

A CONCEPTUAL FRAMEWORK OF SERIOUS GAMES FOR HIGHER EDUCATION

Conceptual Framework of the Game INNOV8 to Train Students in Business Process Modelling

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Abstract: Educational computer games also known as serious games are a new method to teach students. Serious games are considered to be motivation in themselves especially for younger people and seem to be a suitable method to teach students in higher education. The authors of this paper present a conceptual framework of the computer game Innov8 – a business process modelling game to learn the notation BPMN and also how to model business processes. The purpose of the proposed framework is to measure the effectiveness of some aspects of the learning subject business process modelling. Therefore the authors describe the classification of serious games and give a summary about conducted studies in this area of research. After that they describe the framework itself. The paper concludes with a description of further steps of research in the context of a computer course at university.

1 SERIOUS GAMES TO ENRICH EDUCATION

Computer games have become a huge global, cultural phenomenon and also in higher education and training of students. The achievements by using games are enormous, e. g. improved artwork and graphics or immensely impressive physical simulation engines. (Aarseth, 2005). Especially the younger generation is used to this kind of entertainment but also in the context of learning. To some of them, computer games are more important than movies. If computer games don't belong to the violent genres, they can offer opportunities to involve students in special situations and to emphasize specific aspects and interrelations of a given situation while playing. Therefore serious games might be a good opportunity to enrich higher education, to simulate a scenario of the real world and to enhance the didactics for students. Serious games are now taken seriously by scholars and academics (Aarseth, 2005). Serious games can have different positive outcomes. On the one side they are allowing learners to experience situations that are impossible in the

real world for reasons of e. g. cost, time or safety (Corti, 2006; Squire, 2003); on the other side serious games can positively influence the learners' development of different skills for example team work (van Eck, 2006). Thinking skills of motivated learners can be described by the following adjectives enthusiastic, motivational, learner-driven, incremental, contextualised, concentrated, interesting or identificational. These attributes are sometimes difficult to generate by a conventional learning session. Serious games themselves can advance these attributes and therefore boost the learning effects (Schwan, 2006). Other advantages of serious games can be to perform real tasks and scenarios in a virtual context, discovery learning through risk taking/failure, immediate feedback and lots of practice. (Clark, 2006)

The development of serious games largely depends on the development of computers, display possibilities, graphical design, interconnectivity and mobility. Based on these advancements and technology development the market of serious games is characterised by high growth rates (Susi, 2007). In literature we can find several definitions for serious games. Susi et al (Susi, 2007) define them as games that engage the user and contribute to the

achievement of predefined objectives. The adjective serious refers to products used by industries like education, scientific exploration, health care etc. The differences between serious and entertainment games can be summarised, that serious games focus on problem solving of a special task, containing important elements of learning and reflect natural communication (Susi, 2007).

According to the definition above the field to apply serious games is very wide. The focus of the paper is on the programs of higher education where students take specific courses at university in business process management. Besides the general understanding of processes this course aims to educate and trains the students in the process modelling language Business Process Modelling Notation (BPMN). Therefore we selected the software INNOV8 of IBM. This software is specifically for educational purposes and used to train employees and students to the modelling language. Usually BPMN and the phases of business process modelling can be trained by a conventional lecture using slides and also by reading the specific literature to this subject. In this case it depends on the capabilities of the lecturer to impart the knowledge about the notation and also about the whole modelling process. To point out the obstacles of the modelling process in reality e. g. when gathering required information from several departments, especially Innov8, offer a good opportunity to enrich didactics and to demonstrate a specific scenario of reality. Hence the students get the opportunity to have their own experience.

In this paper we will present a conceptual framework of the computer game Innov8. The purpose of the proposed framework is to measure the effectiveness of some aspects of the learning subject business process modelling. In chapter 2 the authors therefore give a summary about conducted studies in this area of research and describe the classification of serious games. In chapter 3 they describe the framework itself. In chapter 4 the research methodology and design for further steps of research are described. The paper closes with a conclusion.

2 RELATED WORK

In this chapter we will bring up some related work in the field of research of digital game studies. First we provide a classification of digital games. Second we mention some important studies in this field of research. Third we refer to related frameworks.

2.1 Classification of Games

To classify serious games there are two aspects: the commercial sector and the genre of the game. There are diverse industries for which serious games are utilised to educate people (Susi, 2007): Application area, military, government, education, corporate, healthcare and others.

In literature we can find several genres of games. A game genre is the type or category of the game played (Yussof, 2009). A game can be assigned to one or more genres. The following enumeration contains the main common genres (Schwan, 2006):

- Action game: computer game that focuses on physical challenges, including reaction-time and hand-eye coordination e.g. shooting games.
- Adventure game: computer game in which the players assume the role of protagonists in an interactive story that is driven by puzzle-solving and exploration.
- Role-playing game: computer game in which players assume the roles of characters or take control of an avatar in a fictional setting.
- Strategy game: computer game in which players' decisions have a high significance in determining the outcome.
- Puzzle: computer game that emphasizes puzzle solving.
- Simulations: imitation of real world scenarios, state of affairs or process e. g. flight simulation.

For this paper we selected the commercial sector education and in choosing the game Innov8 the game genres role-playing game.

2.2 Learning Principles

Gee (Gee, 2003) summarised 36 learning principles that mean the mechanisms by which players learn in the context of computer games. Some of these learning principles are e. g.: active, critical learning principle, self-knowledge principle or situated meaning principle. Computer games always use several of these learning principles. The learning principles (Clark, 2006) which are mainly used in the serious game INNOV8 are the following eight:

- Active, critical learning principle: Learner-driven, massively participative.
- Semiotic principle: Understanding complex environments and inter-relationships.
- Committed learning principle: Massive motivational commitment through virtual identities and participation in a complete world.
- Amplification of input principle: Massive

amounts of feedback, failure and rewards, often in real time.

- Achievement principle: Intrinsic goals with satisfying achievements and rewards
- Probing principle: The learner has to learn by constantly probing – try things out, test them and try again.
- Situated meaning principle: Performance in meaningful and contextualised – not abstract
- Discovery principle: Narrative is kept to a minimum, forcing the learner to explore and discover.

2.3 Related Digital Game Studies

In literature we find some studies about digital games. However the focus of these studies varies widely. Because of the extended and continuing debate concerning negative effects of (violent) computer games we find a lot of studies dealing with the related matters. Susi et al (Susi, 2007) summarize ten studies about these topics and come to the conclusion that several effects of computer games and also serious games can be measured, but they can't find an evidence of effects related to aggressiveness. The effects that had been measured are: Motor skills, educational and informational, social as well as physiological. As well Susi et al (Susi, 2007) mention that a need for more investigation in some specific areas concerning the increase but also the decrease in aggressiveness.

Blunt (Blunt, 2008) describes the result of three causal-comparative exploratory studies conducted with the purpose to find out more about the relationship between the use of video games and learning. The result was that the classes using the game had significantly higher means of learning than those classes that did not use the game. Thus these results point out positive effects of the use of serious games. In addition to these results of computer gaming studies further studies can be found. Most of them address special computer games. From this it concludes that the results are difficult to compare. Especially because we know that serious games vary to a great extent in terms of the industry themes they cover, the game genre and the learning principles.

2.4 Related Frameworks of Digital Games

Garries et al (Garries, 2002) describe a generic model about the input-process-outcome framework of games in their paper. The key component of this framework is the game cycle that includes the steps:

user judgement, user behaviour and system feedback. The inputs of the framework are instructional content and game characteristic. The outcome is the learning outcome. The game cycle is an iterative process while the learner is playing the game again and again (see figure 1). One focus of the framework lays on the iterative loop in the game cycle.

The model in figure 1 describes the learning process for serious games in education very well and also fits into modern didactic theories (Schwan, 2006). This model will be considered when we formulate the framework in this paper. An important aspect which is the mission in the model is the motivation of the learner to play a game.

Another very common model was invented by Keller in 1983 (Keller, 1983) and describes a model of motivation design. The model contains four steps for promoting and sustaining motivation in the learning process: Attention, Relevance, Confidence, and Satisfaction (ARCS). The model is very often used in literature and will be characterised in more detail in chapter 3. The ARCS model will also be applied to measure the motivation in learning.

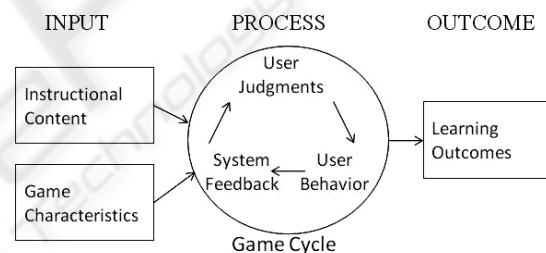


Figure 1: Input-process-outcome framework (Garris, 2002).

3 CONCEPTUAL FRAMEWORK

The following conceptual framework to measure the effects of serious games combines the model of Garries et al (2002) and the ARCS model of Keller (Keller, 1983). The model of Garries contains the steps of a learning process. The ARCS model measures the motivation of the student for learning. Therefore we will give a short overview of the framework and explain single parts of it.

3.1 Overview of the Framework

The framework displayed in figure 2 is an advancement and combination of the two models of Garries et al (Garries 2002) and Keller (Keller, 1983). While Garries et al describes the whole gaming process the

ARCS model reflects on the motivation of the user to play a game and keep on learning while playing.

Another point which was missing is the goals and the objectives to play a serious game. There can be different kinds of goals and objectives which influence the learning process. This aspect is added in figure 2. To measure and interpret the learning effects it is also important to consider what kind of type the player is e. g. frequent player.

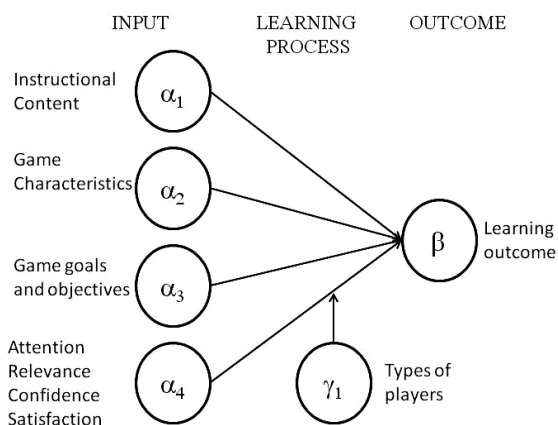


Figure 2: Learning framework for serious games to enrich education.

3.2 Type of the Player

In student education we find a very homogenous group. They are nearly of the same age. But we can still find different types of players. In literature four patterns of types are differentiated (Schwan, 2006):

- Impassioned player: ~ 15 % of all players. These kinds of players are looking for challenges. They have a high frustration tolerance and a high intrinsic motivation.
- Wanna-be-Player: ~ 15 % of all players. These players identify themselves with the impassioned players and want to be like them. They also show a much lower frustration tolerance than the impassioned players do.
- Fun player: ~ 25 % of all players. These players consider playing of games as one alternative as a recreational activity.
- Occasional player: ~ 45 % of all players. These kinds of players only play a game sometimes, most of the time only as amusement.

The affiliation to one of these different types of players can have an influence on the effectiveness of the outcome of a serious game. Therefore this is also mentioned in the framework.

3.3 ARCS Model

The ARCS model consists of the four elements for promoting and sustaining motivation in the learning process. These four aspects will be explained in the next sections.

3.3.1 Attention

There are many simple ways to win the attention of a learner, but the difficulty lies in sustaining attention. The attention to play a game can be gained in two ways (Keller, 1987):

- Perceptual arousal: to surprise the user and gain his interest.
- Inquiry arousal: to stimulate curiosity by posing challenging questions or problems to be solved.

Therefore different methods for grabbing the learners' attention can be applied like active participation, variability, humor or inquiry. It is most important to find a balance between boredom and indifference versus hyperactivity and anxiety.

3.3.2 Relevance

To make the relevance of a game for a learner clear e. g. for their future career and keep it present in their awareness even if they may be intrinsically motivated, there are several strategies by Keller. One of them is, to point out the learner's future usefulness of the subject; another strategy would be to show the learner, how the new learning will use and extend their existing skills. (Keller, 1987)

3.3.3 Confidence

According to Keller (Keller, 1987) it is very important that one has the feeling of confidence in the possibility of success regardless of external factors or innate ability for a learner. Therefore it may be necessary to provide performance requirements or evaluation criteria and also to establish feedback loops. Another fact is to develop the learner by letting him achieve rising steps of success in the learning process.

3.3.4 Satisfaction

The last element of the ARCS model contains satisfaction of the learning game. The learner must get some kind of satisfaction after a learning period; this can be the achievement of any objective, any praise or entertainment. The learner should get some motivation that the newly acquired skills can help to

solve their problems in a real setting. Thereby care has to be taken that the learner will not be patronized by over-rewarding easy achievements.

3.4 Instructional Content

The instructional content can be described as the subject matter learners should learn by playing the serious game. The subject can vary to a great extent and depend on the objectives and the use as well as the target group of the serious game. Gilbert et al. (Gilbert, 2008) differentiate four types of content: facts, procedures, concepts and principles.

The instructional content of the software Innov8 about business process modelling uses the two content types procedures by addressing business processes and concepts by focussing on the business process modelling notation.

3.5 Game Characteristics

The title game characteristic summarises both topics game mechanics and game rules, by which the details of a game are defined (Thompson et al, 2007). Under the topic game mechanics all technical, graphical and game steering information is summarised; this also contains the user interface and the help function. The importance of game mechanics shouldn't be underestimated because e. g. the attraction of a game with pore graphical design can lose attraction for learners in comparison to other options of games. Also the use e. g. of the help function must be clear and understandable. Otherwise if he gets stuck a learner will be frustrated about continuing the game.

Games take place away from the real world in a fixed space and time period. While playing games the rules and constraints of ordinary life are temporarily interchanged by a set of game rules (Garris, 2002). Rules must be described very clearly and carefully as well as be easy to understand; otherwise the motivation of learners will decrease. The game mechanics of the software Innov8 can be categorised in an average level; it has deficits in the steering of the avatar and the graphical design. The help function contains all the information needed. The game rules are understandable and clearly formulated.

3.6 Game Goals and Objectives

The game goals and objectives are established by the game's rules. The goals contain the criteria of winning and the victory conditions (Blunt, 2008). Ac-

ording to a research of Locke et al (Locke, 1990) clear, specific and difficult goals motivate learners to enhance their performance and engagement; such defined goals allow the learner to compare their achievements during the game and these can be seen as a crucial trigger for greater attention and motivation.

The objectives in the game Innov8 are clearly defined and specific but they can't be seen as very difficult. The learners can always compare their current achievements with the end achievement and results.

3.7 Learning Outcome

The learning outcome is the new skills a learner gained after playing a serious game. The learning outcome can be coupled with the game achievement in playing the game. The learning outcome can be modified based on the game achievement's feedback. In one scenario of the game Innov8 the learner has to redesign the process of a call centre including the staffing with people of different skill levels. The learner can always check in a simulation, what the result of the new process will be, if he left the process in the modelled state like it currently was. When reaching a specific score range, the result of the remodelling of the process will be accepted. The score of the game will be displayed and the game is over.

4 RESEARCH METHODOLOGY AND DESIGN

At the beginning of this chapter we want to point out some important aspects of the proposed framework. Then we will describe the next steps of research. Therefore we will explain the research methodology and design.

4.1 Important Aspects of the Framework

The framework described contains modern didactic theories of the constructivism in which the learner has a central controlling role in the learning process. Learning happens in the willful actions of the learner during a serious game.

Another advantage is that the framework contains all important structures and aspects of modern learning in one model. The ARCS model is also integrated into this framework. Therefore the model doesn't only focus on single aspects like game characteristics or game features.

The framework is adaptable to different kinds of serious games. Previous to the actual adaptation all variables have to be checked.

4.2 Research Methodology and Design

The proposed research framework can be transferred in a model which contains hypotheses between the different variables. For example one variable would be instructional content, another one game characteristics. The relationships between the variables are hypotheses which refer to the influence between the variables. The variable "types of player" influences the relationship between the ARCS model and the learning outcome. The aspect if a learner is used to computer games or not makes a difference for the game results and the learning outcome. This model and the hypotheses then represent a structural equation path model. This model can be tested by the Partial Least Squares (PLS) analysis. The PLS procedure was invented by Hermann Wold. It is a second-generation multivariate technique which has the ability to model latent constructs under conditions of non-normality (Chin 1999).

To collect the required data to prove the proposed research model we have already prepared a questionnaire which contains questions for all variables mentioned above (see also figure 1). This questionnaire will be distributed at a university in a class of students who finished their IT laboratory including the lesson of the serious game *Innova8*. The students are assigned to the course "business administration and engineering". A pre-test has already been conducted and the latest result has been inserted in the proposed model.

5 CONCLUSIONS

In this paper a conceptual framework of serious games for higher education for the game *Inno8* has been proposed and explained. The game *Inno8* contains learning sessions about the process how to retrieve information of business processes in a virtual company and also how to model and optimize these processes. The result of the game is an optimized process of a call centre. At the end of the game the students can see their result of optimization.

The proposed model is based on modern didactic theories of learning and has a holistic view of the whole learning process. Therefore it takes care of the input and the outcome of the process but also of the game cycle. Consequently the framework also ad-

dresses the aspects that learning from games can be challenging for multiple reasons.

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