Using the Master Copy - Adding Educational Content to Commercial Video Games

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Abstract: Successful development of educational video games has to overcome plenty of challenges. In addition to the requirements of a successful software development project, an attractive game experience has to be designed and implemented. However a failure in one of the most ambitious tasks of developing an educational game is known as "chocolate-dipped broccoli". This term was used by Bruckman (1999) to describe the unsuccessful integration of game mechanics and learning content. An alternative approach to avoid these problems is not new but still seems to be underrepresented in the field of Digital Game Based Learning: the use of existing, popular video games. Recent research has acknowledged several video games as educational media for the training of professional skills. Besides that video games can be used to spread domain knowledge. Such video games either already contain specific domain knowledge or they can be extended easily to embed domain knowledge. This paper presents case studies of four commercial video games, which are potentially eligible for educational extension. Each game represents a distinct category: *Fliplife* stands for simple, community enhancing Social Network Game (SNG) *Triviador* as a SNG is the synthesis of two well known board games (Risk and Trivial Pursuit). *JuraShooter StGB* - already designed as an educational game - exemplifies mobile device games. Lastly *SimCity 5* is a representative of a classic strategy and simulation game with focus on systems. Each game is shortly introduced, our relevant gameplay experiences and the potential learning content is described. Finally we identify potential extensions regarding additional learning content for each game. Having these examples in mind we suggest a more systematic approach to use commercial video games as learning tools: if a game has been proven as a viable source for transfer of domain knowledge, we suggest categorizing it due to two characteristics: complexity of learning content and mainly attracted player types. Based on such a categorization a directory of games can be compiled. This directory then can be used in a concrete educational scenario to identify appropriate games. As a categorization for learning content we suggest Bloom's revised taxonomy. A well known categorization for player types was proposed by Bartle. Although by far not every commercial video game can be enriched with educational content, the effort to customize existing games seems to be much smaller than the effort to create educational games from scratch. This paper argues for a systematic approach to facilitate commercial video games in educational settings as an additional option apart from individual implementations of educational games.

Keywords: digital game based learning; COTS; commercial video games; SimCity, JuraShooter StGB, Fliplife, Triviador

1. Introduction

Video games are a relatively new type of media. Originally just created for entertainment purposes they are now also used in educational settings. Gee (2005) refers to video games as *learning machines*. In the light of the huge impact on players learning sophisticated models to master a game, educators started to develop educational games. However this approach has seen a lot of failures. Egenfeldt-Nielsen (2007) states that "edutainment started as a serious attempt to create computer games that taught children different subjects. Arguably, it ended up as a caricature of computer games and a reactionary use of learning theory." Papert (1998) uses the picture of a Shavian reversal: "Shavian reversals — offspring that keep the bad features of each parent and lose the good ones — are visible in most software products that claim to come from a mating of education and entertainment". Bruckman (1999) used the expression *chocolate-dipped broccoli* for her observation that "fun is often treated like a sugar coating to be added to an educational core".

All these perceptions mirror at least partially the ultimate complexity of educational game development: Building software is already a risky venture: Ambler (2010) found that only around half of IT projects are successful. The next hurdle to take is to design an attractive game: a commonly acknowledge method uses effort consuming cycles of development and play testing (Fullerton 2008). For educational games this process has to be adjusted to certain learning targets and complemented with an appropriate context and content. Habgood & Ainsworth (2011) call a seamless interlacing of game and educational content "intrinsic integration": learning

content should not appear as a foreign object in the game. Not being all enough, these complex tasks have to be covered with limited financial resources, because normally educational games do not reach those high sales revenues as their commercial counterparts do (Bröker et al. 2011).

As one solution to this dilemma Young et al. (2012) "believe that commercial gaming companies and educational researchers could mutually benefit by bringing academic content into the fictitious worlds originally created without educational content objectives in mind". Commercial video games have been already used as educational tools: The Futurelab Project (Sandford et al. 2006) investigated the usage of "commercial off the shelf [(COTS)] computer games in formal education". *The Sims 2*, *Roller Coaster Tycoon* and *Knights of Honor* have been those COTS games looked at in this study. *The Sims 2* as a medium in formal educational settings have been studied by Peterson (2011) and Panoutsopoulos & Sampson (2012). A. N. Foster (2011) chose *Roller Coaster Tycoon 3* as a tool for the transfer of disciplinary knowledge in economics and social studies.

Looking at all these examples at least three areas of game usage for educational purposes can be identified[1]: First, games can be used as a medium to spur reflection. At Wabash College *Portal* was set on the booklist of an compulsory seminar, which "is devoted to engaging students with fundamental questions of humanity from multiple perspectives and fostering a sense of community" (Abbott 2010). Second games are used to teach professional skills. Poling (2010) facilitated *StarCraft* in a course about *21st Century Skills.* Steinkuehler & Duncan (2008) found that successful play of *World of Warcraft* requires "scientific habits of mind". And third games are employed for construction of disciplinary knowledge. Squire (2003) taught history with a modified version of *Civilization III*. A case study of Moshirnia (2007) done with *Civilization IV* lead to similar results.

So far we have argued that building successful educational video games is a highly challenging task. Then again there exist a lot of intriguing commercial video games. In this paper we want to propose the systematic investigation of COTS games for either existing learning content or the possibility to add and embed appropriate content. We use a comprehensive definition of *COTS video game*: It is any digital game which could be used as host for potential educational content but which currently is not holding that content[2]. In addition to dedicated educational games this would be a further, effort saving approach to establish video games as educational tools.

2. Case studies

The proposed approach to use COTS games for educational purposes is based on a few assumptions: It may be possible that a game can embed educational content. For a systematic approach to classify a game its content should be graded according to a knowledge taxonomy – the knowledge dimension of the game. A well-known taxonomy has been introduced by Bloom (1956) and modified by Anderson et al. (2000). This is not the only valid categorization – e.g. the already mentioned overview of Prensky (2007) classifies content specifically found in video games, but it is a taxonomy commonly utilized in educational contexts.

Players are categorized by player type taxonomies, e.g. Bartle's player types (1996). In addition to these assumptions we hypothesize that the learning objectives are given as well as the structure of the player type distribution. Then it should be possible to choose an appropriate game, enrich it with content and use it in the considered educational setting. Such an approach would need a catalogue of COTS games capable of including educational content. Our case studies introduce four video games as potential elements for such a catalogue.

We describe each game in four categories. *Game description* is a rough summary of the games main characteristics. It conveys a short impression of the game. In the section *Gameplay experiences* we summarize our personal impressions of the gameplay as we think they are relevant to use that game in an educational context. *Learning content* is the caption for an analysis of the structure and type of potential educational content. The part *Possible adoptions* proposes appropriate changes of the game software to support the game's usage as an educational tool.

[1] Prensky (2007) gives a more comprehensive overview of different types of learning content including facts, skills, behaviour and creativity.

[2] This definition implies also educational games themselves - as the example *JuraShooter StGB* demonstrates. The important characteristic we want to point out is the combination of an existing video game and additional educational content

2.1 Fliplife

Game description: Fliplife is a multiplayer, HTML5 based browser game (Fliplife 2012; Fliplife.com 2012). Unlike a typical social network game the relationship between two players is not fixed, but defined according to the amount of common actions: The more interactions two players have, the nearer becomes their relationship. Main objective of Fliplife is a simulation of the player's life: professional career, education and free time. The player pursues a career by taking part in a well- defined set of projects. Spare time activities are sports and parties. These activities are rewarded with energy, which is needed for doing the projects. Education is provided by multiple choice question based quizzes. Fliplife got special attention when it was said to be an assessment tool for a German trust (Söbke, Hadlich, et al. 2012).

Gameplay experiences: The basic game mechanics of Fliplife seem to be very simple, although they can build the foundation for complex problems (Söbke, Bröker, et al. 2012). In general Fliplife shows the characteristics of an online third place: players meet online in their spare time, make acquaintances and friends (Soukup 2006). The game mechanics create a frame for communication with co-players. Fliplife may be a low cost version of an online game which serves as a third place (Steinkuehler & Williams 2006).

Figure 1: Fliplife: project description

Learning content: Fliplife contains domain knowledge: specialist's expertise is represented by career paths and projects. Also the game objects are partly domain specific. However to play Fliplife successfully this knowledge is not mandatory. The so-called university is another possibility to learn: The quizzes are quite demanding and require broad general knowledge.

Possible adoptions: Müller (2012) has investigated possibilities to integrate domain knowledge in Fliplife using the domain of building physics, a discipline in civil engineering concerning the comfort in buildings. Her suggestions include a domain specific career path, a building physics institute as employer and projects from the field of building physics. Apart from descriptive texts, striking graphics could emphasize technical details. Beyond that the university can support learning by field specific quizzes and issuing field specific rewards and badges. Furthermore she suggests assignments which require the player to do a technical analysis of the projects (e.g. "Execute 3 heat protection projects." where *heat protection* is not a shown attribute of a project, but derivable from the project description). For the integration of building physics learning objectives it seems appropriate to upgrade the player's building with more technical details as it is done in the current version. An additional mini game could deal with wall structures: The player has to build wall structures from a given set of materials to meet certain requirements. Crowdsourcing is also an option mentioned by Müller: certain could cause players to deal with technical details. Her main approach to complement Fliplife with domain specific know-how is integration of specific information, graphics and items.

As already mentioned succeeding in the game is not connected to any technical knowledge. Nevertheless it could bring domain affiliated persons together. If those persons are involved in the game, the game's strength

as a virtual place could induce community building processes ("Community of Practice" (Lave & Wenger 1991)).

2.2 JuraShooter StGB - Jagd nach dem Katzenkönig

Game description: *JuraShooter StGB - Jagd nach dem Katzenkönig* is an educational iOS game to memorize the crucial legal terms of criminal law (Lernfreak GbR 2012). This drill & practice game was produced 2011 by a group inspired and led by the german lawyer Raban von Buttlar. Its title refers to a well-known and widely discussed criminal cause (Pötters 2009). Objective of the game is to unmask the alien cats of the Katzenkönig ("cat king"). This is done by instantly tapping the cats that carry parts of the correct answer to a law question. The player is rewarded for correct answer and gets extra points for faster answers and for answering in a correct order. Questions itself are collected in packages. Each package focuses on a certain topic. Currently all content relates to the domain of law.

Gameplay experiences: Our personal gameplay experiences have been dominated by audiovisual feedback caused by tapping the monsters. It seems to act both as a reward and a short cycled feedback. This feedback and the additional entry in the high score list are the main motivational elements of this game. Extrinsic motivation for learning the content vanishes during the play. Answering questions becomes a tool for reaching a high score – at least for a certain type of player. This conclusion is not yet backed up by scientific data. However it is derived from the entries in high score lists: Top entries can only be reached when the player instantly taps the first appearance of each answer. That is when the correct answer is perfectly memorized and can be answered without delay (Buttlar et al. 2012).

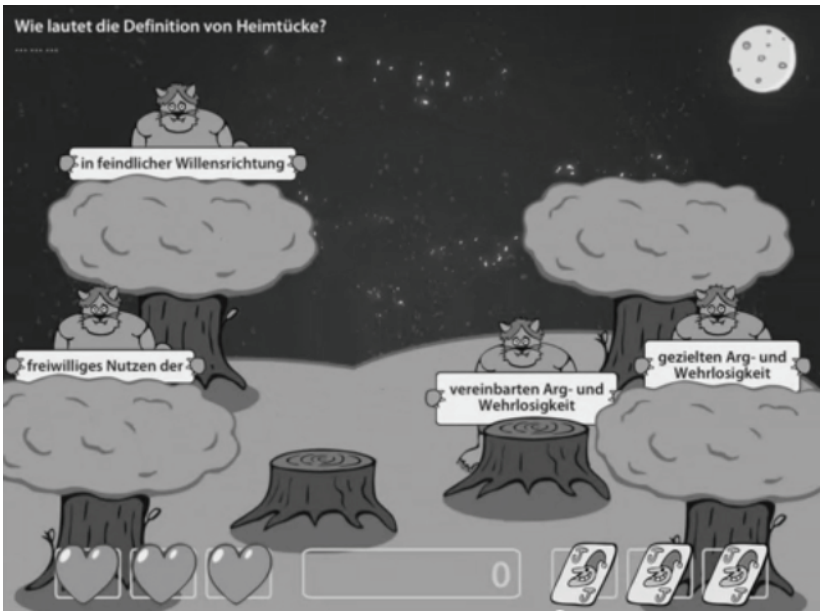

Figure 2: JuraShooter StGB: Tapping definition elements

Learning content: The learning content of this game is obvious. Additional packages of learning content can be added with an existing content editor. The editor does not simply support the text of the question and wrong and correct answers. It also allows determining structural attributes of a question, e.g. to take account of the order of the answer's parts.

Possible adoptions: Possible adoptions of the game include - besides knowledge of other domains - different types and structures of questions, e.g. matching or estimation questions. It could also be necessary to change the narrative (and accordingly graphics) because the main figure "Katzenkönig" is closely related to the law domain.

2.3 Triviador

Game description: Triviador is a Social Network Game (SNG) available on the Social Network Service (SNS) Facebook (THX_Games_PLC 2011). It is an adoption of the well-known board game Risk. While Risk uses dice for random decisions, Triviador replaces dice by questions in several forms. At the first stage a multiple choice

question is asked. If both players choose the right answer, an estimation question with a numeric answer is issued. The player with the nearest answer wins. In case of a tie the fastest answer wins. As a further game element players can use jokers which increase the probability of finding the correct answer in different ways.

Gameplay experiences: Our gameplay experiences contained a similar trait as those already mentioned for JuraShooter StGB: Especially in the war mode the desire to win a duel outshines the awareness of probable learning. In the context of this game questions become a tool to win a match. They are not the primary purpose of playing the game, but an integrated game mechanic.

Figure 3: Triviador: Selecting bases

Learning content: The learning content of the game is given by questions and their answers. Questions are taken randomly from a pool of more than 10.000 questions. So far there are no mechanics for enhancing learning: a player barely can choose the topic of questions. Also the game determines the rhythm of play – a player cannot reflect at her own pace about a question nor can she review a completed question.

Possible adoptions: In general the displayed questions are chosen randomly from a large pool of questions. A so-called *Targeted Subject Booster* allows the attacking player to choose the domain of the question. Furthermore there are some country specific versions of Triviador that use a map of the country and country related questions. To enhance further Triviador's characteristics of a learning tool the player should be able to choose preferred topics in his personal game options. During the matching phase of the game preferably two other players with same topic preferences are assigned. Furthermore the selection of questions could adhere to an algorithm of flashcard systems (e.g. Leitner (2011)). This approach could improve the educational benefit.

Another feature of Triviador is the crowd sourcing of questions: When a player has reached a certain level she is allowed to enter own questions in several categories. These questions undergo a review by other players. After logging in they could opt for answering a certain amount of crowd sourced questions. They have to judge the question in several categories, e.g. if the spelling and grammar is correct and if they want to answer that question in the game. Both activities have educational value. The creation of questions means producing artefacts and judging questions spurs reflection.

We suggest tagging the questions as a further improvement: until now there is only a fixed set of domain categories. Tags would introduce more and specialized categories. A question could bear more than one tag and belong to more than one (sub-)category (Peters 2009).

2.4 SimCity

Game description: SimCity is a well-known and popular simulation game. The first version has been published in 1989. Earlier this year (2013) SimCity 5[3] has been issued on a new technical foundation. SimCity is about building, developing and managing cities. Thus a player takes the role of an engineer when he interacts with the underlying systems. Will Wright, who originally designed SimCity, considers simulation games as tools for experimenting with their base systems (Wright 2007). SimCity has been used and investigated as educational tool (Adams 1998; Gaber 2007; Minnery & Searle 2012).

Gameplay experiences: The attractiveness of SimCity has already been proven by millions of sold copies of every single version of the game. SimCity 5 now supports online multiplayer gameplay, e.g. it connects cities of neighboured players as sources and sinks of (material) streams. From the technical viewpoint of an engineer of urban hydrology[4] we examined the model elements of this discipline. We only found a rudimentary and schematic implementation of an urban hydrology system. D'Artista & Hellweger (2007) have examined SimCity 4 and marked its compliance with current urban hydrology models as insufficient. Compared to their findings the last version of SimCity contains more detailed models[5]. However, they still do not meet the requirements of realistic simulation models[6].

Learning content: An important learning goal connected to simulation games is the understanding of the underlying systems. Every simulation game is based on a model. Players reveal and learn the game's model during gameplay. As our experiences suggest game models often do not meet requirements of reality-like models, i.e. the structure of model does not reflect important real world elements. Devisch marks blurred, incorrect models as one argument against usage of simulation games for learning about real systems (2008). In general the genre Simulation Game has often been used as a pedagogical tool, which is demonstrated by different examples: Foster (2011) examined the knowledge construction using *Roller Coaster Tycoon*, Squire has used mods of Civilization III to teach social science. Mobility was built as an educational simulation game based on scientifically validated models for transport systems (Brannolte et al. 2000), but it has also reached attractiveness as a video game[7].

Possible adoptions: The rule driven simulation engine GlassBox of Simcity 5 is highly configurable. It could be the base for other simulation games as well (Willmott 2012). Until now the API of GlassBox has not been disclosed. If that would happen, adjusting model elements of SimCity could lead to realistic scenarios.

2.5 Questions: A valid game element for learning?

Multiple choice questions (MCQ) are a main pedagogical element of three of the four above presented case studies. MCQs are often criticized. One argument is that they just contain knowledge at the recall level. And students learn to choose the right answer from a set of options instead of knowing all alternatives they have[8]. Scouller (1998) attributes surface learning to MCQ based examinations.

Nicol (2007) presents a framework for MCQs as an educational tool. In general MCQs are considered as a valid assessment tool for the understanding of abstract concepts (Hopkins 1998). Iz & Fok (2007) gave an example for the domain of geomatics - showing that it is possible to cover all levels of the cognitive domain of Bloom's taxonomy with MCQs. Higher levels of complexity may require activities outside the test, e.g. doing calculations to determine the correct answer. Furthermore they found a relation between the complexity of the question and the time students spent on answering that question. Also Simkin & Kuechler (2005) experienced difficulties in constructing MCQs of higher knowledge levels, but they confirmed that this is an practicable approach.

[3] We refer to the current version of SimCity as SimCity 5, although it is officially named SimCity.

[4] Urban hydrology is – besides building physics and law - one of the disciplines we are using for exemplifying usability of commercial video games as educational tools.

[5] For example water pumps can be upgraded to filtration pumps. This allows the reuse of dirty water as drinking water.

[6] As an example it is not possible to use surface water for drinking water catchment. Also storm water management is nonexistent in the game.

[7] This was witnessed by a dialogue partner: when he heard about the authors' affiliation to Bauhaus-Universität, he mentioned the game *Mobility* which production has been scientifically accompanied by members of that University. He named this game a cause for many short nights of his former life.

[8] As an example: the examination regulations of our faculty exclude MCQ based examinations explicitly as a valid test tool (http://www.uni-weimar.de/cms/fileadmin/uni/files/ka/mdu_akad/07/30_2007.pdf, last accessed April, 12th 2013)

Palmer & Devitt (2007) stated, based on a study in the domain of medicine, that MCQ tests "are capable of withstanding the intellectual and statistical scrutiny imposed by a high stakes exit examination". Mukhopadhyay et al. (2010) made a similar conclusion also for MCQs in medical education.

MCQ may not be fun causing game elements. They are neither part of a problem solving, constructive gameplay. But they are a valid educational instrument. And as far as they can be integrated in gameplay without affecting intrinsic motivation negatively, they can be used as an educational tool for the transfer of knowledge. Prensky (2011) defines an appropriate measurement for fun and learning in an educational game: "*1. Is the game fun enough that someone who is not in its target audience would want to play it [...]? 2. Do people using it think of themselves as 'players' [...]? 3. Is the experience addictive? [...] 4. Are the players' skills in the subject matter and learning content of the game [...] significantly improving at a rapid rate, and getting better the longer he or she plays? [...].*" Due to our experiences these questions can be answered positively for all of our MCQ "enriched" examples – mostly without any restriction, but always to a certain grade.

2.6 Levels of knowledge complexity

Game structure and game mechanics form the frame for knowledge that can be included in the game. So the complexity of the learning objectives depends on the game. The following discussion of an example uses Bloom's revised taxonomy: *JuraShooter StGB's* current learning content covers level 1 to 3 in the *Knowledge Dimension*: *Factual Knowledge* is included in the form of domain terminology. The game also contains *Conceptual Knowledge*: legal structures and models are object of the questions, e.g. a player has to be familiar with the "legal model" of a second degree murder. An example for *Procedural Knowledge* is a list of necessary elements of an offense to constitute a punishable crime ("Knowledge of criteria for determining when to use appropriate procedures"). The *Cognitive Process* dimension is only supported in the first level: The player just needs to remember facts. The use of additional types of questions requires a change of the game software. However it would enable the game to include content of other Cognitive Dimension's levels than level 1 "Remember". As an example ordering questions would require comparisons, which is located in level 2 "Understand". As Triviador does support only a smaller set of question types (*Selection question* and *Estimation question*), the complexity of the knowledge is lower.

Iz & Fok demonstrated that all levels of the Cognitive Dimension can be reached by answering questions. However the attractivity of questions may be low when answering needs a lot of work outside of the game. Simulations games - like SimCity - allow to experiment with potential answers in the game itself. Because of versatile possibilities of interaction between player and software simulation games can include also higher levels of the taxonomy – at the cost of much more effort for development of the game.

3. Conclusions and discussion

Educational games often do not meet the promise of a sensed effortless learning. Habgood (2007) observes "chocolate covered brocoli"-like edutainment applications. Missing "intrinsic integration", i.e. intrinsic motivation cannot be consistently perpetuated during gameplay, is considered as an important reason (Habgood & Ainsworth 2011). These failures may result from the enormous complexity to create an "intrinsically integrated" educational video game.

We propose an additional approach to employ video games as educational media for domain knowledge transfer: the systematic review of existing commercial off-the-shelf (COTS) video games. By using existing games the only challenge to overcome is to embed educational content while the game software has been produced and the game itself has been proven as attractive[9]. Furthermore successful games are considered to be learning machines teaching their content effectively (Gee 2005; Becker 2006).

In a larger framework suitable video games could be classified according to two criteria: a first criterion is the potential learning content the game is capable to embed. We propose Bloom's revised Taxonomy (Anderson et al. 2000) as an appropriate categorization. The second criterion is the predominant player type of the game. These classifications would allow selecting appropriate games for a defined learning content and a known set of learners.

[9] For example often these games outperform their educational "counterparts" in terms of audiovisual presentation (Breuer 2012).

Of course this approach has to fight some imponderables. One of them is the question if the suggested taxonomies are resilient in this context. Bartle's taxonomy created for players of a Multi User Dungeon (MUD) may not be directly applicable to players of other game genres. Another item needing further research is the transfer to other context. Gee (2003) postulates that successful learning in games depends on context, i.e. the constructed knowledge is not transferred to other contexts. So players learn to master the game, but are not able to apply their knowledge in real world contexts (Rehm 2013; Niegemann 2009). This may become a problem, as contexts given by commercial games cannot be adjusted easily. So the proposed classification may need to be extended by a context dimension. Also it may be questionable if necessary game related changes are feasible – the developer of a game may pursue other approaches. Concerning our sample there is a mixed situation: *SimCity* has been announced to be open for new content, but the *GlassBox API* has not yet been revealed. *Triviador* is open in parts: new questions can be added, but no new categories can be established and selected during gameplay. Fliplife is extensible theoretically, but de facto it is not yet clarified if the developer company would support customized versions. This has already been done for JuraShooter StGB, which is the only ready for reuse game among our case studies.

Another challenge of simulation games is the problem of simplified and blurred models, which do not sufficiently mirror domain knowledge. FarmVille (Zynga 2009) can be taken as an example: It is build for being extended with additional content (Mahajan 2010). But for crops and animals almost the only fact which is connected to reality is their name – unless they are not pure fantasy elements. Other important simulation model characteristics – as for example maturation periods – are only game specific.

The proposed approach has still a lot of challenges to overcome. Games which can be enriched with educational content are admittedly a rare species. On the other hand the possible gains of employing (modified) COTS games are compelling; even small achievements might be worthwhile. It is an additional option in the field of game based learning. A next step on our agenda is to extend *JuraShooter StGB* to the field of urban hydrology. While the extension of the other three examples is more hypothetical and still has to be substantiated, in the case of *JuraShooter StGB* the financial effort has been calculated: it is about one-tenth of the original application.

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