CREATING GAMES APPROACH MODELS AND IMPLICATIONS FOR THE USAGE OF GAME DESIGN AS A TEACHING METHOD

Gerhard Sprung, Lisa Zimmermann, Alexander Nischelwitzer,
Robert Strohmaier, and Sandra Schadenbauer
FH JOANNEUM
Austria

Abstract

This paper describes the Creating Games Approach (CGA). The paper outlines the development of our approach using the comparison of literature and describing the procedure of our first test and development phase. CGA facilitates the development of games for teaching knowledge and skills not only in IT-related issues like programming but also for other skills necessary to be successful in the so-called participatory culture. Programming is learned just as a tool to produce meaningful products and the children deal with many other tasks and challenges like design, interface and interaction design, usability, project management and many more. In 2010 our concept was tested with more than 100 pupils at Austrian schools. Using the Design Based Research Approach we iteratively developed, used, improved and documented our idea to use Game Design as a teaching method for children at the age between 11 and 16 years. The results and concepts will serve as a basis for developing courses for key players, decision makers, and educators at Austrian schools.

Introduction

Our research showed that students differ concerning motivation, self esteem, expectations of themselves and their colleagues and the reasons for choosing to study in a technical program (Sprung & Zimmermann, 2008). Because these differences cause many students (especially female students) to drop out we decided to research new approaches to change this situation. We now develop new ways to help educators to teach programming as early as possible. We analyze Educational Programming Languages (EPLs) and develop curricula for different classes. After teaching the courses, watching the students and analyzing the results, we intend to implement a program supporting children (especially girls) to start programming in an appropriate way by providing teachers with concepts, workshops, best practice examples, and advice.

Background

The ubiquitous presence of media, the huge amount of unfiltered information and the new ways of communication changed the demands on educators and schools. Children need new skills to deal with these emerging challenges.

Participatory Culture

Jenkins et al. (2009) subsume these challenges under the term "Participatory Culture." The necessary abilities are often called Digital Literacy (Gee, 2003: Gilster, 1997) — for example the ability to use digital technology to find, understand, analyze, evaluate, and produce information.

Educators have to provide all students with the chance to actively participate in this new society. Jenkins warns about the new gap arising between children having the possibilities and abilities to participate and others who are excluded due to organizational, technical or other reasons. They cannot join social networks, and they cannot participate, create and share knowledge. Jenkins et al. (2009) depicted a set of social skills and cultural competencies which they assume to be crucial for the participation in this culture: Play, Performance, Simulation, Appropriation, Multitasking, Distributed Cognition, Collective Intelligence, Judgment, Transmedia Navigation (following the flow of stories and information), Networking, and Negotiation. Especially the ability to experiment with your surroundings (Play), construct dynamic models of real world processes (Simulation), and to meaningful sample and remix media content (Appropriation) indicate that games could play a very important role in the acquisition of these skills.

Resnick et al. (2009) assume that the so-called digital natives (Prensky, 2001) are only partially competent concerning digital media. Even if they use the Internet, text messages, online communities, and games every day, they are not able to create complex content such as games, animations or simulations.

Many young people are participating in the Internet actively by creating content (Lenhart 2005), but this content is usually restricted to text (blogs, newsgroups) and simple pictures or movies. New forms of media, games and interactive stories are seldom created. The distinction between creative consumption and production is not easy because bricolage and remixing blur the line between these poles (Sefton-Green, 2006). It can be seen that young people use media very differently from adults (and also teachers/instructors). They can deal with a lot of information from different channels at the same time, they have a different perception of speed when it comes to film editing and they have grown up with text messages, instant messaging systems and Facebook. However, on the other hand or maybe because of this they need to receive support according to their age and experience in order to be able to process all this information in an adequate way.

Peppler and Kafai (2007) assume "that games shape the perception of the world" and designing games develops the ability to think about the games, in particular the quality, structure, and effect of games.

For Gee (2003) video games are to be seen as a collection of semiotic domains and to actively participate in a semiotic domain the abilities to read the codes (decode), understand the meaning, and produce something meaningful with respect to this semiotic domain are needed. If we interpret the role as a producer as the ability to design and create games, we can assume that children should have the ability to play games, the ability to understand meanings with respect to games and have the ability to make games.

Game Design

Kafai, Peppler, and Chapman (2009) see "media production" as a necessary alternative pathway in media culture. Creating video should be an important part of media education. This is the most direct way to experience the possibilities, restrictions, and dangers of these types of media and through that to gain the knowledge needed about them.

Kafai (1995, 1998a, 1998b) showed the influence of game design as a teaching method concerning understanding, motivation, and experience. She describes game design as giving not only deep insights into the technical and organizational context of game production but also improving the understanding of collaboration and project management. Further successful examples of the use of game design as pedagogical method can be found at Leutenegger and Edgington (2007) and Haungs, Clements, and Janzen (2008).

Kafai (2006) described the approach "Making Games for Learning" as a consequent continuation of Papert's constructionistic model (Papert & Harel, 1991). She describes how not only technical skills and the handling of tools are taught but also the ability to create personal important and relevant products with these tools. Kelleher (2008) proposed and evaluated storytelling to introduce girls to computer programming. Owston, Wideman, Ronda, and Brown (2009) researched the influence of digital game design for the development of literacy.

Girls & IT

Girls play different digital games than boys (Lenhart, 2005), have other reasons to work with computers (Gürer & Camp, 1998; Sáinz & López-Sáez, 2010), and use them differently (Beckwith, 2005). Girls do not necessarily dislike the tool, but often they do not see appropriate possibilities to use IT for something personally relevant and important (Gürer & Camp, 1998; Whitley, 1997).

Denner and Camp (2008) found out that games designed by girls differed significantly from boy's games. They were based on realistic settings, used almost no violence and dealt with fears and social problems. Often several ways to win and the possibility to reach a happy end for all were used.

Constructionism

The behaviouristic approach is meanwhile widely replaced by constructivist methods. Constructivism as a theory of knowledge states that human knowledge is constructed by the individual by combining input with prior experience. Learning processes create individual representations of knowledge, influenced by manifold physiological, neuronal, cognitive, and social processes. Therefore the result cannot be completely foreseen and the process cannot be planned.

Constructivism assumes the existence of a relative and subjective reality built by the learner by combining prior knowledge and experience in situations where this prior knowledge proves to be inappropriate: ". . . accommodation takes place when an existing schema must be modified to fit new information" (Foote, Vermette, & Battaglia, 2001, p. 19).

The teachers have to build and provide authentic situations and complex problems to facilitate learning processes. They have to motivate the learners with interesting, communicative and multimodal situations and provide them with an apt learning environment to build knowledge on their own.

Inspired by this theory Seymour Papert developed an educational theory which he called constructionism (Papert, 1987). Papert claims that products made by learners during the learning process must be relevant und meaningful and he suggests that they be publicly presented (Papert & Harel, 1991).

Summary

To summarize, learning should be self-acting and autonomous. Learners must be motivated in an appropriate way. Problems to solve must be adapted to the environment of the learners. Goals should be socially relevant (Buckley et al., 2008) and valuable for the learner. It is important to focus on current interest, anxieties, and problems of the learners and not on constructed tasks that are mainly fictional and irrelevant to the learners' lives.

The problem or task should be dealt with together and systematically, results should be questioned critically and in the end to be publicly presented. If possible only current and real tasks that allow a possible implementation of the results should be chosen. With this approach scientific methods (hermeneutical questioning → empirical investigation → critical evaluation) are learnt, practiced and used. During the whole process it is important to focus on the effect/s of the planned final result. Personal effects as well as social, cultural, and economic implications shall be constantly analyzed and discussed.

Creating Games Approach (CGA)

The basic idea of our project is to develop a model based on the continuation of the constructionist approach with regard to an increase of motivation for learners,

especially girls, who are to acquire skills and abilities they need for the Participatory Culture.

First we want to describe the idea in detail. Students learn the basics of programming with an EPL at a very early stage (in the first or second grade of high school, i.e., at the age of 10 or 11) in order to apply their knowledge in the years to come. As defined by Jean-Pol Martin (learning by teaching) they are to create applications to help their classmates, students from other schools, cities, or countries as well as adults to better understand content. Depending on the age of the learners, their already acquired skills and content learned from other subjects, these applications will vary. First it will be short presentations and slide shows which could be followed by interactive stories and the production of adventure games and in higher grades where students are better able to understand internal structures and possibilities of games simulations, jump & runs and also 3D-games can be constructed. Apart from the obvious ability to use programming languages, to be able to graphically design something and to edit audio, the programming of games helps students to deal with many other areas in order to produce good games.

Why game design? Games that are used in class are limited by nature. Even as games may be used for many different purposes, the way how to use a game is restricted. In contrast in the CGA content, profoundness and type of interaction are part of the task and the learners have to decide for themselves. Learners can concentrate on the medium or rather the creation process. The CGA does not focus on the games but on the design and production of games. In order to create a complex game several questions need to be answered (see Prensky, 2005):

- Who will play the game when, where and why?
- Which elements are needed for the game?
- Which and when decisions have to be made by the players and which possibilities do they have?
- How can the content and the consequences of decisions made while playing the game be depicted in an understandable way?
- Which activities have to be carried out throughout the game?

Also the content and the messages that are communicated have to be analyzed.

In order to identify which areas of knowledge can and have to be learned during the game design process we identified the following topics: skill and knowledge, computer sciences, project management, media competence, game design, understanding of complex interrelations, and dramaturgy of interactive stories.

Research Design

According to Papert (2000) one fundamental problem of traditional teaching is the assumption that everything has to be true or false, especially in natural science. If we assume that children construct their own reality, their own solution, we have to accept something in between. Furthermore it is not possible to identify all influencing factors in a pedagogical setting. Therefore the success of interactions can almost not be measured with empirical methods. The successful (re)combination of new information with previous knowledge cannot be tested.

These circumstances led us to the decision to use the Design-based Research approach.

Design-based Research (DBR)

Design-Based Research meets the problems of research in the pedagogical field by connecting design, research and practice. Thus DBR tries to develop practical projects in a way that also theoretical insights can be gained (Barab & Squire, 2004; The Design-Based Research Collective, 2003).

One characteristic of DBR is that the research process can and shall influence the study. Instead of generating a controlled test area where factors are analyzed, described, and eliminated, DBR settings include design, application, analysis, and improvement. Wang and Hannafin (2005) characterized DBR as pragmatic, grounded, interactive/iterative and flexible, integrative and contextual. DBR shall be purposeful and systemic. DBR requires manifold documentation of the processes, interventions, changes of the original research design and all recognized influencing factors.

The Project Touch::tell::IT

Touch::tell::IT is the follow-up project of touchIT (Zimmermann & Sprung, 2008), a project that was aiming at reducing the gender gap in technical programs. We try to use these constructionist methods to introduce software development in a socially relevant, problem-based and collaborative way. Thus girls shall be motivated to work on problems by using IT as a tool and to learn programming to solve the problems they are really interested in.

We analyzed and compared different didactic approaches and methods to find the most promising ways to reach this goal as described in the previous chapters. After collecting EPLs and IDEs (Integrated Developing Environment) and comparing them considering the needs for widespread use in Austrian schools in the 2nd to 5th grade (high school) in accordance with the above mentioned didactical approaches we tested the most promising approaches in Austrian

schools. We developed courses for educators and teachers as well as supporting material.

Selection of IDE/Programming Language

In the first step we had to choose an EPL to implement the pretests. The programming language Scratch was chosen because it is easy to use, free, open source, and because it offers a large range of possibilities. There are also a lot of other appropriate solutions.

Scratch

Scratch (Resnick et al., 2009) is a graphical EPL developed at the Lifelong Kindergarten Group at the MIT Media Lab. This programming language is dedicated to show the first steps in programming as it shows in a graspable way the basic principles of programming with a very spontaneous approach. Children understand loops, methods, variables, and basically Object Orientated Programming (OOP) in the first lecture and are able to try it out instantly.

Papert argued that programming languages should have a "low floor" (easy to get started) and a "high ceiling" (opportunities to create increasingly complex projects over time). In addition, languages need "wide walls." "To achieve these goals, we established three core design principles for Scratch: Make it more tinkerable, more meaningful, and more social than other programming environments" (Resnick et al. 2009, p. 63).

Course Sequence Description

We planned our workshops extremely close to the principles of constructionist methods. In the first phase the basics were reconstructed by means of a role play where students collaboratively constructed a fictive language to steer an artifact (we intentionally did not choose a robot) and defined a basic set of instructions and algorithms. In the second phase Scratch was introduced and it was shown, that the developed language can be found almost exactly in the instruction set of the programming language. From then on the students were planning and realizing short interactive stories or games. In small teams and intentionally with only little support from their tutors they started to develop plot, design, and game play learning the required basics for programming by themselves. The different results were collected and made openly accessible through a Moodle and the Scratch homepage. The students knew from the beginning that their products would eventually be publicly presented and they also organized these presentations.

Results and Conclusions

In pre- and post-questionnaires 143 students participated with an age range of 10–16 years. The questions were about media consummation, computer use, and video games. Additionally questions were asked to confirm the results of our

previous research concerning the lack of self esteem and self confidence of girls in the field of ICT (Zimmermann & Sprung, 2008).

Some interesting outcomes of the surveys are that 72% of the female and 80% of the male students want to be able to program video games; 73% male and 89% female students want to create software to design graphics; and 42% of male but only 11% of female students were interested in programming languages.

Another large difference can be found in the use of video games: 70% of the girls and 92% of the boys like to play video games. The boys said they played mainly action games, racing games, and shooter games whereas almost all girls played simulations and social games.

During the project the students were very enthusiastic and creative and the questions they asked showed us that they were really engaged and had understood the underlying principles. For example they asked questions about how to send messages to other objects, how to receive events, and how to use methods and retrieve properties of objects.

The process of implementing and evaluating our approach led us to some important findings:

1.) Game design is hard work and implicitly not motivating in itself. After the initial motivation (easy access) and through quick success experiences (graphically, acoustically) motivation only develops when the social effect of the product is also taken into account.

2.) The social relevance is extremely important for longer lasting intrinsic motivation. It has to be taken into consideration that an introduction into game design that comes too early may also tempt children to play digital games earlier than they would have done without this introduction. Even if we agree that game design is positive for several of the above mentioned reasons, real world play is incomparably more important und should be promoted.

3.) An empirical analysis of the effects of game design is not possible.

4.) CGA requires more commitment and more technical knowledge in different areas (also outside the usual content which can be found in the curriculum). It is also recommended to have contacts to people who work in the area of multimedia.

5.) A website has to be provided where students, teachers, and researchers are able to exchange experiences, findings, opinions, and material.

References

Barab, S., & Squire, K. (2004). Design-based research: Putting our stake in the ground. *Journal of the Learning Sciences, 13*(1), 1–14.

Beckwith, L. A. (2005). Gender HCI issues in problem-solving software. In *CHI '05 Human factors in computing systems* (pp. 1104–1105). Portland, OR.

Buckley, M., Nordlinger, J., & Subramanian, D. (2008). Socially relevant computing. *SIGCSE '08: Proceedings of the 39th SIGCSE Technical Symposium on Computer science Education* (pp. 347–351). New York: ACM.

Denner, J., & Camp, S. (2008). What games made by girls can tell us. In Y. B. Kafai, C. Heeter, J. Denner, & J. Y. Sun (Eds.), *Beyond Barbie® and Mortal Kombat. New perspectives on gender and gaming* (pp. 129–144). Cambridge, MA: MIT Press.

The Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher, 32*(1), 5.

Foote, C. J., Vermette, P. J., & Battaglia, C. (2001). *Constructivist strategies: Meeting standards and engaging adolescent minds.* Larchmont, NY: Eye on Education.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy.* New York: Palgrave McMillan.

Gilster, P. (1997). *Digital literacy.* New York: Wiley and Computer Publishing.

Gürer, D., & Camp, T. (1998). *Investigating the incredible shrinking pipeline for women in computer science*. Final Report – NSF Project 9812016. Retrieved from http://women.acm.org/archives/documents/finalreport.pdf.

Haungs, M., Clements, J., & Janzen, D. S. (2008). Improving engineering education through creativity, collaboration, and context in a first year course. *Proceedings of American Society for Engineering Education Annual Conference*. Pittsburgh, PA.

Jenkins, H., & Purushotma, R. (2009): *Confronting the challenges of participatory culture. Media education for the 21st century*. Cambridge, MA: MIT Press.

Kafai, Y. B. (1995). *Minds in play: Computer game design as a context for children's learning.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Kafai, Y. B. (1998a). Children as designers, testers, and evaluators of educational software. In A. Druin (Ed.), *The design of children's technology* (pp. 123–145). San Francisco: Morgan Kaufmann.

Kafai, Y. B. (1998b). Video game design by girls and boys: Variability and consistency of gender differences. In J. Cassell & H. Jenkins (Eds.), *From Barbie to Mortal Kombat: Gender and computer games* (pp. 91–114). Cambridge, MA: MIT Press.

Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture, 1*(1), 36–40. Retrieved July 3, 2009, from http://dx.doi.org/10.1177/1555412005281767.

Kafai, Y. B., Peppler, K. A., & Chapman, R. N. (2009). *The Computer Clubhouse: Constructionism and creativity in youth communities.* New York: Teachers College Press.

Kelleher, C. (2008). Using storytelling to introduce girls to computer programming. In Y. B. Kafai (Ed.), *Beyond Barbie® and Mortal Kombat.*

New perspectives on gender and gaming (pp. 247–264). Cambridge, MA: MIT Press.

Lenhart, A., & Madden, M.(2005). *Teen content creators and consumers.* Pew Internet & American Life Project Washington DC. Retrieved February 23, 2011, from http://www.pewInternet.org/~/media//Files/Reports/2005/PIP_Teens_Content_Creation.pdf.

Leutenegger, S., & Edgington, J. (2007). A games first approach to teaching introductory programming. *SIGCSE '07: Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education* (pp. 115–118). New York: ACM.

Owston, R., Wideman, H., Ronda, N., & Brown, C. (2009). Computer game development as a literacy activity. *Computers & Education, 53*(3), 977–989. Corrected Proof. Retrieved July 3, 2009, from http://www.sciencedirect.com/science/article/B6VCJ-4WGHJHJ-/2/6f7d3ce08d06eaddcf75c199d9324426.

Papert, S. (1987). *Constructionism: A new opportunity for elementary science education.* Retrieved April 30, 2010, from http://nsf.gov/awardsearch/showAward.do?AwardNumber=8751190.

Papert, S. (2000). *The children's machine: Rethinking school in the age of the computer*. New York: BasicBooks.

Papert, S., & Harel, I. (1991). *Constructionism.* New York: Ablex Publishing Corporation.

Peppler, K., & Kafai, Y. (2007). What videogame making can teach us about literacy and learning: Alternative pathways into participatory culture. In B. Akira (Ed.), *Situated play: Proceedings of the 2007 Digital Games Research Association Conference* (pp. 369–376). Tokyo: The University of Tokyo.

Prensky, M. (2001). *Digital natives, digital immigrants.* Retrieved February 23, 2011, from http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf.

Prensky, M. (2005). Computer games and learning: Digital game-based learning. In J. Raessens & J. H. Goldstein (Eds.), *Handbook of computer game studies* (pp. 97–124). Cambridge, MA: MIT Press.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., & Brennan, K., et al. (2009). Scratch: Programming for all. *Commun. ACM*, *52*(11), 60–67.

Sáinz, M., & López-Sáez, M. (2010). Gender differences in computer attitudes and the choice of technology-related occupations in a sample of secondary students in Spain. *Computing Education*, *54*(2), 578–587.

Sefton-Green, J. (2006). Youth, technology, and media cultures. *Review of Research in Education, 30,* 279–306.

Sprung, G., & Zimmermann, L. (2008). Ways to patch the leaky pipeline in information technologies. In IATED (Ed.), *Proceedings of ICERI 2008*, Madrid.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5–23.

Whitley, B. E. (1997). Gender differences in computer-related attitudes and behavior: A meta-analysis. *Computers in Human Behavior*, *13*(1), 1–22.

Zimmermann, L., & Sprung, G. (2008). Technology is female: How girls can be motivated to learn programming and take up technical studies through adaptations of the curriculum, changes in didactics, and optimized interface design. In iNEER (Ed.), *Proceedings of ICEE 08*, Pecs, Hungary.