Teachers as Designers of Educational Toys and Digital Games

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Abstract

Playing is one of the most important activities of children. It constitutes a basic developmental factor and has a decisive influence on their learning processes. Although learning is not the reason why children choose to play, playing is the predominant way that children learn and "learn how to learn". Through playing, learning-related processes, such as repetition, practice, imitation, exploration and discovery are enhanced and skills necessary for learning, such as internal motivation and engagement are developed. Advancements in technology caused a rapid shift towards digital games, thus making it crucial for education to evolve in order to differentiate the existing leaning methods. Educational digital games have the potential to support learning in terms of improving conceptual and epistemological understanding, process skills and practices, strategic thinking, planning, communication, collaboration, decision making and negotiating skills. However, the successful embedding of learning mechanics into game mechanics has proven to be a complex activity. Recent research proposes that in order to achieve intrinsic integration of the learning content into a digital game, educators, as learning experts, should be placed into the designers' role. However, little research has been carried out in order to reveal the challenges that educators face during such attempts. The aim of this study was to identify the difficulties that educators encounter when they attempt to design educational toys and transfer their design into a digital game with educational value. For the purpose of this study, the designs produced by 16 postgraduate students were analyzed using qualitative methods. In particular, students, who participated in a postgraduate course related to the evolvement of toys through time, were asked to design an educational toy and redesign it as an

educational digital game. In the first part of their design, they had to choose one of the dominant theories around play and explain how they applied it. Furthermore, rules of play, goals and learning context of their educational toy should also be described. The second part of the design should include descriptions of the mechanics they had chosen to achieve the integration of learning content into the gaming mechanics of the digital game. Finally, students should clearly explain the rational of their choice and define how it should lead the player to potential learning of a concept or ability. Even though the analysis of the designs in still in progress, the initial data shows that students faced major difficulties in both design tasks. Even though most of the designs included specific learning goals from various developmental and learning areas, the design approaches were either evaluative or behaviouristic and did not show any learning potential. This evidence is consistent with that of other studies that stress the importance of specific frameworks that need to be developed in order to successfully include educators in design processes.
Keywords: educational toys, digital games, teachers as designers

Play and learning

Campagne (1989) describes toys, as every subject that was created in order to amuse children, while keeping them busy. He, also, supports that anything that exists in a child's environment can potentially be a toy. Every toy has certain characteristics which determine a certain way of use or play and suggest a specific play activity by constituting the material context in which play develops. However, as he mentions, the way of use and the development of play depends on players' characteristics such as their personality, influences, creativity and also on the environment in which the activity takes place.

Schell (2008, p.56) differentiates "play" from "object-toy" and "game". He makes references to phrases like "we play a game" and "we play with a toy". Toys must create experiences for players at imaginary level while giving them feelings of freedom of choice, responsibility, integration, achievement of goals, friendship, and companionship. Each game aims at the essential experience but cannot cover all aspects of human experience.

There is a significant theoretical framework for the preschool education on the benefits of play as a learning tool and as the foundation of the curriculum (Hirsh-Pasek, Berk, & Singer 2009; Sandberg, & Samuelsson, 2003). Shaffer (2006), reports that game-based learning is a very effective method as it offers opportunities for

the development of a variety of educational outcomes. This is based on the engagement motive which toys produce, retains children's interest to stay on target, and eventually leads them to learning (Hirsh-Pasek, et al., 2009). Games induce children to make use of their existing cognitive tools to meet their requirements, while creating new cognitive patterns (Gee, 2003).

Playing cannot be separated from a child's learning and development as it develops brain flexibility and the potential ability to learn in later life (Smith & Pellegrini, 2008). It helps children learn through restrictions that operate in a certain framework (Bruner, Jolly, & Sylva, 1985) and offers the child the ability to make mistakes safely and learn from them (Chan, Tan, Hew, Koh, Lim, & Yong, 2017). However, playing does not have a secure place in the curriculum (Bennett & Kell, 1989; Bennett, Wood, & Rogers, 1997; Cleave & Brown, 1991; Sandberg & Samuelsson, 2003; Samuelsson & Carlsson, 2008). Despite the commonly accepted value of play, it is not established in teaching practice as the quality of learning through playing is questioned and the connection between theory and pedagogical practice has not been achieved (Bennett, Wood, & Rogers, 1997). This "gap" between theory and everyday practice (rhetoric-reality gap) is widely emphasized by researchers (Wood, 2010).

Educational toys

There are two different theoretical approaches on educational toys. The cognitive approach emphasizes on the role of playing in the cognitive development of the child, by supporting that toys are a basic tool that facilitates it. Piaget (1964), in this child-centred approach, studies playing within his theory on children cognitive development by pointing out that through playing, the child experiments and explores that world, by discovering skills and building knowledge.

On the other hand, Lev Vygotsky (1976), in a socio-cultural approach, studies play in relation to the development and functioning of high mental processes, which are formed socially and transmitted culturally (Avgitidou, 2001, p.20). According to Vygotsky, children use and adapt their cultural tools, such as language, to their playing in order to change their social and physical environment. The main feature of Vygotsky's playing is the "imaginary situation", emphasizing the meaning that children give to objects, according to their wishes and needs. This process results in gradual development of new relationships between objects and abstract thinking.

Educational digital games

Even though digital games are mainly connected with fun, research shows that engaging with them can promote a range of skills. Information processing and its direct use (Prensky, 2003), compliance with rules (Prensky, 2003), formation of problem solving strategies (Bottino & Ott, 2006; de Aguilera & Mendiz, 2003; Gee, 2003; Ko, 2002; Prensky, 2003), understanding of complex systems through experimentation (Prensky, 2003), observation (de Aguilera & Mendiz, 2003), logic and reasoning (Bottino, Ferlino, Ott & Tabella, 2007; Ko, 2002; Bottino & Ott, 2006), memory (de Freitas, 2006), classification (Sung, Chang & Lee, 2008) and cooperation (Gee, 2003; Lee, Luchini, Michael, Norris & Soloway, 2004; Prensky, 2003; Williamson & Facer, 2004) are some of the skills that players are developing when aiming for the best performance, the optimal time, or just the completion of a digital game.

Given the widespread inclusion of technology in the educational process and the positive results reported by researchers, integration of digital games in the educational framework was inevitable. The first type of integration followed the instructionist model of Kafai (2006). However, different research studies that measure the educational gain when engaging with educational digital games show contradictory results (Ke, 2009). The second type of integration followed Papert's constructionist theory (Kafai, 2006), where the player is placed in the position of the creator instead of that of the player. Knowledge is expected as a result of the student's engagement not in the playing process, but in the design and development procedures and decisions. In the third type of integration, students are also engaged in analysis, design and development of digital games; however, these processes are exploited to measure and record knowledge acquired by students as part of a more traditional teaching model (Denner, Werner & Ortiz, 2012; Robertson, 2012; Werner, Campe & Denner, 2012).

Teachers as designers

Even though there are multiple researches that show important results when educators use toys for teaching science, mathematics, literacy etc., there are no reports in which educators undertake to design games/toys that fit their educational goals (Elofsson et al, 2016; Gee, 2003; Lowe, 1988; Paris & Yussof, 2012; Sirinterlikci et al, 2009; Skoumpourdi, & Kalavassis, 2003). The professional designer conceives the idea of a certain game/toy to provide a specific experience,

which, however, should differentiate according to the specific context of each educational environment and each educational goal.

Regarding digital games, even though various meta-analysis show that educational digital games can, in general, contribute towards learning (Clark, Tanner-Smith, & Killingsworth, 2016; Girard, Ecalle, & Magnan, 2013; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013; Sitzmann, 2011), in order to achieve successful integration of learning content into games (toys and digital), it is important to involve educators into game design (Bellotti et al., 2012; Arnab et al., 2014; El Mawas, 2014; Sandberg & Samuelsson, 2003; Elofsson, Gustafson, & Samuelsson, 2016; Shaffer, 2006; Sirinterlikci, Zane, & Sirinterlikci, 2009). However, despite their pedagogical expertise, little research that has been made on the field, shows that educators do not manage to integrate learning content into game design effectively (Arnab et al., 2013; Bellotti et al., 2012; Marchiori et al., 2013; Skoumpourdi, & Kalavassis, 2003; Theodosiou & Karasavvidis, 2015).

Aim of the study

Considering that educators can contribute positively to the design of both toys and educational digital games due to their pedagogical expertise and taking under consideration that they either do not attempt such a task or they are not successful, this study places educators in the of the designers' position to further study their experiences.

In more detail, the aim of the study is to identify

- What are the characteristics of the educational toys and digital games that educators design?
- What are the difficulties that educators encounter when they attempt to design educational toys and transfer their design into a digital game with educational value?

Method

Participants and context

Sixteen postgraduate students (one male and fifteen females, between 24-50 years old) who were enrolled in a postgraduate course related to the evolvement of toys through time, participated in the study. Nine of the students were kindergar-

ten teachers, six of them taught in primary school, while ten of them worked in public schools.

Students attended theoretical seminars on various topics related to toys, digital games and playing, they were provided with bibliography and took part in various design tasks. Of the sixteen students who enrolled in the course, fifteen managed to finished it (N=15).

Design task

The main task assigned to students was to design an educational toy and redesign it as an educational digital game.

Regarding the educational toy, students were asked to choose and apply an educational theory in their design and describe the rules of play, the educational goals and the learning context. For the design of the educational digital game, they were asked to integrate effectively learning content into the gaming mechanics and describe how playing the game would lead the player to potential learning of a concept or ability. Students received feedback, in the form of annotations, for both their design drafts (educational toy and digital game) after 4 weeks into the semester, in order to make changes or improvements.

At this point it should be noted that part of the students' assignment was to also construct the educational toy but not the digital game.

Measures and analysis

To answer the research questions, we analyzed the educational toy and the digital game designs using qualitative thematic analysis to (a) identify their characteristics and (b) recognize any points that indicate difficulties that educators faced in the design process.

For the analysis of the designs, two different axes were followed. Regarding the educational toys design, analysis was made in terms of toy type, educational framework, rules and learning content. The digital game designs were analyzed in terms of game type, game elements included (Environment, Hero, Rules, Obstacles, Resources, Aim), game mechanics and learning content. For simplicity reasons, we only included the basic game elements.

As the results were very extensive, we quantified the results for better representation.

Results

Educational toys

Toy type

Analysis of the design of educational toys, showed that the majority of the students chose to design board or racing games and puppets or dolls. Twelve students designed toys for kindergarten, while only three designed toys that could be used in primary school. Table 1 below shows the toy types and corresponding educational levels.

Toy type	**Designs**	**Kindergarten**	**Primary school**
Board game / racing	4	2	2
Puppet/doll	3	3	
Board game / knowledge	2	1	1
Board game / point-gain	2	2	
Construction game	1	1	
Knowledge game	1	1	
Kinetic	1	1	
Persona doll	1	1	
	15	**12**	**3**

Table 1. Toy types and educational levels depicted in students' toy designs

Educational framework

Table 2 below shows the educational frameworks students chose to incorporate in their designs. Even though Piaget framework is presented as the most common choice, in the majority of the designs, students chose to describe theories in general, rather than focus on the framework they had implemented. The multiple reported frameworks in each design provided unclear results on their choices. However, at this point it has to be mentioned that students who designed dolls chose to make clear references to the theories of Freud and Piaget.

Educational framework	**Designs**
Piaget framework	10
Unclear descriptions of the framework and how they have decided to adopt it	9
Freud framework	6
Vygotsky framework	6
Huizinga framework	2

Table 2. Educational frameworks incorporated in students' toy designs

Rules of play

Analysis of the designs showed that students included descriptive rules mainly in board games, where they were necessary to explain how the game is played. As shown in Table 3 below, in five of the designs students did not describe any rules. However, this was expected, as they chose to design free play educational toys.

Rules of play	**Designs**
Descriptive rules	7
Free play with no need of rules	5
Unclear rules	3
	15

Table 3. Rules of play incorporated in students' toy designs

Learning content

Table 4, below, shows the learning content that students chose to incorporate in their designs. Most of the designs included learning content of more than one area. Mathematics and social content were the most popular, while almost half of the designs referred to abstract goals, such as fun. Five designs included general knowledge and movement or motricity goals. Finally, only two students chose to incorporate linguistics learning content.

Learning content	**Designs**
Mathematics	7
Social, collaboration	7
Abstract goal (e.g. fun)	6
Knowledge	5

Movement/motricity	5
Linguistics	2

Table 4. Learning content incorporated in students' toy designs

Digital games

Game type

Table 5 below shows the types of digital games that students chose to design. The paradox is that, even though they were specifically asked to design a digital game, in the majority of the designs students only made extensive descriptions of either a computer application of evaluative character, or a simulation that lacked interaction with the child. The four students that responded to the task, chose to design an action game, a problem solving game, a strategy game and a construction game.

Game type	**Designs**
Software/Application	5
Simulation	5
Action	1
Problem Solving	1
Strategy	1
Construction	1
Educational activity that incorporates technology	1
	15

Table 5. Game types depicted in students' game designs

Game elements

As shown in Table 6, students' designs lacked descriptions of most of the common game elements or the descriptions included were deficient. None of the students described the environment of the game or the available resources for the player to use in order to overcome obstacles. Only one design included adequate descriptions of the obstacles of the game and less than one third of the designs described the hero of the game and game's aim.

Game elements	Designs		
	Adequate description	Deficient description	No description
Environment		6	9
Hero	4	2	9
Rules	2	2	11
Obstacles	1	3	11
Resources		3	12
Aim of the game	3	2	10

Table 6. Game elements included in students' game designs

Game mechanics

Analysis of the designs showed that their majority included no mechanics. Moreover, four students described questions and answers as game mechanics, mainly used to evaluate existing knowledge and not create new one. Table 7 below shows the number of designs that incorporated game mechanics.

Game Mechanics	Designs
No mechanics	10
Questions & Answers	4
Description of Obstacles	1
	15

Table 7. Game mechanics included in students' game designs

Learning content

Even through students were asked to design educational digital games which would lead to potential learning of a new concept or ability, in the majority of the designs, no learning content was integrated. As described above, in the game mechanics incorporation, the four designs in which learning content was described, they were mainly knowledge evaluation games and had no potential construct learning. Table 8 below shows the learning content integrated in the game designs.

Learning content	**Designs**	
	Have the potential to lead to learning	Do not have the potential to lead to learning
No learning content		11
Highway code		1
Linguistics		1
Mathematics		1
Computer use		1
		15

Table 8. Learning content included in students' game designs

Discussion

The use of educational toys and digital games in the classroom has been proven to be effective towards the achievement of specific educational goals (Clark, Tanner-Smith, & Killingsworth, 2016; Elofsson et al, 2016; Gee, 2003; Girard, Ecalle, & Magnan, 2013; Lowe, 1988; Paris & Yussof, 2012; Sirinterlikci et al, 2009; Sitzmann, 2011; Skoumpourdi & Kalavassis, 2003; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013). The engagement of educators, who are considered pedagogical experts, should allow toys and digital games to be specifically designed for specific educational environments or instructional needs. However, existing research shows that educators do not choose to engage in design tasks and when they do, they face multiple problems (Arnab et al., 2013; Bellotti et al., 2012; Marchiori et al., 2013; Skoumpourdi, & Kalavassis, 2003; Theodosiou & Karasavvidis, 2015). In this study, educators were put in the place of the designers and were asked to design an educational toy and redesign it as an educational digital game.

Results from the analysis of both the educational toys and digital games designs, provided us with a number of different conclusions. Educators design with no imagination and their designs lack basic elements. Furthermore, they encounter similar difficulties when designing a toy or a digital game. They choose to incorporate behaviouristic approaches, mostly when they design digital games, as they believe that knowledge will come from repetition. Furthermore, educators mainly design toys and digital games to "teach" or "evaluate". Even though their toys and games should create meaningful and educational experiences by providing tools to

"build", for example, mathematical thinking, they prefer to embed multiplication questions, assuming that asking the result of a mathematical operation will "magically" teach the student how to multiply. Their approach does not consider toys and digital games as the medium to create meaningful learning experiences. Finally, fun and entertainment are often omitted in the design, or appear as non-important or self-evident. These results agree with those of similar studies.

Further research needs to be directed towards the development of support frameworks that will motivate educators to get more actively involved in the design process, while providing them with design tools to help them exploit their pedagogical expertise.

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