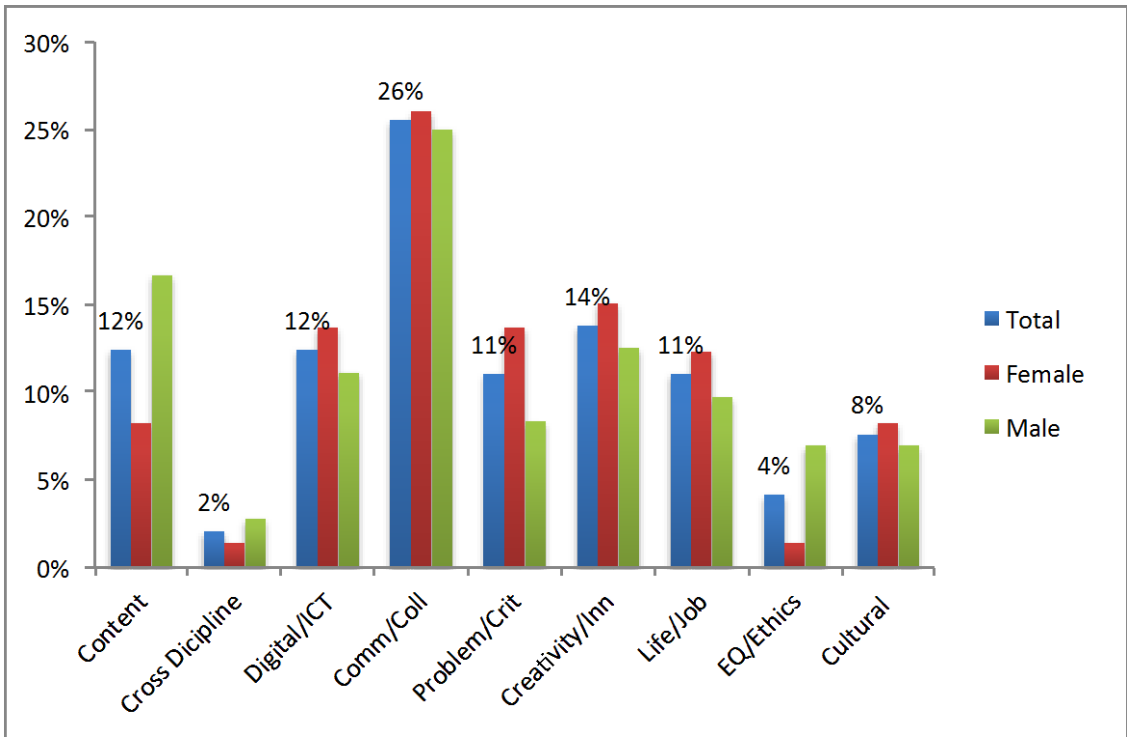


Figure 26: Valuable skills for future employer, iteration 2

The overall outcome showed that students perceived the development of their communication and collaboration skills to be the most significant, at 26%. The type of learning environment created, which enforced collaboration, and the implementation of a working digital innovation within a business via a capstone project enforced the development of these skills. Students felt more capable about their abilities at the end of the course because they were exposed to authentic tasks with real-world relevance. The percentage for communication and collaboration was almost twice that of the other categories, which all came out fairly similarly with one or two percentage points difference. This points to a more balanced result in terms of the overall course design.

The categories that did not feature prominently were cultural competencies, EQ and ethics, and cross-disciplinary knowledge. The low 4% for EQ and ethics was substantiated by the outcome of the ANOVA analysis, which also pointed to a gap in the skills development in terms of EQ and ethics. The outcome for cross-disciplinary skills, at 2%, needs to be questioned because ensuring that students utilise their interdisciplinary skills is a design principle. A similar result was obtained in the first iteration, and the questionnaire needed to be updated for the next iteration. A question ought to be added that asks students to list the nine skills in terms of importance whilst still including the open-ended question regarding skills developed that are beneficial for future employment.

The difference in gender was not that significant, except that male students were more confident about their grasp of content knowledge, cross-disciplinary competencies and ethics than female students. Due to the very

low percentages in both cross-disciplinary competencies and ethics, the results obtained are not significant. The female students had a slightly higher percentage for all the other skills, including ICT and digital skills. Female students were actively encouraged to be included in the technical aspects of the capstone project to boost their confidence in their own technical abilities.

Qualitative analysis of student reflections

Similar to the first iteration, students were tasked to subscribe to a blog and submit three blogs during the semester. They had to write about their progress per week and what they had learned during the week, what they found interesting and what they did not enjoy. In addition, they had to perform certain tasks, such as personality analysis, skills audits and reflection on their goals and aspirations. The findings were analysed and coded according to the nine skills sets. The full set of responses that were deemed relevant to support the evidence can be viewed in Appendix 7.

Design thinking was again, as per the first iteration, distinguished as the most favourable aspect taught in the core content. Students found it to be a wonderful method to assist them with skills development during the rollout of their capstone project. More time was spent at the onset of the course to establish the concepts and assist students to distinguish between the different phases. They were also given tools to use in the initial phases of the design thinking process and were required to practise the concepts within their teams during the lectures.

Figure 27: Example of design-thinking phases and student work

Positive remarks about their introduction to design thinking and the process to roll out a project included for example:

> *What interest me the most is empathy maps, how important it is to feels, know, understand, to say, to think and do for customer. How important it is to think like the entry level user. To feel the customer pain and excitement, say and do enough but not too much, everything has to balance.* (St15)

> *Creating these personas and empathy maps were extremely fun, as you can see in the pictures above and below. Another, brilliant method our lecturer taught us was to create a user story. In the beginning I found it difficult to let my imagination go wild, but when I got the hang of it I just started to go crazy and that was the fun part not having a limit to think out of the box, I think I might have even torn the box up!* (St12)

> *What also interest me is that we as a group are individuals from different cultural backgrounds with different views but thanks to the design-thinking phases we could put all of that together to form a solution that can help our client grow because we all realise his talent.* (St12)

Some aspects around the content provided in the class were not received that positively and some students felt that they could have benefitted from more content.

> *The class could have catered for more people. Cover more content in the future as we had practical learning from this module and the more practical learning we get, the more advantageous for students and the better we fair in the working world (i.e. technical interviews and internships).* (St9)

> *It was a small group, felt like we could have covered more content.* (St41)

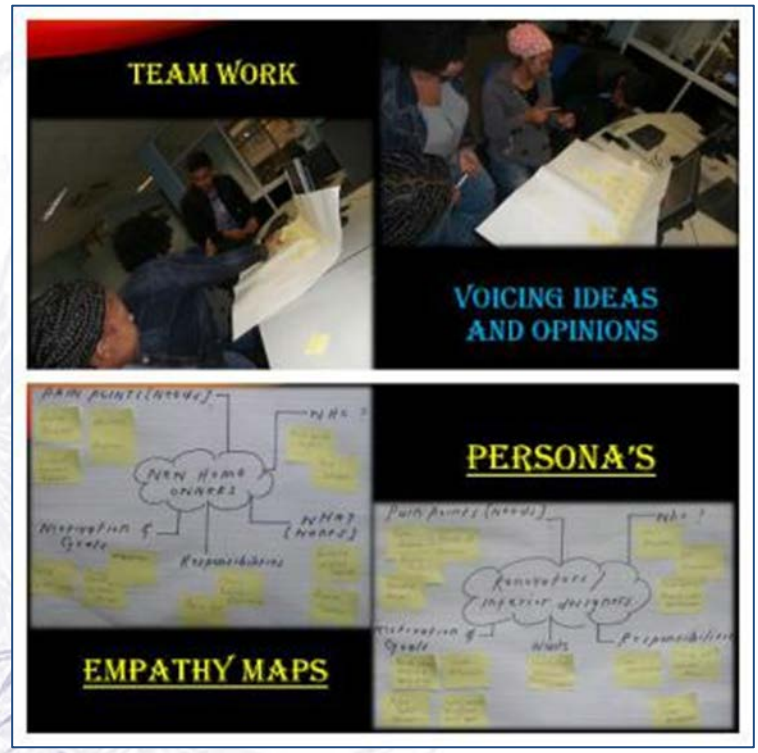


Figure 28: Collaboration to practise design thinking

The incorporation of cross-disciplinary knowledge in the curriculum was again a problem during the second iteration as per the findings of the student surveys. A deliberate intervention was required in the next iteration to test for these skills in the assessment of the capstone project

Students also need to be made more aware of the importance of interdisciplinary skills and encouraged to integrate different subject areas taught during their degree. This will require a review of the requirements for the capstone project to ensure that interdisciplinary skills are utilised by all students and assessed during the rollout thereof. Although students responded positively in terms of the design of the course to encourage cross-disciplinary learning to take place, more evidence of the outcome is required.

> *The formation of the class or the way the module was structured helped us to better perform with our clients for the implementation of our solution.* (St01)
>
> *Adopting different learning style and channels to facilitate learning has helped me a lot to get a wider understanding of what is required.* (St05)

Students responded favourably to the creation of an online environment and more effort was made during the second iteration to assist students with the transition to this environment. All materials were made available online and students were required to post their work in advance and provide feedback to one another. The lecturer also provided feedback to students online and assisted them with questions in an online forum using Google Drive. In addition, students were all encouraged to participate in the development of their digital applications to spread the technical expertise of some to the rest of their team members. They had to present in class each week and all had to be prepared for technical questions from the rest of the group and the lecturer.

The fact that an online environment was created from the start made the facilitation of learning and assessments during the student protests at the end of 2016 much easier. Students were accustomed to online collaboration and their progress was measured and assessed online. The major issue was internet connectivity for those students who mainly accessed the internet on campus.

> *Everything available online made it very accessible to those with good internet connections.* (St07)
>
> *I enjoyed the inclusion of digital learning it was very beneficial.* (St19)
>
> *Close interaction with the students and lecturer help [sic] me to be comfortable in the class being able to ask question [sic] to my lecturer on Google Drive was one of my best strategies to improve my progress in the course.* (St35)
>
> *The digital environment of the module and everything available and done online was great.* (St37)
>
> *As aforementioned, this has been my favourite module to date and it has taught me a lot about technology and about my abilities in the world of technology. I have learned to exploit every opportunity and turn every challenge into an idea as well as implementing all my knowledge into a tangible and also intangible innovative idea.* (St40)

In spite of more guidance to students in the use of the online environment, some students still found it difficult to adapt to the structures provided and this aspect must be reviewed for future iterations to make it less complex.

The Google drive folders were a bit confusing sometimes and we would usually submit in a wrong folder and it would seem like we submitted late. (St27)

It was difficult to submit on Gdrive [sic] because of many folders. (St3)

The development of **meta-knowledge** was emphasised during the course and students benefitted from their experience insofar as the development of communication and collaboration skills was concerned, as seen in the previous section. Peer learning is still an area that needs improvement, as students need to be encouraged to give and receive constructive feedback. In spite of more scaffolding to assist them in the process, they still shy away from peer feedback and see it as a betrayal of their peers if they are seen to be criticising their work.

Being marked by my peers did not work for me in the course. (St24)

More clarity around the marking rubric, and revision of the peer review system is required. (St27)

Similar to the previous iteration, the cultivation of creativity and innovation was a vital component in the course, and this time students were actively encouraged to experiment with different solutions and to test it with their peers to encourage them to explore, test and refine the final product. The method to require students to prepare for lectures before class and to use class times for practical work was difficult for the students at first, but the more they were inspired to experiment and have fun in class the easier it became for them.

The student protests hampered some of this during the end of the semester, but luckily the majority of practical exercises were completed in anticipation of the potential closure of the campus. The online environment was used to complete the exercises, but not enough time was spent on establishing the necessary climate to inspire creativity and innovation. In the next iteration, more applications such as GroupMap should be utilised from the start to encourage brainstorming and mind mapping online.

Personally this course has taken me out of my comfort zone and taught me how to think creatively as well as that no idea is a stupid idea. During one of the teachings in the lectures, our lecturer said that "Think of anything and idea and put it in a sticky note, it does not matter what it is just put it in a sticky note and stick it to the board" it was amazing to know that whatever idea that one has in class won't be posed as a stupid idea. This is one of the reasons that I enjoy and find this module interesting. (AB2)

Coming with innovative ideas is not easy it requires time and effort. The process has helped me to not criticize the idea at the first stage but later. After assessing the credibility of each idea. (BB2)

The most amazing moments of this module is the creativity and innovation side of it. (RF2)

My progress? Throughout my journey in Business Innovation, I have learned how to challenge myself into thinking deeper and outside the box. It has allowed me to exploit the knowledge I have acquired and transferring it into solutions and innovative ideas. (AD2)

According to industry specialists, problem solving and critical thinking skills are often lacking and need to be emphasised strongly in the course. The second iteration was easier because the elements required for an authentic learning environment that cultivates these skills were more familiar and easier to implement. Students were challenged in a practical setting to apply their minds to a problem, come up with various possibilities and to

test them using a design-thinking philosophy. The requirements of the lecturer or facilitator were clearer and the unease that this type of fluid environment brings less difficult.

> *First things first, before we did anything, the lecturer greeted us with a very difficult quiz which mostly required general knowledge and critical thinking, the funniest part all of us failed. Honestly that week I didn't do pre-reading of slides to prepare and gear up myself for the class hence that might be the cause of confusion I felt in class.* (SK2)

> *Therefore my progress so far in the course is that I understand how to apply critical thinking to empathize a business in the design thinking process.* (PG2)

> *My expectations in the beginning were that we will have more theory based activities than practical tasks. Despite the fact that the module was not what I expected, I am enjoying the journey so far. The module is teaching us on a whole new level of thinking, one would say we are being taught to "Think outside of the box".* (SB2)

Feedback from the students in terms of the development of life and job skills was very positive, and they enjoyed the authentic learning environment with "real-world" problems.

> *In my experience and view digital business innovation is a my foundation, it is preparing and training me to be the best in any way that I can be by all the creative thinking exercises, group assignment and all the presentations completed thus far. All the learning and experiences is one of the things that I will take with me to the workplace as it is a great pleasure and a useful skill.* (LG2)

> *Everything that was taught in this course was so relevant to modern business practices and will be very beneficial for my career and business.* (VI2)

> *The lecturer made sure that we possess the qualities stated in the learning objectives at the end.* (ES2)

> *I always questioned that whether I would have the required skillset for the job market and if I would be able to work as a business analyst. The past weeks the course answered those questions and the tasks given made me realise we are bridging the gap between business and IT. Therefore I am satisfied with my progression because so far the course has laid the foundation for me to realise I would be able to work as a business analyst.* (PG2)

> *I must first say it has not been a very easy road because I had to work with people I did not know who have different personalities and attitudes. However, I have learned a lot during this project about myself it showed my strongest character as I need to be able to handle different issues and working under pressure. I am very thankful of the knowledge I have received in this project as I will use it for future endorsement and apply it on the actual working environment.* (NW2)

The development of EQ and ethics and cultural competencies was more difficult to track and, as indicated in the previous section, this is an area that needs more planning in terms of tasks given during the rollout of the capstone project.

> *The practical manner of the course also gives me hope that I will find employment after my studies cause what I have experience so far feels relevant to making a social difference and narrowing our countries digital gap to help grow the economy.* (PG2)

> *As a group we have gotten to a place where our work ethic is sometimes questioned among each other, but we are a unit and we work through them. We do have group separation within the group which can*

lead to its own politics. But thus far it has not caused much trouble but actually helped the group perform better this way. (JD2)

Table 25: Summary of skills data obtained in iteration 2

Code	Description	Regression	ANOVA	Survey skills audit	Reflect	Comments
S01	**Core content**	1 survey 2	1	3	✓	Good mix achieved results
S02	**Cross-disciplinary**	1 survey 1	4	7	✓	Needs refinement
S03	**Digital/ICT**		8	3	✓	Uncertainty amongst students
S04	**Comm/collaboration**		3	1	✓	Good development
S05	**Create/innovation**	2 survey 2	2	2	✓	Good development
S06	**Problem/critical**		5	4	✓	Evidence of development
S07	**Life/job**	2 survey 1	6	4	✓	Evidence of development
S08	**EQ/ethics**		9	6	✓	Limited evidence
S09	**Cultural competence**		7	5	✓	Limited evidence
Comments		Statistical significance of skills in assessments	Rank on F-value for skills develop-ment.	Rank skills for future employer	Significant responses for skills applied in course	

The summary of the findings shows that evidence of the development of skills sets in some areas is still lacking and the course design has to be refined to include a better focus on these areas. The cultivation of cross-disciplinary and digital/ICT knowledge is the most crucial in the design of updates for the next iteration.

Results for teaching and learning interventions

Qualitative analysis of survey results

Another open-ended question in the survey tested the overall outcome of student perceptions in terms of the course at the end. Students were asked to name areas that made a positive impact on their overall learning

during the course. The results were ranked and coded according to the themes that emerged in the answers. The results are displayed in the table below.

Table 26: Results of positive student perceptions of course

Code	Description	Rank 1	Rank 2	Rank 3	Total
A01	**Authentic contexts**	8%	15%	7%	10%
A02	**Authentic tasks**	5%	7%	0%	4%
A03	**Expert performances and the modelling of processes**	0%	7%	4%	3%
A04	**Multiple roles and perspectives**	3%	0%	0%	1%
A05	**Collaborative learning**	16%	7%	7%	11%
A06	**Reflection to enable abstractions to be formed**	0%	7%	4%	3%
A07	**Articulation to enable tacit knowledge to be made explicit**	16%	19%	11%	15%
A08	**Coaching and scaffolding by the teacher**	11%	4%	11%	9%
A09	**Authentic assessment**	8%	7%	4%	7%
Responses		38	27	27	

The aspect that students mentioned as most beneficial in their feedback was the promotion of articulation to enable tacit knowledge to become explicit. A similar result was achieved in the first iteration due to the structure of the course, which requires students to do weekly presentations in their teams during class time and individual check-ins to discuss the growing understanding of topics covered.

> *The presentations done in classes really improved my learning*. (St10)

Students also responded positively to the collaborative learning environment of the course that required students to work in teams and provide feedback to one another face to face in class and online.

> *Working as [a] team is what I truly enjoyed it worked well for me as I was able to get the experience of how other people think*. (St17)

> *The interactive nature of the lectures particularly worked for me. It always demanded collaboration amongst us, which ensured that everyone had an understanding of the work to be completed.* (St34)

The students also responded positively to the authentic context and assessments given, as well as the coaching and scaffolding by the teacher.

Also working on a real project, where we met with clients and work with them also worked because it gave us a glimpse and opportunity to know what will be expected of us in the real world of work. (St03)

The course requires you to go beyond the textbook, and be as real world centred as possible. (St06)

Getting to visit the business and solve their problems worked for me. (St14)

I enjoyed the feeling of working on a real-life project and actually creating the things we documented. I also enjoyed reading about future jobs. (St11)

IFS341 was different to other courses in a good way. We had a chance to interact with the lecturer and other students, we got a chance to do our assignments in class so that we could see our mistakes immediately. (St30)

The fact that we could upload our work on to Google Drive made life so much easier; the lecturer was helpful here as well she would comment where the groups made errors on their assignments so that we could submit good quality work. (St33)

Our lecturer provided us with the opportunity to submit drafts of assignments due before final submissions. She would review the drafts via google docs to guide us to correct mistakes and include missing aspects. (St34)

The lecturer was always helpful, making sure we understood what was going on. (St33)

The practicality of the module is for me personally an example to the EMS faculty. (St06)

The entire curriculum and how it was set for us. It was new and different. (St09)

I enjoyed the course, it was fun and I learnt a lot. The fact that everything was done in class helped me in understanding theory. (St11)

Voice recordings with the slides worked well as we could listen to it until we understand it. (St27)

Students were asked to name the aspects of the course that were not beneficial to them, and the majority of complaints were about the class duration and times. Classes were scheduled for three hours on Friday mornings. The students were not used to one lecture lasting three hours, or to work on practical tasks in teams and to present findings. Some of the comments received were:

Many students did not attend the entire lecture due to another lecture commitment at the same time, the in class study and discussion happen mainly during lecture, and absent students caused problems when it came to group work. (St05)

Having a three hour lecture and the group work was a problem. (St18)

The classes being scheduled consecutively on one day was a problem. (St35)

The only issue I had with the module was the lecture times. Having all the lectures grouped together on a Friday made the work covered seem rushed. (St37)

The problem with team members not attending lectures caused conflict in groups, as mentioned by a few students.

> *Group work did not work for me as some team members would not pitch for lectures and it would put us at a disadvantage.* (St15)

> *That people tended not to come to class and expected other group members to do the work.* (St37)

The format of assessment was also new to the students, and some of them found it difficult to adjust to a different way of assessing.

> *Everything worked for me, except for not getting more time to study for a theoretical part of the course, yes we did cover that, but we were doing it along with the project, I wish we maybe had a test for theory.* (St04)

> *Having the huge group assignment which was built from different tasks relying on group members and not theoretical tests.* (St11)

> *The group assignments were tiring and draining for me, we did a lot of work. There were times where I would feel like I cannot cope anymore.* (St17)

> *The fact that we were not taught much theory and presented every week based on the assignment that we worked through.* (St28)

The last comment, from St28, links to the fact that students found the flipped classroom approach a challenge, along with adjusting to preparing for lectures at home and coming to class prepared to do practical assignments. They wanted to be taught the theory in class and not apply what they had learned.

> *Sometimes coming to class unprepared had given me problems to understand the practical work in class.* (St37)

> *Flying through the notes did not work for me. I felt like we took more time when doing practical things and this is good, however we flew through stuff like the Lean methodology and the scenario planning.* (St39)

Qualitative analysis of student reflection

Similar to the first iteration, students were tasked to subscribe to a blog and submit three blogs during the semester. They had to write about their progress per week and what they had learned during the week, what they found interesting and what they did not enjoy. In addition, they had to perform certain tasks, such as personality analysis, skills audits and reflection on their goals and aspirations. The blogs were reviewed to find evidence of authentic learning elements to which the students responded positively in their learning. The full set of answers can be viewed in Appendix 7.

The learning environment needs to enhance the students' ability to become critical thinkers and apply their knowledge to develop the capabilities to become digital innovators. This requires an **authentic context** to enable students to apply their knowledge as you would in real life. In the development of the draft design principles, it also became evident that an authentic context promotes the abilities of students to find their own solutions to implement a working digital innovation within a business. It furthermore promotes the utilisation of

interdisciplinary skills in the implementation of the capstone project. Evidence from students that they found the course to promote these elements includes:

> *The course was very phenomenal because it teaches about the current issues facing the technological sector and how to improve business process for organisation using advance technology. Learning this course has developed my thinking skills. Working with different individuals was very exciting. I wish the course can be offered to other graduate programs because it equips students for the corporate world.* (LJ2)

> *What was interesting these past weeks in this module was that we were requires thinking practically and really applying our knowledge to real businesses that we think needs digital innovation, and how this innovation can be achieved.* (KY2)

However, some students felt that the engagement with industry partners was not sufficient and that their projects were not "real" enough. An area that needed to be redesigned in the next iteration was the type of industry partners with which students engage. Students ought to be partnered with industry partners that are active in the community and where they can see a real change in terms of their digital innovations.

> *Must include more practicals [sic] and give students an opportunity to employ ideas that can be brought to reality and make a difference.* (ST2)

> *I would like to suggest that in the next group the lecturer must identify companies to work with and actually make sure that relations are built before hand, because companies turn to be moody with projects that are consultative.* (St23)

A teaching and learning environment that incorporates **authentic tasks** is essential in the design of the course, as it enhances the accomplishment of all the draft design principles. Authentic tasks stimulate collaboration and consist of ill-defined activities that create a polished product with real-world relevance. Authentic tasks further require students to examine problems from different perspectives, using a variety of resources to integrate different subject areas. They are complex and performed over a period of time to promote competing solutions and a diversity of outcomes.

> *I found the incremental steps in developing a product interesting. It made me realise that all the small parts come together to form a product or final solution.* (PG2)

> *I've come to realise that in IFS341 a lot of learning takes place because of the practicality of tasks given to us.* (SB2)

The use of peer reviews and online feedback was again applied to **achieve access to expert performance** and the modelling of processes. Because this was an area with which students felt very uncomfortable during the first iteration, more coaching was done to encourage students to participate in peer reviews. Students needed guidance on how to give and receive feedback, and this was an aspect that had to be built into the rubric to test the peer review process. Providing feedback to their peers had to become an activity in which they were actively involved and actively driving to own the process (Boud & Molloy, 2013). The face-to-face feedback during lectures was better in the second iteration, although the online feedback still lacked depth and clarity. Students

were more reluctant to do this on an ongoing basis during the semester, and only became actively engaged in it when they were assessed on their contributions.

> *It was weird hearing where we went wrong or being notified of something that we might have forgotten to add to our assignments, some of us were even in denial about our errors. However for me it was a weird but good experience. It reminded me that we all are human and that everyone cannot get everything perfect every time.* (AB2)

> *What I have encountered for this week is that having our project peer reviewed by our fellow classmates helped with improving certain aspects within to achieve our client's exact requirements. Even though peer reviewing was constructive criticism it was quite harsh comments based on our hard work, yet it only benefited us when updating our project with regards to meeting our client's specific requirements. Keeping our client pleased with our idea was of utmost importance.* (YE2)

> *What I learnt from the exercise was that one does not see their mistakes but quickly notice it on someone else. What I mean by this is that the groups spotted what the other groups did not do or did wrong in their assignments but in actual fact they also did not do the same mistake but they did not take note of it.* (BN2)

> *I must say that I enjoyed being in class regardless of the long hours it takes because I could not wait to hear the finding of the other groups about the project that we were working on, it was so interesting the creativity that we had so much creativity within us as students and the skills that we had been taught.* (AN2)

An area in which students felt that they lacked expert performance was particularly in relation to their technical ability. Students will need more assistance from experts in the rollout of their projects, particularly in areas in which they are not that comfortable.

> *More practical sessions to train students more about how to create a website from scratch or through using platforms such as WordPress or WIX.* (St24)

> *Encourage the use of new software to do things like creating presentations and prototypes.* (St30)

> *There should also be guest people from businesses, that will really help students to interact with them and learn a lot [sic]. Also get more projects that students can participate in.* (St5)

> *Having guest lecturers, persons within the industry to elaborate on working examples. To give students an idea of the work that will be expected in the working IS environment.* (St38)

The provision of **multiple roles and perspectives** was explored more during the second iteration to try to encourage students to explore different avenues. More time was spent in class during which students had to work in their teams and analyse their chosen business from different perspectives. They were given a set of questions to answer and present to their peers regarding the industry forces that have an impact on their business, as well as the market forces and key trends that they envisage. They required a lot of assistance with the exercise in class, but it did give them a better picture of the future outcome. An entire session had to be spent on this, and more material ought to be made available to them prior to the session in future. It would be more beneficial to have students prepare the questions in advance and present their findings during the lecture.

> *As advised by lecturer I did pre-reading of the lecture slides and read the related articles on design thinking and value proposition for the coming class. This helped me a lot because when we attended the class, it was like the lecturer is repeating same thing. We then did presentation based on the two discussed topics on how they fit and how we utilized them in the project.* (SK2)

In the second iteration, the creation of a **collaborative learning environment** became crucial due to several constraints. The lecture times were not suitable for many students, as they had clashes with other subjects and the groups suffered as a result. The student protests at the end of the semester further exacerbated this and forced students to collaborate online with their peers and the lecturer. Google Drive proved to be a good medium, and most students had a very good grasp of the functionality after an initial introduction and training video uploaded by the lecturer. To further encourage a learning environment that uses online collaboration, aspects thereof must be included in the assessment.

> *It proved to me that working together gets faster results than working alone. I have also learnt that understand your team members are of utmost importance as their input add value to a group meeting or idea. Having to adapt to too many different personalities is quite a challenge but it is possible to achieve. This creates a sense of how the real world operates.* (YE2)

> *The group collaborated well and when the going got tough [the] majority of the members would stay on campus till late in the evening to complete tasks but more importantly to work together and bounce ideas off each other so that we could create something of worth.* (RF2)

> *The brainstorming sessions with the project team allowed us to come together to share our knowledge, views, experiences and expertise to generate solutions for our undertaken project.* (WN)

> *The most important thing that I have highlighted during my attendance of lectures was that this module is very different from other modules that I have already completed especially in the Information Systems department. What I have noticed and learnt is that this module is presented digitally ☺well I guess it has to be because after all it is digital business innovation.* (BN2)

However, group work and collaboration can be very challenging to some students and this needs to be monitored throughout to facilitate conflict resolution and teach students the necessary skills to cope in a group environment.

> *Put more exercises which focuses [sic] on the individual because I don't think personal development occurs much in group assignments.* (ST2)

> *Group work did not work for me as some team members would not pitch for lectures and it would put us at a disadvantage.* (BJ2)

The importance of incorporating individual **reflection** was stressed in the literature and incorporated into the course from the first iteration. The incorporation of peer feedback was not successful enough, because students needed more scaffolding in terms of timelines, requirements and measurements. They found it extremely hard to be objective.

> *We needed more clarity around the marking rubric, and revision of the peer review system.* (XM2)

> *I did not enjoy being marked by my peers.* (LJ2)

Provide more guidelines on how to construct an appropriate blog. (St28)

I didn't enjoy doing many self-evaluations. (St38)

A random process of peer feedback must be incorporated in the future and very clear guidance must be provided. The different tasks that they had to perform, such as personality tests and SWOT analysis, can still be included, but with less emphasis. An exercise in EQ can be included to assist them with the awareness thereof, and they can then be tested at the end of the semester in terms of the development of this skill.

I have to say that this course has really been enlightening and insightful as it has taught me a lot and encouraged me to try new things. It has allowed me to gain new skills and also awaken some underlying or shall I call them dormant qualities and skills that I need to embrace and enhance. I am truly thankful for being part of this course and especially a part of my team; it was really nice working with them. (AB2)

Blogging is the best essential tool for reflection. Reflecting has helped me to realise where I went wrong and learn from my mistakes. This is the last blog that I will be writing to reflect on IFS341 but maybe I will use blogging to reflect on life in general. (BB2)

To be completely honest, I was not keen on writing a blog, but after I started writing, I became more at ease with the idea of sharing my thoughts and I quite enjoyed sharing a detailed view about myself. This Digital Innovation module has already made an impact on my life and I hope this is the launch-pad for a successful semester not only for me but for my peers too. (RF2)

Reflecting on your own work is always a good way to learn new things. The following blog will be reflecting to the course IFS 341. This will be done by explaining weekly progress in the course, lesson learnt during week, what was interesting, what was enjoyable and non-enjoyable, and lastly perform the online personality tests and commenting based on the findings. (SK2)

I have to say I really enjoyed doing it because it gives me a great reflection of myself and getting to know myself better. I do not want to end this here I think I want to be a continuous blogger because it is very wonderful to just let your thoughts out and reflect just about anything. (NW2)

I must say, blogging has really made me look deeper into topics and buzzwords in the world of science and technology. And this has for the first time challenged me as a Technology student t think outside the box and share my ideas about the coming future. (KW2)

Articulation to enable tacit knowledge to be made explicit was emphasised via regular presentations in class.

The student presentations were really helpful because we got to hear the views and opinions of other students and it also meant that each student had to do research and understand what they were talking about as each student had to present to the entire class and the lecturer. (BB2)

I learned a lot from reviewing the other groups' assignments as I was exposed as to how my classmates think and it made me realise that they are a really smart bunch of individuals. The most fun form of learning came from the presentations as we were exposed in front of the entire class of the mistakes that we made in our project initiation document. (RF2)

The effective presentation and scrum session in class were very fundamental to help me to grow my understanding in the course. I have strong understanding now of how operations of the business function especial how to apply the knowledge from the course. Many businesses are moving to the digital world now. Digitizing some of the operations of the business to make operations better and create profit is the game change in the business industry. (LJ2)

> *I extensively enjoyed the course. The material we covered was really interesting as I was tested each week with different challenges and obstacles. However, I personally relished each of them as I believe it builds character. This course has introduced me to a new, innovating way of learning, compared to previous modules I did throughout my university career. I have really learned a lot of new aspects and terminologies of IS, which perfectly prepared me for my future career path within this field.* (MM2)

The principle of **coaching and scaffolding** does not make any differentiation between intrinsic and extrinsic feedback in the educational design literature. With extrinsic feedback, advice and guidance that are valuable are provided by a teacher or coach; however, an environment that encapsulates intrinsic feedback based on the results of student actions enables them to be independent (Laurillard, 2012:73). The adoption of intrinsic feedback requires a culture of feedback among students themselves via peer and self-reflection. Students need to accept their own role in the facilitation of their learning to become lifelong learners.

Another way of reviewing this can be through the adoption of sustainable feedback as advocated by Boud and Molloy (2012). Similar to intrinsic feedback, sustainable feedback also requires students to become the constructors of their own understanding. Ways of achieving this can be via the design of assessment tasks that facilitate student engagement over time, with feedback generated by various sources. Sustainable feedback is generated, processed and used to enhance performance in multiple stages of assignments. Another aspect can be to assist students to set goals and plan their own learning (Boud & Molloy, 2012). Students need to understand that they are agents of their own change, and teachers need to establish conditions in which students can operate with agency (Boud & Molloy, 2012).

A learning milieu to be cultivated more consciously in the future ought to motivate students to achieve a positive result with their projects. The outcome must centre on the overall experience from their engagement with businesses, which will have far-reaching implications not only for the team (marks), but also for the greater good that the innovation can offer the community. This did not occur enough and the choice of industry partners for future iterations has to be reviewed carefully. The role of the teacher will be to carefully coach the teams and put just enough scaffolding in place to enable teams to construct their own understanding. There should be a careful balance between the various elements that need to be provided to the students to guide them in the completion of projects. Some students need more assistance, for example:

> *The lecture has been helpful in class and willing to assist in every way, sending videos and guidelines which will therefore help in completion of the initiation phase of the assignment.* (AN2)

> *It has truly been very interesting and a learning experience as we doing it in the presence of our lecturer which makes the weight a little bit lighter since we get assistance and guidance on what is required.* (BN2)

> *I wish we had more time with the lecturer, and that she made reference to projects she has done and part-took in, in the past and what she did when she was faced with hurdles and what happens when things do not go according to plan.* (ST2)

Yet other students do not need this and find it distracting:

> *Lecturer was somewhat repetitive when relaying learning material during group discussions which was distracting*. (BM2)

Authentic assessment needs to underpin the entire process to enable students to implement a digital innovation within an organisation via the application of authentic tasks. The assessments in the second iteration were updated with more detailed rubrics to score students on more varied aspects, such as their collaboration, communication and content knowledge, at the end of the semester. The assessments need to be refined more to test for the development of individual competencies in digital innovation. In the second iteration, students were required to complete a case study in their final assessment that tested this. However, an assessment prior to the final assessment needs to be brought in to identify the areas of improvement and potential interventions required.

Industry results

Organisations within the creative industries were again selected as industry partners for the capstone project. Students worked with a variety of businesses, including the Artscape Theatre, the Iziko Museum, a publishing company, photographers, a printing business, furniture designers, fine artists and music producers.

The industry partners were asked to complete the survey in Appendix 4 after the implementation of the student project to test their overall satisfaction. A six-point Likert scale was used and the results were converted to percentages, as depicted in the table below.

Table 27: Results from industry survey, iteration 2

Questions regarding student conduct	Result
How well did the group of students engage with you to determine your business needs?	78%
How well did the group of students consult you to analyse your current business model?	81%
What was the quality of feedback received by the group to illustrate your current business model?	69%
How well did the group of students communicate different ideas to improve your business?	81%
How well were you consulted to determine the best idea/s to improve your business?	**67%**
How well did the group explain the benefits of implementing a digital innovation for your business?	81%
What is the quality of the group's knowledge of your customers?	**69%**
How well did the group explain different techniques to analyse your customers to you?	**69%**
How well did the different members in the team work together to implement a solution for you?	**58%**
How effective was the overall communication and engagement from the students during the project?	64%
Questions on overall usefulness of new digital innovation implemented	
It helps me be more effective.	86%
It helps me to be more productive.	**69%**
It is useful.	81%
It gives me more control over the activities in my business.	78%
It makes the things I want to accomplish easier to get done.	78%
It saves me time when I use it.	75%
It meets my needs.	72%

It does everything I would expect it to do.	75%
It works the way I want it to work.	**69%**
It has been a useful exercise for me.	**67%**
Questions to test digital savvy of the industry partner	
I am comfortable with my current business model.	75%
I am aware of new technologies that can improve my business.	83%
I am comfortable to adopt new technology in my business.	78%
I would like to increase my awareness of potential digital improvements to my business.	86%
I believe that I can improve my customer relationship management	81%
It is easy to find technology to support my business needs.	**64%**
The digital economy will have a beneficial impact on my business	**67%**
It is essential that my business becomes more digitally savvy	78%
As the digital economy grows, so will my business	75%

Students performed slightly higher in terms of their client conduct than they did in the first iteration, with the exception of cooperative team work, which went down sharply from 69% to 58%. Other areas that were less represented in the second iteration were the consultation with clients to determine the best ideas to improve their business, and their understanding of their clients' customers. The most disturbing aspect was that of team collaboration during client interactions. This must be included in future assessment to measure aspects such as teamwork, work ethic and collaboration. Understanding the client's customers forms part of the rollout of the design thinking process, and more assistance can be provided in the future. Students can also demonstrate their personas and empathy maps in class to test their understanding.

The overall communication with their clients improved as a result of weekly feedback regarding any constraints that they may have experienced in this regard and suggestions by the lecturer and peers in terms of potential solutions.

> *The students were very persistent and even though I was too busy to meet them all the time, they still tried to come up with other ways to communicate with me.* (IP2G3)

There were lower satisfaction levels in terms of the usefulness of the implementation, particularly for "it works the way I want it to" and "it has been a useful exercise". Students experienced more problems with their final implementation in the second iteration as a result of the student protests, which prevented them from coming to campus and collaborating in class during the final few weeks of the semester in their project implementation. This had a knock-on effect on their final project because they became accustomed to the participative class environment in which solutions could be tested and verified in class, and during which they received confirmation from their peers and lecturer. This is an aspect that must be tested in the final iteration, where an online test environment should be created from the onset to circumvent any potential problems that may again arise as a result of student protests during the second half of 2017. Business partners responded positively in terms of the overall effectiveness of the solution to their business (86%).

> *This new system will bring a positive change to the business, which contributes towards achieving the business objective. This system will also make the marketing and distributions function easy and will help the business to acquire more customers.* (IP2G4)

> *It is very useful to me as it includes features and benefits that I initially did not have.* (IP2G1)

> *The students have shown that they did research about the company and what the organisation needs in order to meet clients' expectations and requirements in order to increase the client base for Artscape theatre.* (IP2G5)

Students were not successful enough in explaining the benefits of the digital economy to the industry partners insofar as the impact thereof on their business was concerned. Generating bigger picture thinking and explaining concepts to clients are both areas that need improvement in the future. This will have to be practised in the class environment and included in the assessment of projects. The focus is still too much on piecemeal solutions and an overreliance on the familiar in terms of what they can do or develop technically. The actual technical implementation is important, but an area that focuses on potential future improvements for the business that contains a prototype or design must be included to stretch the boundaries of both the students and the industry. It is important that small and medium enterprises become aware of the potential benefits that digital innovation can unlock for their business.

Facilitator reflections, iteration 2

The facilitator's reflections were documented via a journal about observations and issues expressed by the students and industry partners. Similar to the first iteration, students found it challenging to adjust to the blended learning environment. Other aspects that were new to them included peer learning, regular feedback sessions during lecture times, and the requirement to update blogs with weekly reflections. From experiencing a similar situation during the first iteration, the first lecture was used as an introduction to the concepts, and the lecturer further guided students in the process of using Google Drive and the LMS using online videos.

The venue, class time and duration were problematic for many students because they were not accustomed to long lectures combined with a number of practical exercises based on their pre-reading. Students are familiar with lectures that take place in a large lecture hall where the lecturer is predominantly the active participant in conversation. They required coaching to adjust to the new way of learning and to use their peers as an active soundboard of performance.

The photo stories were excluded in the second iteration and a scenario-planning exercise was added. Unfortunately, student protests commenced at other universities in South Africa in the last quarter of 2016 and the scenario-planning exercise had to be introduced and completed during one lecture in anticipation of a shutdown. This occurred, and the remainder of the semester had to be completed online, which limited the practical aspects being performed during lecture times with assistance from the facilitator and peers. The plus side was that students were well adjusted to the online environment by that time, and the transition was without any major setbacks, apart from issues experienced during the final project implementation.

In this iteration, students were assisted more actively during the ideation exercises, again using design-thinking techniques. Exercises were developed and applied during the lecture to help students with the innovation and ideation process. Entrepreneurship and innovation are more effectively learned via hands-on experiences in which students are required to actively engage in solving problems and creating products instead of memorising content (Celuch et al., 2014).

The lack of technical skills to develop a digital application was again perceived to be a shortcoming for some students. This problem was addressed in the groups, where each group had to include a technical expert. The course duration does not allow for detailed technical training, but in future more ought to be done to give students the necessary assistance to circumvent delays in project implementation due to a lack of technical skills. Online courses that feature technical skills that will benefit the students need to be incorporated as part of the course design. Students must choose a certain aspect in which they feel they are lacking, and this can be customised per student.

The design principle that stresses an environment that allows for mistakes to happen was executed moderately better due to the lecturer being more comfortable with the uncertainties and open-ended nature of design problems. Students are very uncomfortable with productive failure because it goes against a culture based on summative assessments that measure the successful replication of information. Teamwork during lectures to unpack the different projects and collaborative feedback to teams in terms of progress, as well as methods applied to solve problems, require more input. The process of productive failure via the creation of a number of prototypes that are tested must become part of the formative assessment during the project rollout. The importance of a final, implemented solution should not be overemphasised, but rather all the steps in the process to get there.

Reflection on draft design principles

Similar to the first iteration, the facilitator reflected on the outcomes of the course in terms of the draft design principles. The presence of the required skills sets and the elements that support the principles from an authentic learning perspective were reviewed using colours as an indication of success and failure. The areas that were perceived as satisfactory were highlighted in green, the areas that required improvement in amber, and the areas that needed intervention and new strategies in the following iterations were highlighted in red.

A new design principle needs to be added as a stronger emphasis of the cultivation of “social change makers” that implement digital innovations that benefit both business and society.

Table 28: Update to design principles from Iteration 2

Principle	Description and updates	Skills sets required by principle	Authentic learning elements to support
Ensure collaboration takes place	• Students need to perform tasks in teams • Ensure that students collaborate to solve problems in class and in projects • Use peer reviews that are assessed • Within class time, aim to be a facilitator in student learning and not the expert in the room, to encourage experimentation • Use a blended learning environment to encourage online collaboration and face-to-face collaboration, and assess • Assessments need to include aspects such as teamwork, work ethic and collaboration	Collaboration and communication Cultural competency	Authentic tasks – opportunity to collaborate Support collaborative learning Promote articulation to enable tacit knowledge to be made explicit
Provide opportunities for students to find their own solutions	• Encourage innovation by letting students take their own initiative • Do not put too much structure in place; use some scaffolding when required • Let the students discover their own answers by accessing several different sources and experimenting with different techniques to become comfortable with pivoting, adapting and changing • Create an online environment in which students can experiment with solutions	Creativity and innovation Problem solving and critical thinking	Authentic contexts Authentic tasks – ill-defined activities Provide coaching and scaffolding by the teacher at critical times
Implement a working digital innovation in a business	• Require students to do a team-based project with organisations within their community where they are required to implement a real solution • Work in partnership with industry to assess a segment that requires innovation, and monitor the progress	Problem solving and critical thinking Life/job skills EQ and ethics	Authentic contexts Authentic tasks – create a polished product with real-world relevance Provide access to expert performances and the modelling of processes Authentic assessment
Incorporate a design-thinking	• The stages involve students in discovering a challenge, interpreting the context of the challenge, forming ideas,	Core content Creativity and	Authentic tasks – examine from different perspectives

ethos	building prototypes, testing the ideas and developing a solution • Integrate with agile methodology and provide clear guidance on the process to be followed • Include value proposition canvas and guide students in process of empathising with customers via personas and empathy maps	innovation	with a variety of resources Provide access to expert performances and the modelling of processes Authentic assessment
Ensure that students utilise interdisciplinary skills	• Innovation requires flexibility; it demands experience and knowledge that is both broad and deep • To understand problems, students need to combine different academic disciplines in a capstone project • Incorporate this to test for different aspects in the assessment criteria	Cross-disciplinary Collaboration and communication	Provide authentic contexts Authentic tasks – integrate different subject areas Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives
Implement a formal process of reflection	• The use of reflection can assist in anchoring learning and stimulating deeper thinking and understanding • Assess the reflection process using clear guidance in the rubric in terms of expected outcomes	Digital/ICT Life/job skills	Authentic tasks – opportunities to reflect Promote reflection to enable abstractions to be formed Provide for authentic assessment
Allow for mistakes to happen	• Innovation requires the willingness to fail • Students are encouraged to try different approaches and, when something fails, they need to try another approach without being penalised for it • Build steps into formative assessment to encourage students to experiment with different solutions	Creativity and innovation Problem solving and critical thinking	Authentic tasks – competing solutions and a diversity of outcomes Provide coaching and scaffolding by the teacher at critical times
Ensure that tasks culminate in a capstone project	• Involve students in projects that are based on real-world, authentic problems that are meaningful and engaging • Projects ought to be structured to be longer term and interdisciplinary, and students need to provide their own structures • Apply agile methods	Cross-disciplinary Collaboration and communication Life/job skills	Authentic contexts Authentic tasks – complex tasks performed over a period of time Provide for authentic assessment

	• Students need to make use of digital tools to produce high-quality end products within a collaborative environment • Assessments need to be built to take the entire process into consideration, and not just the end product, and to allow for multiple solutions		
Cultivate entrepreneurs with a social conscience	• Partner with entrepreneurial businesses that contribute to their community • Encourage a focus on social awareness • Have a strong emphasis on ethical business practices	EQ and ethics Cultural awareness	Authentic tasks – competing solutions and a diversity of outcomes Provide multiple roles and perspectives

Conclusion

This chapter was a continuation of the third phase of this DBR study and discussed the results from the second iteration that took place during the second semester of 2016. The chapter commenced with a review of the quantitative data in the form of a regression analysis and an ANOVA to test the skills development of students. The regression analysis did not yield a far different perspective to that of the first iteration. The ideal outcome would include more of a spread in the skills that are statistically significant during the second survey. The fact that creativity and innovation showed a statistically significant outcome at the end of both iterations is a positive result. An area of concern in the skills test was that of EQ and ethics which requires intervention in the next iteration. Findings highlighted that the cultivation of cross-disciplinary and digital / ICT knowledge also requires intervention.

The next section described the qualitative analysis of results obtained in the teaching and learning environment. A review of student responses in the second survey, student blogs, course documentation and industry results took place. Reflections by the facilitator were subsequently documented to analyse the areas that needed improvements in later iterations.

The researcher reflected on the outcomes of the course in terms of the draft design principles. The areas that were perceived as satisfactory were highlighted in green, the areas that required improvement in amber and the areas that needed intervention and new strategies in the following iterations in red.

The next chapter contains the results from the third and fourth iteration conducted in the first and second semester during 2017.

CHAPTER 7: ITERATION 3 AND ITERATION 4

Introduction

This chapter follows on the previous two chapters to continue the **third phase** of this DBR study, namely iterative cycles of testing and refining. The first iteration was discussed in Chapter 5, along with suggestions for updates to the course for the next iteration. Chapter 6 described the second iteration, which took place during the second semester in 2016.

The results from the third and fourth iterations are presented and interpreted in this chapter. A similar method to that applied in the first two iterations was used for the data gathering and analysis in the third and fourth iterations. The chapter discusses the results of the quantitative data analysis obtained from a regression and ANOVA analysis for the third iteration, and thereafter the quantitative and qualitative results from the fourth iteration. The third iteration was merely a test of the perceived skills sets and did not contain any qualitative data. The focus of the course was on e-commerce and not designed to teach digital business innovation.

The fourth iteration took place during the second semester in 2017 and the data was analysed to interpret the findings for the second and third sub-questions. The chapter concludes with a discussion of and updates to the design principles.

Once a learning design or intervention has been implemented, evaluated and refined in cycles, the last phase is to reflect on the entire process to produce design principles that can inform future development and implementation decisions. The design principles developed as part of Phase 4 of the study are documented in Chapter 8.

Iteration 3

During the third iteration, the skills development of IS students was tested in a first-semester course that taught e-commerce to third-year students. The objective was to test the skills sets in a different module to validate some of the findings obtained during the first two iterations, and to test the robustness of the survey.

In the course, students are exposed to various programming languages utilised by e-commerce web platforms, including CSS and HTML. They are also trained to write SQL scripts in order to query databases and are required to implement their own e-business using prototyping tools introduced during practical sessions. For a demographic breakdown of the participants in the third iteration, refer to Table 7 in Chapter 3.

Data collection

A student survey at the start and end of the semester was the only data instrument used in the third iteration. The survey, the mapping thereof and the measurement of responses were similar to that in the previous two iterations.

Regression analysis

Regression was again applied to determine the relationship between the variables (skills) obtained in the survey results. The data analysis function in Excel was utilised, using the student assessment scores as the dependent variable. The detailed analysis of the entire result set is available in Appendix 5.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.121915144	0.425185692	0.286733881	0.778238749	-0.784346707	1.028176995	-0.78434671	1.028176995
Core	0.212675037	0.28399808	0.748860828	0.465522839	-0.392652541	0.818002615	-0.39265254	0.818002615
Digital	0.403473738	0.210329903	1.918289947	0.074312221	-0.044833838	0.851781314	-0.04483384	0.851781314
Cross Dicipl	0.080958196	0.345927304	0.234032397	0.818124005	-0.656368398	0.818284791	-0.6563684	0.818284791
Comm	0.122479329	0.468709727	0.261311686	0.797406008	-0.876551805	1.121510463	-0.87655181	1.121510463
Innovation	-0.502226887	0.324483698	-1.547772325	0.142513415	-1.193847517	0.189393743	-1.19384752	0.189393743
Problem	0.960853392	0.371391103	2.587173964	0.020618507	0.169251994	1.752454789	0.169251994	1.752454789
Life Skills	-0.477279076	0.411902105	-1.158719681	0.264685663	-1.35522763	0.400669479	-1.35522763	0.400669479
EQ	-0.366837181	0.327177976	-1.121215998	0.27982553	-1.06420053	0.330526168	-1.06420053	0.330526168
Culture	0.301690277	0.194008057	1.555039936	0.140779345	-0.111828109	0.715208662	-0.11182811	0.715208662

Figure 29: Regression results iteration 3: Survey 1

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	72.3466247	31.62267684	2.287808	0.070843113	-8.942053967	153.6353034	-8.942053967	153.6353034
Core	2.210028533	22.84218694	0.096752	0.92668176	-56.50768229	60.92773936	-56.50768229	60.92773936
Digital	131.5046399	36.29545805	3.623171	0.01516892	38.20419469	224.8050851	38.20419469	224.8050851
Cross	-113.370207	41.96772973	-2.70137	0.042714281	-221.2516908	-5.488723291	-221.2516908	-5.488723291
Communication	-105.6560459	39.39827309	-2.68174	0.043728742	-206.932531	-4.3795607	-206.932531	-4.3795607
Problem	15.73932159	28.46767861	0.552884	0.60415066	-57.43917595	88.91781912	-57.43917595	88.91781912
Life/Job	77.28025517	50.84440561	1.519936	0.188999895	-53.41945033	207.9799607	-53.41945033	207.9799607
Innovation	11.93965531	53.93441101	0.221374	0.833558337	-126.7031619	150.5824726	-126.7031619	150.5824726
Culture	31.14109743	17.2857426	1.801548	0.131495245	-13.29331852	75.57551338	-13.29331852	75.57551338
EQ/Ethics	-57.59587705	37.32103542	-1.54326	0.183416759	-153.5326528	38.34089868	-153.5326528	38.34089868

Figure 30: Regression results iteration 3: Survey 2

The two skills sets that stood out during the first survey were digital/ICT skills and problem solving/critical thinking skills. This shows that students had an accurate perception of the skills required in the initial assessment pertaining to digital and problem-solving skills. The course designed for e-commerce had a strong reliance on the students' ability to develop websites, and this is reflected in the skills applied during the assessments. The course was designed to boost the digital/ICT skills of IS students because this was a problem area in the past. This foundation could contribute to improved results during the fourth iteration, because the assumption is that students will be more confident about their technical abilities.

When the survey was repeated at the end of the semester to test the outcome of the intervention, the skills sets that produced a statistically significant outcome were digital/ICT, cross-disciplinary, and communication and collaboration skills. This is a good reflection of the type of skills that IS students should draw on in a course designed to teach e-commerce skills.

The impact of this course to foreground digital/ICT skills development will be reflected upon in the fourth iteration to test whether further technical interventions are required to teach digital business innovation. The design of the course for the fourth iteration was therefore not adjusted to include additional online courses to teach customised technical skills.

ANOVA Analysis

To test the difference between the scores for the first and second surveys during the third iteration, a one-way ANOVA test was again performed in Excel. The detailed results obtained per skill set for the pre- and post-intervention surveys are in Appendix 6, and a summary of the results is shown in the table below.

Table 29: ANOVA results, Iteration 3

Skill sets tested	F-value	P-value
Core content knowledge	6.136	0.0195 *
Cross-disciplinary knowledge	0.029	0.865 ns
Digital/ICT knowledge	26.286	1.96E-05 **
Communication/collaboration	1.089	0.3054 ns
Problem solving/critical thinking	4.502	0.0428 *
Creativity/innovation	2.958	0.0964 ns
Life/job skills	0.225	0.6384 ns
EQ/ethics	1.234	0.276 ns
Cultural competence	10.749	0.0027 **

(**p < 0.01; *p < 0.05; ns = not significant)

The results show a statistically significant difference in the perceived skills improvement by students for core content taught, and a marked improvement in their digital/ICT knowledge. Although they relied on their cross-disciplinary knowledge for their final assessments, it was not perceived as an area that improved during the course.

The findings obtained in the analysis of meta-knowledge reveal a statistically significant difference only in the students' perceptions of learning for problem-solving and critical thinking skills. This course did not have a strong focus on the cultivation of creativity and innovation, hence the outcome. Although communication and

collaboration was not viewed as an area that improved by the students, the results from the regression analysis show that they did apply communication and collaboration skills during their assessments.

The results from the one-way ANOVA pertaining to humanistic knowledge showed a statistically significant difference in the perceived knowledge of the students at the onset versus after the course for cultural competencies only. The work done in class during practical tasks and the group project that students were involved in contributed to this outcome.

No qualitative analysis took place, as the aim was to test the accuracy of the survey and the quantitative instruments in another course. The findings obtained were satisfactory and show that the areas where statistically significant findings were obtained were the areas that this course should have covered insofar as the skills development that took place.

Iteration 4

The fourth iteration took place during the second semester of 2017 with a group of 31 students enrolled in the IFS 341 Digital Business Innovation course. Further detail on the demographic profile of the participants can be reviewed in Chapter 3, Table 7.

At the onset of the course, the UWC Charter of Graduate Attributes was updated with an additional attribute included in the first tier (attributes of 21st-century graduates) and updates to the wording implemented for the second tier graduate attributes (overlapping clusters of attributes and skills). It was important to review the draft design principles to test that they are integrated into the updated graduate attributes. Table 31 depicts the UWC graduate attributes, with the changes highlighted in red.

Table 30: UWC Charter of Graduate Attributes

Tier 1: attributes of 21st-century graduate	**1. Scholarship**: A critical attitude towards knowledge	UWC graduates should be able to demonstrate a scholarly attitude to knowledge and understanding within the context of a rapidly changing environment. UWC graduates should have the ability to actively engage in the generation of innovative and relevant knowledge and understanding through inquiry, critique and synthesis. They should be able to apply their knowledge to solve diverse problems and communicate their knowledge confidently and effectively.
	2. Critical Citizenship and the Social Good: A relationship and interaction with local and global communities and the environment	UWC graduates should be engaged, committed and accountable agents of social good. They must aspire to contribute to social justice and care, appreciative of the complexity of historical contexts and societal conditions through their roles as professionals and members of local and global communities. They should demonstrate leadership and responsibility with regard to environmental sustainability.
	3. Lifelong Learning: An attitude or stance towards themselves	UWC graduates should be confident lifelong learners, committed to and capable of continuous collaborative and individual learning and critical reflection for the purpose of furthering their understanding of the twenty-first century world and their place in it. Such an outlook includes openness and capacity for finding opportunities to create livelihoods for themselves and others
	NEW 4. Creative & collaborative problem solving: Deep and broad engagement	**UWC graduates should be creative and courageous T-shaped thinkers and problem solvers. This would require sufficient depth in their disciplinary knowledge, as well as the ability to collaborate across diverse disciplinary and professional boundaries in order to solve complex problems.**

Tier 2: overlapping clusters of attributes & skills	**1. Inquiry-focused and knowledgeable**	UWC graduates will be able to create new knowledge and understanding through the process of research and inquiry.
	2. Critically and relevantly literate	UWC graduates will be able to seek, discern and apply information effectively using **multimodal** literacies to convey meaning in a range of contexts.
	3. Autonomous and collaborative	UWC graduates will be able to work independently and in collaboration with others, within and across disciplinary boundaries, in a way that is informed by openness, curiosity and a desire to meet new challenges.
	4. Ethically, environmentally and socially aware and active	UWC graduates should be critical and responsible members of local, national, international and professional communities. They should also demonstrate a thorough knowledge of ethical, social, cultural and environmental issues and make courageous professional and leadership decisions in accordance with these principles.
	5. Skilled communicators	UWC graduates should recognise and value communication as a tool for negotiating and creating new understandings, interacting with diverse others, and furthering their own learning. They should be able to **use effective multimodal communications** as a tool to engage with new forms of complexity in social and working life.
	6. Interpersonal flexibility and confidence to engage across difference	UWC graduates should be able to interact with people from a variety of backgrounds and have the emotional insight and imagination to understand the viewpoints of others. They should be able to work in a productive team, to lead where necessary and to contribute their skills as required to solve complex problems.

Table 31: Align UWC graduate attributes to design principles

Principle	Tier 1	Tier 2	Skills sets	AL elements to support
Ensure collaboration takes place	Creative and Collaborative Problem Solving	Autonomous and collaborative	Collaboration and communication Cultural competency	Authentic tasks – opportunity to collaborate Support collaborative learning Promote articulation to enable tacit knowledge to be made explicit
Provide opportunities for students to find their own solution	Lifelong Learning Scholarship	Inquiry-focused and knowledgeable	Creativity and innovation Problem solving and critical thinking	Authentic contexts Authentic tasks – ill-defined activities Provide coaching and scaffolding by the lecturers at critical times
Implement a working digital innovation in a business	Creative and Collaborative Problem Solving	Autonomous and collaborative Skilled communicators	Problem solving and critical thinking Life and job skills EQ and ethics	Authentic contexts Authentic tasks – create a polished product with real world relevance Provide access to expert performances and the modelling of processes Authentic assessment
Incorporate a Design Thinking ethos	Creative and Collaborative Problem Solving:	Inquiry-focused and knowledgeable Skilled communicators	Core content Creativity and innovation	Authentic tasks – examine from different perspectives with a variety of resources Provide access to expert performances and the modelling of processes

Ensure that students utilise interdisciplinary skills	Creative and Collaborative Problem Solving:	Interpersonal flexibility and confidence to engage across difference	Cross-disciplinary Collaboration and communication	Provide authentic contexts Authentic tasks – integrate different subject areas Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives
Implement a formal process of reflection	Lifelong Learning	Skilled communicators	Digital and ICT Life and job skills	Authentic tasks – opportunities to reflect Promote reflection to enable abstractions to be formed Provide for authentic assessment
Allow for mistakes to happen	Lifelong Learning	Interpersonal flexibility and confidence to engage across difference	Creativity and innovation Problem solving and critical thinking	Authentic tasks – competing solutions and a diversity of outcomes Provide coaching and scaffolding by the lecturer at critical times
Ensure that tasks culminate in a capstone project	Lifelong Learning Critical Citizenship and the Social Good	Ethically, environmentally and socially aware and active	Cross-disciplinary Collaboration and communication Life and job skills	Authentic contexts Authentic tasks – complex tasks performed over a period of time Provide for authentic assessment
Partner with entrepreneurs	Critical Citizenship and the Social Good Lifelong Learning	Ethically, environmentally and socially aware and active	Cross-disciplinary Cultural awareness Life and job skills	Authentic tasks – competing solutions and a diversity of outcomes Provide multiple roles and perspectives

All the graduate attributes could be matched to the draft design principles, and further reflection on the impact thereof will take place in the next chapter.

New design principle included in the fourth iteration

In the first two iterations, students partnered with organisations in the creative industries due to the notion that "creativity was seen as the foundation of innovation, and innovation was seen as the new primary driver of economic growth" (Flew, 2010). Cape Town, where this study took place, was the World Design City 2014 and the view was that the creative industries were crucial to the local economy and ripe for digital innovation. After the first two iterations, it became apparent that the students did not learn enough from their industry partners and vice versa. A decision was made to try a different approach in which students partner with entrepreneurs who are in the start-up phase of their business to facilitate a transfer of skills between the students and the industry partners. When an organisation is in the start-up phase, it is more susceptible to change and the perception was that the students would find it easier to make a difference in the organisation and support the development of the local industry's emerging entrepreneurs.

A group called the 88 Business Collective was identified as the ideal business partner for the fourth iteration. The focus of the group is to empower female entrepreneurs over an 18-month period via the provision of an ecosystem in which to grow their business through collaboration, access to new markets and business consultation.

The aim with the partnership was that the students would be able to provide digital business innovations to the businesses and, in turn, will be exposed to entrepreneurs who are on an accelerated growth path. The students will further be part of the 88 Business Collective and be exposed to a wider community and additional resources for their own development. A prospectus of the business partners can be viewed in Appendix 8. Students ought to learn the capability to ideate and innovate by collaborating with any business (not just those in the creative industries). It is in collaboration, via the building of external and internal networks of people, knowledge and resources and finding new possibilities, that innovation occurs (Mascia, Magnusson & Björk, 2015).

Data collection

A similar data collection strategy was followed as for the first two iterations, using a mixed-methods approach to collect both quantitative and qualitative data. The data collection instruments for the fourth iteration are discussed below.

Results pertaining to skills required for digital business innovation

The first section reviews the results pertaining to the second sub-question: What skills are required by IS graduates to become competent digital business innovators? Students filled in the survey in Appendix 3 at the start of the semester to test their perceptions prior to the course (Survey 1) and again at the end of the course to test the outcome of the intervention (Survey 2). The mapping of questions to skills sets was duplicated from the first iteration to keep the data collection as consistent as possible between the iterations, as per Table 15. Responses were transferred from Google into Excel to calculate percentages in order to conduct the quantitative analysis. The open-ended questions were coded as per the first iteration.

Quantitative data from student surveys, iteration 4

The student survey was updated to include a few additional questions regarding the students' perceptions of online assessments and their experiences of working in an online environment. The updated survey can be viewed in Appendix 9. The mapping of questions to skills sets was duplicated in order to keep the data collection as consistent as possible between the iterations; however, the addition of extra questions changed the numbering, as indicated in the table below.

Table 32: Mapping of survey questions to skills sets

21st-century skill	Mapping pilot survey	Mapping iteration 4
Core content knowledge	1, 2, 3, 5, 6, 7, 9	1 to 8
Cross-disciplinary knowledge	24, 31, 43	23, 30, 46
Digital/ICT knowledge	22, 23, 26, 27	21, 22, 23, 25, 26
Communication/collaboration	8, 11, 12, 16, 17, 18, 19, 22	13, 14, 16, 17, 18, 21
Problem solving/critical thinking	28, 29, 30, 32	27 to 31
Creativity/innovation	29, 44, 45, 46	28, 38, 39, 40, 41, 47, 48, 49
Life/job skills	10, 34, 35, 36, 37, 38, 40, 43	33 to 37, 43
EQ/ethics	15, 33, 39, 47, 48,	15, 32, 42, 51, 53, 54
Cultural competence	19, 20, 21	18, 19, 20, 50

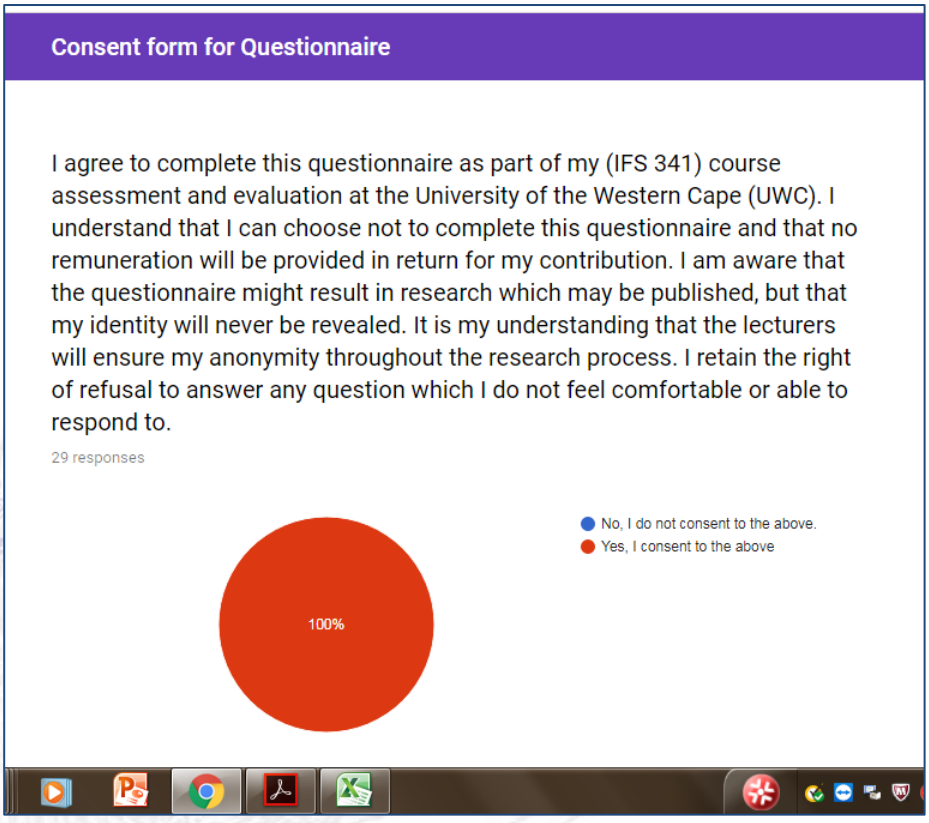


Figure 31: Student consent for survey, iteration 4

Regression analysis

Regression was again applied in the fourth iteration to determine the relationship among the variables (skills) obtained in the survey results. Student assessment scores for their first assignment were used as the dependent variable. The detailed analysis of the entire result set is available in Appendix 5.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.672446548	0.082528737	8.148029095	1.10554E-06	0.495440012	0.849453083	0.495440012	0.849453083
Core	0.147216182	0.165100654	0.89167534	0.387635712	-0.206889503	0.501321866	-0.206889503	0.501321866
Cross	-0.703850796	0.240869698	-2.922122632	0.011143882	-1.220464917	-0.187236674	-1.220464917	-0.187236674
Digital/ICT	-0.210225225	0.148599096	-1.414714021	0.179007662	-0.528938588	0.108488138	-0.528938588	0.108488138
Comm/Coll	-0.20021263	0.20013728	-1.000376493	0.334106093	-0.629464404	0.229039143	-0.629464404	0.229039143
Innovation	0.910963943	0.228929264	3.979237632	0.001370759	0.419959505	1.401968382	0.419959505	1.401968382
Problem Solving	-0.632148008	0.275214844	-2.296925552	0.037568609	-1.222425142	-0.041870874	-1.222425142	-0.041870874
Life/Job	0.132793822	0.16348342	0.812277	0.430228733	-0.217843241	0.483430886	-0.217843241	0.483430886
EQ	0.256721196	0.202084631	1.270364771	0.224661391	-0.176707231	0.690149624	-0.176707231	0.690149624
Culture	0.212048764	0.167819501	1.263552579	0.227026888	-0.147888269	0.571985797	-0.147888269	0.571985797

Figure 32: Regression results, iteration 4: Survey 1

Three variables stand out in the initial survey – that of cross-disciplinary skills, innovation and problem solving. These skills were therefore statistically significant for the results obtained during the initial assessment of the students. This shows that students had an accurate perception of the skills required in the initial assessment pertaining to these three skill sets. The presence of innovation/creativity and problem solving/critical thinking together with cross-disciplinary skills in the first assessment is an improvement from the first two iterations. These skills are the correct skills to emerge from the start of the course. Cross-disciplinary skills also produced a statistically significant result for survey 1 during the first and second iterations. The design of the initial assessments in the course is therefore satisfactory in its ability to draw on the students' abilities to use their interdisciplinary skills.

The reliance on creativity and innovation as well as problem solving and critical thinking from the onset of the course is also a good result, as these were the skills being tested in the initial assignment. The initial assignment consisted of presentations to the class, as well as a project-initiation document per group. Students were required to meet with their clients and draw up a project plan that detailed the entire project as well as the generation of ideas for potential digital innovations. They had to include detail on their scrum sprints and the design thinking process applied. The client's original and updated business models were also included in the documentation.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.090295235	0.342248961	3.185678731	0.005121153	0.37125685	1.809333619	0.37125685	1.809333619
Core Content	0.664751549	0.313519786	2.1202858	0.048135345	0.006070922	1.323432177	0.006070922	1.323432177
Cross Discipline	-0.43621617	0.435962811	-1.00058116	0.330291399	-1.352140053	0.479707704	-1.35214005	0.479707704
ICT/Digital	0.141632321	0.276171311	0.512842266	0.614297965	-0.438582073	0.721846715	-0.43858207	0.721846715
Comm/Coll	0.028813095	0.372321041	0.077387771	0.939168813	-0.753404386	0.811030577	-0.75340439	0.811030577
Problem/Critical	1.785531682	0.616276932	2.897287875	0.009601466	0.490781893	3.08028147	0.490781893	3.08028147
Creativity/Innov	-2.82530789	0.654588257	-4.31616036	0.000415928	-4.200546785	-1.45006899	-4.20054679	-1.45006899
Life/Job	1.832810393	0.49714614	3.686663229	0.00168806	0.788345111	2.877275675	0.788345111	2.877275675
EQ	-0.75423726	0.532745919	-1.41575418	0.173918387	-1.873494902	0.365020383	-1.8734949	0.365020383
Cultural	-0.9201034	0.28640423	-3.21260409	0.004826841	-1.521816361	-0.31839044	-1.52181636	-0.31839044

Figure 33: Regression results, iteration 4: Survey 2

The second survey produced a statistically significant outcome for core content, problem solving/critical thinking, creativity/innovation, life and job skills as well as cultural competency. This result points to a significant improvement from the first two iterations and shows a far more balanced development of student competencies. The final assessment consisted of the results obtained for all the tasks measured in the full project implementation. The skills development that took place in this iteration highlights the importance of industry partners, as well as the type of tasks that students are required to perform during the rollout of the capstone project.

ANOVA analysis

An ANOVA analysis was again conducted to test the outcome of perceived skills development. The table below depicts a summary of the outcome, and the detailed results can be viewed in Appendix 6. The majority of results indicate a significant positive difference ($p < 0.05$ and $p < 0.01$) between the pre-test and post-test results in terms of the students' perceived skills development.

Table 33: ANOVA results, Iteration 4

Skills sets tested	F-value	P-value
Core content knowledge	20.82	4.34E-05**
Cross-disciplinary knowledge	5.55	0.023*
Digital/ICT knowledge	13.72	0.001**
Communication/collaboration	0.592	0.445 ns
Problem solving/critical thinking	6.500	0.014**
Creativity/innovation	4.140	0.048*
Life/job skills	4.00	0.052*
EQ/ethics	6.901	0.012**
Cultural competence	7.164	0.011**

**$p < 0.01$; * $p < 0.05$; ns = not significant

The results show that there was a significant difference in the students' perceived skills improvement in their foundational knowledge, particularly for their core content and digital or ICT knowledge. The increase in digital knowledge from the previous iterations is a positive result. The interventions to expose students to technical skills development in the e-commerce module during the first semester clearly had a positive impact. The development of more specialised technical skills needs to be built into the IS curriculum, and the findings from this study can guide the updated IS curriculum at UWC.

The findings obtained in the analysis of meta-knowledge show an interesting development that was also evident in the regression analysis depicted in Figure 33 above. Previous iterations showed a statistically significant difference in the students' perceived development of communication and collaboration skills. During the fourth iteration this was the only skills area that did not show a statistically significant difference. The rollout of the capstone project required students to collaborate with team members and clients, and the outcome of this skills test is therefore an interesting finding. A review of the qualitative data will shed some more light on this finding and possibly point to changes that may be incorporated in the design of the course.

The results obtained for the perceived development of human knowledge showed a statistically significant difference in all three areas. This is a marked improvement from previous iterations, as EQ and cultural competencies showed a significant increase for the first time. This can be attributed to changes in the choice of industry partners and more explicit instruction in EQ and ethics in the course. Students were required to do personality tests and EQ tests and write about the findings in their blogs.

The following section highlights the results from the qualitative analysis to integrate the findings and obtain a clearer understanding of the overall outcome. As pointed out, this cross-validation of data can highlight areas where there may be potential discrepancies in the findings, especially for findings pertaining to communication and collaboration skills.

Qualitative Data

The steps prescribed by Miles and Huberman (1994) to systematically organise the data were again applied for data obtained from the fourth iteration as depicted in Table 36 below.

Table 34: Qualitative analysis, Iteration 4

Specific data sets	Process steps	Decision rules	Analysis operations (enter codes)			Research comments
			Data for analysis	Conclusions	Confirm conclusions	
S02.4	Analyse S01.4 and S02.4: use themes and subtheme codes	Survey 1 and 2 Question 12: analysis of perceived skills development	S02.2 in Google Forms	Chapter 7	Chapter 7 to update the final design principles	Triangulate skills tested

	Analyse S02.2 themes from open-ended questions	Survey 2 Question 55 to 58 Outcome of course	S02.2 in Google Forms	Chapter 7	Chapter 7 to update the final design principles	Themes identified in responses and open-ended quotes
B04.1-3	Analysis of blogs to identify codes and themes	Analysis of Blogs 1 to 3 and identify relevant quotes per theme	B04.1-3 urls captured on Google Drive	Chapter 7: discussion of process and quotes	Deeper discussion of findings and conclusions in Chapter 7	Substantiate findings with quotations from students per theme
FR04	Facilitator reflections during the course include the analysis of project documentation	Overview of results to identify responses and progress, areas for improvement, constraints experienced by students	Electronic journal in Work and data capture and analysis in Excel	Chapter 7	Chapter 7: integrate findings and update the finalised design principles	Findings to update findings and conclude Phase 4 of the DBR study
IS04	Industry survey at end of course to measure success of implementation	Survey results	Survey in project documentation and hard copies to clients	Discuss areas of concern in Chapter 7	Review to make changes to finalised design in Phase 4	Findings to update findings and conclude Phase 4 of the DBR study

Source: Miles and Huberman (1994)

Student surveys: open-ended questions

Students were asked whether they believed that they had been taught the right skills to find work in their chosen field. This question was included in the initial survey to test their perceptions at the onset of the course and it was repeated at the end of the course in the second survey.

In the initial survey, 57% of the students felt that they had been taught the correct skills. When this question was repeated at the end of the course, 88% of the students felt that they were taught the right skills. Of the students who answered no in the first and second survey, the skills sets that they felt they lacked were selected as depicted in the figure below.

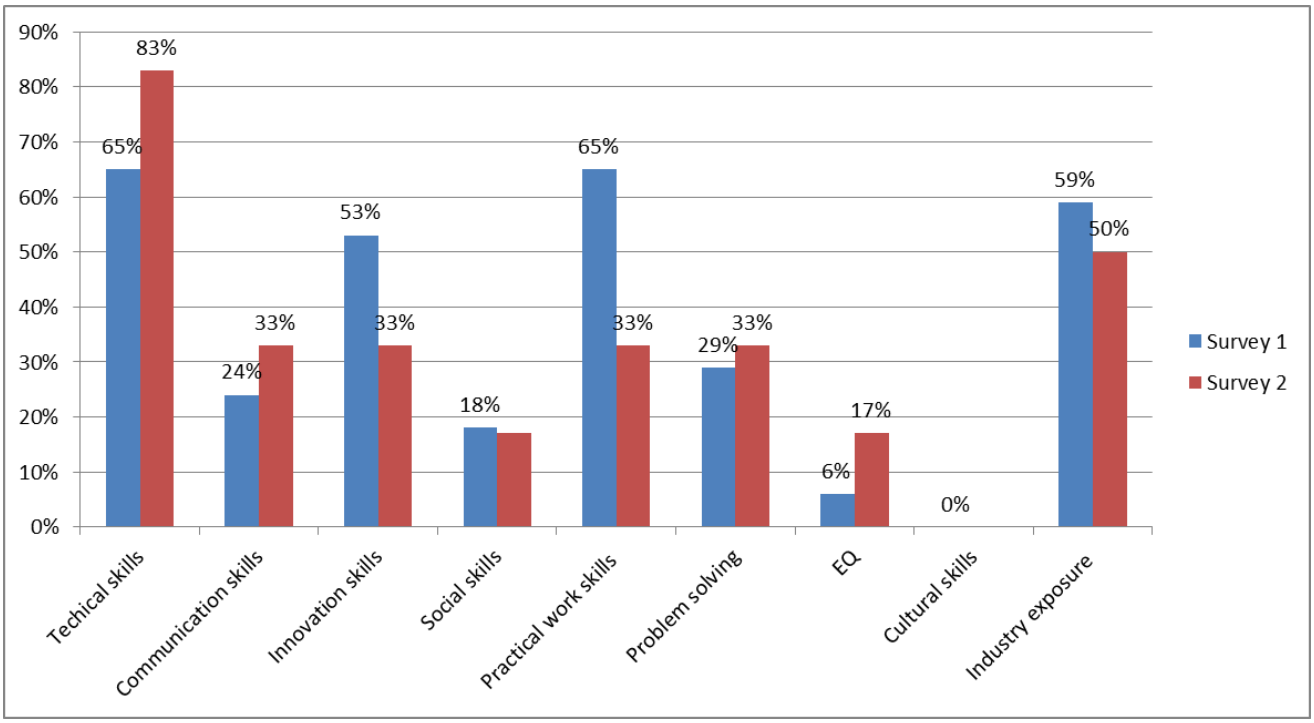


Figure 34: Student skills deficits, surveys 1 and 2

The percentage of students who felt they were not taught the required skills to find work in their chosen fields decreased by 31% from the beginning till the end of the course. Of the 43% who answered no in the initial survey, the majority of students felt they lacked technical skills, practical work skills and industry exposure. Students also felt that they required more innovation and problem-solving skills, and a few mentioned soft skills such as communication, social skills and EQ.

In the second survey, the 12% of students who answered no cited technical skills and industry exposure as the most problematic. When asked specifically what they would require more of, the respondents felt that they lacked programming/coding skills.

Qualitative analysis of student reflections

The reflections from student blogs were analysed, as in the first two iterations, to validate the findings from the quantitative data as they pertain to skills development. Students recorded their experiences during the semester in their blogs and were further tasked to perform personality tests, EQ analysis and reflections on their future path and careers. The findings were analysed and coded according to the nine skills sets and a full transcript of responses that were deemed relevant to support the evidence is available in Appendix 7.

In an analysis of the qualitative data, evidence of student reflections was organised according to foundational knowledge, meta-knowledge and human knowledge. For the development of digital innovation skills pertaining to

foundational knowledge, the skills development that took place for core content, cross-disciplinary and digital or ICT skills were reviewed.

Foundational knowledge

The results from the previous two iterations were satisfactory in terms of the **core content** provided to the students. A detailed outline of potential content that ought to be included can be viewed in Appendix 10.The core content needs to be reviewed annually and updated where required. The design principle that pertains to core content is the incorporation of a design-thinking ethos in the course design, because it is a core aspect in the instruction of digital business innovation to IS students. The other aspects that need to form part of the core content include the business model canvas, the value proposition canvas, agile and scrum methodology and the lean start-up, because their content supports a design-thinking ethos. Below is an example of students engaging with the business model canvas during class discussions.

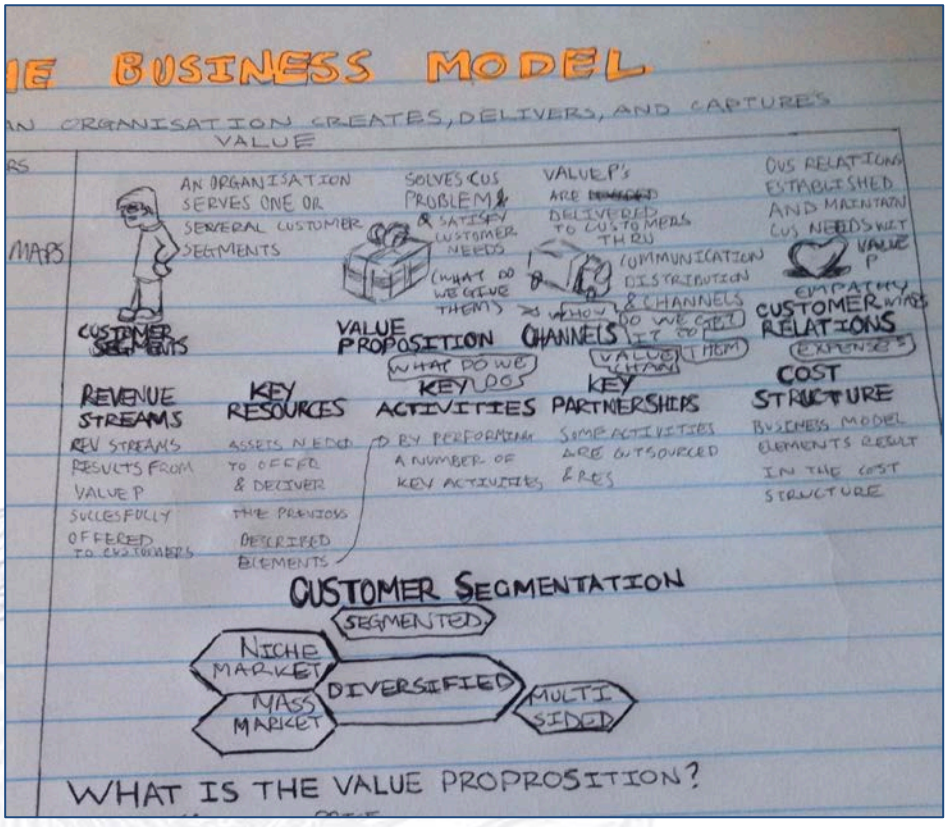


Figure 35: Student engagement with business model canvass

The course requires a future focus and students need to be exposed to new technology on the horizon and the impact thereof on organisations. This can change as new technologies emerge and changes occur in the business landscape. The aspect to hone in on is the wide spectrum covered by digital business innovation, and the students need to be made aware of this.

During the Idea Generation process of our project I encountered many ideas for the first time. Thus I learnt that digital innovation is truly an all-encompassing field of study. (MH)

As the classes progressed I was enlightened on the importance of information systems and the vital part it plays especially in the 21st century for organisations. (BM)

The method of instruction to ensure that a wide selection of core content can be presented in a practical manner is important. The use of voice-over slides that students could view prior to class was again applied in the fourth iteration, with great success.

I was already getting a hang of the content slides because there was a voice note provided in each of the slides. You could say it is a lecture before a lecture and I admire this teaching method. (DW)

I'd like to note that I think slides that come with voice notes on them are a life saver. I mean it makes a lot easier for us students to quickly get an idea of what the next class will be on and know where our understanding is lacking beforehand. (ME)

The podcast made learning a pleasurable experience and the use of technology involved in this process is appreciated especially when one wasn't able to attend the classes. (BM)

The incorporation of **cross-disciplinary knowledge** is a requirement for all study areas in which one wants to future-proof the curriculum. This skills set was therefore included in the development of design principles to ensure the development of interdisciplinary skills via group work and interaction with industry partners.

During the fourth iteration, student teams worked with entrepreneurs from many different industries. Students had to familiarise themselves with the industry and do background research prior to meeting their clients.

I must say, it is really cool that we will work with real world companies and actually help them become better versions of themselves. Golden Rewards 1981 is the company we're going to be working with and I'm very excited because we already have a bunch of ideas to wow our 1st ever client. (ME)

I enjoyed meeting up with the owner of the company because she was quite inviting but most importantly, I had my first meeting with an established business person. Being able to give advice made the whole studying process at university purposeful because I would like to be in her position in future. (KB)

I have always worked in groups, but the group work we did in this course was different to what I'm used to, it was much more practical and it reflected the work environment a little bit more than the usual group work we did. I think this is because this time we actually worked with a real business, which gave us a real professional feel. (AS)

Another recommendation for the future is to pre-select the teams to ensure that students are forced out of their comfort zones, where they always select the same people to work with. This came up as a suggestion from students in the second survey.

The lecturer should randomly choose members for groups. (BM)

From the interpretation of the findings, it is evident that more needs to be done to assist students to develop the right **ICT/digital skills** to become competent digital business innovators. Students are required to implement a working digital artefact and therefore are required to use their digital/ICT skills. They are further tasked to develop blogs using an online platform that further develops digital skills. However, more intervention is required, and a review of the entire IS curriculum needs to take place to ensure that the students are better prepared technically for a digital world. This is beyond the scope of a single course and needs to be embedded in the IS curriculum from the first year.

Students were required to find solutions and were encouraged to become involved in the technical specifications from the onset of the project to build their confidence.

> *During the assignment preparation I have grown interest in programming. After learning that our group could not provide an application for our client, I have started looking at many ways to develop an application and I am in the process of learning about HTML.* (KM)

> *In class we reflected on the meeting and prepared the ideas for her business including a website, invoicing systems and biometric systems for onsite workers. I also learnt more about front-end web development in my own time to execute the project working with HTML, CSS and Javascript. This was done through treehouse.inc.* (TR)

> *Nevertheless, my limited technical skills can still be improved upon and online full-stack programming courses are helping my career aspirations.* (ME)

Students were required to create their own websites for their blogs and were encouraged to use graphics, video clips and other multimedia. This created some discomfort, as this was the first time many of the students were required to create their own on-line environment.

> *More practicality, on how one make graphics and how to insert plugins, is what I would like to be added in future.* (MB)

> *The course lack practical computer work such as coding and programming.* (St22)

Meta-knowledge

The development of meta-knowledge includes communication and collaboration, creativity and innovation, as well as problem solving and critical thinking skills. An analysis of the quantitative data pointed to discrepancies in the perceived development of **communication and collaboration skills**. From a review of the feedback from the students it can be surmised that a big factor that contributed to this was problems experienced in the teams. However, the students learned from this experience. Some extracts from students highlight the main obstacles and lessons learned:

> *The biggest lesson that I learnt personally regarding teamwork was the importance of communication and understanding between the group members in order to ensure that the subtasks being done by each member corresponded correctly to the final product. The website had various areas which needed to be worked on and sometimes group members would misunderstand what needs to be done due to a lack of proper communication.* (ZT)

> *Team members might contribute changes to the project which can have a big impact on the success of the project, so it is important to collaborate with the rest of the project team to ensure the success of the project.* (CO)
>
> *By doing this assignment I have learnt firstly, the importance of team work and being a team player as an individual. As team members we had to improvise and put aside any personal agendas especially those that would sabotage the success of this project. Being in a group and working as a group, I believe it prepares us for the working or the corporate world. It is essential that we are aware of each other's strengths and weaknesses and be able to accommodate each other.* (DM)
>
> *We had so many disagreements but we managed as a group to come up with the best document of the project despite our differences. I have learnt to be patient and persistent with each person and that the importance of team work is vital in order to carry out a project. I think that our differences are a preparation for a greater task in the work place.* (KM)
>
> *In this assignment I learned the value of teamwork, and I have understand that it is imperative that all members of the group need to work together to provide a finished product, and if one member's work is lacking, it can affect another's work.* (AB)

Recommendations need to be included in the updated design principles to stipulate team formations to ensure that collaboration takes place.

The cultivation of **creativity and innovation** forms a vital component in the course and was successful in previous iterations. A similar formula was therefore applied in the fourth iteration, where students were actively encouraged to experiment with different solutions and to present the findings to their facilitator and peers as captured in the updated design principles.

Teams received feedback on their progress and were encouraged to change, update, pivot and start brainstorming and ideating again, if required. An environment needs to be created in which student teams are encouraged to experiment, make mistakes and learn in order to cultivate creativity. The ideas that seem viable can then be tested to implement the best innovations for their clients.

> *What is important is what you do to get back up after failure hits you hard in the face. Although it is difficult to comprehend, failure should be treated as a learning curve that motivates you to get back on track and move forward.* (KH)
>
> *Moreover, gaining an insight on how learning is, as a process, meaning that I have been given the importance of seeing every fail or fall as a chance to do better next time.* (XS)
>
> *Innovatively I acquired this skill by actually doing hands on work, for example actually learning how to develop someone's business using the knowledge we acquired in class and actually thinking outside the box on bringing new ideas that can make a business profitable .* (BM)
>
> *At the end of all the presentations I learned that when brainstorming innovative ideas, go all out and don't worry ourselves with finances and feasibility just yet. Just think and be creative!* (ME)
>
> *I enjoyed most the fact that we had to think outside the box and we had no limitations when brainstorming. The solutions to the company's problem had to bring value to the business but also considering the capacity we have as full-time students. After all was said and done, a final solution or conclusion was reached by funnelling all the ideas.* (TT)

The requirements of what to expect and how to create an authentic learning environment that encourages students to become **critical thinkers** were more familiar in the fourth iteration. Authentic learning emphasises tasks with real-world applications and ill-defined activities. Furthermore as captured in the design principles, opportunities need to be provided for students to find their own solutions. This learning environment encourages students to solve problems using a variety of resources. The students were unfamiliar with this type of learning and needed some coaching to immerse them in the projects (similar to previous iterations).

> *What I enjoy the most and interests me the most is that the course challenges me to think out of the box and to constantly find new solutions to problems that some organisations are facing on an operational level*. (BM)

> *I have also bettered my problem solving skills through this module because we are constantly being challenged by the project.* (LN)

Human knowledge

In previous iterations, the cultivation of human knowledge was problematic, specifically for the development of EQ and cultural skills. An intervention in terms of the type of industry partners and the inclusion of more exercises to build awareness was included in the fourth iteration, as encapsulated in the design principle that stipulates partnership with entrepreneurs. This enables an authentic learning environment that ensures the cultivation of the necessary **life and job skills** for the students to become competent digital innovators.

> *This week was all about me learning to be accountable for my own life and that contingency plans are very important when there are important events involved. So for instance risks are everywhere no matter how big or small provision must always be accounted for to beat those risks; always have a PLAN B!* (KB)

> *This project helped me to form my biggest dream and vision is [sic] to change the way SMEs run their day-to-day operations and provide them with IT systems to better their operations, as I feel that it is the SMEs who really empower the people and the economy.* (TR)

> *One I know for sure is that I am not going to work for someone else my entire lifetime. I know that the little I have in my hands is enough to take me where I want. All I will need is the passion and dedication to follow my dreams. That much said, let me brief everyone on what took place during this week. I also figured out that my present determines my future and I should be responsible in every part of my life so that regret does not eat me alive.* (AS)

> *It is about understanding what your client wants, both inside and outside of the business and providing them with exactly that. Truly a valuable lesson, especially because I would love to venture into business in the future.* (SL)

During the fourth iteration, students were made aware of **EQ** and time was spent during one lecture to conduct a test and discuss individual findings. Students were further encouraged to do another on-line assessment and report the findings in their reflective blogs.

> *She also made us take the EQ test. This test was so informative and insightful as we learnt that we are not always correct in our approach.* (AB)

I think knowing your type of emotional intelligence or the way in which you handle situations can go a long way in finding what you need to improve about yourself, how you approach others and how you justify your actions. It is important to have an understanding about yourself for peace of mind and to enable you to find your life purpose or life path. (MB)

I found our brief touching on the area of emotional intelligence to be interesting. It's a very interesting concept that provides us with an understanding of our awareness, control and ability to express our emotion, as well as handle interpersonal relationships with good judgement. We conducted EQ tests in class, and online in order to see how emotionally intelligent we were. (ZI)

Caro also had in store for us an emotional test (EQ) which is something I never knew existed before that week's class. From what I gathered from that test, I learnt that emotions enable people to make good and rational decisions in organisations and life in general. (TT)

I have a huge feeling that at the end of this module, I'm going to come out the other side of the pool an improved specimen. (ME)

Similar to EQ, the cultivation of **cultural skills** also showed a marked improvement in the results obtained from the quantitative data. A more focused approach was followed to make the students aware of their social imprint on SMMEs, and the choice of industry partners further facilitated the process. Time was also devoted during lecture hours to give instruction on the importance of listening and empathising. Students were required to do empathy maps in previous iterations, but more time was spent explaining the importance thereof during the fourth iteration.

Lastly I learned or acquired interpersonal skills in the sense that in class for example we have different people of all races and ethnicity. In order to have a comfortable learning environment, I had to understand, view and feel how the next person in [sic] thinking, and how to handle conflict especially. That is in new skill I can say is a game changer for me. (BM)

I acquired the skill to listen to what the next person has to say and actually view things from someone's perspective and ideology. This has improved my life drastically as I now am able to actually take in criticism without taking offense to what was said. (MM)

I really admire and applaud her and other women who are doing great in an effort to tackle the high unemployment rate in South Africa. This motivation I derived on top of the motivation I have already will surely take me to my goal of becoming an entrepreneur someday. (MH)

The business is something huge and it is in our (team's) hands, the business change literally has an effect on the owner's life plus the lives of her employees and clients … Imagine how much more we could change other small businesses and literally end up changing the entire world of small businesses. (TG)

Table 35: Summary of skills data obtained in iteration 4

Code	Description	Regression Survey 1	Regression Survey 2	ANOVA	Reflect	Comments
S01	**Core content**		✓	1	✓	Achieved results
S02	**Cross-disciplinary**	✓		6	✓	Achieved results

S03	**Digital/ICT**			2	✓	Achieved results for course but IS curriculum intervention required
S04	**Comm/collaboration**			9	✓	Change team selection process
S05	**Create/innovation**	✓	✓	5	✓	Achieved results
S06	**Problem/critical**	✓	✓	7	✓	Achieved results
S07	**Life/job**		✓	8	✓	Achieved results
S08	**EQ/ethics**			4	✓	Achieved results
S09	**Cultural competence**		✓	3	✓	Achieved results
Comments		Statistical significance	Statistical significance	Rank on F-value	Significant responses	

Results for teaching and learning interventions

Qualitative analysis of survey results

An open-ended question in the second survey tested the overall outcome of student perceptions in terms of the course. Students were asked to name the aspects that worked well for them in the IFS 341 course. The results were ranked according to the elements of authentic learning that were mentioned in the student answers, and an overall percentage was calculated per area, as displayed in the table below.

Table 36: Results of positive student perceptions of course

Code	Description	Total
A01	Authentic contexts	**18%**
A02	Authentic tasks	**10%**
A03	Expert performances and the modelling of processes	**7%**
A04	Multiple roles and perspectives	**3%**
A05	Collaborative learning	**14%**
A06	Reflection to enable abstractions to be formed	**3%**

A07	Articulation to enable tacit knowledge to be made explicit	**24%**
A08	Coaching and scaffolding by the lecturer	**14%**
A09	Authentic assessment	**7%**
Responses		**29**

The results showed a similar pattern to those received in the previous iterations, as the promotion of articulation to enable tacit knowledge to become explicit was again the most cited benefit, followed by the establishment of an authentic context. The collaborative learning environment and the coaching and scaffolding by the lecturer were also positively received.

> *Working with real life companies with real life problems worked for me.* (St06)
>
> *Everything worked, it was much better to do presentations and lots of tasks for marks than too [sic] have two huge tests that count all the marks.* (St08)
>
> *The ability to implement the knowledge I gained from class with practical implementations worked for me.* (St10)
>
> *Getting experience through doing a real project was very beneficial.* (St15)
>
> *The constant presenting of the work done has built my confidence.* (St17)

Students were asked to name the aspects of the course that were not beneficial to them, and the majority of complaints related to collaborating with team members and the internal conflicts that emerged in teams. Some students also found personal reflections (blogging) to be a challenge.

> *The groups being implemented was a problem for me. The lecture should rather randomly choose members in groups.* (St11)
>
> *Forming groups with people and then finding that they cannot commit due to other activities, e.g. work.* (St14)
>
> *Learning to work with different people with different views, skills and personalities has been great, however it's important for team members to commit to the group and pull their weight.* (St20)
>
> *I found working with a team difficult at times especially when there are communication issues amongst the team which could potentially cause frustration amongst the team as a whole for the project.* (St24)
>
> *The blogs did not work for me, I find it difficult to write.* (St04)
>
> *Blogging was not great for me and I would like more basic skills to use digital platforms.* (St07)

Qualitative analysis of student reflection

The data analysis in this section is a summary of the findings from student blogs related to the themes that characterised authentic learning and the insights gleaned from the data. A full set of extracts can be viewed in Appendix 7.

Authentic Context

In the fourth iteration, a similar formula to the previous iterations was applied to create an authentic context for this course. Students were again required to implement a real-life digital innovation within an organisation, and the project was rolled out during the semester. The capstone project consisted of a number of tasks that were performed individually and within teams. A blended learning environment was established to encourage teams to collaborate both online and during face-to-face sessions with team members, peers, the lecturer and clients.

The design of the course needs to facilitate opportunities for students to find their own solutions by implementing a working digital innovation (artefact) in a business via a capstone project.

Students were again very responsive to the creation of an authentic context and felt that they benefitted from a real project environment in which they could apply design thinking and agile/scrum methodologies.

> *I am now even more hungrier [sic] than I was before and I have decided that in the next decade I'll be a proud owner of a virtual restaurant, all thanks to the knowledge I have gained from having to actually do a project for an existing business, bring about improvements and gain both academic and interpersonal skills from presenting in class and to the business itself.* (BM)
>
> *I had my first meeting with an established business person, was excited and nervous but because of her personality she put me at ease. Being able to give advice made the whole studying process at university purposeful because I would like to be in her position in future.* (KB)
>
> *It will not come closer to the real world of work, without it actually being the real world, than this.* (MH)
>
> *This was not just some little assignment, but actually it was more about changing the business for the better into a techno-friendly organization and how the business could accept that change.* (TG)
>
> *I would not change a thing about this learning environment as I feel it produces positive results. It also makes a student want to work hard and for me it makes me want to learn new things every day. It's one of the best lecture environments I've been in.* (DW)

Authentic tasks

The integration of authentic tasks into the learning environment was reflected in all the draft design principles. The activities were designed to match the real-world tasks of industry professionals and were not classroom-based tasks.

> *This module enables us to interact with the real world while studying and getting the sense of how it really works out there. I am lucky in being part of a lecture class where we can interact with each other, where lecture groups are small enough to give each and every one the attention they deserve.* (SH)

The problems encountered could be open to multiple interpretations because they are inherent in the activities performed for a specific industry partner. Students were required to identify their own unique tasks and subtasks to complete their projects.

> *"Throw them in the deep end". If I were to guess, I'd say that is the mindset Caro – my Digital Business Innovation lecturer – has for us this semester.* (ME)

The activities that students were required to complete spanned over an entire semester and culminated in the implementation of a digital innovation for an entrepreneur with whom the students partnered.

> *The lecture environment is very interactive and practical. The method works very well because one can actually see how the work is implemented*. (KB)

The design of the course required teams to examine problems from a variety of theoretical and practical perspectives and to distinguish between relevant and irrelevant information.

> *The lecture environment taught you to think on your feet and actually think beyond what you were taught in class. I enjoyed the presentations and in class discussions. I would not change anything in the lecture or style of lecturing, it's in line with what the business world will demand of us.* (BM)

The design of tasks encouraged students to collaborate within their teams, clients and among their peers, both face-to-face and online.

> *IFS 341 really made me a better individual and scholar. The group work and presentations were a nice way to break the ice between the class [sic] as well us make us better teams. This really sharpened our people skills.* (AB)

Students were required to reflect on their individual and team progress via weekly blogs published online in order to reflect on their learning, both individually and socially.

> *It was my first time to blog and share my experiences of how my class is evolving and how I am progressing each week. Made me realise that I can be able to write [sic] about the things that are budding in my life and share it to the world [sic]. Blogging sharpens ones skills of writing and also how to be able to use different plugins and integrate them to create your website.* (MB)

The summative assessment of tasks throughout the semester ought to enable the improvement of products and culminated in the final implementation of a digital innovation. The activities and assessment thereof were therefore integrated to reflect the entire process, and not just the final product, and were based on progress and achievement.

> *We were never reprimanded on the way we saw a certain aspect or topic. This really made me grow as a person as my thoughts were not shot down, but encouraged and praised. I really like the environment that Caro taught us in. I honestly feel that campus should not just be about tests and exams, but it should rather be practical assignments where pupils can go out into the real world and figure out things for themselves.* (BM)

Access to expert performance

This element of authentic learning was derived from theories of cognitive apprenticeship and situated learning (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991) by Herrington (1997) and is based on the premise that students will better acquire skills when an expert models the process.

This element is built into the draft design principles because a working digital innovation needs to be implemented via a design-thinking process and students are required to formally reflect on the process.

The lecturer and industry partners need to perform the role of experts and assist students when they require assistance with the modelling of processes. Class discussions and presentations further assisted students to acquire digital innovation skills.

> *The perception I have for the lecture environment is awesomeness all the way. There was never a day when I did not enjoy class because there was interaction with the lecturer and other students. The lecturer was always helpful and I felt free to ask anything concerning the course and some life matters.* (TT)

> *The lecturer used the space which allowed as to be creative and be free to express our feelings and be ourselves. A space to grow and become better than we were. The lecturer knew what she was lecturing about, and wanted us too, to see the big picture of the module itself.* (ZG)

A more knowledgeable student can also perform this function in teams and during feedback presentations in class.

> *She also had questions about how she could allocate funding to the resources she may currently need, and my team member ([redacted]) was more than willing to help direct her business with so much advice and most of all encouragement. My other team member ([redacted] and I were completely swept off our feet, because we were surprised how much this guy knew about business innovation and what a genius he was. We were legit Business Analysts for about 2 hours and it was actually supposed to be a 20 minute in-and-out meeting.* (TG)

> *For the last couple of weeks, I've become more used to working in a group and presenting our work to the class after every lecture. It's definitely an interesting way to gain knowledge from your peers and also have the opportunity to grade and criticize their work and, as a class, brainstorm ideas on how they can improve on their work.* (KU)

The sharing of experiences via blogs also attributed to the modelling of processes, because students could review blogs and comment on their peers' progress. A further aspect built into the course was formal peer reviews to enable teams to learn from one another. The application of peer reviews was not always favourably received and, after the first iteration, more guidance was given on how to give and receive feedback. Moreover, sections on the quality of feedback provided and the incorporation of feedback received were included in rubrics.

> *The part I enjoyed the most during the previous few weeks was the peer review assessment. The reason why I enjoyed it was because we were given the freedom to evaluate and judge other people work as we saw it. It made us aware of the way in which our work and assignments will be officially marked, but also allowed us to provide our fellow students with advice and recommendations about their work, as well as suggestions on what to specifically improve. We were also able to see our mistakes*

> *from other group's perspectives, and get extra advice and recommendations and where our assignment needs to be improved.* (ZI)
>
> *The fact is that everyone makes mistakes thus the aim of this exercise was not to embarrass anyone but rather for each group to correct and improve on their mistakes.* (DW)

An example of a presentation of one of the teams to provide feedback to another team can be viewed here:

https://drive.google.com/open?id=0B68XKZZAYGN3OHhaWTktU09fZG8

Multiple roles and perspectives

During the fourth iteration, students were partnered with entrepreneurs from a variety of industries and encouraged to actively familiarise themselves with the industry via exercises in class and engagement with clients. Teams presented the findings of their analysis in class and were required to engage with their industry partner's clients using empathy maps and personas.

Students were required to perform specific roles within the project teams, such as product owner, scrum master or team member, and to document their accountabilities. This enabled them to experience a project environment and take accountability for their role in the successful implementation of the project. At the completion of the project, the different role players provided feedback to others on their interpretation of the role and their overall experience within the team. To incorporate this, the final section of the project report included lessons learned as individual team members during the project, as well as lessons learned as a team.

> *Teamwork called upon us to merge our knowledge and ideas, which intensified the overall talent of the team. The willingness to share is incremental. It has become clear to us that as a group that works well together, we can achieve more than working individually. A broader range of skills was applied to all project activities and sharing and discussing ideas played a pivotal role in deepening our understanding of all subject areas.* (TB)

Different perspectives on what will be successful and what not were encouraged and student teams had to demonstrate that they explored problems using multiple sources and opinions. This was built into feedback presentations, and other teams were required to provide feedback on progress and give their views on what will be successful for other teams and why.

> *I have always worked in groups, but the group work we did in this course was different to what I'm used to, it was much more practical and it reflected the work environment a little bit more than the usual group work we did. I think this is because this time we actually worked with a real business, which gave us a real professional feel.* (AS)
>
> *During the lecture, I enjoy doing activities that uplifts one's capability and to continue knowing how you influence others and how they help you see beyond your own capabilities.* (MB)
>
> *But besides all of that, my overall perception of the lecture environment is that, it was a very productive environment, and each time you enter, you can almost be certain that you will leave smarter than you entered.* (TT)
>
> *I have always had love for wine, but it is only recently that I have developed an interest in its making process and working in this project has really been eye opening. Talking to our client did not only*

provide answers for our project, but also to provide J9 with a website and empowered us as young people to look out for the opportunities that this career has and the opportunities that are out there for us as black females. (KM)

Collaborative learning environment

The creation of a collaborative learning environment is an essential element to enable IS students to become competent digital innovators. This element was therefore translated into one of the design principles, and the aspects to include in the learning environment were explored during the three primary iterations. These included teams to be formed for student projects, where students were required to perform tasks in teams and assessed on their success thereof. The incorporation of peer reviews and the incorporation of blended learning facilitated both online and face-to-face collaboration.

As discussed in meta-knowledge above, team-work can create conflict and misunderstanding and needs to be managed by the facilitator to ensure that students learn from the experience. The reality is that students will be required to work in teams in all future endeavours, and it is recommended that they reflect on the process and document their individual and collective lessons learned. This was done in the final document and students were required to include their individual and collective findings and present these to the rest of the class.

Firstly, the project has provided a platform to improve weaknesses as well as teaching other lessons along the process. The project provided a chance to improve effective communicating with team members, implementation of mutual understanding and lastly, clearly communicating and voicing thoughts. Moreover, the lessons learnt during this process are the importance of setting timeframes for the project, importance of empathizing (understanding others' point of view) with fellow team members, being a team player (supporting others on task delegated to them without hesitation) as well as learning to adjust to the requirement of the work and workload. (XS)

I have always been taught that communication is important in every relationship you build, whether it is work or personal. Well, communication is key which is the greatest lesson I learnt during the process of completing this assignment. With all the ups and downs I learnt that sometimes when you voice out your views there is someone willing to listen and there is always someone that will teach you something. Stay open, be mindful and work hard. These are the valuable lessons I learnt during this process. (SL)

Collaborating on this project has also helped each of us identify or discover our own hidden strengths and weaknesses we were not aware of. For example some of us were better leaders than listeners, or some of us were good at coming up with big ideas, but not so good at putting them into play. (TB)

We also learned that teams who recognise success and celebrate the achievements of individuals will always function better than teams that only point out faults. It's human nature. We are motivated by recognition, not the blame game. When someone was proactive and finished a task beforehand or took initiative in certain cases, we all showed recognition and appreciation making one another feel more motivated, happy, and willing to work even harder. (T1)

Students reviewed each other's work online and could comment on the progress and make suggestions for changes. They were guided in the process to monitor that feedback was constructive and assisted teams to improve on their products. Below is an example of student feedback on presentations given in class.

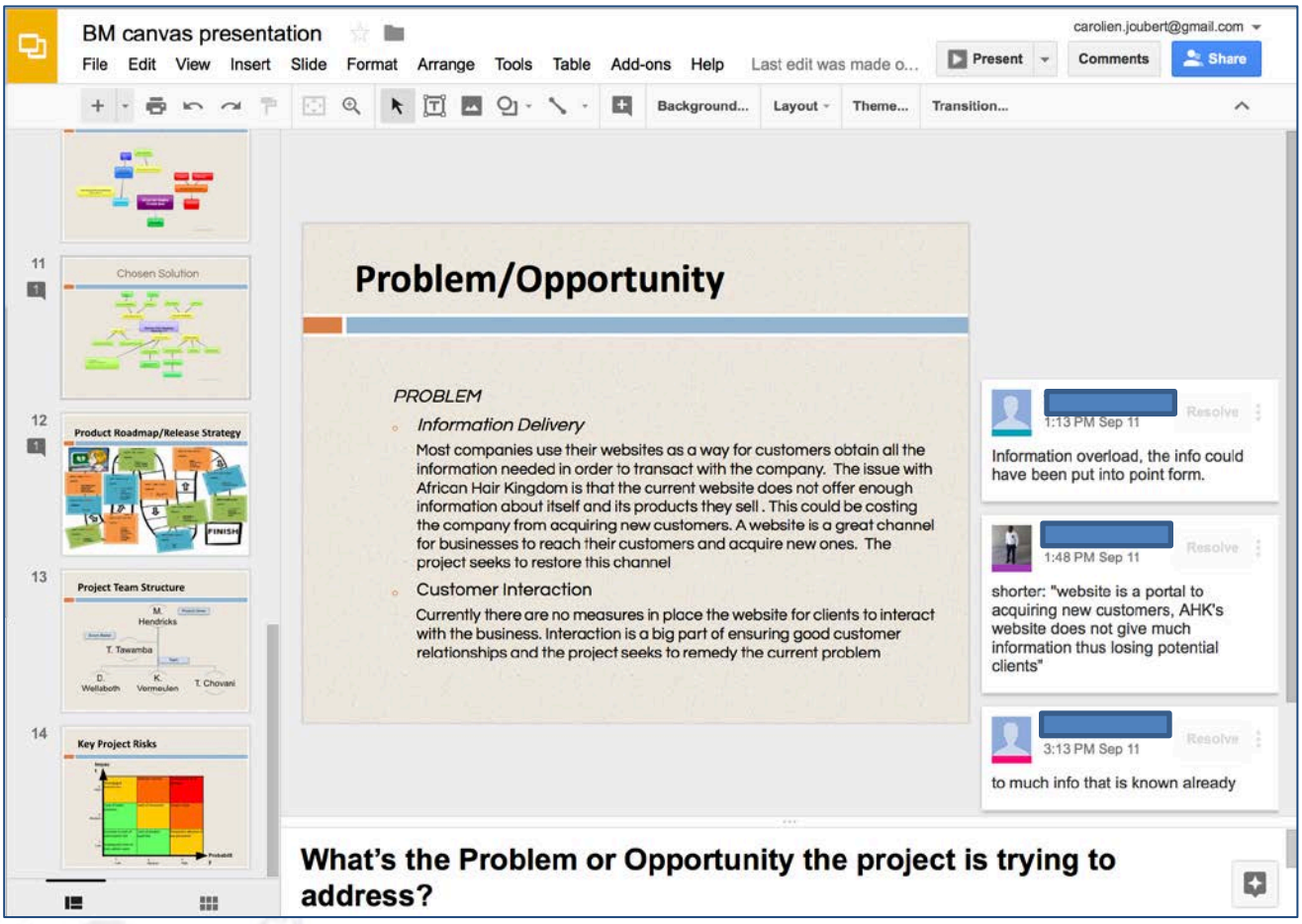


Figure 36: Online collaboration

Reflection

The implementation of a formal process of reflection was incorporated in the design principles for the course. Students were required to reflect on their weekly progress via an individual online blog. This was incorporated from the first iteration and was deemed successful from the start. A few things were adjusted during the course of the three primary iterations to make the process more successful. The most important aspect was to provide clear guidance in the rubric in terms of the expected outcomes, and to provide a certain amount of structure for the students to follow. The structure was too rigid during the first iteration, and more freedom to explore different mediums was allowed in subsequent iterations.

Exercises included in the weekly reflection were a review of the week and what was positively perceived and what did not work well for the students. Students were also encouraged to perform personality tests, for example the online Meyers Briggs Test (https://www.16personalities.com/free-personality-test) and the Enneagram test (https://trans4mind.com/rheti_html/test.html). During the fourth iteration, an EQ test was included to create better awareness thereof and to allow students to reflect on their own development.

It was my first time to blog and share my experience of how my class is evolving throughout and how I am progressing each week. Made me realize that I can be able to write [sic] about the things that are budding in my life and share it to the world [sic]. Blogging sharpens ones skills of writing and also how to be able to use different plugins and integrate them to create your website. (MB)

Blogging has taught me so much; I definitely will continue to do so. It is a space where I can express my views freely. I am happy here, which is what I strive for in this life, to be happy and content with all I do. (SL)

A screen shot taken of one of the blogs can be viewed below as an example of the layout.

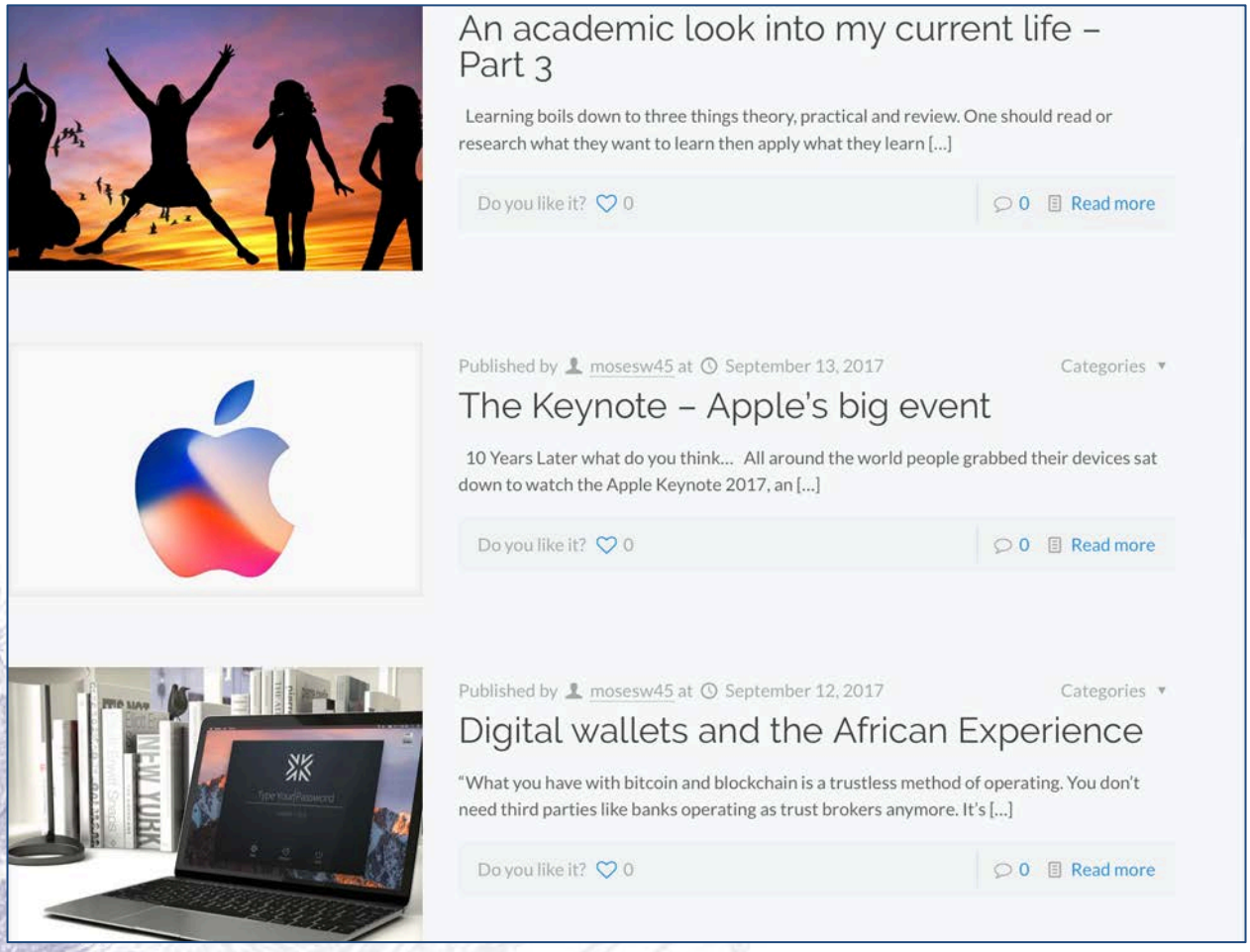


Figure 37: Student blog, iteration 4

Articulation to enable tacit knowledge to be made explicit

Through a process of articulation for tacit knowledge to be made more explicit (Herrington, Reeves & Oliver, 2010), the students demonstrated their understanding of their digital business innovations for clients via weekly oral presentations on their progress. An online environment was further established to allow the students an opportunity to update their project documentation and to receive feedback on their progress. The teams were

encouraged to participate actively and to share their thinking and knowledge during discussions in class and online.

> *Class was a very interactive experience with many presentations as well as questions being asked. Even though presentation is not my favourite form of learning it was still a constructive way to understand how to apply the concepts.* (TR)

> *Listening to the other groups present their businesses was enjoyable and informative*. (MH)

> *I now firmly believe it patches the cracks left by the other IFS modules. The exposure to real world clients forces professionalism in a student. Caro forces students to think and generate not one but multiple ideas, and most significantly, the module has forced us to get used to talking and conveying those ideas to other people and subsequently teaching us to get outside our comfort zone.* (ME)

> *I've become more used to working in a group and presenting our work to the class after every lecture. It's definitely an interesting way to gain knowledge from your peers and also have the opportunity to grade and criticize their work and, as a class, brainstorm ideas on how they can improve on their work* (KH)

Students were coached in expressing their thoughts and opinions and not to be afraid to voice their opinions, and the class environment allowed constant interaction between group members.

> *One thing I learnt is that you need to learn to stand up for yourself. Especially if you are in a group with a lot of males. They tend to want to dominate, to take over and make the project theirs, and as females we are simply accessories that are there to do the admin. You need to learn to voice your opinion, make changes where you see the need to and not allow yourself to be bullied by your male colleagues, and that is what I take into the future.* (SL)

> *Suppose you were a person who learnt to enjoy their own space and in most cases, prefers to talk less when around people. You tried every method to be a seen as a social person as carefully as you could, until when least expected in all your experiments [sic], a platform is given to you and you notice as time goes on and things are happening that you are changing. This has been the case for me when it came to IFS341, being more able to voice my own thoughts, views and values with confidence amongst my team and some of my class mates. Moreover, a leadership role had been offered to me as I had never before wanted to take one as I had struggles [sic] of delegating and voicing my thoughts.* (XS)

Coaching was also provided to students in terms of presentations and they were actively encouraged to get up every week and participate, although they were extremely uncomfortable with this aspect in the beginning.

> *Although I have become better at public speaking I still find doing presentations every week a bit nerve wrecking this may not be to all students, however in my opinion I would have liked to have presentations every second week, as I feel it would put less pressure on students.* (TR)

> *The main reason why I do not like presenting is, I am very shy and do not enjoy speaking in public. However, as the lecturer always says we may hate her now but one day we are going to thank her. I totally agree with her because this skill is really needed in the working world. As I said earlier, even though I do not enjoy presenting, it was very beneficial to me in the sense that I am more comfortable presenting now.* (DW)

Coaching and scaffolding

During the three primary iterations, coaching and scaffolding were an element that required careful balancing and reflection to ensure that the students were supported in their own learning process, with guidance being provided at the right times. It became very important to consciously monitor how teaching, coaching and facilitation contributed both positively and negatively to the students' experience of the course. As a facilitator, there are multiple roles to play, including guiding and mentoring, coaching and scaffolding, facilitating teamwork and collaborative activities, monitoring progress and providing feedback (Baker, 2010).

During the second iteration, the role of feedback was tested to ensure the right balance of feedback from both the lecturer and others to achieve elements of intrinsic and extrinsic feedback or sustainable feedback. This requires feedback from multiple sources, including peers, industry partners, team members and from the facilitator to establishing conditions in which students can operate with agency (Boud & Molloy, 2012). The feedback provided to students therefore needed to be interrogative to test why certain decisions were made and to prompt students to substantiate their choices. This was built into the course design from the first iteration, although the true value only started to emerge during the fourth iteration, when rubrics were adjusted to ensure that the students were measured on the quality of feedback given and the ability to utilise feedback for the further rollout of their projects.

> *We were really required to think about what we did and we sometimes found it very difficult but I guess she was preparing us for when we really get shot down in the corporate world.* (MB)

At the start of the semester, more care was taken to facilitate relationship building between the industry partners and the teams. A third party from the business consortium working with the entrepreneurs was brought in to facilitate the coordination between teams and their chosen partners, and to set up the initial contact. The formulation of teams followed a hybrid approach, whereby students could select some members and others were randomly allocated to test the outcome thereof. As the facilitator, it is important to have coaching skills in order to know when to interject, redirect, scaffold or, in rare cases, to mediate. It is important to scaffold the roles between the different stakeholders with just enough information and support for students to get started with their projects, but not too much where they have no decisions to make for themselves (Stansberry, 2017).

> *So whilst interviewing the owner of the company we met an ambitious, independent lady but the most interesting part in the interview was her willingness to learn from STUDENTS, she did not make us feel inferior she actually listened and took our advice even though she is an educated established business woman.* (KB)

A blended learning approach to flip the classroom was again applied with success, and the students received their learning material prior to face-to-face sessions. The class times were used for the practical application of knowledge and became an interactive space where all teams and the facilitator could engage and provide feedback on progress.

As a slow learner I was accommodated in class the way she teaches accommodated me and made me feel welcomed. (BM)

I'd like to note that I think slides that come with voice notes on them are a life saver. I mean it makes a lot easier for us students to quickly get an idea of what the next class will be on and know where our understanding is lacking beforehand. (ME)

From week two I started doing my pre-reading which made me prepared and ready when I attended the lecture as I would have had an understanding of the work already and not be the first time. It has now been three weeks and I can confidently say I know what is required from me individually and from my group on order to excel in this course. (ZI)

Authentic assessment

This element requires the assessment of integrated tasks that occurs over a sustained period of time and results in a finished, polished product (Herrington, Reeves & Oliver, 2010). The course was designed to include multiple assessments that were linked to the rollout of the final product/artefact. The assessments were summative to enable student teams to improve on the final product. The feedback provided enabled students to realise where they needed to improve to provide a better product.

I feel like our lecture was a bit harsh with her marks but probably because she would like to see us improve. (ZI)

The assessments for the fourth iteration are depicted in the table below.

Table 37: Assessments, iteration 4

Session	Subject	Assessments and requirements
Week 1	Course overview Industry partnership specification Group allocation Introduction to agile and design thinking	
Week 2	Digital innovation ideas and process discovery Online quiz 1	Pre-reading and podcast on iKamva **Individual questionnaire 1**
Week 3	The business model of your organisation recap Online quiz 2	Pre-reading and podcast on iKamva and Google Drive **Individual blog 1** **Team business model canvas presentations**
Week 4	Show and tell design thinking Team progress scrum session	Pre-reading and podcast on iKamva and Google Drive **Team design and empathise presentations**
Week 5	Team presentations	**Team presentation initiation** **Project initiation report** **Individual Blog 2**
Week 6	Peer review feedback presentation Team progress and plans	**Peer review report and presentations**

Week 7	The lean start-up Present preliminary findings The worker of the future Online quiz 3	Pre-reading and podcast on iKamva **Individual blog 3**
Week 8	Final presentations and report	**Final presentations** **Final report** **Client questionnaire**
Week 9	A glimpse of the future	Pre-reading and podcast on iKamva and Google Drive **Team scenarios** **Individual questionnaire 2** **Feedback final implementations**

An example of the rubric for the assessment of the final report can be viewed in Appendix 10. Similar rubrics were used for the other assessments. The assessments were linked to the project and each session was devoted to a step in the process in which students showed progress and obtained feedback.

> *We were never reprimanded on the way we saw a certain aspect or topic. This really made me grow as a person as my thoughts were not shot down, but encouraged and praised. I really like the environment that Caro taught us in. I honestly feel that campus should not just be about tests and exams, but it should rather be practical assignments where pupils can go out into the real world and figure out things for themselves.* (AB)

During the fourth iteration, the structure of the authentic assessments applied and the overall rollout of the course were starting to show the results that were required.

> *IFS341 was essentially designed to introduce IS students like myself to digital business innovation. It is evident to me that IFS341 is capable of living up to its stated promise of equipping any student with the knowledge and skills necessary to use technology to improve business, the environment, and society; identifying the value of technology advancement to meet unmet organisational or social need, and thus making us capable of playing leading roles as innovators of the future. Honestly this was the best class I have ever attended in my entire life, no other has been as fruitful and enlightening to attend as it is.* (KV)

Industry results

As discussed in the introduction to iteration four, a new industry partnership was formed with 88 Business Collective. The organisations that the teams worked with included a hair salon that produces natural hair products, a fashion designer, a recruitment agency, a guest house, a quantity surveyor and a winemaker.

The industry partners were again requested to complete the survey in Appendix 4 after the implementation of the project to test their overall satisfaction. The results of the fourth iteration are displayed in the table below.

Table 38: Results from industry survey, iteration 4

Questions regarding student conduct	Percentage iteration		
	4	2	1
How well did the group of students engage with you to determine your business needs?	**83**	78	76
How well did the group of students consult you to analyse your current business model?	**78**	81	76
What was the quality of feedback received by the group to illustrate your current business model?	**78**	69	67
How well did the group of students communicate different ideas to improve your business?	**89**	81	74
How well were you consulted to determine the best idea/s to improve your business?	**83**	**67**	74
How well did the group explain the benefits of implementing a digital innovation for your business?	**83**	81	69
What is the quality of the group's knowledge of your customers?	**67**	**69**	71
How well did the group explain different techniques to analyse your customers to you?	**72**	**69**	76
How well did the different members in the team work together to implement a solution for you?	**83**	**58**	69
How effective was the overall communication and engagement from the students during the project?	**72**	64	64
Questions on overall usefulness of new digital innovation implemented			
It helps me be more effective.	**78**	86	81
It helps me to be more productive.	**78**	**69**	81
It is useful.	**89**	81	81
It gives me more control over the activities in my business.	**83**	78	83
It makes the things I want to accomplish easier to get done.	**72**	78	83
It saves me time when I use it.	**67**	75	75
It meets my needs.	**83**	72	78
It does everything I would expect it to do.	**83**	75	72
It works the way I want it to work.	**72**	**69**	75
It has been a useful exercise for me.	**72**	**67**	78
Questions to test digital savvy of the industry partner			
I am comfortable with my current business model.	**78**	75	62
I am aware of new technologies that can improve my business.	**78**	83	71
I am comfortable to adopt new technology in my business.	**78**	78	76
I would like to increase my awareness of potential digital improvements to my business.	**89**	86	81
I believe that I can improve my customer relationship management	**83**	81	67
It is easy to find technology to support my business needs.	**72**	**64**	64
The digital economy will have a beneficial impact on my business	**89**	**67**	69
It is essential that my business becomes more digitally savvy	**83**	78	83
As the digital economy grows, so will my business	**78**	75	76

There was an overall improvement in the results obtained from industry in the fourth iteration pertaining to the conduct of teams in terms of their overall communication with entrepreneurs and their teamwork. The area that showed a decline was the teams' knowledge of their client's customers. This is not a serious concern, as teams generally become more knowledgeable as the project progresses. In the fourth iteration, the teams were required to focus on empathy maps and not personas, and a recommendation will be to include both in the future. It may be easier to get an overall picture of the customers if both techniques are applied.

Some teams were still busy with their implementations when the questionnaires were completed by the industry partners and training was also still being rolled out. The results obtained for the usefulness of the system need to be interpreted with this in mind. The usefulness of the system should ideally be tested after full implementation and training have been completed, as some industry partners are still getting used to their new systems.

In their engagement with entrepreneurs, the teams were better able to sell the benefits of the digital economy, according to the findings from the last section.

Facilitator reflection on draft design principles

The collaboration with 88 Business Collective's accelerator programme for female entrepreneurs in this iteration proved to be far more successful than the partnerships in previous iterations. The students were exposed to a wider variety of industries and the business owners were more receptive to change and willing to engage with the teams.

A further benefit was that these businesses exposed students to more ethical business practices, as well as community engagement. A more formal agreement should be entered into with this accelerator for future engagement, and contacts ought to be established with Digital Cape Town as well. The creation of an innovation incubator in IS at UWC needs to be foregrounded in discussions with the faculty. This should not be limited to IS students but open to a wider audience to enable cross-disciplinary development. The inclusion of the last draft design principle was successful.

This iteration also highlighted the requirement to review the entire IS curriculum to ensure that it is better aligned with industry, that students receive the required technical proficiencies and to foreground digital innovation.

The design principle, "allow for mistakes to happen", should be updated to rather state allow for experimentation, as this term will be more acceptable to the wider audience.

The use of colours was again applied to highlight the areas that required intervention. The updated principles are discussed in the next chapter.

Table 39: Update to design principles from iteration 4

Principle	Description and updates	Skills sets required by principle	Authentic learning elements to support
Ensure collaboration takes place	• Students need to perform tasks in teams (provide guidelines for the team construction) • Ensure that students collaborate to solve problems in class and in projects	Collaboration and communication Cultural competency	Authentic tasks – opportunity to collaborate Support collaborative learning Promote articulation to

	• Use peer reviews that are assessed • Within class time, aim to be a facilitator in student learning, and not the expert in the room, to encourage experimentation • Use a blended learning environment to encourage online collaboration and face-to-face collaboration, and assess • Assessments need to include aspects such as teamwork, work ethic and collaboration		enable tacit knowledge to be made explicit
Provide opportunities for students to find their own solutions	• Encourage innovation by letting students take their own initiative • Do not put too much structure in place; use some scaffolding when required • Let the students discover their own answers by accessing several different sources and experimenting with different techniques to become comfortable with pivoting, adapting and changing • Create an online environment in which students can experiment with solutions	Problem solving and critical thinking Creativity and innovation	Authentic contexts Authentic tasks – ill-defined activities Provide coaching and scaffolding by the lecturer at critical times
Implement a working digital innovation in a business	• Require students to do a team-based project with organisations within their community where they are required to implement a real solution • Work in partnership with industry to assess a segment that requires innovation, and monitor the progress	ICT/digital skills Problem solving and critical thinking Life/job skills	Authentic contexts Authentic tasks – create a polished product with real-world relevance Provide access to expert performances and the modelling of processes Authentic assessment
Incorporate a design-thinking ethos	• The stages involve students in discovering a challenge, interpreting the context of the challenge, forming ideas, building prototypes, testing the ideas and developing a solution • Integrate with agile methodology and provide clear guidance on the process to be followed • Include value proposition canvas and guide students in process of empathising with customers via personas and	Core content Creativity and innovation	Authentic tasks – examine from different perspectives with a variety of resources Provide access to expert performances and the modelling of processes Authentic assessment

	empathy maps		
Ensure that students utilise interdisciplinary skills	• Innovation requires flexibility; it demands experience and knowledge that is both broad and deep • To understand problems, students need to combine different academic disciplines in a capstone project • Incorporate this to test for different aspects in the assessment criteria	Cross-disciplinary Collaboration and communication	Authentic tasks – integrate different subject areas Provide access to expert performances and the modelling of processes Provide multiple roles and perspectives
Implement a formal process of reflection	• The use of reflection can assist in anchoring learning and stimulating deeper thinking and understanding • Assess the reflection process using clear guidance in the rubric in terms of expected outcomes	Digital/ICT Life/job skills	Authentic tasks – opportunities to reflect Promote reflection to enable abstractions to be formed Provide for authentic assessment
Allow for experimentation (updated)	• Innovation requires the willingness to fail • Students are encouraged to try different approaches and, when something fails, they need to try another approach without being penalised for it • Build steps into formative assessment to encourage students to experiment with different solutions	Creativity and innovation Problem solving and critical thinking	Authentic tasks – competing solutions and a diversity of outcomes Provide coaching and scaffolding by the lecturer at critical times
Ensure that tasks culminate in a capstone project	• Involve students in projects that are based on real-world, authentic problems that are meaningful and engaging • Projects ought to be structured to be longer term and interdisciplinary, and students need to provide their own structures • Apply agile methods • Students need to make use of digital tools to produce high-quality end products within a collaborative environment • Assessments need to be built to take the entire process into consideration, and not just the end product, and to allow for multiple solutions	Cross-disciplinary Collaboration and communication Life/job skills	Authentic contexts Authentic tasks – complex tasks performed over a period of time Provide for authentic assessment
Partner with	• Partner with entrepreneurial businesses	Life and job skills	Authentic tasks –

entrepreneurs	that contribute to their community • Encourage a focus on social awareness • Have a strong emphasis on ethical business practices	EQ and ethics Cultural awareness	competing solutions and a diversity of outcomes Provide multiple roles and perspectives

Interview with alumni

To further substantiate the result obtained from the three primary iterations, interviews were conducted with 18 alumni to test whether the competencies developed in the course had a positive impact in their work environment. All the respondents concluded that the course had a positive impact on their confidence in their working environment citing examples such as:

> *Yes, a lot. I referred to this module during my interview when I got employment, and apply the principles where I'm currently working.* Al09
>
> *Yes, It definitely boosted my employment confidence, because I knew that one of the essential skills required to be a BA is being able to communicate clearly. So acquiring this skill really had a great impact on my employment confidence.* Al11
>
> *Yes it has, we're using Design Thinking framework for all our IT projects and I was the only intern with experience in it.* Al14
>
> *Yes, I am currently employed partly because of the skills gained from the module.* Al17

Conclusion

The results from the third and fourth iterations were analysed in this chapter to conclude the third phase of this DBR study. Only the quantitative findings from the third iteration were discussed, and this was done merely as a test of the skills sets developed and did not contribute to an update to the overall design. The findings showed that the quantitative measurement of the skills sets is applicable to the study.

The fourth iteration was conducted during the second semester in 2017 and the findings were satisfactory enough to conclude the third phase of this study. The results obtained for the skills sets tested showed a marked improvement on the previous iterations and enough evidence could be found to conclude that authentic learning elements were well represented in the course design. The chapter concluded with updates to the design principles, and most principles were achieved, with a few minor alterations required. The next chapter will contain a more detailed discussion in terms of how the principles can be integrated into the learning environment

The final phase is to reflect on the entire process to produce design principles that can inform future development and implementation decisions. Chapters 8 and 9 conclude this study and document Phase 4 to provide the updated framework and design principles developed.

CHAPTER 8: FINDINGS OF THE STUDY: UPDATED DESIGN FRAMEWORK AND PRINCIPLES

"Our intuition about the future is linear. But the reality of information technology is exponential, and that makes a profound difference. If I take 30 steps linearly, I get to 30. If I take 30 steps exponentially, I get to a billion."

(Ray Kurzweil, nd)

Introduction

This penultimate chapter focuses on the update of the design framework to complete Phase 4 of this DBR study as introduced in Figure 2 in Chapter 1. The first phase explored the proposed intervention to answer the research question and sub-questions through consultation with practitioners, industry partners and students, as well as a review of the literature in Chapter 1 and 2. In the second phase of the DBR study, the draft principles were developed as described in Chapter 4. The third phase consisted of four iterations to test and refine the principles, as portrayed in Chapters 5 to 7. This phase can only be concluded once "satisfactory outcomes have been reached by all concerned" (Reeves, 2006:59). The testing and refining of the principles were deemed satisfactory after the fourth iteration, which took place in the second semester of 2017.

This design research was conducted with two main goals: "creating an intervention that solves problems in practice, and producing theoretical understanding" (McKenney & Reeves, 2012:201). The outcome of the study is therefore to answer the research questions posed and to provide practical guidelines that can be used by other practitioners in their own practice to bridge the gap between theory and practice (Wang & Hannafin, 2004).

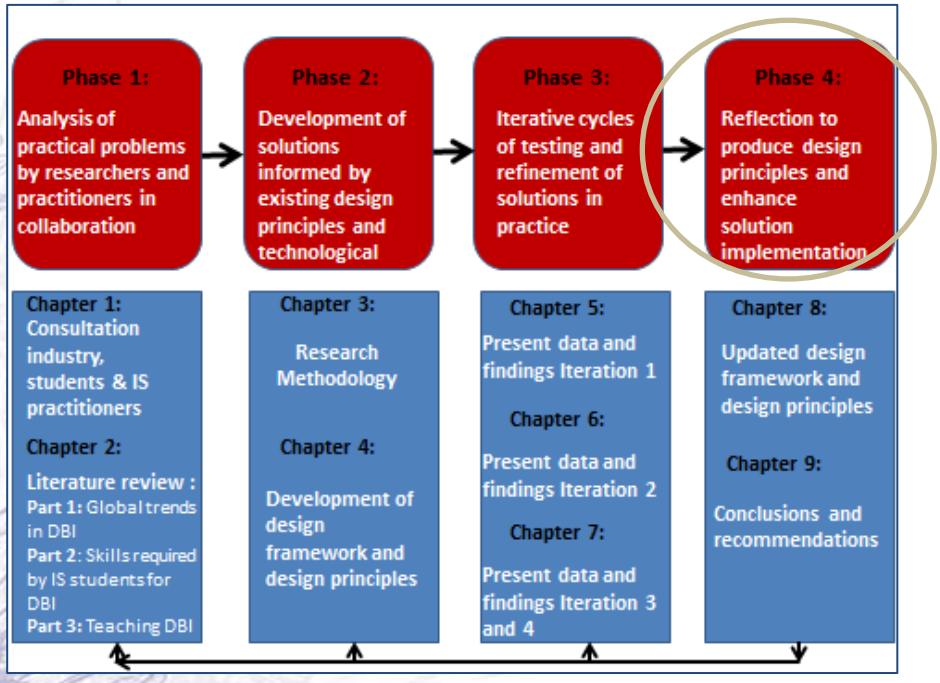


Figure 2: Application of DBR within the study

Phase 4: Reflection to produce design principles and enhance solution implementation

A DBR study has the potential to produce three significant outputs in the form of both knowledge and products, namely design principles (scientific), designed products (practical) and professional development (societal) outputs (McKenney, Nieveen and Van den Akker, 2006; Herrington, McKenney, Reeves & Oliver, 2007).

Scientific outputs: Design principles are a distinctive element of DBR and promote the advancement of both the practical and theoretical understanding of a problem area. The draft principles guide the design and implantation of a proposed intervention. Draft principles are "refined, revised, reorganised, combined, reduced" and new principles are added as the study commences (Herrington, Reeves & Oliver, 2010:180).

Practical outputs: Designed artefact(s) are based on sound design principles to ensure a well-grounded design at the onset of the study (Baskerville, Kaul & Storey, 2015). The artefact can be a technology-based product, an approach or method used or a course or programme that solves teaching, learning and performance problems (Herrington, Reeves & Oliver, 2010).

Societal: Professional development of participants is an additional benefit of DBR due to the collaboration between practitioners, industry and learners (Herrington et al., 2007).

The following sections describe the outcome of the intervention from these three perspectives.

Scientific outputs: design principles

This section describes the updated design framework to incorporate changes to the design principles and provides a detailed description of the design principles developed in the study.

Updated design framework

The draft framework presented in Chapter 4 provided the foundation for the design and implementation of the Digital Business Innovation course implemented in the IS Department at UWC in 2016. These draft design principles were tested and updated during each iteration to guide the subsequent iteration and to ultimately evolve into the refined design principles. The updated design principles become a critical product of the research (Herrington & Reeves, 2011). The **ISE^{DI} Framework** depicted below includes the updated findings from the four iterations.

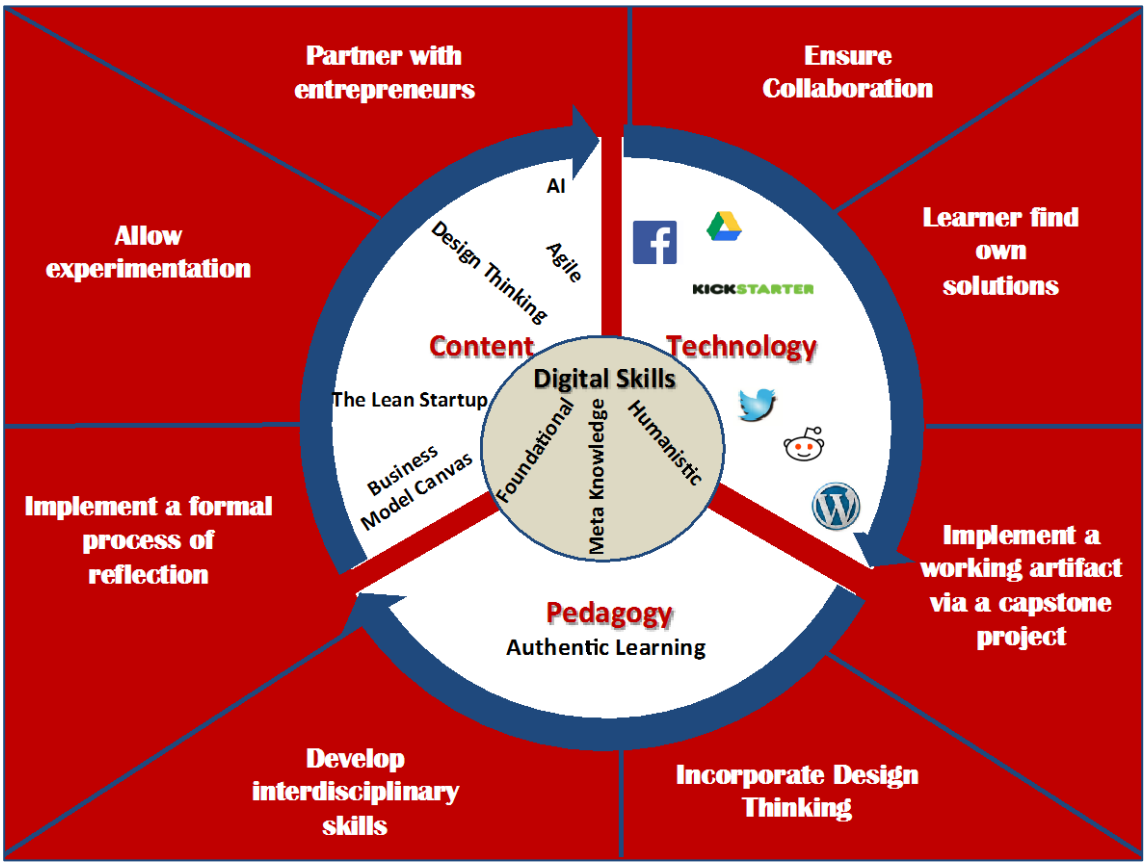


Figure 38: Updated framework for IS education to the power of digital innovation ISE^{DI}

The framework was updated to incorporate revisions to the draft design principles and new principles as a result of findings from the three primary iterations between 2016 and 2017. The name of the framework was changed to the ISE^{DI} Framework, because the design principles that were developed can assist IS educators to grow the teaching of digital innovation exponentially. It further showcases the importance of incorporating digital innovation in IS Education. The framework provides a guideline to answer the research question:

How should digital business innovation skills be taught to South African Information Systems students?

The centre of the framework focuses on the student and illustrates the knowledge areas required to teach the necessary skills to develop competent digital innovators. The skills sets pertaining to each design principle and the development thereof within the course were tested in the four iterations. These skills are discussed per design principle in this chapter to answer the second sub-question of this study:

What skills are required from IS students to develop the competency to be digital business innovators?

The outer circle of the framework illustrates the pedagogy, content and technology required in the teaching and learning environment. This layer illustrates the importance of incorporating authentic learning as the cornerstone,

and the elements that need to be incorporated from an authentic learning perspective are tested and refined in the three primary iterations.

The content to teach and the incorporation of technology in the learning environment are further illustrated. It is important to note that authentic learning is the foundation and is therefore included in the detailed description per design principle. Content and use of technology are suggested in the framework, but the detail is not included in the design principles because content and technology are more variable. Because of this fluctuating relationship between digital technologies and content, the pedagogy to assist students in how to think is foundational and not the content to tell them what to think. Refer to Appendix 11 for a suggested list of topics to be included in the course. The affordances of new technology need to be reviewed and updated continuously, and the content taught can also be reviewed according to the course duration, audience and learning outcomes. Moreover, technology-based tools must accompany appropriate pedagogy (Laurillard, 2012). The pedagogy, content and technology in the outer layer are included to answer the third sub-question:

What teaching and learning interventions are required to teach digital business innovation skills to IS students?

The following section describes the updated principles and provides guidance on how the principles can be instantiated within the teaching and learning environment.

Updated design principles

Once the learning design has been implemented and refined within iterative cycles, the final phase of a DBR study is to reflect on the process and produce the principles that can be applied for future development and implementation decisions (Herrington, Oliver & Reeves, 2010:180).

Three useful outcomes include the design principles, the product and the representation thereof within the learning environment (ibid, 2010). The design principles need to contribute to the existing knowledge base to provide other practitioners with practical guidelines for implementation for similar interventions in similar settings. The principles need to further assist future research to address complex educational problems.

The updated design principles developed in the study are depicted in the table below with guidance to practitioners on the implementation thereof within a learning environment.

Table 40: Updated design principles

Principle	How to integrate principles in the learning environment	Skills sets and UWC graduate attributes	Authentic learning elements supported
Ensure **collaboration** takes place	• **Students need to perform tasks in teams** of up to five students per team. In the first iteration, students were divided into teams prior to the commencement of the course. Students could select their own teams in the second iteration and a hybrid model was applied in the fourth iteration, whereby students could select some members and other members were randomly allocated to teams. This was done to test if the different allocations resulted in different outcomes. Of the three iterations, the first model was the most favourable, as this is the closest to a real-world scenario. Students from different disciplines can be divided into the same group to further encourage learning to take place. • Use **peer reviews that are assessed**, with clear rubrics to indicate the assessment criteria, which should include aspects around the giving and receiving of feedback (Boud & Molloy, 2013). • **Lecturer needs to facilitate** class sessions to ensure that all teams participate in the learning activities via presentations on progress by each team during lectures. Observe team activities during lectures to review participation by individual members, and monitor potential conflict in teams. Allow teams to resolve their own conflicts and provide some scaffolding where required. Only intervene and mediate when the situation becomes untenable. • Use a **blended learning environment** to encourage online collaboration as well as face-to-face collaboration. An online environment via a Google Drive is recommended, as this enables real-time participation by multiple stakeholders. Lecturer can monitor	**Skills development** Collaboration and communication Cultural competency EQ and ethics **Graduate attributes** Tier 1: Creative and collaborative problem solving Tier 2: Autonomous and collaborative	**Authentic tasks:** opportunity to collaborate Support **collaborative construction of knowledge tasks**

	and comment on progress made in the rollout of student projects to provide guidance for improvements. • Assessments need to include the monitoring of **collaboration by team members** and their overall work ethic. Include a section in the final project documentation that rates individual team member contributions out of 100% (compiled and signed by all team members collectively).		
Provide opportunities for students to **find their own solutions**	• This refers to the concept of "productive failure", where students are given the opportunity to collaborate, apply prior knowledge and consider possible solutions and present their findings to the larger group. When the students struggle and sometimes fail to find a solution, they gain a deeper insight into the problem and its elements. After the presentation of findings, the lecturer explains the essential concepts and methods of the solution to assist students in consolidating their knowledge via a comparison of good and bad answers (Sharples et al., 2016). • Structure the class to enable each team to work together, i.e. around a table or in a breakaway venue if possible. Encourage the teams to be innovative and to use their **own initiative in exploring concepts** relating to their capstone projects. Use lecture times to allow students to explore, investigate and present findings. The lecturer is not the "sage on the stage", but a facilitator who support students "to filter, compare, contrast, and re-contextualise learning strategies and experiences, and identify new sources for relevant knowledge acquisition, which is what they will then do for themselves continually throughout the rest of their lives" (Bridgstock, 2016:311). • Do not put too much structure in place; some background material ought to be provided prior to the lecture via, for example, voiceover PowerPoint and videos, and lectures can be used to **practically explore** this further and incorporate the relevant areas into capstone projects. Provide material to students to enable them to explore freely during lectures, such as sheets of white paper, sticky notes and coloured pens.	**Skills development** Problem solving and critical thinking Creativity and innovation **Graduate attributes** Tier 1: Lifelong learning Scholarship Tier 2: Inquiry-focused and knowledgeable	Authentic **contexts** **Authentic tasks**: ill-defined activities Provide **coaching and scaffolding** by the lecturer at critical times

	• Allow students to discover their own answers by accessing several different sources and experimenting with different techniques to **become comfortable with pivoting, adapting and changing.** • Create an online environment in which students can experiment with solutions outside of class, such as a Google Drive with folders for each team. The online environment needs to be monitored by the lecturer and feedback given to groups when they go off track.		
Implement a **working digital innovation (artefact)** in a business via a **capstone project**	• Require students to do a team-based project with organisations within their community where they are required to implement a **real solution/polished product**. • The implementation of a working solution (IT artefact) within a business via a capstone project can provide meaning and relevance to the course. It further enables collaborative problem solving and the integrated assessment of achievements (Herrington, Reeves & Oliver, 2010). It should take a significant period to complete and be integrated with the learning tasks (Bozalek et al., 2013). • Focus on the **process to get to the finalised polished** product, and not solely on the completion of the project. The result for students is a more complete understanding of the innovation process, and a more holistic understanding of themselves (Celuch, Bourdeau & Smothers, 2014). The project ought to be broken down into a number of tasks that culminate in the finished project. Students get formative feedback during this process to enable them to rework solutions and create a more polished product. The completion of the project becomes the curriculum (Bozalek et al., 2015). • Capable digital innovators can be developed if instruction takes place via an authentic learning environment, with scaffolding being provided to students in their engagement with industry partners (Bridgstock, 2014). • The project processes are continuously assessed and students must	**Skills development** Digital/ICT skills Life and job skills EQ and ethics **Graduate attributes** Tier 1: Creative and collaborative problem solving Tier 2: Autonomous and collaborative Skilled communicators	Authentic **contexts** **Authentic tasks**: create a polished product with real world relevance Provide **access to expert performances** and the modelling of processes **Integrated assessment** of learning

	learn to manage the risks and evaluate their progress progressively.		
Incorporate a **Design Thinking** ethos	• The stages involve students in discovering a challenge, interpreting the context of the challenge, forming ideas, building prototypes, testing the ideas and developing a solution. • Incorporate **multi-modal pedagogies** to create an environment to allow for free design to take place. Multimodal pedagogies "acknowledge learners as agentive, resourceful and creative meaning-makers who communicate using the communicative potential and multiple resources of their bodies and of their environment to interconnect" (Stein, 2008:122). • **Integrate** design thinking **with Agile/Scrum methodology** and provide scaffolding to assist students with the process they need to follow to integrate the steps. Make students aware of human-centred design (UX) and take them through the process of design thinking, where they start with client needs and combine user stories with empathy maps and/or personas. They then follow the process of prototyping, testing and repeating the process where required. • Include the **value proposition canvas** to guide students in the process of empathising with customers via personas and empathy maps to gain a real understanding of client needs prior to the development of prototypes.	**Skills development** Core content Creativity and innovation **Graduate attributes** Tier 1: Creative and collaborative problem solving Tier 2: Inquiry-focused and knowledgeable Skilled communicators	**Authentic tasks:** examine from different perspectives with a variety of resources Provide **access to expert performances** and the modelling of processes **Authentic assessment**
Develop student **interdisciplinary skills**	• Students need to work in teams that are cross-disciplinary and it is recommended that teams are selected by the facilitator. • Students are further required to engage with industry partners from various disciplines. It is recommended that relationships are formed with businesses prior to the commencement of the course. The allocation of businesses to teams can be randomised or via a voting process, or a profile of the team can be given to businesses to select the teams that they want to work with. • Students need to be exposed to the human (UX), organisational and technical aspects related to a design. Transformations in the world	**Skills development** Cross-disciplinary Collaboration and communication **Graduate attributes** Tier 1: Creative and collaborative problem solving Tier 2: Interpersonal flexibility and confidence to engage across	**Authentic tasks**: Integrate different subject areas Provide access to **expert performances** and the modelling of processes Provide **multiple roles and perspectives**

	are sociotechnical, involving technological artefacts and their appropriation in human contexts (Beath et al., 2013). IS students need to be able to integrate this in order to be competent digital innovators, which requires interdisciplinary skills. This is enabled via a combination of learning that combines what the students are taught as part of the curriculum and exposure to other interests in different contexts (Cobo, 2013).	difference	
Implement a **formal process of reflection**	• Dewey (1938) proposed reflection as a catalyst for learning because it can stimulate deeper thinking and understanding. • Formal reflection needs to be **incorporated into course design** in the format of a student blog that needs to be updated on a weekly basis. Any online blogs can be utilised, for example WordPress. Provide guidelines on content to be included in the blogs, such as weekly reflections on what has been learned, what they enjoyed and what they did not enjoy, as well as other exercises such as personality tests, EQ exercises, etc. • Assess the reflection process using **clear guidance in the rubric** in terms of expected outcomes. Lecturer and peers must provide **formative feedback** to students on their blogs during the semester, and the formal assessment of all blogs occurs at the end of the semester.	**Skills development** Life and job skills Digital/ICT skills **Graduate attributes** Tier 1: Lifelong learning Tier 2: Skilled communicators	**Authentic tasks**: Opportunities to reflect Promote **reflection** to enable abstractions to be formed Provide for **authentic assessment**
Allow experimentation	• As emphasised by the second principle, students must be allowed to reach their own conclusions independently and, in this process, there must be an acceptance that **mistakes are part of the learning process**. Innovation requires one to be willing to fail and to try other options. Encourage this via summative assessment of the tasks that culminate in the capstone project. Focus on the process followed and not the initial outcomes to allow students to learn from mistakes and refine the final product. • In the application of design thinking, students interact with their industry partners and their clients to understand their requirements to create a prototype or minimum viable product (MVP). They need to test this with the stakeholders and, if the product is not	**Skills development** Creativity and innovation Problem solving and critical thinking **Graduate attributes** Tier 1: Lifelong learning Tier 2: Interpersonal flexibility and confidence to engage across difference	**Authentic tasks:** Competing solutions and a diversity of outcomes Provide **coaching and scaffolding** by the lecturer at critical times **Integrated assessment** of learning

	satisfactory, they need to "fail and fail fast" and make the necessary changes, or pivot if they need to start afresh (Ries, 2011). The ability to apply digital simulation and prototyping tools can dramatically lower the cost of research and development processes for organisations and increase opportunities for innovation via the exploration of new ways to discovering novel ideas (Fichman, Dos Santos & Zheng, 2014:348). • Student teams present the progress of their projects on a regular basis during class to showcase their progress. **Feedback is provided** per presentation to point out possible pitfalls and afford students the opportunity to update accordingly. Peers are also involved in the feedback process to open the conversation and allow an environment of mutual learning and sharing. • Trained behaviour often prevents students from experimenting and making mistakes because we are so conditioned to linear thinking. It is often difficult for tolerate initial confusion, if one cannot see the "end game" when participating in such exercises (Celuch, Bourdeau & Smothers, 2014:34). Lecturers need to provide a supportive environment of learning and experimentation, particularly at the beginning of the course. • Use ideation exercises and brainstorming to allow students to become more accustomed to experiment, and change course if required.		
Partner with entrepreneurs	• Students will benefit from new networks that will expose them to "real-world" situations. This will afford them the opportunity to build or use authentic professional networks prior to graduation. Important learning occurs outside the formal course environment when students are collaborating with industry and community organisations (Bridgstock, 2017). • Lave and Wenger (1991) postulate a process of "legitimate peripheral participation" as a way for newcomers to be exposed to and immersed in the activities and artefacts of new **communities of practice**. In this process, new knowledge and skills are acquired.	**Skills development** Life and job skills EQ and ethics **Graduate attributes** Tier 1: Creative and collaborative problem solving Critical citizenship and social good.	**Authentic tasks:** Competing solutions and a diversity of outcomes Provide **multiple roles and perspectives**

	The benefits of using these external networks or communities of practice have been highlighted as favourable ways to gain input into innovation practices (Chesbrough, 2010). • Learning and innovation activities clearly point to the increased importance of developing and using social networks for innovation (Mascia, Magnusson & Björk, 2015).	Tier 2: Autonomous and collaborative Skilled communicators	

Practical output: designed product/artefact

The major output of this study was a framework to teach digital business innovation to strengthen the capabilities of IS graduates to participate in, and ultimately orchestrate, digital transformation in business and society. The purpose of the artefact was to ensure an industry informed curriculum design in IS that is future proof within a digital economy.

This required the study of interventions within an authentic setting to enable evolving pedagogical goals, as well as the development of design principles leading to a new framework to teach digital business innovation. Three iterations of the course were implemented and evaluated to improve the quality of the course design and to fine-tune the draft principles (McKenney et al., 2006).

The artefact needs to have a positive impact on the learning environment to justify the value of theory (Parker, 2015). The results in Chapters 5 to 7 show the positive impact on student learning and the growth of an innovative and entrepreneurial culture amongst the IS graduates who participated in the course. The course can be implemented at other institutions using the design principles and guidelines, as well as the course outline and detailed themes and topics in Appendix 11.

Societal output: professional development of participants

The design principles developed in the study have a solid foundation in theory and practice and were tested and refined during three iterations of the course. These design principles can be refined and updated further by sharing them with other researchers and practitioners through presentations and publications. The peer review of design principles is necessary for the overall enhancement of professional practice, so that it eventually yields improved educational outcomes, such as increased student engagement (Herrington & Reeves, 2011). This study provides a future-focused approach in the development of IS graduates to enable them to utilise digital technology to create opportunities for innovations to transform business and society.

This study took place at a university in South Africa and the principles are based on the improvement of practice within this local context. However, the principles can provide the basis for other practitioners beyond the local that are experiencing similar circumstances (Herrington & Reeves, 2011).

It is expected that the model will continue to evolve as more practitioners implement it within their teaching areas. One of the purposes of DBR is to circulate information to the broader educational community to inform both theory and practice. Appendix 12 includes presentations on the principles that have already been shared to date through conferences and education networks.

Conclusion

This penultimate chapter described the updated design framework and design principles to complete the final phase (Phase 4) of this DBR study. The final phase of the study illustrates the updated framework, titled the ISE^{DI} framework. This framework was developed to assist IS educators to grow the teaching of digital innovation exponentially. The updated eight design principles developed in the study are subsequently described, with practical applications to guide IS educators with the implementation of digital innovation in IS education. The framework and updated design principles answer the primary research question of this study.

It must be stated that design principles cannot be 'set in stone' and ought to be viewed as "informed reusable guidelines" for educators who wish to find solutions (Herrington & Reeves, 2011:598). In Chapter 9, this study is summarised to provide recommendations, areas of future research and the limitations of the study.

CHAPTER 9: CONCLUSION

"Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning."

(Winston Churchill, The Lord Mayor's Luncheon, Mansion House, November 10, 1942.)

Introduction

This chapter summarises the findings regarding the development of a framework to teach digital business innovation to South African graduates in Information Systems. The focus was to define the skills required by IS graduates to become competent digital business innovators in business and society, and further to develop design principles for the HE teaching and learning environment. The purpose of the study was to prepare IS students to use digital technology to improve the effectiveness of business, the environment and society. This required an industry informed curriculum design that is future proof within a digital economy.

The objectives of the research were addressed as follows:

Industry partners, IS practitioners and IS students were consulted, and the existing literature was reviewed, to commence Phase 1 of the study. These findings were presented in Chapters 1 and 2, which investigated the impact of global industry trends in digital innovation on the IS curriculum. The trends identified helped to establish the skills required for IS students to develop the competency to become digital business innovators. The knowledge areas identified included foundational knowledge, consisting of core content, cross-disciplinary and digital knowledge. Meta-knowledge included creativity, innovation, problem solving, critical thinking, communication and collaboration, and human knowledge included life and job skills, EQ and ethics, as well as cultural awareness.

Students need to develop the skills to become lifelong learners with a future-focused outlook in an ever-changing world. The trends and skills identified assisted in the exploration of the teaching and learning interventions required to teach digital business innovation to IS students. These were reviewed in terms of the correct pedagogy, content and technology to apply in the teaching and learning environment. The incorporation of authentic learning elements was defined as a cornerstone in the draft design.

Chapter 3 motivated the research philosophy and choice of paradigm for the study to define the research approach prior to commencing with Phase 2. This chapter motivated an interpretivist paradigm and DBR as the research method as summarised in Table 6.

The second objective was addressed in Phase 2 via a proposed solution to teach digital business innovation skills to IS students. This phase was discussed in Chapter 4 where the draft design framework and design principles to be applied in the study are outlined.

The third objective was to conclude Phase 3 of the DBR study via iterative cycles of testing and refinement of the draft design principles. The first iteration took place during the first semester of 2016 and was evaluated to provide recommendations for improvement for the second iteration, which took place during the second semester of 2016. Two further iterations followed in 2017. The third iteration was not a full implementation, but merely a test of the skills defined in the framework to test the impact thereof on other IS courses. The final iteration took place in the second semester of 2017. Both qualitative and quantitative data were collected in a mixed-methods design to evaluate the courses.

The fourth objective was the conclusion of the study in Phase 4, which consisted of the final recommendations for a framework and design principles in Chapter 8, and recommendations, limitations and suggestions for future research in this final chapter.

Implications of the research

This study was prompted by the disparity between the unprecedented opportunities opening up for the IS field as a result of digital innovation, and the skills gap of IS graduates to harness these opportunities. IS education ought to equip students to use technology to improve the effectiveness of business, the environment and society, with digital innovation being at the heart of this transformation (Fichman, Dos Santos & Zheng, 2014).

To address this, the ISE^{DI} Framework was developed to teach digital business innovation to South African IS students, as defined in Chapter 8. The objective of this framework was to exponentially grow the teaching of digital innovation in IS education, not only to equip students to be employable within a digital world but, more importantly, to instil a culture of innovation and deeper learning approaches within IS education. This will help to solve the mismatch between what is taught in formal education versus what is required by an innovative society. The study highlighted the requirement to review the entire undergraduate IS curriculum at UWC to ensure alignment with industry, instruction of the required technical proficiencies and to foreground digital innovation. A wider adoption of the framework at other HEIs is also recommended.

The study produced scientific outputs resulting in the eight design principles described in Chapter 8 (Table 40). These design principles assisted in a practical output or designed artefact in the form of a digital business innovation course for IS students.

For the results of the practical outputs, substantial evidence was acquired from students to serve as proof of the outcome of the course. Chapters 5 to 7 describe the results obtained from both the qualitative and quantitative data in the iterations. The evaluations of and reflections on each iteration provide evidence of what worked well and what could be improved upon. These findings were implemented in subsequent iterations to ensure a rigorously tested artefact. The results obtained from the projects implemented within industry by the student teams were received very positively from the start; however, the overall results of the final iteration exceeded expectations.

The scientific output from this research is expected to evolve more as the researcher continues to collaborate with other practitioners and presents findings to the broader professional community. Some examples are cited in Appendix 12. However, this is an area for growth, hence the quote at the beginning of this chapter.

Limitations and challenges

Working with students in a real-world setting within a complex learning environment can lead to challenges and also indicate potential limitations of the research. The researcher designed, presented and tested the findings, and her personality and enthusiasm for the topic may have had an impact on the outcome. The test will be to replicate the course in other environments to further refine the framework. The researcher actively collaborated with the students during the implementation of their digital projects and, although they were assured of anonymity and an unbiased review of all data, they might have been more candid in their responses if a third party conducted the research.

The course was tested at one university, and a review of the framework and principles in a broader context may yield different results. Students were limited in terms of the digital solutions that they could implement as a result of time constraints and technical proficiencies. A learning environment in which there is wider scope for exploration with, for example, virtual-reality equipment, advanced digital-editing software and 3D printers, may present a different outcome.

There was active participation between the students and industry during the rollout of the study. It was not possible to pre-empt any interpersonal issues that occurred in the teams or requirement limitations experienced with the industry partners. The actions taken were different for the different groups and resulted in different reactions. The researcher was actively involved in the process in order to adapt strategies and be as responsive as possible to changes. This provided valuable insights and possibilities for innovative solutions in certain circumstances, as described in Chapters 5 to 7. However, it is difficult to gauge whether the positive and negative outcomes were as a result of the interventions, or other, external factors.

The study took place in South Africa, and the principles may therefore be best suited to the social conditions in this country. However, it is anticipated that they would also resonate beyond this particular context.

Recommendations for future research

The ISE^{DI} Framework including its underlying design principles ought to be tested in different settings to determine their scalability within a teaching and learning environment. For example, what would the implications be for transferring the course to a completely online environment? What technological affordance would be required to facilitate the process, and what would the impact be on the content and pedagogy?

The final principle added needs to be explored further, and it is recommended that a digital-innovation incubator be established at UWC to create a dedicated space for experimentation and iteration. Students from IS and

other disciplines need to work together with entrepreneurs to engage in ideation, prototyping, and seeking funding in order to develop beneficial solutions for communities. The space should link students and entrepreneurs to opportunities via collaboration with local start-ups, investors and government representatives through special programmes and events such as hackathons.

Research can be undertaken to study the learning process in the context of collaboration between entrepreneurs and student teams, and the factors that need to be present to advance the culture of entrepreneurial thinking. These forms of collaboration provide research potential for enhancing the understanding of knowledge inflows and outflows, and the implications for performance in digital innovation.

The collaboration between SMMEs and IS students could lead to combined capabilities to develop new products and services within communities. To do this, it would be necessary to study the impact of networks that may allow for new ways of combining knowledge, skills and expertise, and the impact thereof on innovation.

Final reflection

An integrated approach by the researcher, other practitioners, students, industry partners and the community was required in the study. The study was a collaborative effort, and much of the insights obtained came from continuous engagement among all the parties involved. The study emphasises the importance of continuously evaluating our practice to ensure that it is future focused, and that the skills being developed are relevant to the future world of work.

Information Systems is an ever-changing field. Students need to be equipped to thrive in this uncertain environment and to identify the opportunities that will benefit business and society. Therefore the students need to be aware of the bigger picture and the impact that they have on society, and work closely with community organisations or SMMEs to develop and implement beneficial solutions. This is the end of this chapter, but the "end of the beginning" of the research journey in digital business innovation, along with students and other practitioners collaborating with entrepreneurs. In conclusion, I present the voice of a student in a poem from her blog, titled *"Until we meet again"*.

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UNTIL WE MEET AGAIN

So I was asked to blog

as an assignment for a mark,
Which required me to go deep
to think about things I did not speak,
But I needed to "design think",
and be agile in my train of thought,
Because when I look back now,
I realized that I learned a lot,

Assignments after assignments, I thought it would never stop!

At night my bed seems unfamiliar,
Have a Monster energy drink,
Sharing on drive, link after link,

My degree will be my ink, as no one can take it from me

I will work hard for honours,
a true success "photo" story,
Your past predicts your future
your survival proves your stature

after obstacles faced, I will bloom like a flower in nature

Let's reflect
to show a little respect
to the lecturer who taught it all
and a group that learned to stand tall
I was made to stand above,
uniquely crafted with love.

Andrea

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Appendix 1

UNIVERSITY of the
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DEPARTMENT OF RESEARCH DEVELOPMENT

01 June 2016

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape approved the methodology and ethics of the following research project by:
Ms C van den Berg (Information Systems)

Research Project:	A framework for teaching digital business transformation skills to South African Information System graduates.
Registration no:	15/7/193

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Private Bag X17, Bellville 7535, South Africa
T: +27 21 959 2988/2948 . F: +27 21 959 3170
E: pjosias@uwc.ac.za
www.uwc.ac.za

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to action through knowledge

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Appendix 2

Student Consent Form

UNIVERSITY of the WESTERN CAPE

Information Systems 731/341
Consent Form

University of the Western Cape

Title: A Framework for Teaching Digital Business Innovation to Information Systems Graduates

……

Researcher: C.L. van den Berg ……

Please initial box

1. I confirm that I have read and understand the information sheet explaining the above research project and I have had the opportunity to ask questions about the project. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. (If I wish to withdraw I may contact the lead researcher at any time) ☐
3. I understand my responses and personal data will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the reports or publications that result for the research. ☐
4. I agree for the data collected from me to be used in future research. ☐
5. I agree for to take part in the above research project. ☐

_____	_____	_____
Name of Participant (*or legal representative*)	Date	Signature
_____	_____	_____
Name of person taking consent *(If different from student researcher)*	Date	Signature
_____	_____	_____
Student Researcher (*To be signed and dated in presence of the participant*)	Date	Signature

Copies: All participants will receive a copy of the signed and dated version of the consent form and information sheet for themselves. A copy of this will be filed and kept in a secure location for research purposes only.

Researcher (UWC student):

C van den Berg
Lecturer
Information Systems
Economic and Management Sciences
University of the Western Cape

Supervisor:

Dr Johan Breytenbach
Senior Lecturer
Information Systems
Economic and Management Sciences
University of the Western Cape

HOD:

Dr Mmaki Jantjies
Senior Lecturer
Information Systems
Economic and Management Sciences
University of the Western Cape

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Appendix 3

Student Survey

For a copy of the student survey, please go to: https://goo.gl/forms/sBFS8LY5EmrUd69x2

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Appendix 4

Questionnaire to Industry Partners

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P/Bag X17, Bellville 7535, South Africa Tel.: +27 21 959 3247
Fax: +27 21 9592598 E-mail: cvandenberg@uwc.ac.za

Subject: Feedback Student Project Digital Business Innovation

To Whom It May Concern

This questionnaire is part of a project being conducted by the University of the Western Cape Information Systems Department. The questionnaire has been developed to measure your satisfaction with the project and the conduct of the students during their engagement with your company.

Your feedback will assist us in overall improvements to the projects conducted in the department. By completing this questionnaire, you are consenting to participate in our study. You may choose to participate or not and are free to discontinue participation at any time. All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to the university or to the group members that worked with your company.

I would greatly appreciate your taking the time to complete the questionnaire.
If you have any questions about the study, please feel free to call me at (082) 927 0716 or email at cvandenberg@uwc.ac.za.

Thank you for your participation.

Caro van den Berg
Lecturer Information Systems Department UWC

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INSTRUCTIONS

This questionnaire has three sections and consists of four printed pages. Please mark **ALL** your answers in the most appropriate block with a cross. After you have completed your responses, please return the questionnaire to **cvandenberg@uwc.ac.za** or student representative.

SECTION 1: STUDENT CONDUCT

Please rate your responses by marking the correct block.

Extremely Poor	Poor	Acceptable	Good	Very Good	Excellent

1: How well did the group of students engage with you to determine your business needs?

2: How well did the group of students consult you to analyse your current business model?

3: What was the quality of feedback received by the group to illustrate your current business model?

4: How well did the group of students communicate different ideas to improve your business?

5: How well were you consulted to determine the best idea/s to improve your business?

6: How well did the group explain the benefits of implementing a digital innovation for your business?

7: What is the quality of the group's knowledge of your customers?

8: How well did the group explain different techniques to analyse your customers to you?

9: In your perception, how well did the different members in the student team work together to implement a satisfactory solution for you?

10: How effective was the overall communication and engagement from the students during the project?

11. Do you have any additional comments regarding the student conduct?

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SECTION 2: USEFULNESS OF NEW SYSTEM

Strongly Disagree	1	2	3	4	5	6	Strongly Agree	N/A

Please rate your responses by marking the correct block from 1 to 6 where 1 is strongly disagree and 6 is strongly agree

Question	1	2	3	4	5	6	N/A
1. It helps me be more effective.							
2. It helps me to be more productive.							
3. It is useful.							
4. It gives me more control over the activities in my business.							
5. It makes the things I want to accomplish easier to get done.							
6. It saves me time when I use it.							
7. It meets my needs.							
8. It does everything I would expect it to do.							
9. It works the way I want it to work.							
10. It has been a useful exercise for me.							

11. Do you have any additional comments regarding the usefulness of the new system?

SECTION 3: DIGITAL INDEX OF YOUR BUSINESS

Strongly Disagree	1	2	3	4	5	6	Strongly Agree	N/A

Please rate your responses by marking the correct block from 1 to 6 where 1 is strongly disagree and 6 is strongly agree

Question	1	2	3	4	5	6	N/A
1. I am comfortable with my current business model							
2. I am aware of new technologies that can improve my business							
3. I am comfortable to adopt new technology in my business							

4. I would like to increase my awareness of potential digital improvements to my business							
5. I believe that I can improve my customer relationship management							
6. It is easy to find technology to support my business needs							
7. The digital economy will have a beneficial impact on my business							
8. It is essential that my business becomes more digitally savvy							
9. As the digital economy grows, so will my business							

Please mark the applicable blocks in the table below.

10. What will change in the Digital Economy in your business?

Altered business model (to include online)	
Greater emphasis on online activity	
Improved research / information gathering capacity	
Improved online marketing capacity (interactive web content etc)	
Increased competition from outside businesses	
Online Education & Training	
Communication with suppliers	
Communication with existing clients	
Accessing new clients (leveraging social media platforms etc)	
Financial management (banking, tax lodgements)	
Business administration (booking travel etc)	
New product development	
Other (Please specify)	

11. What are your barriers to digital business (including the internet)?

Lack of knowledge / understanding	
Cost versus Benefits	
Lack of time	
Internet coverage	
Internet speed	
Information security concerns	
It's a low (business development) priority	
Other (Please specify)	

12. Which of the following digital platforms do you currently use?

Website	
A mobile version of your website	
A mobile phone app	
Free email service (Gmail, Yahoo, Hotmail)	
Email hosting service (3rd party provider)	
Manage customer data electronically	
Social media channels – Facebook	
Social media channels – Twitter	
Social media channels – Linked In	
Social media channels - Flickr	
Social media channels - Tumblr	
Social media channels – Google+	
Social media channels - Pinterest	
Social media channels – Blogs	
Use search engine optimisation	
Use Google Adwords	
Use Facebook advertising	
Use Twitter paid promotions	
Pay per click website advertising	

Thank you for your participation and for the valuable insight and experience provided to the student group.

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Appendix 5

Iteration 1, Regression Analysis

SUMMARY OUTPUT ITERATION 1: SURVEY 1

Regression Statistics	
Multiple R	0.554234506
R Square	0.307175887
Adjusted R Square	0.092161507
Standard Error	0.05176065
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0.034447807	0.003827534	1.428629506	0.22182491
Residual	29	0.077695783	0.002679165		
Total	38	0.11214359			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.74779172	0.102730979	7.27912581	5.12841E-08	0.537683277	0.957900164	0.537683277	0.957900164
Core Content	-0.206756226	0.092984647	-2.22355231	0.034128785	-0.396931182	-0.01658127	-0.396931182	-0.01658127
Digital/ICT	0.098401292	0.080483141	1.222632353	0.231312368	-0.066205214	0.263007798	-0.066205214	0.263007798
Cross Diciplinary	-0.285763933	0.139739302	-2.044978965	0.050026282	-0.571562896	3.50295E-05	-0.571562896	3.50295E-05
Communication/Collaboration	0.139710783	0.138141677	1.011358674	0.320209162	-0.14282067	0.422242236	-0.14282067	0.422242236
Problem Solving/critical thinking	0.064557047	0.068061179	0.948514966	0.350705191	-0.074643694	0.203757789	-0.074643694	0.203757789
Creativity/Innovation	-0.202929586	0.12582365	-1.612809564	0.117616861	-0.460267844	0.054408673	-0.460267844	0.054408673
Life/Job Skills	0.113459921	0.163407149	0.694338784	0.492995172	-0.220745224	0.447665067	-0.220745224	0.447665067
EQ/Ethics	0.223530794	0.151920601	1.471365912	0.151961328	-0.087181723	0.534243312	-0.087181723	0.534243312
Cultural	-0.071724536	0.091111152	-0.78722016	0.437539811	-0.258067766	0.114618694	-0.258067766	0.114618694

SUMMARY OUTPUT ITERATION 1: SURVEY 2

Regression Statistics	
Multiple R	0.456858
R Square	0.208719
Adjusted R Square	-0.03685
Standard Error	0.049011
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0.018375	0.002042	0.849936	0.578078886
Residual	29	0.069661	0.002402		
Total	38	0.088036			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.648443	0.075916	8.541567	2.07E-09	0.493176691	0.80370849	0.493176691	0.80370849
Content	-0.03364	0.111081	-0.30282	0.76419	-0.260823311	0.193548614	-0.260823311	0.193548614
Digital/ICT	-0.04042	0.104196	-0.38791	0.700914	-0.253523778	0.172685996	-0.253523778	0.172685996
Cross Dicipline	-0.09113	0.108358	-0.84105	0.407201	-0.312750335	0.130481716	-0.312750335	0.130481716
Comm/Collaboration	0.019057	0.148432	0.128386	0.89873	-0.284520337	0.322633349	-0.284520337	0.322633349
Problem Solving /Critical T	-0.05213	0.136827	-0.38097	0.706004	-0.331970322	0.227716749	-0.331970322	0.227716749
Innovation/Creativity	0.24601	0.129414	1.90095	0.067289	-0.018671819	0.510692464	-0.018671819	0.510692464
Cultural competencies	-0.06634	0.101042	-0.65655	0.516645	-0.272994824	0.140315287	-0.272994824	0.140315287
Life/Job Skills	0.087042	0.176885	0.492081	0.626366	-0.274729379	0.448813493	-0.274729379	0.448813493
EQ/Ethics	-0.03262	0.135068	-0.24148	0.810885	-0.308860048	0.243628704	-0.308860048	0.243628704

Iteration 2

SUMMARY OUTPUT ITERATION 2 SURVEY 1

Regression Statistics	
Multiple R	0,619262194
R Square	0,383485664
Adjusted R Square	0,170076856
Standard Error	0,041822195
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0,028287394	0,003143044	1,796953308	0,117172978
Residual	26	0,045476495	0,001749096		
Total	35	0,073763889			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0,693542994	0,080340986	8,632492975	4,12457E-09	0,528399733	0,858686255	0,528399733	0,858686255
Core	0,077396987	0,077151029	1,003188003	0,325015827	-0,081189225	0,235983198	-0,081189225	0,235983198
Digital	-0,021535025	0,068633662	-0,31376768	0,756201095	-0,162613536	0,119543487	-0,162613536	0,119543487
Cross	0,232534317	0,071060376	3,272348545	0,003009465	0,086467623	0,378601011	0,086467623	0,378601011
Problem solving	0,022904143	0,096379207	0,237646108	0,814018341	-0,175206154	0,221014441	-0,175206154	0,221014441
Innovation	0,021148603	0,084332497	0,250776431	0,803958193	-0,152199327	0,194496532	-0,152199327	0,194496532
Comm/Coll	-0,04047238	0,047380799	-0,854193699	0,400799819	-0,137865007	0,056920247	-0,137865007	0,056920247
EQ	-0,023143698	0,086888636	-0,266360468	0,792062659	-0,201745846	0,155458451	-0,201745846	0,155458451
Life / Job Skills	-0,240322287	0,11120142	-2,161144042	0,040075104	-0,46890008	-0,011744494	-0,46890008	-0,011744494
Cultural	-0,035277259	0,074415105	-0,474060459	0,639413802	-0,188239698	0,11768518	-0,188239698	0,11768518

SUMMARY OUTPUT ITERATION 2 SURVEY 2

Regression Statistics	
Multiple R	0.621708276
R Square	0.38652118
Adjusted R Square	0.202477534
Standard Error	8.080392628
Observations	40

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	1234.127147	137.1252385	2.100160416	0.061800792
Residual	30	1958.782351	65.29274502		
Total	39	3192.909498			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	65.34248964	17.30322329	3.776318928	0.00070334	30.0045933	100.680386	30.0045933	100.680386
Digital	-28.97052242	19.8096504	-1.462444911	0.154017343	-69.42722581	11.48618096	-69.42722581	11.48618096
Core Content	-20.60595666	10.98410126	-1.875980216	0.070418341	-43.03848412	1.826570806	-43.03848412	1.826570806
Cross Diciplinary	-4.898880173	18.40309083	-0.266198772	0.791907202	-42.48300568	32.68524534	-42.48300568	32.68524534
Communication/Collaboration	-16.99437483	17.11387533	-0.993017333	0.328643878	-51.94557102	17.95682137	-51.94557102	17.95682137
Problem/Critical Thinking	-10.02529355	24.02826744	-0.417229148	0.67948159	-59.09756231	39.04697521	-59.09756231	39.04697521
Creativity/Innovation	32.98786662	19.05989858	1.730747227	0.093772156	-5.937639269	71.9133725	-5.937639269	71.9133725
EQ/Ethics	-1.037306916	26.00190424	-0.039893498	0.968442346	-54.14027976	52.06566593	-54.14027976	52.06566593
Life/Job	42.26725759	24.57240402	1.720110802	0.095713964	-7.916286321	92.4508015	-7.916286321	92.4508015
Culture	4.652281214	9.408786874	0.494461324	0.624582032	-14.56302507	23.86758749	-14.56302507	23.86758749

Iteration 3

SUMMARY OUTPUT ITERATION 3 SURVEY 1

Regression Statistics	
Multiple R	0.681223456
R Square	0.464065396
Adjusted R Square	0.142504634
Standard Error	0.120935689
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0.189962386	0.021106932	1.443165495	0.254601604
Residual	15	0.219381614	0.014625441		
Total	24	0.409344			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.121915144	0.425185692	0.286733881	0.778238749	-0.784346707	1.028176995	-0.78434671	1.028176995
Core	0.212675037	0.28399808	0.748860828	0.465522839	-0.392652541	0.818002615	-0.39265254	0.818002615
Digital	0.403473738	0.210329903	1.918289947	0.074312221	-0.044833838	0.851781314	-0.04483384	0.851781314
Cross Dicipl	0.080958196	0.345927304	0.234032397	0.818124005	-0.656368398	0.818284791	-0.6563684	0.818284791
Comm	0.122479329	0.468709727	0.261311686	0.797406008	-0.876551805	1.121510463	-0.87655181	1.121510463
Innovation	-0.502226887	0.324483698	-1.547772325	0.142513415	-1.193847517	0.189393743	-1.19384752	0.189393743
Problem	0.960853392	0.371391103	2.587173964	0.020618507	0.169251994	1.752454789	0.169251994	1.752454789
Life Skills	-0.477279076	0.411902105	-1.158719681	0.264685663	-1.35522763	0.400669479	-1.35522763	0.400669479
EQ	-0.366837181	0.327177976	-1.121215998	0.27982553	-1.06420053	0.330526168	-1.06420053	0.330526168
Culture	0.301690277	0.194008057	1.555039936	0.140779345	-0.111828109	0.715208662	-0.11182811	0.715208662

SUMMARY OUTPUT ITERATION 3 SURVEY 2

Regression Statistics	
Multiple R	0.917213186
R Square	0.841280029
Adjusted R Squar	0.555584082
Standard Error	6.751027997
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	1207.866198	134.2074	2.944669108	0.123474898
Residual	5	227.8818951	45.57638		
Total	14	1435.748093			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	72.3466247	31.62267684	2.287808	0.070843113	-8.942053967	153.6353034	-8.942053967	153.6353034
Core	2.210028533	22.84218694	0.096752	0.92668176	-56.50768229	60.92773936	-56.50768229	60.92773936
Digital	131.5046399	36.29545805	3.623171	0.01516892	38.20419469	224.8050851	38.20419469	224.8050851
Cross	-113.370207	41.96772973	-2.70137	0.042714281	-221.2516908	-5.488723291	-221.2516908	-5.488723291
Communication	-105.6560459	39.39827309	-2.68174	0.043728742	-206.932531	-4.3795607	-206.932531	-4.3795607
Problem	15.73932159	28.46767861	0.552884	0.60415066	-57.43917595	88.91781912	-57.43917595	88.91781912
Life/Job	77.28025517	50.84440561	1.519936	0.188999895	-53.41945033	207.9799607	-53.41945033	207.9799607
Innovation	11.93965531	53.93441101	0.221374	0.833558337	-126.7031619	150.5824726	-126.7031619	150.5824726
Culture	31.14109743	17.2857426	1.801548	0.131495245	-13.29331852	75.57551338	-13.29331852	75.57551338
EQ/Ethics	-57.59587705	37.32103542	-1.54326	0.183416759	-153.5326528	38.34089868	-153.5326528	38.34089868

Iteration 4

SUMMARY OUTPUT: ITERATION 4: SURVEY 1

Regression Statistics	
Multiple R	0.83257569
R Square	0.693182279
Adjusted R Squa	0.495942316
Standard Error	0.05241989
Observations	24

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0.086913505	0.009657056	3.514410909	0.017563386
Residual	14	0.038469829	0.002747845		
Total	23	0.125383333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.672446548	0.082528737	8.148029095	1.10554E-06	0.495440012	0.849453083	0.495440012	0.849453083
Core	0.147216182	0.165100654	0.89167534	0.387635712	-0.206889503	0.501321866	-0.206889503	0.501321866
Cross	-0.703850796	0.240869698	-2.922122632	0.011143882	-1.220464917	-0.187236674	-1.220464917	-0.187236674
Digital/ICT	-0.210225225	0.148599096	-1.414714021	0.179007662	-0.528938588	0.108488138	-0.528938588	0.108488138
Comm/Coll	-0.20021263	0.20013728	-1.000376493	0.334106093	-0.629464404	0.229039143	-0.629464404	0.229039143
Innovation	0.910963943	0.228929264	3.979237632	0.001370759	0.419959505	1.401968382	0.419959505	1.401968382
Problem Solving	-0.632148008	0.275214844	-2.296925552	0.037568609	-1.222425142	-0.041870874	-1.222425142	-0.041870874
Life/Job	0.132793822	0.16348342	0.812277	0.430228733	-0.217843241	0.483430886	-0.217843241	0.483430886
EQ	0.256721196	0.202084631	1.270364771	0.224661391	-0.176707231	0.690149624	-0.176707231	0.690149624
Culture	0.212048764	0.167819501	1.263552579	0.227026888	-0.147888269	0.571985797	-0.147888269	0.571985797

SUMMARY OUTPUT: Iteration 4 Survey 2

Regression Statistics	
Multiple R	0.798277292
R Square	0.637246635
Adjusted R Square	0.455869952
Standard Error	0.11320169
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	9	0.405204652	0.045022739	3.513387857	0.011171483
Residual	18	0.230663205	0.012814623		
Total	27	0.635867857			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.090295235	0.342248961	3.185678731	0.005121153	0.37125685	1.809333619	0.37125685	1.809333619
Core Content	0.664751549	0.313519786	2.1202858	0.048135345	0.006070922	1.323432177	0.006070922	1.323432177
Cross Discipline	-0.43621617	0.435962811	-1.00058116	0.330291399	-1.352140053	0.479707704	-1.35214005	0.479707704
ICT/Digital	0.141632321	0.276171311	0.512842266	0.614297965	-0.438582073	0.721846715	-0.43858207	0.721846715
Comm/Coll	0.028813095	0.372321041	0.077387771	0.939168813	-0.753404386	0.811030577	-0.75340439	0.811030577
Problem/Critical	1.785531682	0.616276932	2.897287875	0.009601466	0.490781893	3.08028147	0.490781893	3.08028147
Creativity/Innov	-2.82530789	0.654588257	-4.31616036	0.000415928	-4.200546785	-1.45006899	-4.20054679	-1.45006899
Life/Job	1.832810393	0.49714614	3.686663229	0.00168806	0.788345111	2.877275675	0.788345111	2.877275675
EQ	-0.75423726	0.532745919	-1.41575418	0.173918387	-1.873494902	0.365020383	-1.8734949	0.365020383
Cultural	-0.9201034	0.28640423	-3.21260409	0.004826841	-1.521816361	-0.31839044	-1.52181636	-0.31839044

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Appendix 6

ANOVA Analysis, Iteration 1

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Core Content	37	25.49762	0.689125	0.01399
Core Content	37	32.12381	0.868211	0.006543

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.59333	1	0.59333	57.79069	8.46E-11	3.973897
Within Groups	0.739215	72	0.010267			
Total	1.332545	73				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Digital/ICT	37	23.22667	0.627748	0.024704
Digital/ICT	37	29.38	0.794054	0.012518

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.511669	1	0.511669	27.49258	1.51E-06	3.973897
Within Groups	1.340004	72	0.018611			
Total	1.851673	73				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Cross Diciplinary	37	29.8	0.805405	0.008488
Cross Dicipline	37	32.06667	0.866667	0.006173

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.069429	1	0.069429	9.471097	0.002952	3.973897
Within Groups	0.527808	72	0.007331			
Total	0.597237	73				

ANOVA results for foundational knowledge, Iteration 1

SUMMARY

Groups	Count	Sum	Average	Variance
Communication/Collab	37	28.02143	0.757336	0.008673
Comm/Collaboration	37	31.14	0.841622	0.005983

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.131426	1	0.131426	17.93551	6.66E-05	3.973897
Within Groups	0.527592	72	0.007328			
Total	0.659018	73				

SUMMARY

Groups	Count	Sum	Average	Variance
Problem Solving/critical	37	28.64	0.774054	0.026291
Problem Solving /Critica	37	31.75	0.858108	0.00646

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.130704	1	0.130704	7.981524	0.006111	3.973897
Within Groups	1.179059	72	0.016376			
Total	1.309764	73				

SUMMARY

Groups	Count	Sum	Average	Variance
Creativity/Innovation	37	27.73333	0.74955	0.014359
Innovation/Creativity	37	30.98333	0.837387	0.009312

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.142736	1	0.142736	12.05994	0.000875	3.973897
Within Groups	0.852162	72	0.011836			
Total	0.994899	73				

ANOVA results for meta-knowledge, Iteration 1

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SUMMARY

Groups	Count	Sum	Average	Variance
Life/Job Skills	37	30.62032	0.827576	0.007214
Life/Job Skills	37	32.28611	0.872598	0.005108

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.037498	1	0.037498	6.086094	0.016005	3.973897
Within Groups	0.443613	72	0.006161			
Total	0.481111	73				

SUMMARY

Groups	Count	Sum	Average	Variance
EQ/Ethics	37	32	0.864865	0.009365
EQ/Ethics	37	33.8	0.913514	0.005507

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.043784	1	0.043784	5.888352	0.017746	3.973897
Within Groups	0.535368	72	0.007436			
Total	0.579151	73				

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Cultural	37	30.7	0.82973	0.012611
Cultural competencies	37	32.40333	0.875766	0.009483

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.039207	1	0.039207	3.549067	0.063617	3.973897
Within Groups	0.795401	72	0.011047			
Total	0.834608	73				

ANOVA results for human knowledge, Iteration 1

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ANOVA Analysis, Iteration 2

Anova: Single Factor Iteration 2

SUMMARY

Groups	Count	Sum	Average	Variance
Core Content	40	35,17143	0,879286	0,007346
Core	36	27,46333	0,76287	0,01381

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,256785	1	0,256785	24,6823	4,22E-06	3,97023
Within Groups	0,769866	74	0,010404			
Total	1,026651	75				

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Digital/ICT	40	29,71667	0,742917	0,019913
Digital	36	24,47	0,679722	0,016414

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,075667	1	0,075667	4,144293	0,045355	3,97023
Within Groups	1,351101	74	0,018258			
Total	1,426768	75				

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Cross Diciplinary	40	34,93333	0,873333	0,011578
Cross	36	28,73	0,798056	0,025533

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,10737	1	0,10737	5,906424	0,01751	3,97023
Within Groups	1,345208	74	0,018178			
Total	1,452578	75				

ANOVA results for foundational knowledge, Iteration 2

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Communication/Collaboration	39	32.95	0.844872	0.013262
Comm/Coll	35	26.85	0.767143	0.012197

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.111446	1	0.111446	8.734349	0.004218	3.973897
Within Groups	0.918689	72	0.01276			
Total	1.030135	73				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Problem/Critical Thinking	40	33.73333	0.843333	0.00994
Problem solving	36	28.3	0.786111	0.013944

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.062041	1	0.062041	5.242563	0.024894	3.97023
Within Groups	0.875722	74	0.011834			
Total	0.937763	75				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Creativity/Innovation	40	33.48333	0.837083	0.010263
Innovation	36	27.55	0.765278	0.011974

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.097693	1	0.097693	8.823029	0.004009	3.97023
Within Groups	0.819368	74	0.011073			
Total	0.917061	75				

ANOVA results for meta-knowledge, Iteration 2

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
EQ/Ethics	40	35,31	0,88275	0,010523
EQ	36	33,12	0,92	0,019017

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,026291	1	0,026291	1,808098	0,182844	3,97023
Within Groups	1,075998	74	0,014541			
Total	1,102288	75				

Reject

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Life/Job	40	34,97143	0,874286	0,014476
Life / Job Skills	36	33,41667	0,928241	0,0073

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,055159	1	0,055159	4,977278	0,028712	3,97023
Within Groups	0,820073	74	0,011082			
Total	0,875232	75				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Culture	31	25,13333	0,810753	0,036177
Cultural	31	27,7	0,893548	0,010846

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,106254	1	0,106254	4,519285	0,03764	4,001191
Within Groups	1,410681	60	0,023511			
Total	1,516935	61				

ANOVA results for human knowledge, Iteration 2

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ANOVA Analysis for Iteration 3

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Core Content	15	11.07	0.738	0.010017
	15	12.53333	0.835556	0.013249

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.071378	1	0.071378	6.135831	0.019551	4.19597182
Within Groups	0.325721	28	0.011633			
Total	0.3971	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Digital/ICT	15	9.65	0.643333	0.019595
	15	12.95	0.863333	0.008024

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.363	1	0.363	26.28621	1.96E-05	4.19597182
Within Groups	0.386667	28	0.01381			
Total	0.749667	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Cross Dicipl	15	11.97	0.798	0.010146
	15	12.06667	0.804444	0.01109

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.000311	1	0.000311	0.029336	0.865238	4.19597182
Within Groups	0.297299	28	0.010618			
Total	0.297611	29				

ANOVA results for foundational knowledge, Iteration 3

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Comm/Coll	15	12.24	0.816	0.00914
	15	12.76190476	0.850793651	0.007524

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.009079486	1	0.009079486	1.089711	0.305464511	4.195971819
Within Groups	0.233296357	28	0.008332013			
Total	0.242375843	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Innovation	15	11.6	0.773333333	0.010667
	15	12.53333333	0.835555556	0.008963

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.029037037	1	0.029037037	2.958491	0.096464004	4.195971819
Within Groups	0.274814815	28	0.009814815			
Total	0.303851852	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Problem/Critical	15	11.76	0.784	0.007726
	15	12.76666667	0.851111111	0.00728

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.033779259	1	0.033779259	4.502059	0.042836996	4.195971819
Within Groups	0.210085926	28	0.007503069			
Total	0.243865185	29				

ANOVA results for meta-knowledge, Iteration 3

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Life/Job Skills	15	11.95	0.796666667	0.01181
	15	12.23888889	0.815925926	0.012852

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.002781893	1	0.002781893	0.225605	0.638486395	4.195971819
Within Groups	0.345263374	28	0.012330835			
Total	0.348045267	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
EQ/Ethics	15	12.36	0.824	0.013211
	15	13.16	0.877333333	0.021364

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.021333333	1	0.021333333	1.234024	0.276074506	4.195971819
Within Groups	0.484053333	28	0.017287619			
Total	0.505386667	29				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Culture	15	12.67	0.844666667	0.013612
	15	10.52	0.701333333	0.015055

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.154083333	1	0.154083333	10.74964	0.002788273	4.195971819
Within Groups	0.401346667	28	0.01433381			
Total	0.55543	29				

ANOVA results for human knowledge, Iteration 3

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ANOVA Analysis for Iteration 4

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Core	22	15.14285714	0.688311688	0.014825294
	22	18.7	0.85	0.012797619

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.287574212	1	0.287574212	20.82142557	4.33915E-05	4.072653759
Within Groups	0.580081169	42	0.013811456			
Total	0.86765538	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Cross	22	16.86666667	0.766666667	0.019365079
	22	18.8	0.854545455	0.011274651

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.084949495	1	0.084949495	5.545054945	0.023281841	4.072653759
Within Groups	0.643434343	42	0.015319865			
Total	0.728383838	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Digital/ICT	22	15.6	0.709090909	0.017272236
	22	18.64	0.847272727	0.013354113

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.210036364	1	0.210036364	13.7160563	0.000614338	4.072653759
Within Groups	0.643153329	42	0.015313175			
Total	0.853189693	43				

ANOVA results for foundational knowledge, Iteration 4

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Comm/Coll	22	17.63333333	0.801515152	0.01518278
	22	18.23333333	0.828787879	0.012412217

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.008181818	1	0.008181818	0.592992853	0.445574024	4.072653759
Within Groups	0.579494949	42	0.013797499			
Total	0.587676768	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Innovation	22	17.475	0.794318182	0.019757846
	22	19.2	0.872727273	0.012911255

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.067627841	1	0.067627841	4.140171436	0.04822158	4.072653759
Within Groups	0.686051136	42	0.016334551			
Total	0.753678977	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Problem Solving	22	17.56	0.798181818	0.018358442
	22	19.46666667	0.884848485	0.007061087

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.082622222	1	0.082622222	6.500688778	0.014522482	4.072653759
Within Groups	0.533810101	42	0.012709764			
Total	0.616432323	43				

ANOVA results for meta-knowledge, Iteration 4

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Life/Job	22	17.4	0.790909091	0.033775854
	22	19.43333333	0.883333333	0.013201058

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.093964646	1	0.093964646	4.000460759	0.051981528	4.072653759
Within Groups	0.986515152	42	0.023488456			
Total	1.080479798	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
EQ	22	17.62888889	0.801313131	0.014776559
	22	19.6	0.890909091	0.010812891

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.088301796	1	0.088301796	6.901421917	0.01197139	4.072653759
Within Groups	0.537378451	42	0.012794725			
Total	0.625680247	43				

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Culture	22	18.05	0.820454545	0.017775974
	22	20.05	0.911363636	0.007602814

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.090909091	1	0.090909091	7.164179104	0.010561908	4.072653759
Within Groups	0.532954545	42	0.012689394			
Total	0.623863636	43				

ANOVA results for human knowledge, Iteration 4

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Appendix 7

Transcriptions of student blogs, Iterations 1, 2 and 4

Table 1: Iteration 1

Code	Comments from students
S01	I have accomplished so much in a short space of time. I have gained technical and non-technical skills that could take me anywhere in future in terms of my career. (Mic1)
S02	I have also been able to align my knowledge that I have learned over the years relating to information systems which I thought I had forgotten. I am curious what the next few weeks hold for me. (LR) I have learnt the necessary procedures, tools and skills to utilise for IS in the business environment when piloting a project. This is vital for me, because as much as I am in the IS field, the business environment is where I will execute IS projects and implement my knowledge and skills. (Taz1)
S03	I had no prior technical experience when developing an actual system just theoretical knowledge, the main assignment has helped me to develop some programming and developing skills with regards to a system. (Sim1)
S04	Despite the pandemonium among students our team moral [sic] has growth [sic] substantially and we have become more of a little family, not only slaving away for assignments but bringing each other breakfast in the morning, treats in evening to create a more positive and pleasant working environment. (NA1) Communication is crucial in team work and it is important to ensure that each member is aware of what is required of them. (HK1) Doing this task with my group, made this experience very enjoyable and full of fun. We managed to do the work through constant collaboration and lots of laughter! (ZA1) What was interesting for me to find out how information systems as a discipline greatly involve the interaction of technology with people. This entails that a large part of this discipline involves the social aspect. As it largely involves people one has to master the skill of interacting with not only the technology and processes involved in technology but the people aspect as well. (LB1) In this whole process, writing is not left behind because everything needs to be documented. In documentation one needs to learn to write a good document and be able to present it in a very simple but professional way. (Seth1) My writing and communication skills have improved drastically. Throughout this course we have needed to submit documents in which my English had to be impeccable, but we human and we make mistakes. Luckily we had the opportunity to be reviewed and review other works in which I could easily pick up what writing skills I lack and how I can improve it. I have learnt how to communicate better with people in general. Throughout this course I've had to be in countless group meetings, consultation with peers and the lecturer and well as people outside of this course such as the client for our project. This has also helped be to handle people better, I have realised that my opinions are not always right and have learnt to listen more. Conflict management skills are definitely one that has

	been improved on! (SS1) The past three weeks has taught me a lot of myself and about others. The knowledge regarding academics was not nearly as rich as the knowledge I gained about working with others and staying true to who I am. We are learning how to accept each other's personalities and communicating better. (AD1)
S05	This module allows us to be creative and to be innovative. What was more interesting to me was to see that there are other ways of doing things. In presentation for instance we do not have to spend a lot of time doing slides. As we can do voice over slides, do a video and present it in class, do a show or act. (VAT1) I have enjoyed all the lectures and tasks done in this course so far. What I enjoy more is that we are doing practical work which prepares us for life after this course, the tasks done in this course help us to be more creative/innovative and help us to gain some technical skills that will work to our advantage in the workplace. (Ned1)
S06	The lecturer provided the class with a quiz involving a number of riddles. A similar quiz was given to the class in the beginning of course. The lecturer executed this exercise to determine if our thinking and train of thought has changed throughout the course. From my perspective, I feel that my thinking has changed or improved. Answering the questions seemed much easier than before, and the results certainly indicated that. (LR1)
S07	It has not been easy for almost all of us here; we have all got our share of hardships, obstacles, failures, and painful experiences. But in all of that for us to be here that means we managed to pick ourselves up, dust off and continued with the journey. (JAM1) I am also gaining knowledge and experience in personal and social skills which will help me as a person in the working environment. (Taz1) I have learnt so much skills and knowledge. I am confident about the things I have learnt and I am confident that I could apply these in the "big world" now. (Sim1)
S08	
S09	
A01	I enjoyed this exercise when it was done in class, but even more once we applied it to our chosen business as it helped to actually show progression with something that we had learnt. (PA1) The course was fun and interactive in class. I enjoyed every time when attending it. (Mic1) The structure of the IFS 731 module has interested me as it is completely different to what was expected from students. It is more practical in terms of class discussions and tasks. This adjustment can however not be done overnight but through hard work and dedication to the programme. (ZA1) The interaction for our assignments with the owners of companies was particularly interesting as it gave us the opportunity to solve a real-world problem. Throughout the project life cycle one should not just give focus on the technology aspect of it, but also the human interaction as well. This entails

	communicating to the users, whether it be the business owner, employees or customers. (LB1) We met with the owners of the business and had an experience of the outside world, we did an analysis of the business and brain stormed on which digital innovations that we would like to implement in that business. (Seth1) The first thing I've learnt is how to apply my current knowledge to the real world. It is of utmost importance that we be able to apply the theory that we have learnt to real life situations. (Sim1) Above all else, I am enjoying the practicality of the course. I am finally seeing how what I learn can be applied in real-world situations. (DC1)
A02	This experience is more than just the content we learn in class, it can be used as a learning experience in many aspects – building relationships, working as a team, building confidence and the ability to verbally explain. (Taz1) I have enjoyed the fact that I am becoming aware my own strengths through these tasks that we find ourselves challenged with. (Chris1) I have enjoyed that the conducting of the tasks has allowed for us to actually gain practical experience for once. It has allowed me to develop a new set of skills and knowledge and it has been fun to actually go out there, identify a digital opportunity and develop a system that will change a business. (SS1)
A03	One is constantly interacting between groups, other colleagues, guest speakers and the lecturers. I enjoy this interaction as I gain insight into others' opinions and views. I found that this is also when I learn most. (Sim1) We then turned our attention to peer review presentations where we reviewed another group's assignment for IFS 731. This was absolute fun. We enjoyed being able to help another group improve their work and at the same time it taught us how to spot and fix our own errors. (SW) In future I do not think it is a good idea for students to review each other because sometimes we can be biased and also unfair. (PM1) Something I found interesting was seeing the different groups present. Each group showed different creative ways to explain their business canvas. This allowed the class to learn from each other. (Taz) As a group we decided to act out our feedback in-front of the class, instead of preparing PowerPoint slides. I enjoyed everything about the act that we did because we were prepared and had fun while doing it. (Mic1) This taught me how to adequately review a document, as well as to not only give negative feedback but positive ones as well that will ultimately be enlightening and beneficial to the group being reviewed. (LB1) I personally really enjoyed reviewing their document, not because of finding faults in another team's work, but because it helped me realise what we could improve in our assignment because, while we did the review I actually realized that we had made a few of the same mistakes in our document!

	(MC1) The peer review was probably one of the most interesting and yet challenging task I have ever had to complete with my group members. (KH1) The interesting part that stood out for me was that we might be doing group assignment and activities, but at the end we need the help and advice from our other fellow course members in aspects where we as a group might lack. (CJ1) The constructive feedback from our peers wow!! (Vat1) It was interesting to be the one criticizing and suggesting corrections. As we realized that we most probably made similar mistakes. I loved the idea of having that much power! hahahahahaha (evil laugh). (AD1) Unlike the previous, this assignment was really exciting. We had to review another team's assignment and comment on their work. Identifying their mistakes made us realize our mistakes and reviewing their document and presentation made us believe we could have done better. (HK1)
A04	One is now afforded the ability to interact with one's peers within classroom discussions as well as work in groups in tackling classroom exercises. This helped me to understand the theory behind what is done in class. Our class is made up of a diverse group of people from various cultural backgrounds. At the end of the day our classroom truly has a good structural support system. (KD1) What was also found enjoyable was my ability to interact during lectures as a result of reading and interacting, such as following news, staying abreast with what's new and participating in discussions with fellow colleagues regarding important topics. Thus the lectures themselves have become more enjoyable. (LB1)
A05	So far this module has been a great learning curve, especially the aspect of managing group dynamics. The content itself is not a hurdle, rather time management and considering others' views. (LvR1) Working in groups has been the biggest learning experience, having to solely depend on your team to work just as hard as you. (Taz1) During the last two weeks on the course I have learned the importance of connecting deeply with my team members beyond the project or assignment we were working on. (Mic1) We also have been placed in groups in order to complete most tasks which is a big bonus since I will be compelled to work with different people from unique cultures, backgrounds and ideologies once I graduate. (MC1) The fact that we were placed into groups with random people we did not know but have to work with throughout the course, gives you a real life experience of what it would be like in a place of work one day, where you have to be able to communicate and work efficiently with people from various backgrounds. It has allowed me to engage with class mates beyond the norm, criticizing their work openly allowing them as well as ourselves to recognize our mistakes and improve on it. It has also allowed me to better understand my personality and why I react to things the way I do. (KH1)

	Before the module I was that student who was an introvert, I was used to working individually most of the times and I really did not like public speaking, even in my undergraduate studies, I never answered a question in class voluntarily because I do not like public speaking. IFS731 made me to overcome my fears and got me out from my comfort zone of working individually. (BK1) Through the interactive lectures and ongoing group work, I have learnt new things about myself and ultimately new skills and knowledge pertaining to the content. I've enjoyed being able to interact with my peers and fellow colleagues and learn new things from them. Working in a team has also allowed me to identify my strengths and weaknesses and I have enjoyed how they help me balance it out or improve on it. (SS1) The course is very challenging as it requires a person to be disciplined, manage time very well and be able to work with diverse groups. It encourages participation during lectures and individual contribution in group work. (Vat1)
A06	When we were doing our last presentation on the reviews, I really enjoyed class that day. Because everybody was so funny and creative but at the same time gave clear and constructive feedback to help peers do better next time. I also enjoy the blogs so much, that when I am posting I forget that it's for marks. I think it is such a good idea for reflection even though I write too much instead of using models and fancy words. And it also helps me go back to what I have done already and see if I still remember. (Yam1) Writing this blog gave me a sense of direction in that it has allowed me the ability to be able to evaluate where I currently am in life. It has made me aware of the things I have accomplished thus far. It puts everything into perspective and I now see exactly what I am and should be working towards. (KD1) In writing these blog posts I have enjoyed documenting my journey so far. Even in just three blog posts I can see the progression in the way I write, the way I think and my ability to turn an assignment into something enjoyable, in hope that others will also enjoy my story telling. (Taz1) The journey of a student is one to be acknowledged and reflected upon to assist in the growth and improvement of a student. This blog is therefore not only for the benefit of the reader, but for the writer as well. As the blogs progressed, my ability to write and reflect has improved. (LB1) Let me sum up by writing; personal or self-reflection is very important to do. It helps identify what you have learned so far, to identify the challenges you came across and how you could have changed to avoid those challenges, what milestones you have achieved and finally, did you have fun in the process. My three weeks have been fun, even though a bit challenging and somewhat busy. (Seth1) These blog posts have been quite useful in allowing me to actually reflect on what I've done and learnt which brings a different dimension in the way I perceive the coursework. Thank you for joining me on this journey. (MK1) There are various things that stood out for me in this course, not necessarily because I enjoyed it or because it was easy, but because it helped me grow and helped me learn. (KH1) Writing these blog posts was helpful to me, because I was able to reflect on my progress and the knowledge I obtained in the end-user practical module. I also plan to use blogging as a platform of

	advertising my business in the near future. (BK1) These blogs have helped me immensely to see my progress as an IS student. Not only have I learnt about my growth in Information Systems but I have learnt about the growth of me as an individual. (Sim1) Not only have I acquired knowledge about my field of study, but I have also learned a lot about myself. By posting these blogs for you all I now know my strengths and weaknesses. I know what aspects about myself I need to perfect and what needs to developed and turned into strength. (DC) Her class not only taught me a lot of new skills, but also allowed us to reflect on who we are, or who we thought we were by doing these blogs. (AD1)
A07	During this session we were told to look at everything we learnt up until this point with regards [sic] to this specific module. We then had to mind map our understanding of the various concepts that we have learnt thus far. Along with this, we had to connect what we learnt in a practical manner, whilst linking everything together like pieces of a puzzle. (ZA1) The number of group meetings in preparation for the presentations as well as the presentations itself was highly enjoyable. The members of the group that I am a part of are not only knowledgeable but are a fun group of people to learn and grow with. The team dynamic has also improved over time, as our group is beginning to work more as a unit and less as individuals. (LB1)
A08	Our lecturer guides us and constantly reassures us that this is a platform where our mistakes can be corrected and where we are not judged. We are constantly put at ease, and that is something I cherish and am very much grateful for. (ZA1) The lecturer facilitates the class in such a way that one does not feel intimidated if they have to present. She guides you on how you should go about a task if your interpretation of it is veering off course. (Chris1 I have learnt a lot throughout the course and it has given me the opportunity of doing things beyond my abilities. It has showed me that the way we grasp things makes it better for us rather than expecting the norm from what it requires. (CJ1)
A09	We gained project management skills through understanding the importance thereof and through practicing [sic] certain aspects on a daily basis. This empowered me to become a team player and to fit myself well within my group. My writing skills have made a great improvement, as I am able to ensure that everything written makes sense, and I am capable of changing sentence constructions if need be. The constant assignments assisted me in developing a skill to know when something is visually appealing. Additionally, my presentation skills have definitely improved since I have enrolled for this course. (ZA1) Ways in which our documents and presentations in the end user practical course were reviewed allowed for changes and improvement to be made. Feedback is essential when writing a document, this helps you to improve your writing skills which is good any day. (Seth1) I thoroughly enjoy these tests as it forces one to step away from the norm and think out the box. I feel tests like these are important as students are generally expected to cover large amounts of theory which is later regurgitated in an assessment. We are not encouraged to think outside of the proverbial

	box enough especially in a field such as Information Systems. (MK1) Over these past few weeks, I think the most interesting part has been to see how we've all grown and improved. The assignment given to us has been an opportunity for us as students still, to expand our horizons and actual do something professionals do. (SS1)
CT	Overall, the activity helped me to understand the application of design thinking, lean and scrum in devising digital solution for a business. The activity helped me to see and understand the link between design thinking, lean, and scrum methodology. I have understood the concepts to an extent that if I would be placed in a situation where application is required I would be able to apply them. (PM1) What really interested me was the design thinking process. I personally took in design thinking as it made me look at how to be creative or incorporate creativity when thinking about things from a business and I.T. perspective. It showed me how address problems from a new point of view and be more liberal when it came to finding solutions to problems. (FA1) After presenting the business model canvas, we then had to go back as a group and choose one idea or solution to implement for the business. Following this we had to produce a project initiation document. The document entailed giving a background to the industry and business, and then giving a detailed description with visual aids as to how we came up with the ideas to then funnel them out to pick one final idea. Within the document, we also had to go into further explanation on our solution in terms of the scope, risks and methodology. (Taz1) Since the start of my honours years there are so many new topics that have been taught which has increased my interests in the study of information technology as a whole. One of the key skills that come to mind is DESIGN THINKING, it opens your mind to new ideas and a different perspective of how to do things. (Seth1) In the same lecture, each group was then required to do a presentation based on all of the work covered thus far in the module. It was during preparation for this presentation that something clicked and I better understood how all of the pieces of the puzzle (i.e. business model canvas, design thinking, agile and Lean) fit together and relate to one another. (MK1) It was the first time I heard about the concept design thinking and it gripped me like I would grip the handles of a roller coaster ride. The delicate manner of how design thinking is incorporated in the three IS components that are used to define Information Systems are mesmerising. (FF1)
PED	A great deal of class interaction, group work, additional reading as well as students presenting presentations; with the lecturer providing facilitation and insight. This seems to be almost a contrast to my experience doing my undergraduate studies, which just involved the lecturer just providing the lecture, with minimal class interaction, and us the students studying the content afterwards in preparation for tests and examinations. (LvR1) We took the learning experience away from sitting in the lab listening to theory-based explanations, following slides and making notes. The module evolved away from that, to becoming a module filled with hands-on activities and presentations to help students to become mentally and physically involved in the lectures. I believe this to be a very effective method of teaching making it an easier and more comfortable environment to learn in. (TZ1)

	We got a canvass and were sent in our groups to practice the business model as Carolien explained it in her videos on iKamva, so she just briefly touched on them in class, after we were sent it groups [sic] we had to present our work to the whole class, which gave us a chance to work on our agile techniques and our logical thinking. (LB1) The end user practical helps not only improve your skills but also helps in understanding yourself, your personality and what skills you poses. The next blog will be continuing with my weekly reflection and progress. It will also be giving you an overview of my occupational and overall goals. (Seth1) To conclude End User Practical has been exciting and challenging over the past couple of weeks however the module has taught me a lot about; firstly theory within IS and how it is applied within the real world, secondly about myself and others in terms of how to work as a team, take constructive criticism from others without taking offense and lastly it allowed me to challenge myself and go beyond limits I set for myself. (KH1) Other things that I have learned the importance of doing pre-reading or preparing for the lectures in advance because I may never know when the lecturer decides to do a quiz or ask questions relating to the prescribed readings/what the lecturer touched on previously. (Vat1)
TECH	The process of developing and compiling the project initiation document was a collaborative effort. This was made possible by the use of Google drive doc. The use of Google drive enabled the team to work simultaneously and be more productive. It enabled the team to help each other and communicate utilizing the functions made available on Google drive. The use of Google drive eliminated the use of What's app [sic] for communicating, during the time when the team was working because it had its own. (PM1) The exercise enabled groups to acquire skills through using software's [sic] such as Canvanizer to assist in the development of business model canvas where preferred. There were also groups that helped each other by distributing the relevant software and providing structural advice. (FF1)

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Table 2: Iteration 2

Code	Comments from students
S01	
S02	I enjoyed the feeling of working on a real-life project and actually creating the things we documented. I also enjoyed reading about the future jobs. Vus
S03	I enjoyed working on my group assignment, I was very busy building the site proposed to the client. Working on it enhanced my skills in web development. Vus I am an avid user of social media and learning about different ways one can innovate a business through digital means was interesting. JF
S04	A good team member wants his team mates to succeed. By adding value to your Groups, not only are you displaying a strong commitment to your groups and the IFS341 class as a whole, but it also holds you in good stride when it comes to delivering a good result. MM Firstly I have learned that teamwork in developing a product is vital to project progression and that a team should consistently collaborate. PG The lessons learnt during the weeks was the importance of communication skill where we have to go to Iziko museum explaining to their stakeholders what we are expected to do and what we need from them, thereafter we had to communicate with their clients to get the relevant information so that we will be able to do the group assignment. SK
S05	Personally this course has taken me out of my comfort zone and taught me how to think creatively as well as that no idea is a stupid idea. During one of the teachings in the lectures, our lecturer said that "Think of anything and idea and put it in a sticky note, it does not matter what it is just put it in a sticky note and stick it to the board" it was amazing to know that whatever idea that one has in class won't be posed as a stupid idea. This is one of the reasons that I enjoy and find this module interesting. AB Coming with innovative ideas is not easy it requires time and effort. The process has helped me to not criticize the idea at the first stage but later. After assessing the credibility of each idea. BB The most amazing moments of this module is the creativity and innovation side of it. RF Digital Business innovation gives me the opportunity to think innovative internally and externally in the business industry. In the past three weeks I have learnt most businesses are going digital which, in conclusion, means the concepts that are being thought in the course I need to apply then in the field. LJ The previous lecture that we had was so interesting as we had to think creatively. We worked on our group assignment which required us to think about implementations that are digital and creative for a business. My group and I came up with amazing ideas for the business that we have chosen. BN My progress? Throughout my journey in Business Innovation, I have learned how to challenge myself into thinking deeper and outside the box. It has allowed me to exploit the knowledge I have acquired

	and transferring it into solutions and innovative ideas. AD Firstly, by conducting the questionnaire I have learned that one should always think out of the box and creatively. This is how great innovations are born. Secondly, I have a clearer understanding on how to apply the business model canvas to the design thinking process. PG
S06	First thing first before we did anything, the lecturer greeted us with a very difficult quiz which mostly required general knowledge and critical thinking, the funniest part all of us failed. Honestly that week I didn't do pre-reading of slides to prepare and gear up myself for the class hence that might be the cause of confusion I felt in class. SK Therefore my progress so far in the course is that I understand how to apply critical thinking to empathize a business in the design thinking process. PG My expectations were that we have more theory based activities than practical tasks. Despite the fact that the module was not what I expected, I am enjoying the journey so far. The module is teaching us on a whole new level of thinking, one would say we are being taught to "Think outside of the box". SB
S07	In my experience and view digital business innovation is my foundation, it is preparing and training me to be the best in any way that I can be by all the creative thinking exercises, group assignment and all the presentations completed thus far. All the learning and experiences is one of the things that I will take with me to the work place as it is a great pleasure and a useful skill. LG As aforementioned, this has been my favourite module to date and it has taught me a lot about technology and about my abilities in the world of technology. I have learned to exploit every opportunity and turn every challenge into an idea as well as implementing all my knowledge into a tangible and also intangible innovative idea. AD Everything that was taught in this course was so relevant to modern business practices and will be very beneficial for my career and business. Vusi The lecturer made sure that we possess the qualities stated in the learning objectives at the end. ES I always questioned that whether I would have the required skillset for the job market and if I would be able to work as a business analyst. The past weeks the course answered those questions and the tasks given made me realise we are bridging the gap between business and IT. Therefore I am satisfied with my progression because so far the course has laid the foundation for me to realise I would be able to work as a business analyst. PG I must first say it has not been a very easy road because I had to work with people I did not know who have different personality and attitude. However, I have learned a lot during this project about myself it showed my strongest character as I need to be able to handle different issues and working under pressure. I am very thankful of the knowledge I have received in this project as I will use it for future endorsement and apply it on the actual working environment. NW
S08	The practical manner of the course also gives me hope that I will find employment after my studies cause what I have experience so far feels relevant to making a social difference and narrowing our countries [sic] digital gap to help grow the economy. PG As a group we have a gotten to a place where our work ethic is sometimes questioned among each

	other, but we are a unit and we work through them. We do have group separation within the group which can lead to its own politics. But thus far it has not caused much trouble but actually helped the group perform better this way. JD
S09	I had many issues during working with my group. Firstly, being the only person in my group who does not understand Xhosa, the home language of the rest of my group, I had to continually remind my group members to discuss the assignment in English because of the language breech. It made me feel like the odd one out when we are supposed to be a unit. JD
A01	As an individual, I am extremely grateful for this assignment as it has given me a good perception of the corporate world. YE The course was very phenomenal because it teaches about the current issues facing the technological sector and how to improve business process for organisation using advance technology. Learning this course has developed my thinking skills. Working with different individuals was very exciting. I wish the course can be offered to other graduate programs because it equips graduates for the corporate world. LJ I enjoyed working with the group and the client we had, it gave me a feeling of how the real world works like and I am so excited to be giving a working solution to a real entity. Vusi My progress so far in the course is great. The reason for this is that the course helps me to understand the theory in a more practical manner. For instance, I was introduced to design thinking in IFS 351. It was all theory based which I just studied to pass the module. However in IFS 341 I progress by applying critical thinking to the design process and thanks to the lecturer and her practical manner in which she presents the class I fully comprehend now how to start off with the design thinking process to innovate a business digitally. PF The main progress for the past weeks was preparing and doing the group assignment which is the initiation part. We as a group selected the Iziko museum as the business we will use for the assignment, and then we physically went to Iziko museum for interviews with the stakeholders and the clients to have access on [sic] the information we will need to complete the assignment. SK
A02	As a whole I am satisfied with the progress that my group and I have made over the past few weeks as our website is almost complete and our project document is near completion, we merely need to attend to some of the suggestions that we received when our project was peer reviewed and we need to get We Drop's approval of the website that we designed. RF I found the incremental steps in developing a product interesting. It made me realise that all the small parts come together to form a product or final solution. PG I've come to realize that in IFS341 a lot of learning takes place because of the practicality of tasks given to us. SB What was interesting these past weeks in this module was that we were requires thinking practically and really applying our knowledge to real businesses that we think needs [sic] digital innovation, and how this innovation can be achieved. KY
A03	I feel that during our peer review presentations we as a class might have been a wee bit harsh with

	regards to our feedback. I feel like we were too critical instead of giving constructive criticism. BB It was weird hearing where we went wrong or being notified of something that we might have forgotten to add to our assignments, some of us were even in denial about our errors. However for me it was a weird but good experience. It reminded me that we all are human and that everyone cannot get everything perfect every time. AB What I have encountered for this week is that having our PID peer reviewed by our fellow classmates helped with improving certain aspects within our PID to achieve our client's exact requirements. Even though peer reviewing was constructive criticism it was quite harsh comments based on our hard work, yet it only benefited us when updating our PID with regards to meeting our client's specific requirements. Keeping our client please [sic] with our idea was of utmost importance. YE We are not familiar with programming so we did what we thought will work but after getting those comments from our peers we got to see where to fix and where we went wrong. I believe that their comments as well as the lecturer's comments helped us a lot in creating the final report. BB What I learnt from the exercise was that one does not see their mistakes but quickly notice it on someone else. What I mean by this is that the groups spotted what the other groups did not do or did wrong in their assignments but in actual fact they also did not do the same mistake but they did not take note of it. BN In this task I would say firstly I learned from the other group's mistakes. Secondly I can see why it is important to read over everyone's work to ensure cohesion. Kan Each group was given about 10 minutes to present the solutions they have decided to implement in order to add value to the business that they were collaborating with. This was extremely interesting as it allowed everyone to track the progress made by each group since the previous progress presentation. It also enabled the class members to critically evaluate the effectiveness of the solutions proposed for each individual business, while giving the groups an opportunity to justify their decisions at the same time. PG All the benefits and documented reasoning for conducting peer reviews were all proven correct and the entire peer review process was highly beneficial. Besides the overall benefits of the peer review, all the groups took kindly to the lecturer's request of displaying a light-hearted presentation of the peer reviews. One of the groups decided to start and end off their presentation with a dance, requesting the participation of the entire class including Ms Caro. SB In order to conduct the peer review as effectively as possible, my group decided to have each member review the section(s) of the Project Initiation Document that they completed for our own document. We believed that this was the best way of conducting the peer review as each individual already has knowledge of the requirements pertaining to each section. This, with the added benefit of having done considerable research on these sections would allow our team to analyse the information quality and identify any forms of plagiarism or misinterpreted facts. In addition to this, our class was given strict instruction to make the presentation of our peer review a fun and light-hearted display. JG I really enjoyed the part of listening from other groups presenting as it was my opportunity to gain information and I did not enjoy the part where it was my turn to present my group work as I do not feel

	comfortable with public speaking. SK All groups had to present the feedback of the peer review of each team back to the class. This was an exciting process and very informative. The reason being everyone was laughing at the fact that they have made some of the mistakes which were mentioned on other groups. NW I must say that I enjoyed being in class regardless of the long hours it takes because I could not wait to hear the finding of the other groups about the project that we were working on, it was so interesting the creativity that we had so much creativity within us as students and the skills that we had. AN
A04	I enjoy each and every lecture of IFS341 that I attend because in every lecture we always do something interesting which will require an individual to want to learn more. BB As advised by Lecturer I did pre-reading of the lecture slides and read the related articles on design thinking and value proposition for the coming class. This helped me a lot because when we attended the class, it was like the lecturer is repeating same thing. We then did presentation based on the two discussed topics on how they fit and how we utilized them in the project. SK
A05	It proved to me that working together gets faster results than working alone. I have also learnt that understand your team members are [sic] of utmost importance as their input add value to a group meeting or idea. Having to adapt to too many different personalities is quite a challenge but it is possible to achieve. This creates a sense of how the real world operates. YE I cannot wait for the part of the project which follows after initiation because at least now we have built relationships at Artscape therefore we will not struggle to find required information. Also as a group we know each other better now so working together will be easier. BB The group collaborated well and when the going got tough majority of the members would stay on campus till late in the evening to complete tasks but more importantly to work together and bounce ideas off each other so that we could create something of worth. RF What also interest me is that we as a group are individuals from different cultural backgrounds with different views but thanks to the design thinking phases we could put all of that together to form a solution that can help our client grow because we all realise his talent. PF Seeing each group present and identifying how much progress they have made was inspiring. Along with this, our class displayed a great sense of comradeship by asking valid questions and then providing positive and constructive criticisms as needed. JG The most motivating thing for me was witnessing other group members in class presenting their work, which showed me how hardworking and determined to their projects [sic]. I really enjoy the way our class just blend in together and respect each other, which gives us a health [sic] environment to work well and learn more from each other. This shows how blessed we are to have a wonderful lecture as she is able to hold the class well and motivates us to do more. NW The brainstorming sessions with the project team allowed us to come together to share our knowledge, views, experiences and expertise to generate solutions for our undertaken project. WN We are concluding our group assignment this week and I believe that our team effectiveness can be measured by looking at how we approached the assignment and course objectives. Our effectiveness

	as a team can be broken down into the following: Unity, being self-conscience, being goal oriented, having a positive environment, having frequent discussions, freedom to express opinions, having few disagreements, quick decision making, being well balanced, having constructive criticism, and shifting leadership roles. KK
A06	I have to say that this course has really been enlightening and insightful as it has taught me a lot and encouraged me to try new things. It has allowed me to gain new skills and also awaken some underlying or shall I call them dormant qualities and skills that I need to embrace and enhance. I am truly thankful for being part of this course and especially a part of my team; it was really nice working with them. AB Blogging is the best essential tool for reflection. Reflecting has helped me to realise where I went wrong and learn from my mistakes. This is the last blog that I will be writing to reflect on IFS341 but maybe I will use blogging to reflect on life in general. BB To be completely honest, I was not keen on writing a blog, but after I started writing, I became more at ease with the idea of sharing my thoughts and I quite enjoyed sharing a detailed view about myself. This Digital Innovation module has already made an impact on my life and I hope this is the launch-pad for a successful semester not only for me but for my peers too. RF Reflecting on your own work is always a good way to learn new things. The following blog will be reflecting to [sic] the course IFS 341. This will be done by explaining weekly progress in the course, lesson learnt during week, what was interesting, what was enjoyable and non-enjoyable, and lastly perform the online personality tests and commenting based on the findings. SK I have to say I really enjoyed doing it because it gives me a great reflection of myself and getting to know myself better. I do not want to end this here I think I want to be a continuous blogger because it is very wonderful to just let your thoughts out and reflect just about anything. NW I must say, blogging has really made me look deeper into topics and buzz words in the world of science and technology. And this has for the first time challenged me as a Technology student to think outside the box and share my ideas about the coming future. KW
A07	The student presentations were really helpful because we got to hear the views and opinions of other students and it also meant that each student had to do research and understand what they were talking about as each student had to present to the entire class and the lecturer. BB I learned a lot from reviewing the other groups' assignments as I was exposed as to how my class mates think and it made me realise that they are a really smart bunch of individuals. The most fun form of learning came from the presentations as we were exposed in front of the entire class of the mistakes that we made in our project initiation document. RF The effective presentation and scrum session in class were very fundamental to help me to grow my understanding in the course. I have strong understanding now of how operations of the business function especial how to apply the knowledge from the course. Many businesses are moving to the digital world now. Digitizing some of the operations of the business to make operations better and create profit is the game change [sic] in the business industry. LJ The presentations allowed us to gain insight on the projects undertaken by our peers. This enabled us, to compare our solutions and views against theirs. The lecturer also made use of peer reviews,

	which required us to review the presentations as well as their written work. This interactive approach, enables us as students to view the mistakes of others, which will help us identify the mistakes which are overlooked in our project team. WN
A08	Her way of teaching is unique and inspiring and thus has made me look forward to learning week in, week out. MZ The Lecturer played her role well and she was able to get everybody's attention easily. YE I apply the skills I learned In class thanks to my lecturer and her wonderful industry examples and assistance. LJ It has truly been very interesting and a learning experience as we doing it in the presence of our lecturer which makes the weight a little bit lighter since we get assistance and guidance on what is required. BN I enjoyed the atmosphere of the IFS341 class, it is so friendly. I enjoyed the fact that I can freely add value in class discussions, the lecturer has an open door policy, and the lecturer goes around the class when she lectures so as to reach everyone. The lecturer is easy to reach and the class members are easy to work with. ES Digital Innovation was just simply amazing! The lecturer was just simply outstanding. She was precise, informative and very fun. And that is what makes learning interesting and not boring to students. Students need to first see enthusiasm about the course from the lecturer and only then will that positive energy spread to students. Oh my! I have been at university for a while now and not once did I see a lecturer as understanding and compromising and [sic] Ms Caro. The lecturer kept communication lines open at all times and the general setting of the lectures was interactive and this ensured that everyone participated in topics covered. This kept me interested throughout this module. WN
A09	The Project Initiation Report was the source of the endless learning or described in contemporary speech "Learning for days!" The project report required us to create a new business model, empathy maps, persona templates, user stories, a prototype and a release strategy. These were just some of the main content as our report was 51 pages long! RF Teams obtained constructive criticism from the lecturer which then helped on the project initiation document. ES In order to conduct this assessment fairly, our lecturer provided us with a standard rubric to be used when doing the peer review. JG The second week started off on a very positive note, where our lecture tested our thinking abilities. I did by all means enjoy such exercise because such exercises enhance our thinking abilities and gives [sic] us the opportunity to express ourselves and think outside the box. I would encourage, if possible that modules that require students to express themselves to have such tasks, as it could be highly beneficial for students. I also enjoyed the online quiz that was issued to us. Ndo The lecture [sic] has actually been helpful in class and willing to assist in every way, sending videos

	and guidelines which will therefore help in completion of the initiation phase of the assignment. AN
CT	What interest me the most is empathy maps, how important it is to feels [sic], know, understand, to say, to think and do for customer. How important it is to think like the entry level user. To feel the customer pain and excitement, say and do enough but not too much, everything has to balance. NW Creating these personas and empathy maps were [sic] extremely fun, as you can see in the pictures above and below. Another, brilliant method our lecturer taught us was to create a user story. In the beginning I found it difficult to let my imagination go wild, but when I got the hang of it I just started to go crazy and that was the fun part not having a limit to think out of the box, I think I might have even torn the box up! YE Overall, I enjoyed the lecture and content that was covered such as the business model and current digital innovations, for once I had no complaints about a lecture period and that's really something to write home about! RF Working with team has helped me to expand my skill of working with people. Project report writing skills that I have acquired in the course will help me in the working world. Design thinking and empathy map skills helped me to analyse customer needs. LJ This course does not dwell on what has happened or how we can rectify what has already happened. It is more focused on solutions on how we can change the world into being more digital as it is slowly but surely going on that route. I have learnt that this course is based on the present and the future, how businesses operate now and what can be done to improve businesses digitally. LG I firstly learned about Design Thinking Process in depth, the importance of design thinking, how helpful design thinking is in innovation, the connection between the components of design thinking and how it can be implemented in a project. I learned about the importance of knowing and taking care of the users to create useful innovation. ES I enjoyed the content of the course. It is specific and the voice notes by Caro makes one understand the content in [sic] more completely. I also enjoyed the group project. SK The content was new to me but I can sure say that I did not waste my money registering for this course because I know that I am walking out with something. XW I enjoyed exploring the concept and processes involved in design thinking. Understanding design thinking and implementing the processes thereof with my group members, established the importance of the concept to ensure the growth of a business for the foreseeable future. WN
PED	The lectures are easy to understand, almost everyone in class participates and that is increasing the interest and curiosity of students. Hence, I cannot wait for this week's lectures. BB What excites me in this course as well as what I enjoy about it is that it is hands on, meaning that we mostly put everything to action by doing it practically. As much as we do have theory in order for us to understand what we are doing more in depth we mainly focus on practical which is exciting and interesting. Example of what I have mentioned would be for the past lectures we have been working on a group assignment where we had to choose a business of our choice and start by building a business model canvas for it. BN

	Introducing concepts to us in a new and exciting manner – we had to do business model canvas' [sic] on a large sheet of paper and populate it using sticky notes within our groups. Thirdly, the lecturer is assisting many of us overcome our fear of public speaking by making us present our canvas' [sic]. To make things even more interesting the lecturer gave a quiz (which was not for marks) that tested our intuitive abilities. This got us thinking and curious to find out what the actual answer was. The idea of spending three hours in the same class seemed daunting but because we were having so much fun in the lecture, time flew. Kan I learnt that it is important to do pre-reading for it reinforces learning. I learnt to respect everyone's idea. ES In overall I enjoyed this module, unlike other modules it was very practical and taught us a whole new way of approaching businesses and clients. Many skills taught in this module will be adventures that we will encounter in future. As we sign off our undergraduate degrees, this module will be one to remember. SB I have never been into a class where the students and the lecturer were interacting during the class, as the content was being taught. XW This was a very interesting lecture for me, because it opened my mind more around the business model content. I loved everything about the lecture, because it is very active and allow a person to think on their feet. This is very important because it brings out the creative juices that I did not know I even had. NW Many of the methodologies that were mentioned were ones that the students have covered before in previous modules. Students know the theory behind the methodologies; however practical work on these methodologies may not have been done before. An example is the scrum methodology. Caro told the class that this method will be focused on this term. Additionally, the students have most of the day booked on a Friday to work in the BOE Lab therefore scrum is perfect for meetings to work on the assignment. JF I extensively enjoyed the course. The material we covered was really interesting as I was tested each week with different challenges and obstacles. However, I personally relished each of them as I believe it builds character. This course has introduced me to a new, innovating way of learning, compared to previous modules I did throughout my university career. I have really learned a lot of new aspects and terminologies of IS, which perfectly prepared me for my future career path within this field. MM
TECH	The most important thing that I have highlighted during my attendance of lectures was that this module is very different from other modules that I have already completed especially in the Information Systems department. What I have noticed and learnt is that this module is presented digitally :-) well I guess it has to be because after all it is digital business innovation. BN We found many recommendations on Google Drive suggested by Caro. This week's focus was on improving all aspects highlighted on our project by our lecturer and peers. SB As per normal, the week in the life of one of the "Frienovators" consisted of our biweekly SCRUM meetings as well as a final group meeting, which was in addition to the daily communications via social media and Google Drive, to prepare for our presentation on the topic for the week. JG

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Table 3: Iteration 4

Code	Comments from students
S01	The new skills is [sic] have learnt during the course are a lot, from academic, social, interpersonal, innovation just to mention a few. Academically I learnt new content and the skills I took is the skill of preparing a proper presentation for a client, what to include, and what not. BM During the Idea Generation process of our project I encountered many ideas for the first time. Thus I learnt that digital innovation is truly an all-encompassing field of study. MH Empathy maps helped me understand what exactly African Hair Kingdom and other businesses' customers look for and expect from the business. This applies to potential customers and current customers who are the most important stakeholders of the business. I also learnt that an empathy map is the key to getting to know your audience because it allows business owners to shift their focus from product-oriented production to customer-oriented production. TT I was already getting a hang of the content slides because there was a voice note provided in each of the slides. You could say it is a lecture before a lecture and I admire this teaching method. DW
S02	
S03	During the course of the whole assignment preparation I have grown interest [sic] in programming, After learning that our group could not provide an application for our client, I have started looking at many ways to develop an application and I am in the process learning about HTML. KM In class we reflected on the meeting and prepared the ideas for her business including a website, business cards, invoicing systems and biometric systems for onsite workers. I also learnt more about front end web development in my own time while working with HTML, CSS and Javascript. This was done through treehouse.inc. TR
S04	Team work is great and more productive when all members make an effort. MB So whilst interviewing the owner of the company we met an ambitious, independent lady but the most interesting part in the interview was her willingness to learn from STUDENTS, she did not make us feel inferior she actually listened and took our advice even though she is an educated established business woman. KB The meeting went well, we got all the answers we needed for the Project initiation. Now the real work was in motion, the group went through so many arguments and many disagreements in the process of completing the assignment and preparing for the presentation. At the end we all did our tasks and completed the assignment together with the presentation. KM In class, we had to sit in our groups and this was competely [sic] fun and one would enjoy the class when we are supporting each other. TR "Working in groups will be an essential part of my career in the working world of project management, and when 1 person in the group fails, we all fail together as a group. Group works are all about the members being active as a unit!

	That is why it is so important that we lay ground rules and communicate about those rules so that we are all on board… and no one gets left behind." TG Even though I do not enjoy working in groups, I had amazing group members. We helped each other and made sure the task was completed before time. DW I will leave that for everyone to crack their head and think hard about it. In an effort to help human beings, other human beings have developed personality tests which assist people in discovering who exactly they are and how they operate psychologically. TT Suppose you were a person who learnt to enjoy their own space and in most cases, prefers to talk less when around people, and most times whom you not comfortable around. You tried every method to be a seen [sic] social person as carefully as you could, until when least expected in all your experiments and trials, a platform is given to you and you just notice as time goes and things are happening. Additionally, this has been the case for me when it came to IFS341, being more of voicing my own thoughts, views and values with confidence amongst my team and some of my class mates. Moreover, a leadership role had been offered to me as I had never before wanted to take one as I had struggles [sic] of delegating and voicing my thoughts. XS
S05	Innovatively I acquired this skill by actually doing hands on work, for example actually learning how to develop someone's business using the knowledge we acquired in class and actually thinking outside the box on bringing new ideas that can make a business profitable💰💰💰 BM The part I did not enjoy was when one member undermined, other member's ideas. ZG Personally, I think that this course requires each and every one to think out of the box and be very creative. DW At the end of all the presentations I learned that when brainstorming innovative ideas, go all out and don't worry ourselves with finances and feasibility just yet. Just think and be creative! ME I enjoyed most the fact that we had to think outside the box and we had no limitations when brainstorming. The solutions to the company's problem had to bring value to the business but also considering the capacity we have as full-time students. After all was said and done, a final solution or conclusion was reached by funnelling all the ideas. TT
S06	What I enjoy the most and interests me the most is that the course challenges me to think out of the box and to constantly find new solutions to problems that some organisations are facing on an operational level. BM I have also bettered my problem solving skills through this module. LN Moreover, gaining an insight on how learning is, as a process, meaning that I have been given the importance of seeing every fail or fall as a chance to do better next time. XS What is important is what you do to get back up after failure hits you hard in the face. Although it is difficult to comprehend, failure should be treated as a learning curve that motivates you to get back on track and move forward. KH
S07	As the classes progressed I was enlightened on the importance of information systems and the vital part it plays especially in the 21st century for organizations. BM This week was all about me learning to be accountable for my own life and that contingency

	plans are very important when there are important events involved. So for instance risks are everywhere no matter how big or small provision must always be accounted for to beat those risks; always have a PLAN B! KB When I started my final year, I had the same mentality that lectures would be boring and not interactive, but surely my Information Systems lecturers proved me wrong. Being part of the Information Systems department has provided a fun and exciting journey of learning. The lectures I attend this year have been second to none. TT This module allows me to tap into my strengths namely problem solving, being a team player, communicating and organizing. LN My biggest dream and vision is to change the way SMEs run their day-to-day operations and provide them with IT systems to better their operations, as I feel that it is the SMEs who really empower the people and the economy. TR One I know for sure is that I am not going to work for someone else my entire lifetime. I know that the little I have in my hands is enough to take me where I want. All I will need is the passion and dedication to follow my dreams. That much said, let me brief everyone on what took place during this week. I also figured out that my present determines my future and I should be responsible in every part of my life so that regret does not eat me alive. AS It is about understanding what your client wants, both inside and outside of the business and providing them with exactly that. Truly a valuable lesson, especially because I would love to venture into business in the future. SL
S08	Lastly I learned or acquired interpersonal skills in the sense that in class for example we have different people of all races and ethnicity. In order to have a comfortable learning environment, I had to understand, view and feel how the next person in [sic] thinking, and how to handle conflict especially. That is in new skill I can say is a game changer for me. BM She also made us take the EQ test. This test was so informative and insightful as we learnt that we are not always correct in our approach. AB I think knowing your type of emotional intelligence or the way in which you handle situations can go a long way in finding what you need to improve about yourself, how you approach others and how you justify your actions. It is important to have an understanding about yourself for peace of mind and to enable you to find your life purpose or life path. MB I also found that I learned a lot about myself as a person doing personality tests and emotional intelligence tests. MH I found our brief touching on the area of emotional intelligence to be interesting. It's a very interesting concept that provides us with an understanding of our awareness, control and ability to express our emotion, as well as handle interpersonal relationships with good judgement. We conducted EQ tests in class, and online in order to see how emotionally intelligent we were. ZI During the week, the week of week 7 to be precise, I actually learnt about something new and rather interesting, our lecturer taught us a little bit about Emotional Intelligence, also known as EI. I was never really familiar with the term before this class, I think it was actually the first time I hear about it. AS Caro also had in store for us an emotional test (EQ) which is something I never knew existed before that week's class. From what I gathered from that test, I learnt that emotions enable

	people to make good and rational decisions in organisations and life in general. TT I have a huge feeling that at the end of this module, I'm going to come out the other side of the pool an improved specimen. ME
S09	I acquired the skill to listen to what the next person has to say and actually view things from someone's perspective and ideology. This has improved my life drastically as I now am able to actually take in criticism without taking offense to what was said. BM I really admire and applaud her and other women who are doing great in an effort to tackle the high unemployment rate in South Africa. This motivation I derived on top of the motivation I have already will surely take me to my goal of becoming an entrepreneur someday. MH The business is something huge and it is in our (team's) hands, the business change literally has an effect on the owners life plus the lives of her employees and clients … Imagine how much more we could change other small businesses and literally end up changing the entire world of small businesses. TG I must say, it is really cool that we will work with real world companies and actually help them become better versions of themselves. Golden Rewards 1981 is the company we're going to be working with and I'm very excited because we already have a bunch of ideas to wow our 1st ever client. ME
A01	I am now even more hungrier [sic] than I was before and I have discovered that in the next decade I'll be a proud owner of a virtual restaurant, all thanks to the knowledge I have gained from having to actually do a project for an existing business, bring about improvements and gain both academic and interpersonal skills from presenting in class and to the business itself. BM I enjoyed meeting up with the owner of the company because she was quite inviting but most importantly, I had my first meeting with an established business person, was excited and nervous but because of her personality she put me at ease. Being able to give advice made the whole studying process at university purposeful because I would like to be in her position in future. KB Meeting with the organization, we as the project team were able to identify the problem areas in the business, together with the owner and assistant. After the meeting with Golden Rewards we as a group could sit down and brainstorm on ways we can help this company achieve their full potential. SH It will not come closer to the real world of work, without it actually being the real world, than this. MH Lastly, the meeting was interactive and very mind opening … in the sense that … this was not just some pretty little assignment, but actually it was more about changing the business for the better into techno-friendly organization and how the business could accept that change and the clients of course. TG The environment involves interacting with your fellow class mates through group work and presentations. I would not change a thing about this learning environment as I feel it produces positive results. It also makes a student want to work hard and for me it makes me want to learn new things every day. It's one of the best lecture environments I've been in. DW

A02	The lecture environment taught you to think on your feet and actually think beyond what you were taught in class. I enjoyed the presentations and in class discussions. I would not change anything in the lecture or style of lecturing, it's in line with what the business world will demand of us. BM The lecture environment is very interactive and practical. The method works very well because one can actually see how the work is implemented. KB This module enables us to interact with the real world while studying and getting the sense of how it really works out there The lecture environment is quite stable in the [sic] sense. I am lucky in being part of a lecture class where we can interact with each other, where lectures groups are small enough to give each and everyone the attention they deserve. SH "Throw them in the deep end". If I were to guess, I'd say that is the mindset Caro – my Digital Business Innovation lecturer – has for us this semester. ME
A03	I enjoyed the part where we had to put the clients perspective about the business we choose (J9 wine) onto the Empathy map. Also were [sic] the lecture will come and explain to us other parts we did not understand. I had a clear understanding about the empathy map when we did it practically. ZG The method of delivery used by the lecturer is excellent, the slides provided is [sic] very informing and appreciable, they are the first set of PowerPoint slides I've ever received with audio clips attached to it. They are very innovative; I enjoy listening to them and reading them very much. The group work thus far is great, allowing me to practice [sic] my teamwork skills, communication skills, while also enabling me to exercise my presentation skills and innovativeness/creativity, and allowing me to do some real work with a real company. KU The most interesting part of Digital Innovation was that I could brainstorm any technology idea without limiting myself and also knowing that building of any brainstormed idea into a final product is pretty much possible. Although my group members and I were not prepared for the presentation, I really enjoyed testing my own confidence and my ability to grab an audience's attention. TT
A04	IFS 341 really made me a better individual and scholar. The group work and presentations were a nice way to break the ice between the class [sic] as well us make us better teams. This really sharpened our people skills. I really loved IFS 341. I wish every subject was like 341. AB The part I enjoyed the most during the previous few weeks was the peer review assessment. The reason why I enjoyed it was because we were given the freedom to evaluate and judge other people [sic] work as we saw it. It made us aware of the way in which our work and assignments will be officially marked, but also allowed us to provide our fellow students with advice and recommendations about their work, as well as suggestions on what to specifically improve. We were also able to see our mistakes from other group's perspectives, and get extra advice and recommendations and where our assignment needs to be improved. ZI For the last couple of weeks, I've become more used to working in a group and presenting our work to the class after every lecture. It's definitely an interesting way to gain knowledge from your peers and also have the opportunity to grade and criticize their work and, as a class, brainstorm ideas on how they can improve on their work. KU The fact is that everyone makes mistakes thus the aim of this exercise was not to embarrass anyone but rather for each group to correct and improve on their mistakes. DW The perception I have for the lecture environment is awesomeness all the way. There was

	never a day when I did not enjoy class because there was interaction with the lecturer and other students. The lecturer was always helpful and I felt free to ask anything concerning the course and some life matters. The lecture venue was the only problem and it was stuffy at times, so there should be an improvement with the air-conditioning. Breaks should have been included between the lecture sessions for students to get their concentration levels back up. TT
A05	During the lecture, I enjoy doing activities that uplifts ones [sic] capability and to continue knowing how you influence other [sic] and how they help you see beyond your own capabilities MB Another lesson was to be prepared for each lecture and the solution for that was to be proactive and prepare for the lesson. This course consists of group work and when a group have chemistry then high expectancies can be attained. The last lesson that I think is most important is to turn every obstacle into an opportunity to strive for success. KB The lecturer used the space which allowed as to be creative and be free to express our feelings and be ourselves. A space to grow and become better than we were. The lecturer knew what she was lecturing about, and wanted us too, to see the big picture of the module itself. I would not change anything in her teaching style, she is good and I hope we make her proud at the end of the year. ZG I enjoyed the way in which the class was conducted by the lecturer and my fellow classmates. It was interactive and exciting and the only class I wish I could have attended every lecture. MH No class is perfect but I love how this one is structured, information sharing in class is divided between lecturer and students. One way or the other, students learn something every week and walk out of the venue having been positively influenced by either his/her peers or the lecturer. ME This course really helped me to get out of my comfort zone and engage to [sic] something different. I developed new skills especially presentation and team work skills which are vital for a working environment. DW I have always worked in groups, but the group work we did in this course was different to what I'm used to, it was much more practical and it reflected the work environment a little bit more than the usual group work we did. I think this is because this time we actually worked with a real business, which gave us a real professional feel. AS But besides all of that, my overall perception of the lecture environment is that, it was a very productive environment, and each time you enter, you can almost be certain that you will leave smarter than you entered. TT I have always had love for wine, but it is only recently that I have developed an interest in its making process and working in this project has really been eye opening. Talking to our client did not only provide answers for our project, but also to provide J9 with a website and empowered us as young people to look out for the opportunities that this career has and the opportunities that are out there for us as black females. KM
A06	It was my first time to blog and share my experience of how my class is evolving throughout and how I am progressing each week. Made me realize that I can be able to write [sic] about the things that are budding in my life and share it to the world [sic]. Blogging sharpens ones [sic] skills of writing and also how to be able to use different plugins and integrate them to create your website. MB

	The IFS lecture environment is extremely competitive and no one wants to be the sore loser, which in fact should push me, to work even harder to stay on top of my game, and achieve maximum success for myself! TG I had to learn how blogging work [sic], which wasn't quite a difficult task, as soon as I was done with the first blog, I kind of got the hang of things. This was one of the interesting tasks as it actually gave us an opportunity to reflect on the work we did throughout the semester. AS Blogging has taught me so much; I definitely will continue to do so. It is a space where I can express my views freely. I am happy here, which is what I strive for in this life, to be happy and content with all I do. SL
A07	To be honest departing from the lecture room and my fellow colleagues (students) took my hand when we were done presenting our presentation, it was a memorable moment and I really enjoyed that feeling when we received a standing ovation. KB Class was a very interactive experience with many presentations as well as questions being asked. Even though presentation is not my favourite form of learning it was still a constructive way to understand how to apply the concepts. TR Listening to the other groups present their businesses was enjoyable and informative. MH Although I have become better at public speaking I still find doing presentations every week a bit nerve wrecking [sic] this may not be to all students, however in my opinion I would have liked to have presentations every second week, as I feel it would put less pressure on students. TR She also had questions about how she could allocate funding to the resources she may currently need, and my team member ([redacted]) was more than willing to help direct her business with so much advice and most of all encouragement. My other team member ([redacted]) and I were completely swept off our feet, because we were surprised how much this guy knew about business innovation and what a genius he was. We were legit Business Analysts for about and 2 hours and it was actually supposed to be a 20 minute in-and-out meeting. TG I now firmly believe it patches the cracks left by the other IFS modules. The exposure to real-world clients forces professionalism in a student. Caro forces students to think and generate not one but multiple ideas, and most significantly, the module has forced us to get used to talking and conveying those ideas to other people and subsequently teaching us to get outside our comfort zone. ME I've become more used to working in a group and presenting our work to the class after every lecture. It's definitely an interesting way to gain knowledge from your peers and also have the opportunity to grade and criticize their work and, as a class, brainstorm ideas on how they can improve on their work KH The main reason why I do not like presenting is, I am very shy and do not enjoy speaking in public. However, as the lecturer always says we may hate her now but one day we are going to thank her. I totally agree with her because this skill is really needed in the working world. As I said earlier, even though I do not enjoy presenting, it was very beneficial to me in the sense that I am more comfortable presenting now. DW As usual, class presentations were nothing but exciting as we shared what we gathered about the company with the other groups. I have not encountered anything I do not enjoy

	with this module. TT One thing I learnt is that you need to learn to stand up for yourself. Especially if you are in a group with a lot of males. They tend to want to dominate, to take over and make the project theirs, and as females we are simply accessories that are there to do the admin. You need to learn to voice your opinion, make changes where you see the need to and not allow yourself to be bullied by your male colleagues, and that is what I take into the future. SL
A08	As a slow learner I was accommodated in class through a lecturer that turned to [sic] someone I now idolize. The way she teaches accommodated me and made me feel welcomed. BM Understanding each and everything taught in class has been easy, with the recordings that Caro made on the lecture slides. It gives me a chance to listen the lectures [sic] over and over whenever I would like some clearance [sic], unlike having to listen to a lecturer for one hour and not be able to recall everything. KM She was preparing us for when we really get shot down in the corporate world. MB I'd like to note that I think slides that come with voice notes on them are a life saver. I mean it makes a lot easier for us students to quickly get an idea of what the next class will be on and know where our understanding is lacking beforehand. ME From week two I started doing my pre-reading which made me prepared and ready when I attended the lecture as I would have had an understanding of the work already and not be the first time. It has now been three weeks and I can confidently say I know what is required from me individually and from my group on [sic] order to excel in this course. ZI The podcast made learning a pleasurable experience and the use of technology involved in this process is appreciated especially when one wasn't able to attend the classes. BM
A09	I feel like our lecture was a bit harsh with her marks but probably because she would like to see us improve. ZI We were never reprimanded on the way we saw a certain aspect or topic. This really made me grow as a person as my thoughts were not shot down, but encouraged and praised. I really like the environment that Caro taught us in. I honestly feel that campus should not just be about tests and exams, but it should rather be practical assignments where pupils can go out into the real world and figure out things for themselves. AB
TECH	More practicality, on how one make graphics n [sic] how to insert plugins, is what I would like to be added in future. MB Nevertheless, my limited technical skills can still be improved upon and online full-stack programming courses are a helping [sic] my career aspirations. ME Rumour has it that we are about to finish the semester, and we are apparently supposed to be getting ready for strikes soon. Well, let me tell you something interesting, our lecturer Caro, has more than prepared us for any possible strike action which may take place, and guess what?? We are almost done with our assessments, and not only that, we have been using the GoogleDrive platform quite a lot, and that means, if and when we have to engage online due to strike action, we will be well prepared to do so. AS

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Appendix 8

Industry Partners, Iteration 4

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1. OVERALL SCOPE OF PROGRAMME

Collectively with our partners, we believe brands that will endure are those that will be measured against their worth to society. The economic potential of South Africa faces many challenges but needs to be proactively harnessed through an integration of role-players aligned to the intervention of government. We believe our Accelerator Programme focused on women entrepreneurs from marginalized communities will assist our corporate partners to not only comply with the new B-BBEE codes but will accelerate the growth of scalable businesses in our ecosystem.

Accelerating World-Class African Businesses

The 88 Business Collective Enterprise Development Programme supports women entrepreneurs holistically by providing:

- Quarterly Board of Advisory Meetings
- Monthly on-site support by a Retired Business Executive
- Regular workshops focussed on branding, finance, operations, using technology, marketing & sales
- Digital support through an app developed for this purpose
- Network support by encouraging the 88 entrepreneurs to support and buy from each other
- Regular awards and acknowledgement for top performers (media coverage)
- An ecosystem for the women entrepreneurs to grow through collaboration

There are various programmes focused on entrepreneurs but what sets the 88 Business Collective apart is that the programme offers Emerging Women Entrepreneurs continuous business development support over an 18 month period and a platform for accountability and a sounding board for making better business decisions. This is to ensure business growth by increasing revenue, improving access to markets and an increase in net jobs created as they expand their reach and product/service distribution.

PARTNERSHIPS:

We have secured the following organizations as strategic partners:

- ABSA, Western Cape sponsored our launch and continuous to be a strategic partner.
- PwC and Webber Wentzel will provide professional services to our Collective over the 18-month period.
- Wesgro and the Black Management forum are strategic partners in providing u access to women entrepreneurs on their database.

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2. PREMIUM PROGRAMME PROFILES

Mampho Sotshongaye

Founder and Managing Director: Golden Rewards 1981

I founded my company 2010 while I was working as a Contracts Manager and I left the company April 2012 to focus on my business with the aim of providing better quality on our roads using 99% local labour. I specialize in routine road maintenance and vegetation management. We pride ourselves in using state of the art construction and maintenance techniques. Our focus is on being competitive, innovative and to offer our clients' superior service and our employees a pleasant working environment and opportunities for growth. We are building tomorrow, today.

Nomaxabiso Precious Kyriakides

Founder and Managing Director: African Hair Kingdom

I started African Hair Kingdom nine years ago as a hair salon offering a wide variety of extensions, wigs and hair accessories, supported by a team of experienced stylists. My passion for natural African hair grew immensely over the years based on personal experience especially with my kids so I turned this passion into a product line. I appointed a team of formulators; trichologists, technicians and stylists to develop a total hair care system for dry to very dry African hair. We consulted our valued clients every step of the way during development and believe our product range addresses natural hair challenges faced by so many Africans. We proudly launched Afro Pride natural hair products in 2016 and it is an exciting new addition to the African Hair Kingdom family.

Suraya Williams

Founder and Managing Director: Design Twenty-Six

With 14 years' experience in the corporate environment, I started Design Twenty Six in February 2013 as a legacy to my late mother. The name Design Twenty-Six resonates to my birth date and the amount of garments we produce per style in order to keep it exclusive. I manufacture from home in Mitchell's Plain and sell my garments at a shop in Philippi Village. For our special occasion dresses our customers contact us for an appointment, which is conducted from home in Mitchell's Plain. My vision is to transform Design Twenty Six into a significant business enterprise that delivers superior value to our customers, employees and Mitchell's Plain at large. Our garments are designed to meet our customer's look and tell her story. We will be Mitchell's Plain's most preferred boutique of in-house manufactured designer labeled clothing and custom made dresses providing confidence and status to our target market.

Olivia Nocawe Ngweni

Founder and Managing Director: Thembela Kuthi Staffing Services (Pty) Ltd

The name of my business means trust in us. I started my entrepreneurial journey after I was retrenched in the corporate sector. Over the past 16 years I have gained extensive experience in placing black talented and qualified candidates nationally. I completed my studies in Human Resources and Business Management. I am the previous Provincial Executive Committee of SAWEN and passionate about people and entrepreneurship. I am growing my business by increasing our customised and cost effective service offering in human resources development, labour relations and facilitating People Management, Entrepreneurship and Consumer Financial Education for the NGO's, Small, Medium and Large companies.

Janine Petersen

Founder and Managing Director: J9 Wine

The J9 wine range was founded by Janine Petersen who decided to turn her passion for wine into an iconic brand. After having worked extensively with big names in the wine industry of South Africa, Janine ventured into creating the J9 range. With research, she increased her knowledge of the wine industry and received support from industry players to embark on this venture. Sourcing wine from across the coastal region and working with only the best wine makers. As single mother of two, Janine is proud to be one of South Africa's youngest Black Wine Brand owners. "I have achieved what many women in my community can only dream of however my goal is to show them that is it all possible through hard work and perseverance.

Lungisa Haai

Founder and Managing Director: Lungista Guesthouse

Lungisa Haai is the Owner and Director of Lungista Guesthouse in Summergreens, Cape Town. Lungisa always loved accommodating and entertaining visitors at home and she turned this love into a business. She registered Lungista Guesthouse in February 2015 and converted her home into a guesthouse. They have hosted visitors who are on contract Johannesburg, Durban and Pretoria and university students coming to Cape Town to play sport. The guesthouse has also hosted continental visitors from Nigeria, Angola and Tanzania. They have a catering unit which specializes in African cuisine for guests at their request as well catering for corporate clients. You might arrive a stranger at Lungista Guesthouse but you will leave a friend.

Ziyanda Manzana

Founder and Managing Director: Manzi Quantity Surveyors

Manzi Quantity Surveyors, a professional consulting firm established in 2008. Manzi Quantity Surveyors is proudly South African and 100% owned by Ziyanda. The members of the company are registered Professional Quantity Surveyors with the Council of South African Quantity Surveyors and are also Professional Members of the Association of South African Quantity Surveyors. The firm has been established with a dynamic approach of recognising project specific needs with the commitment to service excellence in meeting the basic need of the quantity surveying services of providing value for money on behalf of the client.

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Appendix 9

Student Survey, Iteration 4

A copy of the questionnaire can be viewed on this url: https://goo.gl/forms/8dOfNd8F9NwfQJne2

Appendix 10

Rubric, Final Assignment

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FINAL REPORT RUBRIC

Criteria	5 (for total of 5) or 9 to 10 (for total of 10)	4 (for total of 5) or 8 to 7 (for total of 10)	3 (for total of 5) or 6 to 5 (for total of 10)	2 (total of 5) or 4 to 3 (for 10)	1 (total 5) or 2 to 1 (for 10)	Group mark	Total
Layout	The report has a clear table of contents, introduction, main body describing the sections, conclusion and references. Correctly apply referencing	The report has a clear table of contents, introduction, main body describing the sections, conclusion and references. References in main body are not correct.	The layout does not follow the stipulated specifications, is difficult to read and certain sections are incomplete.	All the required sections are not covered in the report.	The report is incomplete and does not follow a logical sequence.		5
Relevance of information	Information is highly informative and relevant. The reader is captivated by the information.	The report contains relevant, up-to-date information that informs the reader.	The information is correct and understandable	The information does not inform the reader and is poorly portrayed.	There are errors in the report insofar as information quoted.		5
Executive summary	One page clearly describing entire project. Well written, concise with an excellent overall description.	Good summary of project, some information not included.	The report has an average discussion about the final project. Lacks comprehension.	Poorly executed, exceeds page limit and limited comprehension.	Poor quality with limited insight.		5
Receiving feedback	Excellent reflexive account of how feedback was used to improve final product, what was helpful and not helpful and what was used to improve product.	Main issues of how feedback was used to improve product are evident and reasons provided for how feedback was used.	Use of feedback to improve product is evident.	No account of how feedback has been used to improve product.	No improvement of final product.		5
Product implementation phases	Group has a thorough understanding of the different phases and describes each Sprint comprehensively.	Group has a good understanding of the implementation but some Sprints are not fully explained.	Group did not produce enough evidence to show the result of each Sprint.	Group has a limited understanding of the overall implementation.	Poorly executed with limited information on implementation.		10
Overall result of final	Well-executed project with an excellent,	Well-executed project with a working product	Well-executed project, final	Project completed but no final product	Poorly executed, no		10

implementation	workable final product implemented.	implemented.	product missing some elements.	implemented.	evidence or workable product.		
Business benefits	Connect the business goals and objectives to the specific performance realised from the implementation of the final project.	Link between the business goals and objectives and performance expectations not immediately clear.	Cannot link the business goals and objectives to performance of final project implementation.	Limited evidence of a link with business goals and objectives.	Poorly executed with little evidence of any benefits to the project.		5
Design thinking	Excellent execution with clear rollout of entire process, with examples, graphics and prototypes included.	Good theory but missing some credible evidence in certain phases of the rollout.	Lack information about the rollout and limited evidence in certain sections.	Poorly executed, not clear how process was rolled out.	No examples, graphics or prototypes included.		10
Scope	Excellent execution, clear demarcation of in and out of scope, aligned with goals and objectives. Future plans clear and guidance provided for rollout.	Can clearly understand the scope of the project and good logic in the inclusion of out-of-scope aspects. Future plans not immediately clear and understandable.	Contains what is in and out of scope but missing some logic and link with project goals and objectives and future plans.	Difficult to understand and interpret.	Poorly executed, cannot understand logic and reasoning.		5
Risks	Excellent execution with risks clearly categorised, cannot fault logic and reasoning.	Good execution with risks categorised, but some risks are not immediately clear.	Risks not clearly categorised, lacks some logic	Not enough risks listed and problems with categorisation.	Poorly executed, with limited reasoning and logic applied.		10
Communication plan	Excellent execution, with clear demarcation of stakeholders and methods of communication for each. Contains evidence of communication during project rollout.	Good execution, with all stakeholders included and communication platforms applied. Lacking some evidence of communication during the project rollout.	Average execution, with most stakeholders included. Lacking evidence of communication during rollout and logic in the execution.	Not enough evidence provided and missing information and logic.	Poorly executed, with limited evidence provided.		10
Training plan	Excellent execution with clear guidelines on resources, schedule, delivery plan and overall	Good execution with clear guidelines in place, but lacks some clarity in schedule or	Average execution with clear guidelines in place, but missing certain important	Not enough information and clarity in terms of the overall	Poorly executed, with limited evidence provided.		10

	execution.	delivery plan and overall execution.	areas of the overall execution.	execution and rollout provided.			
Lessons learned and team contribution to final product	Insightful and meaningful content provided. Clear evidence of learnings from all team members and overall contribution to project rollout.	Good execution, but some reflections are missing credible insights and learnings.	Average execution, with information being repeated and lacking insight.	Evidence of learning not sufficiently provided.	Poorly executed, with limited evidence provided.		5
Correct grammar, spelling, punctuation, and language	Could not find errors and report was easy to read and understand.	Few errors, report easy to read and concise.	Few grammatical and spelling errors, but some sections were more difficult to read.	Some grammatical and spelling errors. Report was difficult to read due to the use of language.	Very difficult to read and made many errors.		5
Total							**100**
Further comments							

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Appendix 11

Detailed Course Design: Themes and Topics to cover

COURSE DESIGN

2nd Semester Digital Business Innovation

THEME	TOPICS	SUB-TOPICS	LEARNING OUTCOMES	NBR WEEKS
Introduction to Digital Business Innovation	✓ Major digital technologies ✓ The concept of digital platforms and the emergence of new business models and new products and services ✓ Strategies of successful companies which have used digital technologies to get sustainable competitive advantage ✓ Theories on innovation in the context of digital technologies and contemporary economies ✓ Industry partnerships	✓ Business innovation in contemporary economies ✓ Digital disruptions and the impact thereof ✓ Case studies of successful digital disruptors ✓ How innovation can transform businesses ✓ Learn to think like a digital innovator ✓ IT-enabled business trends for the decade ahead ✓ The scope of innovation, and factors driving successful innovation. ✓ Introduction to industry partners ✓ Team formulation and industry partner selections	✓ Complete questionnaire 1 and submit results via Google Forms ✓ Present findings from case studies to showcase potential digital innovations and the impact thereof ✓ Critically analyse components of the digital economy and apply knowledge in a project	1 week
Business Models	✓ Application of the business model canvas ✓ Understanding your business and incorporating the business model canvas ✓ Different sections in a business model and the logical sequence of analysis	✓ Business transformation using innovation ✓ Identify innovation opportunity ✓ The Business Model canvas and application thereof ✓ Bimodal business planning ✓ The digital business model and application to traditional business models ✓ Barriers that can impede the implementation of digital innovations and tactics for overcoming those barriers ✓ Barriers ✓ Value proposition canvas	✓ Participate in the planning and implementation of digital innovation in organisations ✓ Apply the taught models, methodologies and techniques in consultation with organisations to implement a digital innovation project ✓ Manage a project within a client environment, with a focus on timely implementation, change management, efficient team work and effective communication	1 week intro 3 weeks initiation planning

		✓ Application of business model canvas to industry partner and present findings		
Agile and Design Thinking	✓ Introduction to agile methodologies ✓ Deep dive into Scrum ✓ Design-thinking methodology ✓ A framework for Design Thinking and Agile	✓ Agile manifesto, process, teams, purpose, benefits ✓ Agile and Scrum and why use Scrum ✓ Practical applications of Scrum and link to industry projects ✓ Scrum teams ✓ Design thinking steps ✓ Present ideation exercises ✓ Application of empathy maps and personas ✓ Release strategies applicable per project	✓ Critically analyse components of the digital economy and apply knowledge in a project using Scrum methodology to follow a design-thinking approach during the rollout ✓ Participate in the planning and implementation of digital innovation in organisations ✓ Apply the taught models, methodologies and techniques in consultation with organisations to implement a digital innovation project ✓ Manage a project within a client environment, with a focus on timely implementation, change management, efficient team work and effective communication ✓ Implement digital business innovation in a business	1 week intro 8 weeks rollout
Into the Future	✓ The Lean Startup ✓ Workers of the future ✓ Scenario planning ✓ Emotional intelligence ✓ Ethical leadership and business practices	✓ Incorporate elements of Lean Startup within project environment ✓ Digital future and impact on people ✓ Artificial intelligence ✓ Virtual reality ✓ Man versus machine ✓ Machine learning ✓ What is scenario planning and conduct scenario-planning exercise with industry partner ✓ Students need to conduct EQ tests and report back on findings ✓ Quizzes on ethics and ethical practices in business to test the overall scores and then talk about findings	✓ Critically analyse the future of chosen industry ✓ Perform scenario-planning exercise in collaboration with industry partner ✓ Present findings and critically analyse peer reports ✓ Individual presentations of findings on EQ and ethics	2 weeks

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Appendix 12

Presentations on principles shared with professional networks

10th Annual University Teaching and Learning Higher Education Conference, 26 August 2016, Durban, South Africa, Petersen, F & Van den Berg C (2016). *"Improving the design and delivery of Information Systems undergraduate course design*".

Education Student's Regional Research Conference (ESRRC) Conference, 2 September 2016, Cape Town, South Africa, Van den Berg, C. *"A new framework to teach digital business innovation to Information Systems students".*

University of Western Cape EMS annual research week, 3 October 2016, Cape Town, South Africa, Van den Berg, C. *"A new framework to teach digital business innovation to Information Systems students".*

4th Annual South African Research Association Conference, 24 October 2016, Cape Town, South Africa, Bozalek, V, Van den Berg, C, Collett, K, Verster, B & Mohamed, S. *"Processes involved in developing Design-based Research in Teaching and Learning Courses".*

ICED and HELTASA Conference, 22 November 2016, Cape Town, South Africa, Van den Berg, C. *"Enhancing the Information Systems curriculum for a digital economy. A case for authentic learning to teach digital business innovation to Information Systems students".*

Research for enhancing Teaching and Learning PGDip Teaching and Learning, Stellenbosch, South Africa, 20 February 2017, Van den Berg, C. *"A new framework to teach digital business innovation to Information Systems students".*

New academics' transitions into a complex HE context: challenges and opportunities, 4 May 2017, Cape Town, South Africa, Van den Berg, C. *"A new framework to teach digital business innovation to Information Systems students".*

University of Western Cape Research Week, 4 September 2017, Cape Town, South Africa, Van den Berg, C. *"A framework to teach digital business innovation to Information Systems students".*

University of Western Cape Teaching and Learning Week, 4 September 2017, Cape Town, South Africa, Van den Berg, C. *"A framework to teach digital business innovation to enhance entrepreneurial skills".*

Higher Education Learning and Teaching Association of South Africa (HELTASA) conference, 21 November 2017, Durban, South Africa, Van den Berg, C. "*Future proofing the curriculum: Design principles to embed digital innovation skills in the Information Systems curriculum".*