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ChEdventure - A Chatbot-based Educational Adventure Game for Modeling Tasks in Information Systems

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Abstract. Practitioners in business information systems are frequently faced with tasks that involve interpretation and representation of organizational information as models, e.g. business processes, the involved participants, and data. Usually, this information comes from varied sources like stakeholders and documents, often resulting in subjective, biased, or incomplete information. Simulating a realistic organizational environment is important for the education of future business process experts, but challenging to achieve in the educational setting. In this work, we propose a chatbot-based educational adventure game that can introduce complex and often contradictory sources of information in a fun learning approach and help the students in abstracting and interpreting this information, constructing models as an outcome. We elaborate on the first design ideas and requirements.

Keywords: Gamification · Chatbot · Information Systems.

1 Introduction

The identification of process models and system requirements is one of the most important skills of a business information systems specialist [33]. In this regard, university education and research places a strong emphasis on process identification and elicitation, as well as use case elicitation in practice [33]. The elicitation and creation of models require future specialists to analyse complex and sometimes contradictory circumstances and to perform simplification and abstraction.

Besides document study and desk research, interviews, workshops, and observations of different persons engaged in respective processes are typical methods in process identification and elicitation [3].

In the education of future business process experts, the primary focus often lies on the proficient use of modeling notations and the application of Business Process Management (BPM) life cycles. However, the pitfalls from practice usually remain a big challenge in teaching, too, even though case teaching is used widely. In reality, numerous contradictions or inconsistencies usually arise in the identification and elicitation of processes and use cases, especially in workshops or interviews — however, this is natural, as people can take different perspectives [3] [14]. These different perspectives should also be gathered and are essential for a comprehensive and adequate analysis. Nevertheless, it is vital for every business (process) expert to get a bird's eye view of a process or use case — unfortunately, all too often workshop participants take a so-called frog's eye view, which makes it difficult for the expert to stay focused on the big picture [14]. Experienced business process experts can deal well with such frog's eye view situations and the digression from the actual problem [14].

In the training of future business information systems experts, the problem is to provide adequate and realistic experiential knowledge and convey this knowledge to the students – teaching through cases often fails to achieve a deep immersion of students into respective situations. When traditional teaching methods fall short, technology-enhanced learning methods through the use of chatbots or gamification have often been applied in education to target learning goals like improving motivation, metacognitive thinking, or self-efficacy [32]. Thus, we hypothesize that a chatbot-based adventure game that can simulate realistic workshop experiences can provide an experiential simulation of modeling problems for business information systems education.

2 Related Work

Adoption of gamification in education has been on the rise as gamification leads to an immersive and engaging learning environment [23]. Different terminologies have been used in this context with some subtle differences with respect to the elements used in the design and the goal of gamified design, e.g., gamification, edugames, serious games, etc. [21], [23]. Of these, serious games have been categorized as a type of game that focuses primarily on learning, where the game plays the role of an instructor and provides learning content to the learners [22] and are further designed in different genres such as action, puzzle, adventure, etc. [8]. Fernandez-Vara & Osterwil [13] claim that the genre adventure is very well suited for tasks that involve challenges related to knowledge in a variety of domains.

2.1 Adventure Games in Education

In the literature, educational adventure games have been designed to foster not only conceptual learning, but also learning goals like motivation, problem-solving, computational thinking, and critical thinking [2], [17], [20]. According

to Dickey [9], the adventure genre lends itself naturally to problem-solving situations. Through the learning goals, the learners acquire new knowledge during or after the game. On the other hand, the learning techniques are the considerations in the game design that determine "how" the learning goal will be achieved. Mortara et al. [24] claim that adventure games are well-suited for "learning by doing", where the learners learn by creating knowledge and retain more knowledge while doing so. Silva [28] has identified additional learning techniques that are suited for adventure games, e.g., practice and feedback, discovery learning, situated learning, role-playing, coaching, and intelligent tutors.

Narratives and storytelling play a significant role in the design of educational adventure games, as they provide scaffolding for problem-solving [9], [13], [26]. Fernandez-Vara et al. [13] further stress the importance of puzzle-solving in adventure games and assert that every puzzle provides insight and motivation for further learning.

In terms of interactivity, the early adventure games used text-based interaction [24], where the user provided some short text-based commands to navigate through the game. Later, the interactivity evolved into a very commonly adopted approach in adventure games, the so-called "point and click" activity in 2D environments where the user uses an input device e.g. a mouse, to point to an element in the game and click to initiate some activity within the game [24]. Some works like [18] have explored technologies like geocaching and augmented reality to enhance the overall experience of the games. However, the benefit of text-based adventure games has been observed even recently in specific domains like teaching Unix commands or improving reading and writing skills [25], [29].

2.2 Chatbots in Gamified Education

Chatbots have been considered as a suitable companion for gamification in several domains like History and Culture, Professional Skills and Health/Mental Health [7], [15], [27]. Fadhil et al. [12] use chatbots to teach about healthy diet as an innovative way of engaging and interacting with the learners. Specifically, in adventure games, chatbots have taken up the role of a "narrator" [5] or characters in the story with whom the player interacts [1], [16]. In a recent survey, Goebl et al. [15] have identified "simulation of human interaction" and "improving interaction" as additional motivations for using chatbots in serious games – reducing "the stigma of supposedly boring reads" and adding the possibility to train social and communicative skills. Moreover, [15] have recognized natural language processing in serious games as a relatively new area of research while pointing out the potential for text-based conversational learning.

3 Solution Design

Referring back to the problem described in Section 1, our main concern is to teach students of business information systems the capabilities required to make sense of a complex and sometimes contradictory world, perform simplification

and abstraction and distill the outcome into a model. Our main hypothesis is that a well-designed chatbot-based adventure game will be an adequate solution to this problem. Our proposed solution is based on the following:

- Our knowledge of modeling tasks in information systems (IS) education, with a focus on business process modeling. The knowledge originates from teaching experiences and exercises that are suggested e.g. in books like [10] (see e.g. exercises in Chapter 5 of that book).
- The characteristics and successful design principles of adventure games in education, as laid out in [13].

3.1 Game design

According to [13], the strong advantages of adventure games in education are their capability to integrate a large variety of domain knowledge and the fact that they provide a narrative framework for problem-solving. [13] define an adventure game via five characteristics: adventure games are at the same time 1. story-driven, 2. have a main character whom the player controls, 3. have puzzle-solving as a core element, 4. allow interaction through object manipulation and 5. motivate exploration of a (problem) space.

Let us motivate the use of adventure games in IS education by discussing how these characteristics can be mapped to IS modeling tasks. As a running example, let us consider the University of Newton (as referred to in exercise 5.3 in [10]) that wants to improve its student admission process.

- **Story-driven:** in IS teaching – and more generally in business education – *cases* are a popular teaching instrument. In an educational IS adventure game, such cases can become the drivers of a story – in our example, the admission process at the University of Newton is the case to investigate, and exploring how this process works today can form our story.
- **Controlling a main character:** for IS adventure games, one may typically envision the main character to be a consultant who needs to build an understanding of how his/her customer performs their work, e.g. the student admission. Being a consultant implies talking to many people, studying documents, and materials and synthesizing the collected information – precisely the tasks that process discovery (and other modeling tasks) involve.
- **Puzzle solving:** [13] state that good puzzles are interrelated and solving them brings the story forward. We believe that e.g. process discovery can be posed as a set of interrelated puzzles (see below).
- **Interaction through object manipulation:** in [13], talking to other game characters is mentioned as an important specific form of object manipulation. In a process discovery game, talking to e.g. the various stakeholders in the student admission process of Newton University will play a key role. Interaction with other artefacts, e.g. consulting the university's guidelines or historical emails, data from past student admissions, etc. is also an important strategy.

– **Exploration:** in IS adventure games, the case (here: the admission process) is the world that should be explored. The more stakeholders a player talks to, the better (s)he understands that world.

Based on these analogies, we can conclude that a well-designed educational IS adventure game will allow students to get immersed in a case and develop important competencies. This also has to do with the nature of puzzles that are typical in adventure games, which [13] divides into "selective encoding", "selective comparison" and "selective combination", which we can map to learning goals of a modeling game as follows:

– being able to identify which stakeholders have the most relevant information and assess their statements critically ("selective encoding"). For instance, some staff members at the University of Newton might tell you how student admission worked when *they* were students – which is of no concern for the current reality.
– being able to synthesize answers – corresponding to what [13] calls "selective comparison" – and, in doing so, deal with incomplete or partially incorrect information. For instance, it would not be surprising if each stakeholder at Newton University has their own interpretation of the official guidelines.
– being able to simplify and generalize the collected information into an abstract model ("selective combination").

Overall, the use of a game will benefit IS students because it helps them to get deeply immersed in a case and because challenges like contradictory answers of stakeholders will not be seen as sources of frustration, but as part of playing the game, i.e. a challenge that needs to be solved to get to the next stage.

3.2 Requirements

Based on the above-mentioned learning goals and on the design principles developed by e.g. [13], we can derive some requirements/design considerations for an educational IS adventure game for modeling. We again take the student admission process at the University of Newton as an example:

– Stakeholders at Newton University (i.e. the game characters) should be represented by chatbots to whom the player(s) will have to ask the right questions to collect the desired information. These chatbots should be intelligent enough to understand a range of question formulations and to lead an "enjoyable" or sometimes funny conversation (see next section).
– The entire task of modeling (e.g. the student admission process) should be divided into sub-problems that build on each other (e.g. into modeling subprocesses or into first finding process activities and then arranging them in a certain order) that can be solved one after the other. When students have solved a sub-problem, there should be a "clear and rapid feedback" [13]. Similarly, students should be made aware quickly when they start to follow a wrong route, without "punishment", rather conveying that mistakes are part of the learning process.

Apart from these learning goal-related requirements, the immersion of students will also depend on a set of non-functional requirements, comprising:

- A good and convincing storyline, based on the teaching case.
- Natural dialogues with stakeholders
- Good graphics, showing e.g. the offices in the campus of the University of Newton, the characters working there and digital artefacts (e.g. address book, computer log file, manuals, etc.)
- Humor, e.g. by including "crazy" characters who look funny and/or have funny things to say.

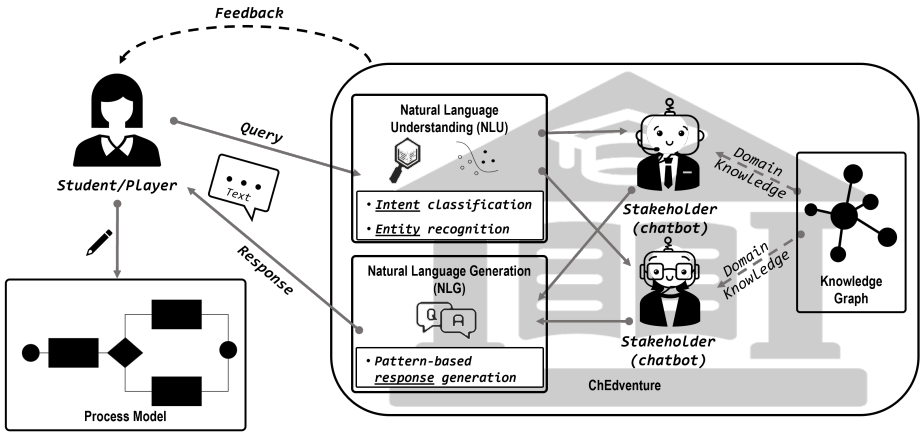

Fig. 1. ChEdventure: Proposed Design and Architecture

3.3 Chatbot design

Goebl et al. [15] observe that educational chatbots fall under the category of task/goal-oriented chatbots and may focus on short and specific conversations within a restricted domain [19]. This observation is consistent with the requirements of the chatbot we propose. As specified in the previous section, the chatbots in our game should be able to understand different formulations of questions. Combining domain-specific training phrases with pre-trained language models can significantly improve the understanding in chatbots [30]. Since the chatbots in our proposed adventure game will play the role of stakeholders in an organization, they should have domain knowledge corresponding to the role they play in the organization, which can be specified as an ontology [19]. The character implementation of the chatbot may follow the framework proposed by El Hefny et al. [11]. Thus, the system will be designed to integrate multiple domain-specific chatbots that can interact with a single student using text-based interaction within the game environment. Eventually, the system may evolve into a multi-agent

system where even human agents e.g. lecturers or other students can be involved during the game, who may play the role of "helpers" or even "challengers". This design can be achieved by choosing a chatbot development framework like Rasa [6] that allows custom configuration of a natural language understanding pipeline and integration of external components like natural language generation models and knowledge graphs. Our proposed design and architecture is depicted in Fig. 1.

3.4 Evaluation

For our educational game, we propose to carry out a quantitative and qualitative evaluation, similar to the approach by Benotti et al. [4] and Virvou et al. [31]. With around 400 students that attend the topic of BPM, we will form two equal groups: one group will receive the case described in the previous section in text form, and the other group will play the gamified version of the same case. Both groups will be given a post-test with the same set of questions that will assess the learning about the case, where a student will receive points for every correctly answered question. Some control questions on general concepts in BPM will be included in the post-test to allow better comparison. The performance of the groups will be compared by measuring the total points received by the students in both the groups. Additionally, the group that plays the game will receive specific questions to gather qualitative feedback about students' experience with the game and its effect on the students' learning.

4 Future Work and Conclusion

In this paper, we proposed a hypothesis to support experiential learning in business information systems through a chatbot integrated into an educational adventure game. We then outlined the premises and requirements of our education domain for business information systems where the learners need to learn how to interpret reality through modeling tasks. Finally, we made a proposal for designing chatbots that will act as characters in the game. The chatbot design and implementation in an experiential adventure game such as the one outlined by us has a great potential for future research in the areas of natural language understanding, chatbot personality design, knowledge engineering, and response generation for text-based chatbots.

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