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A TEXTILE-BASED LEARNING GAME AS A DESIGN CHALLENGE: A LEARNING BY DESIGN PROJECT IN TEACHER EDUCATION

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Abstract

High quality teachers and teacher education are the key components in meeting the challenges education has confronted over the past few decades. Thus, the focus in teacher education can no longer be on theory-based and lecturing-based pedagogy. This article describes one pilot-project in teacher education which may break down **the traditional concept of a curriculum unit, disciplines, and knowledge-based** *and teacher-centred instructional strategies. This pilot-project was* **contextualized within the framework** *of learning-by-design. The students' design challenge was to produce a* **textile-based learning game for** *teaching textile material knowledge at school.* **The idea of this article is to describe the produced learning** *game, the students'* **learning process, and their experiences while playing the game with pupils. The** *data derives from artefacts, essays and portfolios from two craft student teachers. The project changed the learners' practices: the students had to solve* **the design challenge; they needed different kinds of** *skills, multi-disciplinary knowledge, holistic thinking,* **information processing, critical evaluation and** *co-operation to support the activity. The produced learning game integrated different school subjects. Almost invariably, all the pupils liked to learn textile material knowledge through playing,* **the only thing** *the students would have altered was the size and the rules* **of the game.**

Key words: *contextualizing, learning-by-design, learning game, teacher education, textile material knowledge.*

Challenges for Teacher Education

High quality teachers and teacher education are the key components in meeting all the challenges we have been confronted with in education over the past few decades (Buchberger, Campos, Kallos, & Stephensson, 2000; EC, 2005). This is why the focus in teacher education can no longer be on long-standing traditions and teaching content specific knowledge and facts (Buchberger et al., 2000; Laurilland, 2002; EC, 2005). The traditional theory-based and lecturing-based pedagogy does not motivate and does not give opportunities for reflection, nor does it ensure sufficient application to practice (Azer, 2009). It has been concluded that learning has to be modified so that it may be more authentic, more useful, and more contextualized (Paris & Winograd, 2001; Perkins, 2009). To accomplish such demands, teacher education should be oriented more towards process-, problem-, project, and research-oriented learning environments, as well as inquiry-oriented cultures (Buchberger et al,. 2000). All these demands encourage teacher education to experiment with new ways of educating teacher students.

Domain specificity and "situatedness" are generally recognized parameters of any theory of learning. This has shifted from teacher-centred forms of teaching towards more student-centred approaches, in which the content of learning, as well as the nature of a learning situation

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form the main elements of contextualization (van Oers, 1998). Thus, most of the instructional theories focus on authentic tasks that help students to integrate needed domain specificity knowledge, skills and attitudes, coordinate individual skills that comprise a complex task, and transfer their learning to practice (e.g. Rule, 2006). Approaches that focus on this kind of learning are mainly based on authentic contexts and projects, real-life situations and job-related problems (Segers, Dochy, & Cascallar, 2003). Fruitful and challenging learning tasks also take into account the distributed nature of knowledge, in a natural way (Korthagen, 2010). Relevance and choice in the learning task, along with discourse within a community of learners empowers students to increase their knowledge and skills. These kinds of instructional strategies may inherently break the traditional concept of a curriculum unit, disciplines, knowledge-based and teacher-centered instructional strategies and make the learning environment multi-disciplinary (Laurilland, 2002; Lombardi & Oblinger, 2007).

This article describes just one pilot-project in teacher education that breaks the traditional concept of instructional strategies with contextualizing learning within the framework of learning-by-design. The student teachers' design challenge was to design and produce a textile-based board game as an example of a student-centred way to teach textile material knowledge at primary and secondary school.

Contextualizing through Learning-by-Design

Learning-by-design means context-making (see van Oers, 1998). This kind of contextualizing aims at a process where students learn the contents and skills in the context of engaging in design challenges (see Hmelo, Holton, & Kolodner, 2000). Learning-by-design emerges from the constructionist theory (Papert, 1993). It proposes a pedagogy in which students are placed in the position of producers of knowledge, skills and abities (Kalantzis & Cope, 2005). The design challenge provides the reason for learning the necessary content, and engaging in the challenge also provides a natural and meaningful venue for using both new information and skills.

Constructionism suggests that new ideas are most likely to be created when learners are actively engaged in building some type of external artefact, for example programs, machines or games that they can reflect upon and share. When students are asked to design something for the use of others, their learning becomes instrumental toward a larger intellectual and social goal (Kafai, 1995). Students act as designers, creators and problem solvers in multiple ways, but in the design process they are the ones who identify the problems, set the final constraints and plan themselves how to solve the design challenge (Kafai, 1996). According to Kolodner (2002), the need to make one's design idea work is a challenge with respect to information retrieval, the identification of incomplete and poor conceptions, and the debugging of those conceptions and solutions. The iterative design process provides opportunities to apply and test new solutions.

In order to challenge learners in the process, the design task should be open-ended and authentic (Kalantzis & Cope, 2005; Lombardi & Oblinger, 2007). A challenging design task is an ill-structured problem which cannot be immediately solved without sustained investigation. Lombardi and Oblinger (2007, 3) state that authentic activities provide the opportunity to examine the design task from a variety of theoretical and practical perspectives, using different kinds of resources requiring one to distinguish relevant from irrelevant information. Authentic activities enable students to make choices and reflect upon their learning process, and their skills and abilities. Experimentation and exploration as concrete actions help the analysis and synthesis of the process and product (Han & Bhattacharya, 2009).

In learning-by-design the teacher acts as a facilitator and motivator by creating an open-ended design task, by organizing an empowering learning environment, and by challenging and

scaffolding in a balanced manner (Hmelo et al., 2000). Han and Bhattacharya (2009) argue that reflecting on the design process make students more accountable for their learning while they have to share, pilot, evaluate and modify their work. As a whole, learning-by-design takes a holistic and integrated approach to assessment. The key principles are, for example, not testing but assessing individuals in a group context, peer-review, qualitative judgements, assessment of personal knowledge and performance, or the building of portfolios (Kalantzis & Cope, 2005). Constructionist design is not complete without the opportunity for the public sharing of artefacts (Holbert, Penney & Wilensky, 2010).

The contextualizing is done both at the teacher's and the student's level: the teacher has to choose and design the basis for the process and related activities, and at the student's level it denotes the process that takes place within the student and the team during the learning-by-design process. In practice, this means that a student, as a part of a team, has to determine a particular goal, examine prior experiences, find out about available means and actions, and relate one's own motives, goals, objects, and means to the task and the whole learning process.

Learning by Designing a Game

Kafai (1995) states that a game design idea starts out as an abstract project and becomes concrete as the designer creates and implements its different features. Thus, the game designer becomes more and more involved in the design process and renders the project and learning as personally meaningful (Papert, 1993; Holbert et al., 2010). This means that the design of a game engages students' thinking, feeling, and learning. The design and problem-solving process contains the construction of personalized connections to the objects, to each other, and to oneself. (Kafai, 1995.)

According to Holbert et al. (2010), the game design process allows the learner to imagine a variety of possible endpoints to the design challenge, because the main point mainly concentrates on the components, rather than the finished objects. By building and sharing personally meaningful artefacts, learners become more aware of the nuances of the problem (Papert, 1993; Kafai, 1995). Participatory design means a social activity among people who have different expertise and capabilities and, therefore, the participants are able to negotiate, make proposals, and set rules for the work to be done (Johansson & Linde, 2005). The questions raised during the process help learners to establish connections between what is known and what is learned, and ask for what purpose it is learned (Kafai, 1995). This kind of critical thinking can lead to creative and surprising designs. Whether building a tangible object or a game, learners should have the ability to see other learners' ideas, borrow from them, deconstruct them, and to present one's own ideas and prototypes (Kafai, 2006; Westera, Nadolski, Hummel, & Wopereis, 2008).

By constructing a game, learners have to construct new relationships with knowledge. The context of designing a game provides an analytical framework for learners to actively engage with different issues: to ask themselves what is difficult about the topic, how to represent it, which theme to choose for the game, how to integrate the topic into the game context, and how to accomplish the game. They must take into account themes, stories, characters, and interaction (Kafai, 2006). Thus, it emphasizes the importance of how the students learn to make an artefact and to organize the knowledge in a way needed in a learning game. The learning game should make the students' learning whole (see Perkins, 2009), instead of just producing short knowledge-based answers. Gunter, Kenny and Vick (2008) suggest that educational games can be evaluated on the basis of how well academic content is embedded within the game's story context, promoted to transfer the knowledge, and encourages repetitive usage of the content. A high quality educational game would foster learning, retention, transfer and the naturalization of academic content. Several game researchers (e.g. Crawford, 1997; Costikyan, 2002; Brandt,

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2006; Sotamaa, Ermi, Jäppinen, Laukkanen, Mäyrä & Nummela, 2005) also claim that a teacher as a game designer has to think about the goals of the game and the instructional aspects of the game and gaming.

Research Methodology

The Context and Participants of the Study

The purpose of this study is to describe the student teachers' learning-by-design project. The students' design challenge was to produce a textile-based learning game for teaching textile material knowledge at primary and secondary schools. The main idea is to describe the produced learning game, the students' learning process during this project, and the experiences they gained while playing the game with secondary school pupils.

The learning-by-design project took place in a craft teacher education course at the University of Eastern Finland at the end of 2010. It was an example of contextualization in a textile technology course and teaching practice. Thus, the design challenge was an authentic learning task for two students. The students made a twofold learning game as a team: the first game was targeted for primary school and the second for secondary school.

In their previous course, the students had familiarized themselves with learning games and had analyzed those forest-themed games that had been previously produced in primary school teacher education. They also attended a workshop in which learning games were introduced in practice to primary and secondary school teachers. Thus, teacher students had an overview about textile-based learning games and about the pedagogical aspects of using games at school. The students were in the beginning of their advanced studies stage. They had had at least basic and intermediate courses in all sections needed by a craft teacher.

Data and Analysis

The data of this descriptive case-study consists of artefacts, essays and portfolios from two craft student teachers. The students made portfolios and wrote reflective essays during their design process. The essays are answers to open questions about their experiences of the process and their learning, as well as about their experiences about the presentation of the games to the target audience and playing with those games. Thus, the data of this study consists of a textile-based learning game and written materials.

In qualitative research, data collection and data analysis are associated procedures, because the preliminary analysis is promoted during the process of data organization from the very beginning. Thus, in order to reach a full description, data analysis underwent several phases. First, the data was collected in the beginning of 2011; the separate texts were integrated, the game was described in an outline, and photographed in detail.

Secondly, both researchers read the texts independently. The analyses attended to identify the general themes and meanings in the texts. After this, the artefacts were analyzed by using phenomenological description. This means that the general description of the content and its characteristics is the main task, and anyone's subjective sensations or understandings are not attached to the descriptions (Anttila, 2006). According to Finlay (2009, 9), the core of the descriptions has to be 'the things in their appearance'. The general descriptions of the game are the characteristics that emerged within the analysis of the game. The photographs were used as reminders when researchers made the descriptions of the game; it was easier to work when they did not have to pick up artefacts during the analysis. This can be expected to have reduced mistakes and subjective interpretation, because the researchers did not have to rely on their memory.

The final phase of the analysis was to learn how this kind of project succeeded in breaking down the traditional concept of a curriculum unit, and knowledge-based and teacher-centered instructional strategies. Thus, the results contain the description of the students' learning process and its outputs.

One way to valid qualitative studies is to address the issue of trustworthiness and honesty (Lincoln & Guba1985; Bryman 2001). To enhance the rigour of this qualitative study, the following criteria for trustworthiness were taken into account: credibility and conformability, identification of the thematic categories, and investigator triangulation. In the analysis, dependability was certified by peer examination and theory support. The case-study approach focuses strongly on validity, which was assured through the use of two researchers, who both worked independently of one another. After having both analyzed and compared the data they revealed its uniformity. Transferability can be evaluated from the rich data and thorough description, and finally evidence-based findings. The credibility of the results can also be assessed by comparing them with the earlier studies.

Results of Research

The Learning Game

The student teachers received their design challenge in their textile technology course. The main idea in the learning-by-design process was to experiment with a new way of educating teacher students. The idea of the design challenge was that student teachers would obtain adequate expert knowledge needed for a craft teacher about the material technology and the teaching of those contents at school. Thus, the implementation of the course did not consist of any lectures and exams. The course consisted of independent and team-work, shared expertise, and design process. The students' design challenge was to design and produce a textile-based learning game for teaching textile material knowledge at primary and secondary school. Disseminating knowledge about textile materials is challenging in craft education: it is usually overlooked and pupils are not easily motivated to learn it. Thus, the student teachers made the decision to construct a '*Clothesline rally'* game that would inspire pupils to learn these contents through playing.

The '*Clothesline rally'* game consists of two independent games (size 150 cm x 150 cm), but they can also be used as one integrated game. The game consists of two parts: two game boards and game elements (Table 1). The first part of the game deals with knowledge about natural fibres and the second part about artificial fibres. The idea of the game is based on questions and answers like in the Trivial Pursuit game. The players may move on the board by throwing dice and by answering questions about fibres, their raw-materials, usage, and care or maintenance of textiles produced from natural or artificial fibres (see Figure 1). The game is washable, and it is easy to pack and store in its own bag.

The game boards are made by textile materials with textile-printing and appliqué techniques. The pawns are buttons, felted balls and clothes pegs. The layout of the games look like a clothesline: there are few clothes on the clothesline as a hint for the answers. Players can explore the miniature clothes, their raw-materials and textures (see Figure 2). The natural fibre game focuses on knowledge about wool, cotton, linen, silk and mohair. The artificial fibre game focuses on acrylic, polyester, viscose, nylon and spandex. The winner is the player who has the most clothes pegs at the end of the game. The players are asked to play in groups.

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Table 1. 'Clothesline rally'game elements.

Game elements	
Two game boards	Natural fibres and artificial fibres size 150 cm x 150 cm.
Question cards	140 pieces
Dice and pawns	16 pieces
Miniature clothes	10 pieces
Clothes pegs	100 pieces

Figure 1: 'Clothesline rally' game made by textile material (artificial fibres).

Figure 2: A miniature cloth as an example of the use of cotton.

There were some constraints to be taken into account in the design process, for example, the contents of the core curriculum and the target group. In the objectives of the core curriculum of craft education from 5 to 9 grades teaching the knowledge of material and consumer information and the usage of textile materials in an appropriate and creative way is mentioned. This is why the questions about natural fibres are based on the curriculum of the upper classes of the primary school (grades 5-6, ages 12-13) and the questions about the artificial fibres on the curriculum of the secondary school (grades 7-9, ages 14-16). Student teachers orientated themselves with the core curriculum to choose the right target group and appropriate contents. Students had to obtain information about the suitability of the game for the chosen age group, how the game could be instructive and fun at the same time, how the game could be used as part of learning and how the game could be further developed and applied to different school subjects. The core curriculum states that phenomena in crafts should be integrated into other school subjects. Thus, the questions of the game integrate textile knowledge into other school subjects and educational themes, for example, into chemistry, history, mathematics, biology, language, and environmental knowledge, in the following way:

- Chemistry: The manufacture of viscose fibre requires water. Which of the following is the chemical symbol for water? Answer: a) HO, b) HO_2, c) H_2O.

- Environmental knowledge: What kinds of environmental impacts do the manufacturing process of spandex and other synthetic fibres cause? Answer: a) products do not

decompose; b) the manufacturing process requires harmful chemicals to humans and the environment.

- Textile history: In which year did the English chemists C.F. Cross and E. J. Bevan invent the viscose preparation method? Answer: a) 1491; b) 1891; c) 1991.
- Biology: Why do spinner insects spin themselves a cocoon? a) they sleep at night in the cocoon; b) the larva develops into a butterfly in the cocoon; c) they can breed only inside the cocoon.
- Geography: How did the famous Silk Road which passes through Asia get its name? a) the Silk Road region was exceptionally high species of silk butterflies; b) Marco Polo brought via this road tons of silk to Europe; c) Silk was one of the main trade goods of merchants who journeyed along the road.

The student teachers wanted to invest in the visual appearance of the game to inspire pupils as much as possible, so the layout of the game is colourful and it contains a lot of details: miniature clothes to be explored, buttons and felted balls as pawns, and coloured clothespins as chips. Although the game deals with textile materials as a whole entity; it can be used independently, because there are two separate board game elements. The layout of the game boards are coloured differently to make the division of the fibres easier. The miniature clothes in the clothespin are examples of the usage of the fibres. Pupils may explore and touch those clothes and their materials and find hints for the questions to be answered. The questions in the game are as practical as possible so as to connect with knowledge in the pupils' everyday lives, although they are simultaneously integrating different school subjects. Thus, the questions focus, for example, on fibre properties, textile products and textile care. Student teachers had to embrace the whole content of their own textile technology course to be able to apply it to the context of designing a learning game. Thus, the educational academic content was embedded within the questions and answers of the game, the miniature clothes promoted transfer of knowledge in practice, and encouraged repetitive usage of the content.

The Learning Process

Students' experiences of contextualization through learning-by-design were encouraging: they found the ill-structured design task challenging, in a positive way. Contextualization aroused an active knowledge and skills building process while students had to construct an external artefact for the use of others. Students had to retrieve information and talk about possibilities, resources, and constraints. The learning-by-design process made use of participatory design and socially distributed cognition: students had familiarized themselves with previously produced learning games, they attended a learning game work-shop, and they were encouraged to collaborate with other students and experts.

Creating a game was suitable for the idea of learning-by-design; because it was a process of problem-solving that must be resolved through design and development. It required both an understanding of the craft in game design and multiple abilities and knowledge. It especially challenged the knowledge of content-related issues of the game, which was the content of the students own textile technology course. They had to transform, for example, the information about properties and use of textile fibres, laundry, textile history, manufacturing and environmental impacts, to support the pupils' educational goals.

The game design process included the idea of the game, designing the mechanics and

materials for the game, visualizing the materials (board, components, and rules sheet), writing the rules, making a prototype and testing the game with the target group. As a collaborative process, the game design required discussion and clarification of goals, problems, sub-problems, and actions. All this engaged students as stakeholders in a complex set of activities and required participation. Thus, the more the students were solving the learning problem, the more they were learning.

The brainstorming in the beginning of the design process proved time-consuming. The process was concretized through articulation and visualization of the materials (board, components, and rules sheet), writing the rules, and eventually making a prototype. In addition to these elements, students had to take into account suitable craft techniques. Students reported that after the main idea of the game was perceived, the layout, the mechanics, techniques and materials were easy to design. The students find that contextualization through learning-by-design and designing a learning game was a meaningful way to study academic textile technology contents. They said that they had learned a lot during the process. They had to familiarize themselves with the basic characteristics of each fibre and their differences, and with the core curriculum and teaching and integrating textile knowledge in a school context. The students had to integrate their psychological, educational and instructional knowledge in the problem-solving process. The student teachers found the learning-by-design method to be more effective than traditional university lectures and exams or exercises. They had achieved a deeper insight into the contents; and they felt they had achieved skills and knowledge a craft teacher really needs in practice. The students had found the learning process to be motivational, although the production of the game had been laborious.

Students' Experiences about Playing the Game

The student teachers introduced The '*Clothesline rally'* game for secondary school pupils (2 classes of 7 graders) during their teaching practice period. The pupils were interested in the game and in learning by gaming. According to them, the most interesting feature of the game was the layout of the game and its small miniature clothes. They liked to explore and touch the textile-based game. They soon found that they can get hints for the answers from the clothes, for example, from the texture and technical details of the clothes. Those two classes played the game in groups for two hours; they settled down and focused on gaming. The majority of the pupils felt that gaming was a good teaching method. Pupils preferred gaming over traditional learning, because it had set challenges and required problem-solving. These kinds of factors are essential for educational games and are also needed during a learning process.

Student teachers received critique only about the size of the game and about some of the rules. Pupils had found the game boards to be too large: it was a little bit difficult to move the pawns. A few of the pupils said that it would be necessary to deal with the issues more exactly after gaming. Gaming would therefore be also used as an introduction to a new issue or a revision of the learned contents. Student teachers themselves noticed how the game and gaming had had other educational goals: miniature clothes had introduced elements of investigative learning into gaming, and action in groups had promoted team-work and social learning. Pupils were impressed about the layout of the game and had appreciated the needed craftsmanship and respected the craft related activities in a way that is expected in the core curriculum. Student teachers had found this kind of approach towards textile material knowledge to be motivational.

Discussion

This article describes a pilot-project in which students produced a concrete external artefact through social interaction and shared representations of their understanding and thoughts. The textile-based learning game was innovative. It allowed a multidimensional approach towards learning and teaching by breaking down the traditional theory-based and lecture-based pedagogy in teacher education (see Azer 2009). The focus was not on content specific knowledge and facts in exams (see Buchberger et al., 2000; Laurilland, 2002; EC, 2005).

The implementation of the project through learning-by-design changed the learners' practices: the students had to solve the design challenge; they needed different kinds of skills, multi-disciplinary knowledge, holistic thinking, information processing, critical evaluation, and co-operation in order to support the activity. They had to critically examine the design task from a variety of theoretical and practical perspectives in a way Lombardi and Oblinger (2007) have been calling for. Although a game design process is an artistic process, it also contains a lot of technical design at the same time, and it requires skills and knowledge acquisition. Students had to create plans, build a prototype, and test and analyze it by collecting information from various sources and by working together to solve the design challenge (see Kafai, 1995; Kolodner, 2002; Han & Bhattacharya, 2009). As a constructionist design, the pilot-project also contained the opportunity for the public sharing of the artefacts as play sessions with the target group (see Holbert et al., 2010).

According to Kafai (2006) and Westera et al. (2008), in designing a game, students are supposed to be confronted with various kinds of ill-defined problems that allow several solutions and presume the application of necessary knowledge and skills, and collaboration with fellow students. Constructing the learning game required multiple abilities in the designing process, an understanding of craft in game design and also pedagogical aspects of learning by gaming. Student teachers had to think about the goals of the game and the instructional aspects of the game and gaming at primary and secondary school contexts, as a team (see Crawford, 1997; Costikyan, 2002; Brandt, 2006). It was important to understand how the players act and their experiences of playing (see Sotamaa et al., 2005). Thus, the students' learning target ensured transfer and application into practice (see Segers et al., 2003; Azer, 2009). Rule (2006) and Westera et al. (2008) emphasize that it is important in higher education to engage learners in complex problem spaces that mimic real world situations and practice student teachers' thinking skills and meta-cognition. Students succeed in transforming academic knowledge to such a form that may foster learning, retention, transferral and naturalization of the knowledge-based content (see Gunter et al., 2008).

Contextualization through learning-by-design offers opportunities to reflect on the student teachers' own learning and teaching. Learning-by-design challenged the students' self-assessment: they had to share their best practices, pilot, evaluate, articulate, and modify their work. The holistic and integrated approach of assessment included peer-reviews as discussions, written materials in portfolios and essays, and assessment of personal knowledge and performance while working as a team in a way Kalantzis and Cope (2005) suggest. The design challenge enabled the students to make choices and reflect upon their learning process, their skills, and abilities. Experimentation and exploration as concrete actions helped the analysis and synthesis of the process and product in the articulation and in the portfolios, as well as in gaming with pupils (see Kalantzis & Cope, 2005; Han & Bhattacharya, 2009).

Conclusions

This pilot-project provided evidence that learning-by-design challenges can create an active, multi-disciplinary and constructive context for learning in teacher education. It offered opportunities for interaction, communication and co-operation. The contextualization stimulated students to set their own goals and to assume responsibility for the process. In practice, the design challenge required students to transform academic knowledge into learning and teaching. Learning-by-design made the learning whole, just as Perkins (2009) wants: instead of a theory-based and lecture-based pedagogy, it emphasized the importance of authenticity and motivation in order to sustain learning and thoughtful practices. The process-, problem- and project-oriented implementation led to inquiry-oriented practices that supported co-operation and reflection.

The challenges education is confronting are encouraging teacher education to develop alternatives for the teacher education curriculum and to experiment with new ways of educating students. The contextualization of the project through learning-by-design and game-construction may be just an example of those possibilities that may break down the traditional concepts of a curriculum unit, disciplines, and knowledge-based and teacher-centered instructional strategies in order to make high quality education a practice in teacher education, and in other contexts other than those described in this article.

References

Anttila, P. (2006). *Tutkiva toiminta. Ilmaisu, teos, tekeminen. [Investigative activities. Expression, work, making]*. Hamina: Akatiimi.

Azer, S. A. (2009). What makes a great lecture? Use of lectures in a hybrid PBL curriculum. *The Kaohsiung Journal of Medical Sciences,* 25(3), pp. 109-115.

Brandt, E. (2006). Designing Exploratory Design Games a framework for participation in participatory design? *Proceedings Participatory Design Conference 2006,* (pp. 57-66).

Bryman, A. (2001). *Social Research Methods.* Oxford: University Press.

Buchberger, F., Campos, B. P., Kallos, D., & Stephensson, J. (2000). Green Paper on Teacher Education. High Quality Teacher Education for High quality Education and Training. Thematic Network on teacher education in Europe. Fakultetsnämden för lärarutbildning. Umeå Universitet, Sweden. Retrieved from http://www.umd.umich.edu/casl/natsci/faculty/zitzewitz/curie/TeacherPrep/50.pdf

Costikyan, G. (2002). I Have No Words & I Must Design. Toward a Critical Vocabylary for Games. *Proceedings of Computer Games and Digital Cultures Conference* (pp. 9-30). Tampere: Tampere University Press.

Crawford, C. (1997). *The Art of Computer Game Design by Chris Crawford.* http://library.vancouver.wsu.edu/sites/library.vancouver.wsu.edu/files/ACGD.pdf (Accessed March 25. 2011).

EC (European Comission). (2005). *From Berlin to Bergen. General Report of the Bologna Follow-up Group to the Conference of European Ministers Responsible for Higher Education.* Oslo. Retrieved from http://www.ond.vlaanderen.be/hogeronderwijs/bologna/documents/GRP_for_MC/TheBFUG-Report-from-BerlintoBergen-May-2005.pdf

Finlay, L. (2009). Debating Phenomenologial Research Methods. *Phenomenology & Practice,* 3(1), pp. 6-25.

Gunter, G. A., Kenny, R. F., & Vick, E. H. (2008). Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games. *Education Technology Research and Development,* 56*,* pp. 511-537.

Han, S., & Bhattacharya, K. (2009). Constructionism, Learning by design, and Project Based Learning. In M. Orey, *Emerging perspectives on learning, teaching, and technology.* Retrieved from http://projects.coe.uga.edu/epltt/.

Hmelo, C. E., Holton, D. L., & Kolodner, J. L. (2000). Designing to learn about complex systems. *Journal of the Learning Sciences,* 9(3), pp. 247-298.

Holbert, N., Penney, L., & Wilensky, U. (2010). Bringing Constructionism to Action Game-Play. Constructionism 2010. Paris. Retrieved from http://ccl.northwestern.edu/papers/2010/Holbert%20Constructionism.pdf.

Johansson, M., & Linde, P. (2005). Playful Collaborative Exploration: New Research Practice in Participatory Design. *Journal of Research Practice,* 1(1), article M5.

Kafai, Y. (1995). *Minds in Play. Computer Game Design as a Context for Children's Learning.* New Jersey: Lawrence Erlbaum.

Kafai, Y. (1996). Learning Design by making Games: Children's Development of Design Strategies in the Creation of a Complex Computational Artefact. In Y. Kafai & M. Resnick (Eds.), *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World* (pp. 71-96). New Jersey: Lawrence Erlbaum.

Kafai, Y. B. (2006). Playing and Making Games for Learning. Instructionist and Constructionist Perspectives for Game Studies. *Games and Culture,* 1(1), pp. 36-40.

Kalantzis, M., & Cope, B. (2005). Introduction: The learning by design approach. In M. Kalantzis, B. Cope & Learning by Design Project Group, *Learning by design* (pp. v-xi). Melbourne: Victorian Schools Innovation Commission & Common Ground Publishing.

Kolodner, J. (2002). Facilitating the Learning of Design Practices: Lessons Learned from an Inquiry into Science Education. *Journal of Industrial Teacher Education,* 39(3), pp. 9-40.

Korthagen, F. A. (2010). How teacher education can make a difference. *Journal of Education for Teaching,* 36(4), pp. 407-423.

Laurilland, D. (2002). *Rethinking teaching for the knowledge society.* (pp. January-February, 17-25). Retrieved from http://net.educause.edu/ir/library/pdf/erm0201.pdf

Lincoln, Y. S., & Cuba, E. A. (1985). *Naturalistic inquiry.* Beverly Hills CA: Sage Publications.

Lombardi, M. M., & Oblinger, D. G. (2007). *Authentic learning for the 21st century: An overview. Educause learning Initiative.* Retrieved from http://net.educause.edu/ir/library/pdf/ELI3009.pdf.

Papert, S. (1993). *The Children's machine: rethinking school in the age of the computer.* New York: Basic Books.

Paris, S. G., & Winograd, P. (2001). *The role of self-regulated learning in contextual teaching: Principles and practices for teacher preparation.* A Commissioned Paper for the U.S. Department of Education Project. Retrieved from www.ciera.org/library/archive/2001-04/0104prwn.pdf.

Perkins, D. N. (2009). *Making learning whole: how seven principles of teaching can transform education.* San Francisco: Jossey-Bass.

Rule, A. C. (2006). The components of authentic learning. *Journal of Authentic Learning,* 3(1), pp. 1-10.

Segers, M. Dochy, F., & Cascallar, E. (2003). *Optimising new modes of assessment: in search of qualities and standards.* Kluwer academic publishers, 2003 (Dordrecht).

Sotamaa, O., Ermi, L., Jäppinen, A., Laukkanen, T., Mäyrä, F., & Nummela, J. (2005). The Role of Players in Game Design: A Methodological Perspective. *DAC - Digital Experience: Design, Aesthetics, Practice* (pp. 34-42). Tampere, Finland: University of Tampere.

van Oers, B. (1998). From context to contextualizing. *Learning and Instruction*, 8(6), pp. 473-488.

Westera, W., Nadolski, R. J., Hummel, H. K., & Wopereis, I. (2008). Serious games for higher education: a framework for reducing design complexity. *Journal of Computer Assisted Learning,* 24*,* pp. 420-432.

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