Towards a knowledge conversion model enabling programme design in higher education for shaping industry-ready graduates

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Abstract. The increase in the request for competent, skilled Information Systems graduates has prompted higher education institutions to adapt learning strategies. One way of achieving this is through the application of knowledge conversion processes transforming data to capability. Knowledge conversion processes can be utilised to optimise learning in higher education institutions. The purpose of this study is to propose a knowledge conversion model grounded in educational theory and organisational theory within a real-world context. The model was applied to an Information Systems undergraduate programme at a major higher education institution in South Africa. It was established that the Information Systems programme conformed well with the principles of knowledge conversion as it enabled industry-ready Information Systems graduates. Furthermore, the knowledge conversion model can be utilised as a blueprint for programme design as well as identifying potential gaps in existing programmes.

1 Introduction

Upon graduating, alumni need to make a positive contribution to the commercial environment packed with dynamic problems and opportunities [1]. The dynamic problems and opportunities are partly created by ubiquitous computing where most systems are computerised. The design, development and implementation of these computerised systems increased the demand for aptly trained Information Systems graduates or "*Informaticians*". This demand has placed increased pressure on higher education institutions (HEIs) and educators to improve their educational practices in order to deliver students that are "ready" to operate in the real-world [2].

Rapid changes in the commercial environment, changing industry demands, new market trends and changes in technology have a direct impact on how effective students can learn and how effective they will be in the workplace [3]. Many educational teaching methodologies have been adopted and tested to respond to the educational challenges associated with preparing "real-world ready" [4, 5]. Some of these methodologies are teacher-centred, while others are student-centred. All of these methodologies share the same goal, which is to provide learners with the best education and knowledge as possible. However, this knowledge is not static and when considering *Informaticians* in particular, the field of system analysis and design (SAD) is dynamic and continually adjusting to the needs of organisational information systems [5]. Flexibility is needed in the field to ensure that students are learning new methodologies and the techniques necessary to deliver a product that meets the needs of industry, the client [5].

Therefore, the purpose of this study is to ensure that industry ready graduates are shaped by applying a model for knowledge conversion facilitating programme design in HEIs.

The remainder of the paper follows the following structure: in section 2 we provide the background to the study presenting the creation of different types of knowledge and learning [6, 7]. The background provides an overview of the learning process hierarchy [8], Bloom's taxonomy of learning [9] and the knowledge conversion and learning processes [10]. The approach to this study is discussed in section 3 where after we explore the relationship among education, learning and knowledge conversion processes and propose an education knowledge conversion model in section 4. In section 5 we complete a mapping of an Information Systems degree to the knowledge conversion model for education in order to illustrate the proposed model's suitability for programme design. We discuss the findings and conclude in section 6.

2 Background

Higher education institutions deal with multiple challenges and resource burdens such as rising costs, funding problems and remaining at the leading edge of all subject areas [11, 12]. These challenges entice universities to seek relationships with industry in order to relieve societal pressure to show contribution to economic growth through education and knowledge generation [13]. The collaboration between HEIs and industry refers to the interaction between any parts of the higher educational system and industry aiming to encourage innovation through knowledge and technology exchange [11].

The main aim of HEIs, is to create new knowledge and to educate, while organisations in industry focus on capturing knowledge that can be leveraged for competitive advantage [13]. These pressures on both parties have led to an increasing incentive for identifying and developing collaboration opportunities that aim to enhance innovation and economic competitiveness at institutional levels through knowledge conversion between academic and commercial domains [8].

In the next sections we consider the nature of knowledge, as well as higher education institution-industry collaboration and in particular the relevance of knowledge conversion as an organisational prerogative in the education domain.

The nature of knowledge

The definition of knowledge has drawn a substantial amount of speculation in the literature [14]. Polanyi [15], a medical scientist turned philosopher, was the first to articulate the concept of two different, mutually exclusive, dimensions of knowledge, namely tacit knowledge ("there are things that we know but cannot tell") and explicit knowledge [15: 601]. Cognitive psychologists divided knowledge into declarative and procedural knowledge. Declarative knowledge refers to the descriptions of facts, methods and procedures that can be articulated. Procedural knowledge refers to motor (manual) skills and cognitive (mental) skills observable in actioning something [16, 17]. What these definitions make clear however, is that knowledge is a combination of various elements [17, 18].

Knowledge that has been articulated and formally recorded in document databases, knowledge bases, manuals, handbooks and program code is *explicit* knowledge [19]. *Implicit* knowledge, which is far less tangible than explicit knowledge, is knowledge in a person's internal state and refers to knowledge deeply embedded into an organisation's operating practices [20]. Implicit knowledge that is difficult to articulate is referred to as *tacit* knowledge and includes relationships, norms and values. In this instance the knowing is in the doing and tacit knowledge is therefore much harder to detail, reproduce or share [21].

Comparable to tacit and explicit knowledge, distinction is made between action-centred skills and intellective skills. Action-centred skills are developed through learning by doing. Intellective skills combine abstraction, explicit reference and procedural reasoning, making it easily representable and therefore easily exchangeable [22]. In educational theory, Bruning [23] suggests that knowledge can be procedural (action-centred) or declarative (non-action-centred). Procedural knowledge is implicit in this instance and declarative knowledge is explicit. However, learning of a procedural skill may access an explicit description, while knowledge on how the procedure is applied in a specific environment, may only be learnt through doing or socialising, pointing to implicit knowledge [23].

Irrespective whether education or organisations are considered, both must be able to accomplish the explicit-to-implicit knowledge and the implicit-to-explicit knowledge transition [24, 25].

The learning process hierarchy

The Mirriam-Webster Dictionary defines learning as (1) the act or experience of one that learns; (2) knowledge or skill acquired by instruction or study; and (3) modification of a behavioural tendency by experience (such as exposure to conditioning) [26]. What this definition makes clear is that learning essentially considers the combination of two different processes: an internal psychological process of acquisition and elaboration, and secondly, an external interaction process between the learner and the learner's social, cultural or material environment [27]. As both of these processes must actively be effected for any learning to take place, the stages are reflected in the learning process hierarchy (Figure 1) consisting of four layers: data, information, knowledge and capability [8]. *Data* consists of structured recordings of transactions and events and is presented without context [21]. Information is data with relevance and purpose added, and it expands the concept of data in a broader context [28]. *Information* becomes individual knowledge when it is accepted and retained as appropriate representations of the relevant knowledge. *Knowledge* comes with insights, framed experiences, intuition, judgement and values and encompasses the scope of understanding and skills that are mentally created by people [21]. The process of applying knowledge to solve problems, leads to *capability* [8]. Capability is an "integration of knowledge, skills, personal qualities and understanding used appropriately and effectively" [29:2]. Capability enables people to not only apply their knowledge and skills within different and ever-changing environments, but to also continuously develop their knowledge and skills long after they have left formal higher education, enabling them to take appropriate action within unfamiliar and changing circumstances [29].

The learning process in higher education is usually a bottom-up process and starts from the data layer, moving up slowly to the capability layer [8]. The purpose of the learning process is to engage the learner to develop their personal capability. The nature of the process, the content and context of the learning, the products for assessment each require some degree of growth in personal autonomy from the learner [29]. In this context, many scientists and teachers are looking for a more efficient path to capability [8].

In order to consider a potential more efficient learning process of progressing from data to capability, Bloom's taxonomy of learning and knowledge conversion and learning processes are discussed in the next sections.

Figure 1: Learning process hierarchy [8]

Figure 2: Bloom's taxonomy of learning [7]

Bloom's taxonomy of learning

In Taxonomy of Educational Objectives, the seminal work on learning objectives published in 1956, educational psychologist Dr Benjamin Bloom and his collaborators created Bloom's Taxonomy [9]. The purpose of Bloom's taxonomy was to promote higher-order thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts. Higher-order thinking was achieved by building up from lower-level cognitive skills [30].

Bloom's taxonomy includes a set of three hierarchical models used to classify educational learning objectives into levels of complexity and specificity namely, cognitive, affective and sensory domains [7]. Six levels, through increasingly more complex and abstract mental levels, within the cognitive domain were identified as depicted in Figure 2. The six levels, each of which is built on a foundation of the previous level, include *remembering* (recall previous learned information), *understanding* (comprehending what facts mean), *applying* (applying the facts, rules, concepts and ideas), *analysing* (separating material or concepts into component parts), *evaluating* (judging the value of information and ideas) and *creating* (design, combining parts to make a new whole) [7, 30]. Design in this instance is an outcome of the evaluation process which comes as a result of analysis. Therefore, evaluation leads to the main objective of the whole process which is to design (*create* in terms of the revised Bloom's Taxonomy) [31].

Learning strategies govern the approach for achieving learning objectives which in turn point towards the instructional strategies advising the medium that will actually deliver the instruction [32]. Specific learning objectives can be derived from the taxonomy, although it is most commonly used to assess learning on a variety of cognitive levels [9].

Knowledge conversion and learning processes

Knowledge and continuous learning are essentials of success in the new economy [33]. The management of knowledge is intrinsically connected to knowledge sharing between individuals, as well as to the collaborative processes involved [34].

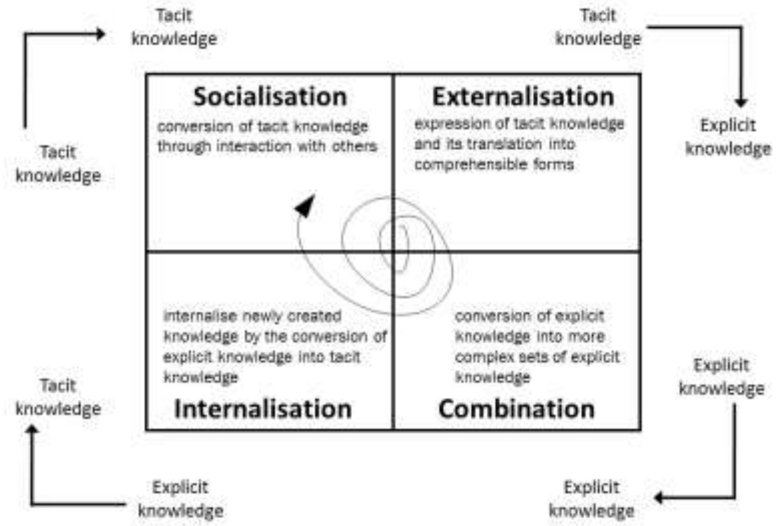

Figure 3: The knowledge conversion model [10]

Nonaka and Takeuchi [6] defined a model that is based on the fundamental assumption that knowledge is created and expanded through social interaction between implicit – specifically tacit - and explicit knowledge. This interaction is, known as knowledge conversion and it is referred to as the SECI model. The process of knowledge conversion advances through four different modes as shown in Figure 3: socialisation (tacit to tacit), externalisation (tacit to explicit), combination (explicit to explicit) and internalisation (explicit to tacit). *Socialisation* is the conversion of tacit knowledge among individuals through shared information and experiences by means of observation, imitation and practice. *Externalisation* is the process whereby tacit knowledge is articulated as explicit knowledge through collaboration with others using conceptualisation and extraction. Explicit knowledge is not only shared via document management systems, e-mails, in meetings, etc., but also through education, learning and training interventions. *Combination* is the enrichment of the collected information by re-configuring it or enhancing it by sorting, adding, combining or categorising it so that it is more usable. In order to act on information, individuals should understand and *internalise* it. This involves the process of creating their own tacit knowledge. The process is closely related to learning-by-doing through studying documents or attending training in order to re-experience to some degree what others have previously learned [6, 10].

An individual progresses through five stages in order to acquire new personal knowledge namely, researching, absorbing, doing, interacting and reflecting [35]. During the *researching* stage, an overview of the topic of study is observed. The *absorbing* stage follows where an incoherent and disorganised mixture of data and information are formed in the individual's mind while listening, watching, reading and sensing. The *doing* stage ensues, where different tasks are completed and actions performed in order to organize all pieces of information and connect them with each other with the outcome to form first knowledge. An individual's first knowledge is then enlarged during the *interacting* stage as own opinions are formed during discussions about the topic of study. The last stage is the *reflecting* stage during which newly formed knowledge is considered and evaluated in the context of other existing knowledge and personal experience, hence forming an individual's own unique world-view [35].

In spite of certain differences in the knowledge conversion and learning processes, the main idea of both processes is that personal knowledge can only be created by individuals on their own and that they follow particular steps to do so [36]. The background for creating knowledge is information and in order to create knowledge, an individual needs to observe a sufficient amount of information [24, 35]. In the next section we explore the research approach followed to design the knowledge conversion model for education, and how it may inform module design.

3 Method followed to design knowledge conversion model for education

Our overall objective for the paper was to design a knowledge conversion model for education supporting programme design. The purpose of such a model is to support programme designers to optimise learning by applying knowledge conversion principles and ultimately deliver graduates that can thrive in real-world of work. In order to achieve this outcome, we followed a design-based approach [37]. 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, and leading to contextually-sensitive design principles and theories"

[38:6]. Design based research produces both theories and practical educational interventions as its outcomes [39] and encompasses five basic characteristics [38]:

- Pragmatic – research goals are solving current real-world problems by designing and ratifying interventions as well as extending theories and refining design principles.
- Grounded – design based research is grounded in both theory and the real-world context.
- Interactive, iterative and flexible - in terms of research process, design-based research is interactive, iterative and flexible.
- Integrative – researchers integrate a variety of research methods and approaches from both qualitative and quantitative research paradigms, depending on the needs of the research.
- Contextual –research results are connected with both the design process through which results are generated and the setting where the research is conducted.

With these characteristics guiding our research, we built upon prior literature about knowledge conversion and education in order to create a knowledge conversion model for education with the aim to solve a real-world problem (pragmatic nature of our research). The knowledge conversion model for education is grounded in educational theory (learning process hierarchy, Bloom's taxonomy of learning) and organisational theory within a real-world context (knowledge conversion model for organisational learning, learning process). Our research approach was of a qualitative nature and the context of our research was higher education.

The study was conducted at a HEI in South Africa that offers a B.Com degree in Information Systems. This degree contains a multi-disciplinary subject area, where information, Information Systems, and the integration thereof into the organisation, are studied for the benefit of the entire system (individual, organisation and community). In order to apply the knowledge conversion model designed for education, we used the Information Systems degree and utilised the designed model for the mapping of the entire 3-year undergraduate degree, corroborating the interactive, iterative and flexible nature of our research.

In the next section we discuss the application of the knowledge conversion model for education to the Information Systems degree in detail.

4 Exploration of knowledge conversion in education

In order to consider a more efficient learning process of progressing from data to capability, we defined an integrated model utilising knowledge conversion, knowledge exchange and learning processes (Figures 2 and 3) describing the processes of progressing among levels in the learning hierarchy (Figure 1). The proposed education knowledge conversion model is depicted in Figure 4. The premise for the design of the proposed education knowledge conversion model is to apply knowledge conversion processes typically found in industry and to consider how it may guide course and module design in a HEI.

In order to progress from data to capability in the learning hierarchy, we propose the application of particular knowledge conversion processes where, with each knowledge conversion process, particular education programme enablers are associated with. In order to achieve the explicit-to-implicit knowledge and the implicit-to-explicit knowledge transition, we consider the data layer first [24, 25].

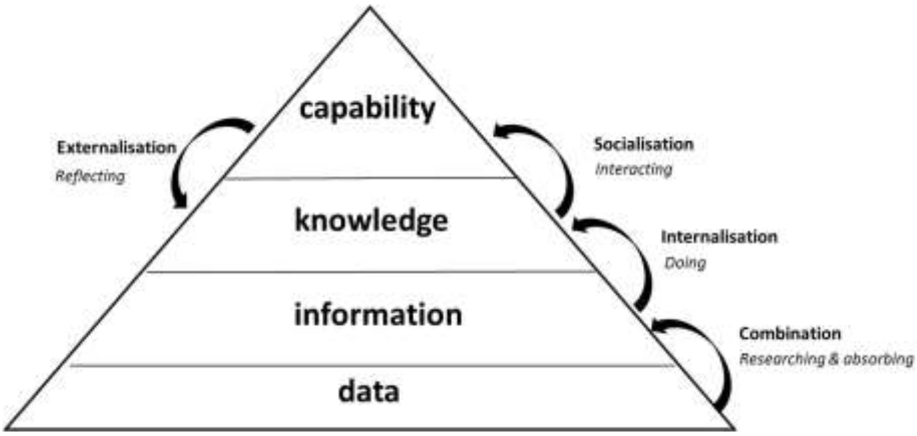

Figure 4: Proposed knowledge conversion model for education (adapted from [10] and [8])

The attributes of the data layer include facts, events, records, transactions, etc. without context and thus data has no meaning. It is a description of the world that represents discrete facts about an objective reality and as it can be verified, it can be decisively proven to be accurate or inaccurate. Data as such does not provide meaningful results and is the point of departure towards eventually reaching a meaningful outcome. In the context of a HEI the data layer refers to the learning of concepts, facts to be committed into memory, as well as quantitative measurements.

Information attributes point to data with relevance and purpose added as patterns in data reveal relationships. Analysis, categorization and explanation are attributes from a higher education perspective and in this context, refer to understanding and comprehending meaning. Therefore, moving from memory (data) to understanding (information), the process of combination may be applied as it enriches and enhances collected information through sorting and categorising it so that it is more usable. The outcome of combination is about understanding relations. Some educational programme enablers for the combination process from the literature are depicted in Table 1 and include lecture notes, textbook, book marking, flash cards, etc.

The knowledge layer deals with the fusion of multiple sources of information over time, in order to create conceptual frameworks. Furthermore, knowledge gives perspective through experiences, values, and insight and contains our beliefs and expectations. From a higher education viewpoint, application enables the use of a concept in a new situation e.g. apply what was learned in the classroom into novel situations in the work place. Thus, moving from understanding (information) to application (knowledge) the knowledge conversion process internalisation may be utilised as it is about linking concepts together into a network of ideas, beliefs, memories and forecasts. The outcome of internalisation is about understanding patterns. Some examples in Table 1 of educational programme enablers for internalisation points to simulations, experiments, project-based learning, fishbowls, debate etc.

The fourth layer is the capability layer comprising of the application of knowledge in order to solve problems. Capability talks to a set of principles, providing the ultimate context and frame of reference. From a higher education standpoint, new meaning or structure are built from diverse fundamentals using judgment and evaluation forming a whole. Consequently, moving from application (knowledge) to judgement (capability) the knowledge conversion process socialisation may be utilised where knowledge is conceded through practice, guidance, imitation, and observation. The outcome of socialisation is about understanding principles. Some examples in Table 1 of educational programme enablers for socialisation include consortiums, industrial, apprenticeship, hands-on experience, design labs etc.

Table 1. Education knowledge conversion model with enablers of educational programmes

Learning process step [8]	Level of understanding [40]	Knowledge conversion process [6]	Educational programme enablers - illustrative	Examples from the literature
Data to information	Researching & absorbing	Combination	E-mail, physical message boards, online message forums, gazette, lecture notes, textbook, book marking, flash cards, learning based on repetition, reading	[10, 24]
Information to knowledge	Doing	Internalisation	Lectures, workshops, tutorials, group work, homework, simulations, experiments, virtual reality, project based learning, e-learning, context-steered learning, blog, fishbowls, debate	[8, 10, 24, 41, 42]
Knowledge to capability	Interacting	Socialisation	Social activities, consortiums, industrial, training, apprenticeship, hands-on experience, design labs, incubation centres	[10, 11, 24]
Capability to knowledge	Reflecting	Externalisation	Orals, tests, examination, assignments, peer presentations, tutoring, peer learning, industry projects, co-operative research, community collaboration, academic spin-offs, mentoring, imitation, observation and practice	[10, 11]

An additional knowledge conversion process, externalisation points to the expression of tacit knowledge and its translation into comprehensible forms. When tacit knowledge is made explicit, knowledge is crystallized, permitting it to be shared with others, and thus forming the basis of new knowledge. Examples of the reflective nature of externalisation as a knowledge conversion process includes mentoring, imitation, observation and practice as depicted in Table 1.

5 Programme mapping to the knowledge conversion model for education

In order to apply the knowledge conversion model designed for education, we used the Information Systems degree of a HEI in South Africa and mapped the entire 3-year degree applying the knowledge conversion attributes of the model as shown in Figure 5. Each section (triangle) of Figure 5 represents one subject area in the Information Systems programme e.g. Critical Thinking & Problem Solving, Programming etc. For each section, the data, information, knowledge and capability hierarchy are depicted as layers with each layer containing the label relevant to that particular layer. Data elements are depicted by circles, while information is represented by solid dots. Once the knowledge layer is reached, application is illustrated by connecting the dots.

The undergraduate Information Systems programme offers a well-rounded balance of technical and business focused modules from which students can choose from. This particular Information Systems degree, is the only Information Systems degree in Africa that is internationally accredited by the Accreditation Board for Engineering and Technology (ABET). In addition, Bloom's taxonomy of learning [7] was utilised to derive specific learning objectives for the modules in the Information Systems programme.

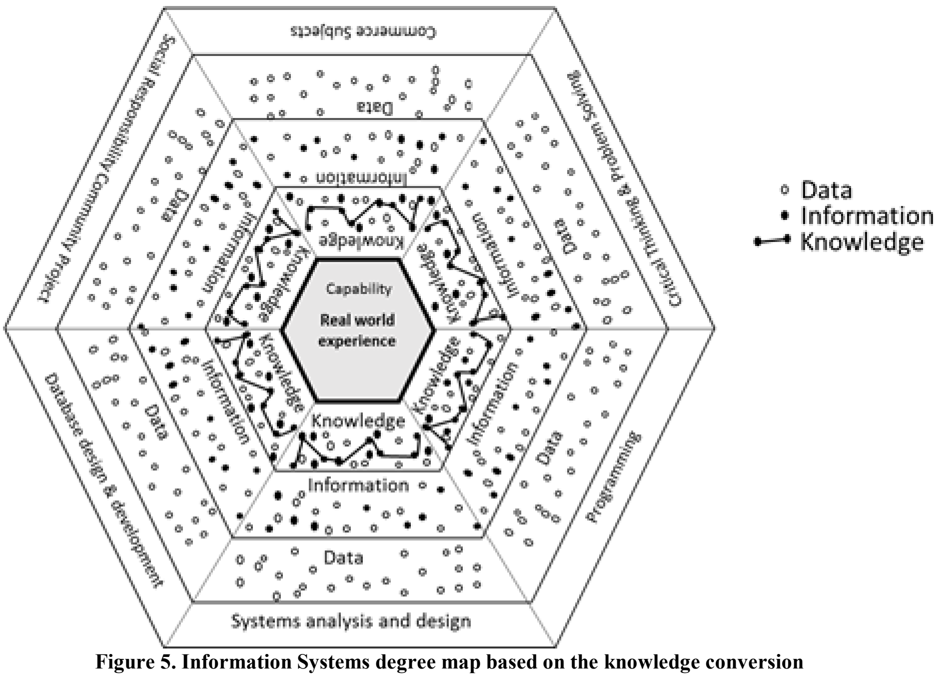

Figure 5. Information Systems degree map based on the knowledge conversion model for education

The Information Systems programme at undergraduate level is constructed in such a way as to give students exposure to three areas of development:

- Information Systems modules which includes systems analysis and design, programming and database design and developed on first, second and third year level. Students have a choice of Commerce oriented modules as electives which includes business management, accounting, taxation, statistics, internal auditing or marketing management. These modules are taken across all three years of studies.
- Students are compelled to do a community based project, usually in their second year of study. The project involves working in a team to solve a community project, based on project management principles, therefore on time, with available resources within a restricted (small) budget. The students need to report on their progress and their reflections of their experiences through digital reporting.
- Critical thinking and problem solving skills are introduced as a separate module in the first year. This module aids the student in different problem solving methodologies, argumentation and design process.

The learning process steps [1] for an Information Systems student is an iterative process up to where a student can internalise the knowledge obtained throughout his/her years of study. Therefore, every year the student gets exposed to new terminology (data) which he/she needs to make sense of (information) in order to apply it to a case scenario (1^{st} and 2^{nd} year) or real-life scenario (3^{rd} year Information Systems project, 2^{nd} year community based project).

Data to Information

Students are provided with a prescribed book and accompanying lecture slides. A combination of tools are used to support students in researching and absorbing the terminology associated with the various modules. The lecturers make use of the learning management system (Blackboard) of the university to communicate with the students. Students also have the ability to communicate among themselves or with the lecturer through a discussion board. Quizzes, focused on testing the understanding of discreet elements of a module, is part of the assessment plan. Students also need to do sign up for both weekly tutorial classes and practical classes where a number of data elements are combined in order to understand the relationships between these elements. For example, in systems analysis and design (SAD) module, after teaching students about the project management aspects of a new information system, students will complete elements of the scope of work in the tutorial sessions and construct a project plan in MS Project in their practical session. This allows students to “absorb” the elements of a scope of work, as well as force them to research different elements in a project. In programming, students are taught the basics of programming (Computer Science at school is not a pre-requisite), which includes the terminology, various programming structures such as loops, and methods. In the database module, students learn the introductory concepts associated with databases and are doing weekly practical sessions to combine different data elements.

Information to Knowledge

After students have combined the various elements of the particular study unit, students have to internalise their knowledge of the subject area covered. This is accomplished by "doing". In the first year of study, knowledge internalisation is accomplished by using a small case study. In the second year of study, knowledge internalisation is accomplished by doing a larger case study with full project management aspects. With regards to programming, students after their first year are able to create a Windows form based programme as well as a basic web based application with HTML, CSS and Javascript. At the end of their second year, absorbing the new terminology learnt, students are able to use the MVC model in web development, connect to a database, do object oriented programming and are able to create a complete client-server web based application. The database student do a general database design for a given case study. They further do normalisation to the 3NF for final implementation. In the second semester they learn about object oriented databases which compliments the object oriented analysis and design and programming.

Knowledge to Capability

Students have at least two opportunities to socialise their knowledge by interacting with the real-world. In the first instance students, as part of groups of 5 choose a community based project from a pre-defined list of projects for the year. This include projects such as repairing computers at disadvantaged schools, renovation and building at disadvantaged schools, teaching mathematics to students at disadvantaged schools and creating websites for non-profit organisations and disadvantaged schools. Service learning empowers students by showing them that they can make a difference in communities. Jordaan [43] reports that even though the "students' collective actions are not always successful, they learn from their mistakes by engaging in a continuous sequence of action and reflection". Therefore, these types of projects allow students to interact with real-world, apply knowledge learnt from modules, and life skills [43].

In the second instance all Information Systems students need to complete a final year project with a real-world client. The project is project managed by the students, from "understanding the problem" to designing and developing the system to installation and handover which includes training and user manuals. Students combine the skills learnt from the programme, which includes their business knowledge from the Commerce modules, with their own unique personal and professional interests to build and implement a computer information system in the real-life organisation. Students are assessed throughout the year-long project on various aspects such as project management, logical design, physical design, prototype development, data base design, and complexity of the system. An external examiner from industry examines each of the deliverables. However, as the creation of personal knowledge is an individual activity [36] students are graded individually as well as per group for their final-year industry project.

Capability to Knowledge

The externalisation of knowledge occur in four instances: firstly, reflection from students on lessons learnt when interacting with a real-life client, what they have learnt from the commercial environment, and how the experience can be improved for the following years' students. Secondly, industry feedback on their experience of working with the students, industry is becoming aware of the capabilities of soon to be graduates, thirdly the lecturers through the students' interaction with real-life clients, reflect on the business knowledge learnt from different types of industry advice and finally, through mentorship in the community based programme module where students identified as mentors share their lessons learnt with the newly established community project teams.

6 Discussion and Conclusion

Tepper [44] reported on the challenges associated with teaching SAD to first-year students. This includes (1) the need for students to develop analytical and inter-personal skills, and (2) students initially not really understanding the need for the module, which influences their motivation to learn. An added challenge in the SAD module is that future employers have certain skills in mind when they employ SAD interns or graduates. Saulnier [1] reported that employers still require students to have both soft skills (such as the ability to work in a team and solve problems) and hard skills that are organisation specific. The challenges experienced by the students, in addition to the requirements of future employers, make the Information Systems course complex for both the students, who have a steep learning curve, and the educator, who needs to adopt the correct pedagogy to prepare the students for future employment.

As indicated in the previous sections, students in Information Systems courses are challenged by course content that changes rapidly. Students need to stay relevant in a market where technology, methodology (techniques and approaches to develop new systems) and industry trends change quickly [1, 3]. Information Systems courses typically discuss systematic methodologies for analysing a business problem and deter-mining if and what role computer-based technologies can play in addressing the business need [3]. All these changes in Information Systems courses directly impacts on a student's ability to effectively master Information Systems course content and skills. Students in software development need to become lifelong students.

Students must therefore rather focus on learning processes where learning be-comes an act of discovery, rather than focusing on mastering the programme content that might be irrelevant in the near future. Students should focus on understanding and examining the given problem, researching the problem background, analysing possible solutions, developing a proposal and producing a final result [3, 45]. During this process, students develop a greater understanding of relevant and contextual Information Systems course content and skills, and the required critical thinking abilities to produce the final result [1, 3]. In learning processes like these, students engage in active learning that leads to mastering changing academic content, such as Information Systems courses and content.

In this study we have designed a model for knowledge conversion in education and we have applied the model by mapping the Information Systems degree from a HEI utilising the model and principles as a guide. We established that the Information Systems programme conformed well with the principles of knowledge conversion i.e. data to information to knowledge to capability. We found that the programme was designed to present basic building blocks, create association among the building blocks and then apply the knowledge gained through the process. The capability of the Information Systems graduates is demonstrated through the delivery of a real-world business solution incorporating all required aspects of their commerce modules, critical thinking and problem solving, and Information Systems modules. In addition, we have provided some example mechanisms that may be utilised in programme design to support the conversion from a data level all the way to capability.

By using the model for knowledge conversion for education in HEIs as a blueprint, lecturers and instructional designers can ensure that the design will enable an optimised learning process, delivering graduates that is aligned to the requirements of a competitive industry environment.

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