Towards a knowledge conversion platform to support Information Systems Analysis and Design industry ready graduates

Marie Hattingh[1][0000-0003-1121-8892] and Lizette Weilbach[2][0000-0002-0827-2444]

[1] University of Pretoria, Private Bag X20, Hatfield, 0028, marie.hattingh@up.ac.za
[2] University of Pretoria, Private Bag X20, Hatfield, 0028, lizette.weilbach@up.ac.za

Abstract. The dynamic field of Information Systems Design (ISD) presents several challenges to educators at Higher Education Institutions (HEIs) when being tasked to provide "industry-ready" graduates. An added challenge is the lack of instructional material that not only provides the theoretical content, but also includes appropriate applicable examples and an environment where "lessons learnt" can be integrated into the instructional content. This paper reports on a study undertaken by the authors to develop a web-based knowledge conversion platform that will allow ISD educators to provide theoretical content, case study examples and lessons learnt by lecturers and students from previous years, which could assist current students' understanding of this dynamic environment. The paper presents the BA bot: a chatbot integrated with Google Drive which provides a knowledge conversion platform for students and lecturers. The authors map the BA bot to the knowledge conversion platform to illustrate how knowledge conversion takes place, from the lowest level (data) to the highest level (capability). The paper concludes with a reflection and a summary of future work to be undertaken in order to extend the capabilities of the BA bot.

Keywords: knowledge conversion model, chatbot, technology platform, ISD industry ready graduates.

1 Introduction

The field of Information Systems Design (ISD) is dynamic [1, 2] and ISD educators need to ensure that ISD graduates have the capability to meet the needs of industry. A number of researchers have reported on the challenges of ISD education, for example: Tepper [3] reported on the importance of analytical and inter-personal skills for ISD graduates. Saulnier [4] emphasized the need for ISD graduates to have both soft skills and hard skills. Furthermore, Pretorius and Hattingh [5] reported on the contextual environment which influences student performance whilst completing their ISD course modules. These challenges are compounded by the need for good instructional content that will give the students the "real-life" exposure required to be "industry-ready".

The authors are respectively the second year and third year ISD module co-ordinators at their institution. The way in which their modules are aligned, allows students gradual exposure to ISD concepts until they have to complete their capstone project (for a real-life client) in their final year. Their main challenge is to optimize the transition between the first and second year; the second and third year; and finally completing the third year, while there is no "textbook" that provides an all-encompassing theory explanation with appropriate examples, supported by add-on lessons learnt throughout

the years (by both the students and the lecturers). Finding a suitable and all-encompassing textbook to prepare "industry-ready" graduates is problematic.

One way to address this challenge is to create an online platform where the knowledge from lecturers, current and former students can be shared with students preparing for, and those currently busy with, the capstone project. In this context, ISD knowledge refers to the soft- and technical skills of a lecturer facilitating the project implementation, as well as the soft- and technical abilities of a student who needs to operate in a group to deliver such a project. Researchers distinguish between tacit/explicit and implicit knowledge [6] and [7]. Tacit/explicit knowledge refers to knowledge that is contained in books, databases and manuals [6]. It is proposed that the platform includes explicit knowledge for ease of reference in a summarized (abbreviated) form. Implicit knowledge is knowledge contained in organizational practices, which is not necessary documented [5]. Capturing the implicit knowledge of both the lecturers (based on their years of experience in facilitating the capstone project) and that of the students who completed the project is invaluable to students preparing for, and those that are currently completing the capstone project. To this extent, the research question answered by this paper is:

To what extent can an Education Chatbot be developed as a knowledge conversion platform for industry ready ISD students?

In order to answer this question, the authors provide an overview of the knowledge conversion model in section 2, followed by a brief discussion on the use of chatbots in education in section 3. Section 4 provides a summary of the case for which the knowledge conversion platform was developed. Section 5 details the methodology followed and section 6 presents the mapping of the chatbot platform to the knowledge conversion model. The paper concludes in section 7 with a reflection on the applicability of the platform for ISD educators and explanations of future research in section 8.

2 The knowledge conversion model

The knowledge conversion model used as basis to develop the knowledge conversion platform presented in this paper was proposed by Smuts and Hattingh [1] and needs further explanation (see Figure 1). In their model Smuts and Hattingh describe the four learning process steps of turning data into information; information into knowledge; knowledge into capability; and capability back into knowledge. These steps are important for learning to take place and should be considered from a bottom up approach when developing a platform to cater for knowledge conversion. Smuts and Hattingh link each of the steps to the level of understanding required for the step to take place and they describe the knowledge conversion process which is linked to each step. Furthermore, their model proposes examples of educational program enablers to assist with each of the steps.

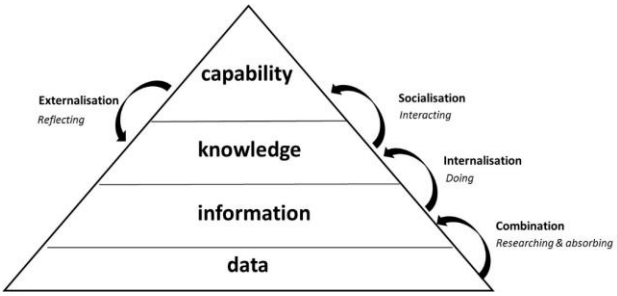


Fig. 1. Knowledge Conversion Model [1]

Data is found on the lowest level of the model and represents the learning of concepts or facts without context which need to be remembered so that students can recall it when needed. The process of converting data into information is called "combination" and the level of understanding required for this process to take place is described as researching and absorbing. The mechanisms proposed to be used as enablers on this level in Higher Education Institutions (HEI) are email, on-line message forums, gazettes, lecture notes, textbooks, book marking, learning based on repetition and reading.

The second layer of the knowledge conversion model is information. For data to be converted into information, it has to have added relevance and purpose to make it more usable. This knowledge conversion process is called "internalization" and the required level of understanding needed is described as doing. The mechanisms proposed to be used as enablers on this level in HEIs are lectures, workshops, tutorials, group work, simulations, experiments, virtual reality, e-learning, context-steered learning, blogs, 'fishbowls' and debates.

The knowledge layer is the third layer of the model. On this layer a number of different sources of information merges to form conceptual frameworks that provide perspective. Knowledge is gained through experience and insights and includes the holder's beliefs and expectations. Having knowledge means that you will be able to apply what you understand and have learnt in a new situation.

The fourth layer of the model is capability. Having capability means that you are able to apply your knowledge to solve problems and that you are able to build new meaning from different fundamentals while making use of your own judgement and evaluation capabilities. The knowledge conversion process when moving from knowledge to capability is called "socialization" and the required level of understanding needed, is interacting. The mechanisms proposed to be used on this level in HEIs are social activities, industrial training, apprenticeship, hands-on experience, design labs and incubation centers.

The knowledge conversion process called "externalization" takes place when capability is transformed back into knowledge. This process requires a reflecting level of understanding and entails the articulation of tacit knowledge by transforming capabilities into a graspable or understandable form. It is only when tacit knowledge is made explicit and clear that it could be shared with others and turned back into knowledge. The mechanisms proposed to be used as enablers on this level in HEIs are orals, tests, examination, assignments, peer presentations, tutoring, industry projects, co-operative

research, community collaboration, academic spin-offs, mentoring, imitation, observation and practice.

3 The Use of Chatbots in Formal Education

Shawar and Atwell (in: Molnár and Szüts [8]) define chatbots as chat software or computer programs which are supported by artificial intelligence. The functionalities of these bots range from answering simple elementary questions, to acting as fully-fledged participants in complex conversations. Chatbots can take part in both text-based and voice dialogues and can typically provide answers to questions posed by different users. According to Britz [9] chatbots, also known at conversational agents or dialogue systems, are currently a hot topic and well-known companies such as Microsoft, Facebook (M), Apple (Siri), Google, WeChat, and Slack are making big bets on them.

Chatbots range from simple bots that can only handle basic messages and requests to more complex bots that are able to participate in more complex dialogues by being programmed to learn from their previous conversations [9]. A taxonomy of chatbots differentiates between retrieval-based and generative models [8].

Retrieval-based chatbots use repositories and heuristic imitation of human memory to answer questions. This is done by simple pairing, while more complex questions are answered through the incorporation of machine language. Decision tree structures are created which are used to direct users to pre-determined conversations.

Generative models on the other hand are smarter and they might mislead you into thinking that you are talking to a real human. They imitate a human conversation and are not 'taught' to provide predetermined human answers. They rely on machine-based translation and generate the responses they provide from scratch. One disadvantage of these type of chatbots are that they might make some grammatical errors in their responses and training them is a lot more time consuming as they require quite a lot of training data to perform well.

According to Cunningham-Nelson et al. [10] chatbots could be used to improve student interaction as they are able to provide standardized information to hundreds of students in a prompt way. This information can include assessment criteria, assessment due dates, and the location of suggested resources. In doing so they can reduce the administrative burden of lecturers and increase the support offered to students. Lecturers could consequently have more time at hand to do course development and needed research. The current methods to engage with students, which include email and face-to-face conversations, lack prompt and personalized communication at more suitable times.

Another common use for chatbots in education is to provide answers on common questions [10]. Answering FAQs on behalf of the lecturer could mean that the bot is available 24/7 and able to answer students' questions in a timeous way. The knowledge base of multiple FAQ could also be kept for several years and could easily be transferred between lecturers who might be presenting the same subject. The chatbot also offers the potential to identify problematic communication between the lecturer and the learners should many students ask the same question.

Chatbots could also play a significant role in answering online short response questions [10]. The advantage offered by this is that the bot could confirm the wording or

understanding of a student and if misconceptions are discovered, the student could be directed to the sources relevant for clarifying the misconception. The statistics of the feedback provided could furthermore also highlight the areas that most students struggle with.

4 The Case for which the Knowledge Conversion Platform was Developed

In a second year ISD module students are expected to follow a structured systems development methodology to analyze and design an end-to-end software solution for a given mini business case. Students choose their own teams of five members each and are given a detailed case study. They are then required to complete four project deliverables which include: (1) a software solution proposal (i.e. a written-up business case with a complete set of functional (use cases) and non-functional requirements); (2) a functional specification (i.e. a detailed logical analysis including logical models that represent the various functional requirements (use cases) and the data needed to fulfill the requirements as set out in the solution proposal – in doing this they could either follow the structured analysis or the object oriented route (UML models)); (3) a technical specification (i.e. a detailed technical design including technical models that add the technology required to implement the different functional requirements); and (4) a complete prototype (i.e. detailed screen designs for each requirement).

When students reach their third and final year, they again get exposed to the complete development of an end-to-end software solution, but this time around they don't get given a written-up mini business case as in their second year. They now have to find their own real-life client for which they can develop a solution and use the knowledge gained from their second year, to write up the business case themselves.

By completing the mini case in their second year and the real-life project in their third year, students are inter alia exposed to data and facts on the following topics: (1) Information Systems Development methodologies; (2) Problem Solving Techniques; (3) Project Management aspects; (4) Project Management tools (MS Project and ASANA), (5) Process Modelling (logical and technical); (6) Relational Database Modelling (logical and technical); (7) Object Oriented modeling (UML); (8) Modelling tools (Systems Architect and PowerDesigner); (9) Interface design; and (10) Output design.

5 The research methodology used

In order to design and develop the knowledge conversion platform to support the learning of ISD industry ready students, the authors followed a design-based research approach [11]. According to van den Akker [12] this approach is also known as design research, development research or design experiments. It can be defined as 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"* [13] (p. 6). This approach typically consists of four

cycles which include [14]: (1) Analysis of practical problems by researchers and practitioners in collaboration; (2) Development of solutions informed by existing design principles and technological innovations; (3) Iterative cycles of testing and refinement of solutions in practice; and (4) Reflection to produce design principles and enhance solution implementation.

During the first phase of the research, the practical problem of representing the required content on ISD to both second and third year students were investigated. Furthermore, the problem of third year students not having a platform on which they could share their tacit knowledge, knowhow, tips, and lessons learnt, with forthcoming third year students, were analyzed. In the same way, the problem of finding a way in which the tacit knowledge and knowhow of the third year lecturer could be captured to assist newly assigned lecturers in facilitating the third year projects and in preparing the second year students for their final year, were also analyzed and discussed.

In the second phase of the research, the knowledge conversion model, as proposed by Smuts and Hattingh [1], as well as the characteristics and possibilities offered by chatbots to assist with formal education, were studied and used to inform the design and structure of the knowledge conversion platform proposed in this paper.

In anticipation of formal testing, a feedback link has been included in the chatbot connected to a Google Form to allow students to provide feedback. The intention is to use this feedback to adjust, enhance and refine the proposed platform, after which the researchers will aim at reflecting on the platform in an attempt to come up with the design principles of a typical knowledge conversion platform to support ISD learning on undergraduate level.

6 The proposed knowledge conversion platform

The first iteration of the knowledge conversion platform was developed as a web-based chat bot using free online Chabot software - Snatchbot.me. As the bot provides a platform to share content on ISD topics, it was named the Business Analysis bot, or in short, the BA bot. The following sections will discuss the structure of the BA Bot and the tools used to support the structure of the BA Bot.

6.1 The structure of the platform

On determining the content of the platform, it became evident that the bot had to contain both tacit and explicit knowledge to produce industry-ready students. Figure 2 represents how the BA Bot was structured. Each topic included a theoretical overview of the most important concepts of that topic, with additional examples and case studies (from past tests, examinations and assignments) which allow students to practice the concepts in different scenarios, Frequently Asked Questions (FAQs)/Common mistakes, and videos and notes explaining how to execute the modelling concepts within the modelling tool.

The current structure of the bot is represented in Figure 2 below.

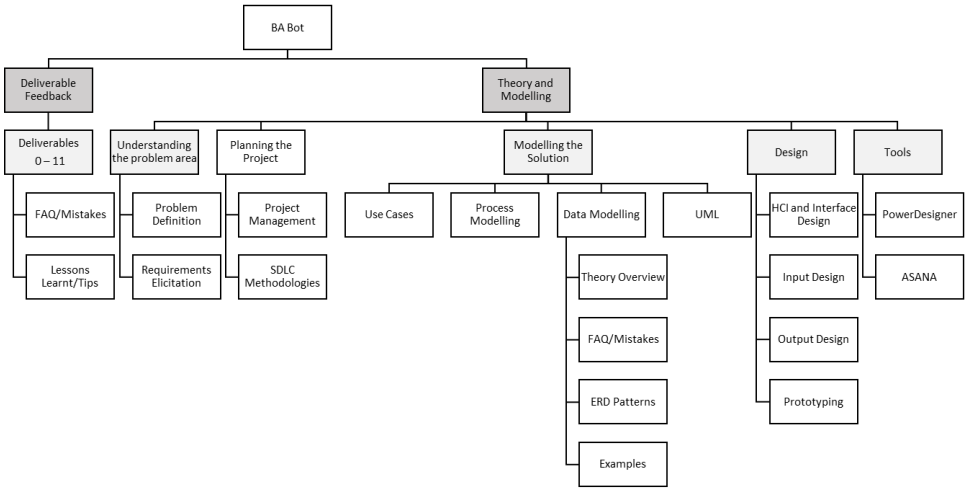


Fig. 2. The current structure of the BA bot

Finding a textbook which ticks all the necessary boxes on the content required by the second and third year curriculums, is a tedious and almost impossible task, especially when one considers the extent to which the IT industry evolves and changes. Extending the bot to include changes or new topics is easy and much less cumbersome. For each of the topics presented in section 5, the bot provides content which can be related to all four levels of the knowledge conversion model as presented by Smuts and Hattingh and as presented in figure 3 [1]:

6.1.1 Converting data into information. On the data level the platform presents discreet building blocks in the format of theoretical overviews, and FAQs, populated by the second and third year lecturers and assistant lecturers. Students have to move upwards through the levels of the knowledge conversion model to use the data or facts they learnt in their first and second years, to combined it with relevance and purpose, and to consequently turn it into information. Figure 3 below is a snapshot of theoretical concepts covered in the BA Bot.

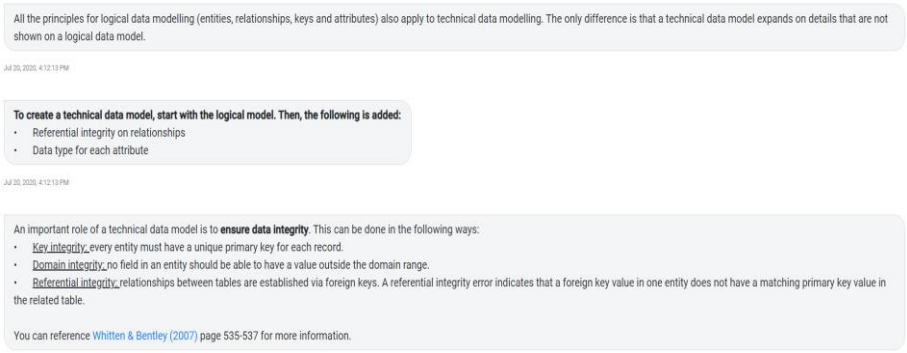
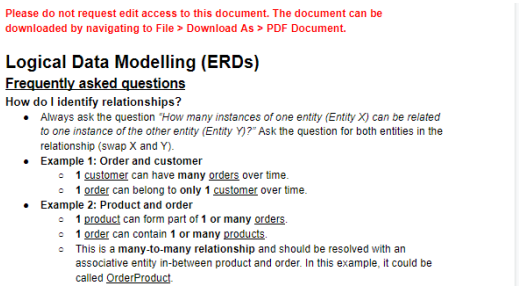


Fig. 3. Applying the knowledge conversion model to the knowledge conversion platform

Figure 4 presents a snapshot from the Google Doc for Logical data modelling FAQ and common mistakes.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Logical Data Modelling (ERDs)

Frequently asked questions

How do I identify relationships?

- Always ask the question *"How many instances of one entity (Entity X) can be related to one instance of the other entity (Entity Y)?"* Ask the question for both entities in the relationship (swap X and Y).
- **Example 1: Order and customer**
  - **1** customer can have **many** orders over time.
  - **1** order can belong to **only 1** customer over time.
- **Example 2: Product and order**
  - **1** product can form part of **1 or many** orders.
  - **1** order can contain **1 or many** products.
  - This is a **many-to-many relationship** and should be resolved with an associative entity in-between product and order. In this example, it could be called OrderProduct.

Fig. 4. Applying the knowledge conversion model to the knowledge conversion platform

6.1.2 Converting information into knowledge. Internalization happens by doing. As experience and insight are needed to turn information into knowledge, students on the second-year level tend to struggle with applying their knowledge to the context of the given case studies. The platform presents integrated examples, case studies and "know how" videos which could assist them in this regard.

Additionally, lecturers developed integrated notes that integrate the Commerce subject content within the ISD environment. Figure 6 provides an excerpt where lecturer notes within Google Docs explain how the VAT component needs to be integrated within an IS.

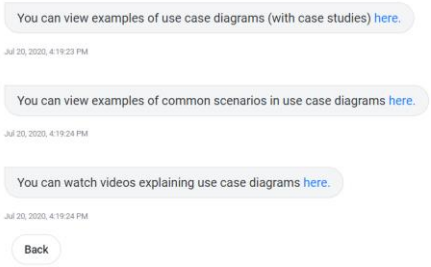
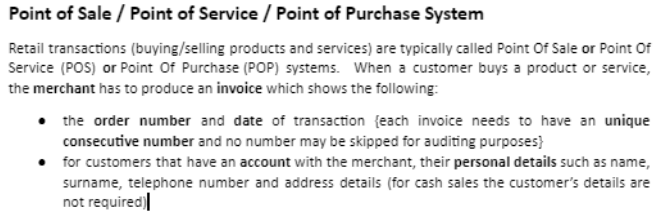


Fig. 5. Options in the BA Bot to learn from contextualized Case Studies


Point of Sale / Point of Service / Point of Purchase System

Retail transactions (buying/selling products and services) are typically called Point Of Sale **or** Point Of Service (POS) **or** Point Of Purchase (POP) systems. When a customer buys a product or service, the **merchant** has to produce an **invoice** which shows the following:

- the **order number** and **date** of transaction {each invoice needs to have an **unique consecutive number** and no number may be skipped for auditing purposes}
- for customers that have an **account** with the merchant, their **personal details** such as name, surname, telephone number and address details (for cash sales the customer's details are not required)

Fig. 6. Integrating Commerce Knowledge within the ISD Environment

6.1.3 Converting knowledge into capability and capability into knowledge. These two processes happen firstly through socialization and then through externalization. For

the former, students get to turn their knowledge into capabilities to solve real world problems when they attempt the capstone project in their third year. For the latter, students and lecturers can capture their learnt lessons and knowhow using Google Forms. In this way they can provide feedback and add to the content of the bot. In the same way third year students can share their tips, knowhow and lessons learnt with the bot, making it available and accessible to second (and future third year) students. Figure 7 shows a screenshot of the Google Form used for feedback that is accessible through the BA Bot.

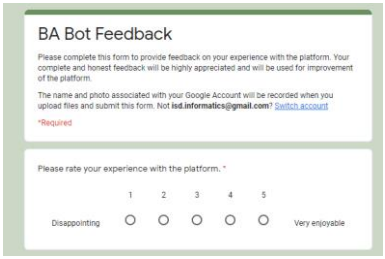


Fig. 7. BA Bot Feedback Form

6.2 The tools utilized in conjunction with the platform

The tools associated with creating the BA Bot environment in which knowledge conversion takes place, is free, which makes it an attractive approach for HEIs. The following tools were used: (1) Snatchbot.me used for the bot environment; (2) Google Drive which provides flexibility in updating content; (3) Google Forms used for student feedback; (4) Google Docs used for FAQs, summary feedback on assignments/tutorial and lessons learnt. This dynamic environment makes it very easy for lectures to add to their content, as opposed to only having a static textbook with set case studies; and (5) A YouTube video channel used to post recordings of practical lessons and tutorials using the document camera, as well as student recordings (to instigate a learning community/culture).

7 Conclusion

The proof of concept of the knowledge conversion platform proposed in this paper was implemented as a Chabot, better known as the BA bot. The aim of the bot was to develop a platform that could support knowledge conversion between the different levels of the knowledge conversion model as presented by Smuts and Hattingh [1], in an attempt to support industry-ready ISD graduates. Finding an appropriate textbook that stays up to date and covers all aspects as required by the IS curriculum is a tedious and almost impossible task. The flexibility and adjustability of the BA bot provides for the timeous and constant adjustment of its content. The bot therefore contains the necessary discreet building blocks and theoretical overviews required by ISD students and students can turn these facts into information by combining it with relevance and purpose, but the biggest advantage of the bot is that it provides a platform on which students and lecturers could share their tacit knowledge in the form of lessons learnt, knowhow and best practices. This provides for the externalization of ISD knowledge and offers a way

in which both the tacit an explicit knowledge apparent in the second and third year ISD modules could be cultivated and preserved for the future.

8 Future work

For future work we intend to enhance the current bot by integrating it with Slack – a collaboration platform. The success of the bot will be measured through experimental research to determine the continuous intention of second year ISD students to use the platform for their capstone project.

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