Pedagogical Integration of Digital Game-Based Learning - Processes Involved

Eva Brooks[1,2(✉)] and Jeanette Sjöberg[1,2]

[1] Aalborg University, Kroghstæde 3, 9220 Aalborg, Denmark
eb@hum.aau.dk
[2] Halmstad University, Kristian IVs väg 3, 30118 Halmstad, Sweden
jeanette.sjoberg@hh.se

Abstract. Aligned with the digital development in society, the use of digital game-based learning (DGBL) as a pedagogical enhancement has increased markedly in schools recently. However, due to various reasons, teachers are not always as enthusiastic to adopt the new technology in their classroom. In this paper we apply Engeströms activity system as an analytical approach to understand teachers' considerations of opportunities, resistance or barriers and pedagogical functions of digital game-based learning as a teaching method. As related research has shown, there is a lack of research answering the question of how DGBL could be designed to structure and facilitate learning as well as of considering the classroom settings and barriers of implementing DGBL. We attempt to contribute to these problems by applying the activity system framework in the context of digital game-based learning (DGBL), in particular the interplay between resistance as an obstruction or opportunity and design of teaching activities by means of digital games. The research questions posed in the study are: 1) How do teachers evaluate the designs of digital games in relation to how they support or hinder learning? and 2) What kind of constraints do teachers identify while translating educational games? The study applies a qualitative approach and includes cases of two separate workshops with a total of twelve participating teachers and one toy- and game designer. The workshops were designed to provide a framework for preschool- and primary school teachers to evaluate challenges and potentials of DGBL. Findings show, among other things, that when a game does not offer exploration or encourage curiosity, a game's design becomes simplistic and children lose their interest, revealing a gap between game mechanics and a game's pedagogical relevance and usefulness. Furthermore, by starting to question the relevance of games, the teachers were able to appropriate digital educational games while assessing the game's value in relation to a subject-specific area.

Keywords: Activity theory · Digital game-based learning (DGBL) · Educational game apps · School teachers · Teaching method

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1 Introduction

Arguments that are often posed in the literature of Digital Game-based Learning (DGBL) indicate that digital games can offer enriched learning experiences compared to traditional teaching methods. It is still unclear though how this actually happens [1]. In an attempt to elucidate this matter, researchers have investigated the use of educational digital games in different subject areas as well as developed models and frameworks for analysing games [1–3]. Besides providing explanations about digital games' educational possibilities and constraints, their motivational and social components to learning, they do not fully offer an answer to how the games should be designed and structured to facilitate learning. This is in line with a study by Kickmeier-Rust and Albert [4] which questions the actual impact of DGBL and suggests that poor game design can influence learning processes and outcomes.

Considering the arguments acknowledging DGBL in positive terms, the barriers that teachers face when they try to optimise DGBL in their teaching are rarely conveyed [5]. Hence, understanding of these resistance and constraints is important to understand how teachers translate digital games into their educational settings as well as understanding the classroom practices in which game-based learning processes are intended to be applied [6, 7]. For example, the choices that they make, including pedagogical constraints that they embody [5]. In her article, Kindred [8] suggests that resistance in learning and at work can be considered as having a productive role in learning and self-development. In contrast to traditional views of resistance as a constraint impeding learning, the author proposes that resistance can be seen as a constructive and deconstructive process in which people create bridges between past and present, during which people act as drivers of change. To reveal such processes, we have applied activity system theory, where human activity constitutes a context in which a constant dynamic movement, historically and interactionally, takes place [9].

The present study investigates how 14 teachers in two workshops discuss and argue while evaluating the design of digital game apps and their pedagogical benefits and barriers or constraints and, furthermore, designing a teaching activity including digital game-based learning. The format and content of the workshops were intended to also become a resource to facilitate their further implementation of DGBL. Research questions posed in this study:

- How do teachers evaluate the designs of digital games in relation to how they support or hinder learning?
- What kind of constraints do teachers identify while translating educational games?

The following section outlines related work to the topic of this paper followed by a presentation of the theoretical framework and methodology. Next follows a description of the outcomes of the study followed by a discussion and conclusion.

2 Related Work

The introduction of DGBL in schools has increased markedly in recent years [10], largely as a result of an increasingly digital society. As mentioned above, previous research has

pointed to the benefits of DGBL in various subject areas, such as language [e.g. 11], math [e.g. 12] and science [e.g. 13]. The problem-solving and collaborative activities are often highlighted as extra favourable for learning [14]. Despite this, several teachers are hesitant about integrating the use of DGBL in their teaching for various reasons [15]. These are, for example, a lack of technology resources, technological turmoil, cost and the teachers' lack of knowledge to use technology [e.g. 5, 16, 17, 15]. In addition, there is relatively little research that highlights the teachers' views on the integration of DGBL in teaching activities [5].

However, earlier studies have shown that both teacher students (i. e preservice teachers) as well as practicing teachers have an ambiguous stance regarding the use of DGBL in the classroom: on the one hand they believe that there is a great potential in using games in educational settings and they considered games to be important educational tools, but on the other hand they were reluctant to use them themselves in their own teaching because they were unsure of how to incorporate, or if they wanted to bring DGBL into their future classrooms [e.g. 18, 19, 20]. In a study with Danish teachers, with the aim to discover teachers attitudes towards learning games and apps, Marchetti and Valente [21] found three major attitudes emitted from the teachers: (a) designers of content, teachers who were inventive with the technologies; (b) mediators, teachers who see themselves between the content and the chosen tools; and (c) IT-concerned, teachers who feel IT was something they had to learn in addition to their daily labour [21]. According to previous research of technology and/or games as a tool in the classroom, the overall largest determining factor as to whether a teacher would incorporate DGBL in their teaching or not is the teacher's perception of "usefulness" [22, 23].

In a recent systematic review over research between May 2009 and May 2019, Sun, Chen and Ruokamo [10] aim to unveil how digital game-based methods are being implemented in primary education to assess how teachers' pedagogical activities support digital game-based learning in primary education. The results indicate among other things that teachers' most significant concern regarding learning outcomes is knowledge acquisition, followed by attitude and motivation, skill outcomes, and behaviour change. Hebert and Jenson [24] emphasise that it is a critical component of effective DGBL to recognise the teacher's role in designing and facilitating learning environments that support DGBL, including adapting content to suit the needs of diverse learners. They argue that teachers need to be provided with professional development that focuses on cultivation of pedagogical skills, to create effective DGBL environments. Similarly, an Israeli study by Hayak and Avidov Ungar [25], examined 28 elementary school teachers' perceptions of the integration of DGBL into their instruction at different stages of their career. The results show that teachers at different stages of their career express different perceptions regarding the integration of digital game-based learning into their instruction, which can be related to the need for professional development. In addition, they identify key characteristics among teachers regarding patterns of adopting digital game-based learning and implementing digital game-based learning in teaching with relevance to professional development and teacher training [25].

The related work has shown that teachers' understanding and implementation of digital games in teaching activities is a complex endeavour, which requires considerations not only to games as such but also to how they fit to specific subjects and how content

and design can support children's learning. To be able to identify these aspects, we have applied Engeström's activity system as an analytical framework, which is introduced in the following section.

3 Theoretical Framework

In this paper, we apply the activity theory as a theoretical framework. Hassan [26] points out that this approach has a focus on different forms of practices and learning processes, providing a model of humans in their social and organisational context [26]. Activity theory originated in the 1920s and 1930s by, among others, Vygotsky and Leontjev [27]. In this original tradition, Vygotsky developed mediated action as a unit of analysis [28, 29]. This was done as a triangular unity including subject, object and mediating tools and signs (Fig. 1).

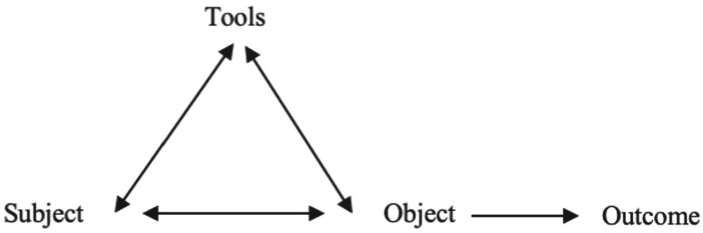

Fig. 1. The activity system as proposed by Vygostsky (1978).

The learning from this unit was the uncovering of the interaction between object and mediating artefact [9]. Activity theory is extensively used in the field of learning, but less used in the study of games [30–32].

Activity as a unit of analysis in activity theory focuses on interactions between subject and object in a process where transformations are achieved. The interaction is mediated by tools, which shape an ongoing interaction [33]. The original activity model proposed by Leontjev (1978) was further elaborated by Engeström [27], where he described an activity as a collective phenomenon conceptualised as *Activity System* in the form of a triangle (Fig. 2). The three sides of the model represent the core elements of the system (subject-object-community) and the corners represent the mediating means to the main elements (tools-social rules-labour division). The activity as such is directed towards the object resulting in an outcome. Engeström has further developed the model to include a diversity of perspectives and interactions between several interacting systems, which is conceptualised as Activity System Network [34]. An activity is not a static unit, but rather a dynamic one. Continuous transformations happen between the parts of the system based on, for example, changes in the subject's motivation or skills or changes in the labour division among the members of a community [9, 31]. Engeström [9] emphasises that it is the object that constitutes a dynamic activity, which is why an activity system is concentrated around its object as well as the contradictions between the different items within the activity system.

Contradictions are central to the dynamics of an activity system as they generate disturbances and conflicts in a team. But they also stimulate innovative thinking and action

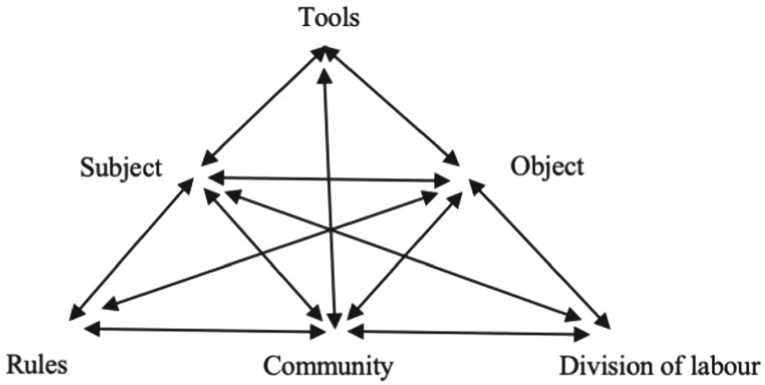

Fig. 2. The activity system as proposed by Engeström (2014).

and, thereby, potentially local changes [35]. Engeström and Pyörälä [36] identified that such situations can be complex and risk becoming fragmented, for example when there is not a common language or understanding between members in a team. This kind of challenge calls for establishing new ways for practitioners to work collaboratively towards the object, which Engeström [37] has conceptualised as acts of knotworking. Knotworking represents a model for overcoming fragmentation of the object, which for example could be through a team's way of seeking ways to negotiate and combine their different viewpoints of expertise. In this way, contradictions "do not speak for themselves", but can be identified when practitioners articulate them in words and actions [38:49]. Expressed differently, contradictions should be identified in their real and historical progression. In her article, Kindred [8] argues that resistance in learning is critical in the implementation of change. She furthermore addresses the engagement of resistance, rather than its repression or avoidance, as essential for cognitive shifts reflecting knowledge integration and thus resistance should be considered as a constructive activity.

This paper applies Engeströms activity system [27] as an analytical approach in order to understand teachers' considerations of opportunities, resistance or barriers and pedagogical functions of digital game-based learning as a teaching method. As related research has shown, there is a lack of research answering the question of how DGBL could be designed to structure and facilitate learning as well as of considering the classroom settings and barriers of implementing DGBL. We attempt to contribute to these problems by applying the activity system framework in the context of digital game-based learning (DGBL), in particular the interplay between resistance as an obstruction or opportunity and design of teaching activities by means of digital games.

4 Methodology

The study applies a qualitative approach [39] and includes cases of two workshops (Case 1 and Case 2). The workshops were designed to provide a framework for preschool- and primary school teachers to evaluate challenges and potentials of DGBL. Hence, different apps were selected within the subjects of math, language, and science. These

were introduced to the teachers complemented with an evaluation guide to be used for valuing the apps' learning designs, both regarding their content and form. The teachers were divided into groups and each group should choose one of the game apps that were introduced to evaluate.

Case 1 consisted of nine female teachers from schools in the south-west of Sweden. The nine teachers (three from preschool and six from primary school) were divided into three groups (two participants in group 1; four participants in group 2; and three participants in group 3). The group of four teachers were working in the same school and teacher team. The other two groups included teachers from different schools. Case 2 consisted of three male participants from north-east of Denmark; a preschool teacher, a leader of preschools and an assistant professor in mathematics at a teacher education programme. Moreover, an Indian female toy and game designer participated in Case 2, where all four participants worked together in one group.

Each group had a workstation at their disposal, which was equipped with a fixed camera facing the centre of each table and recorded the activities during the whole workshop. In total, 400 min of video data was gathered. Additional 80 min of video data from Case 2 were lost, which resulted in a follow-up interview after the workshop to capture their further insights from the workshop. The data also includes the groups' final presentations of their game evaluations as well as field notes by the two authors.

4.1 Apparatus

Before starting the workshop, the participants were introduced to some background information and material. To start with, they received a general introduction to game-based learning, for example that using games in education is not a new phenomenon but has been around for decades. Furthermore, the introduction included some general information about game mechanics and their implications in an educational context. For example, that a game-based approach is based on rules, clear goals and includes choices that when applied generate different consequences. Intentions and suppositions related to games designed for learning were discussed, for example that they were supposed to offer students opportunities to collaborate around specific game content and, thereby, add a learning perspective to the gaming experience. Finally, the teachers were introduced to categories of different games and their respective goals, for example collaborating games, explorative games, problem-solving or strategic games and achieving goals games.

4.2 Procedure

After the introduction to the workshop, the participants were divided into groups and started the workshop activities. The workshop was divided into four sections and lasted for three hours. Table 1 illustrates the design of the workshop.

The introduction of the workshop clarified definitions of DGBL and game categories as well as the goal of the workshop. The chosen apps were presented and demonstrated. Based on our previous questionnaire study [15], which was directed to teachers in preschools and primary schools, we identified that teachers primarily used digital games in the subjects of mathematics, language and science. This became the foundation for

Table 1. DGBL workshop design.

Time	Activities
14:00–14:15	Introduction of the workshop and the selected game apps
14:15–14:30	**Workshop section 1**: Exploring and testing the different game apps. Each group chooses which one of the game apps to evaluate
14:30–15:20	**Workshop section 2**: Evaluating the chosen game app including a focus on the game's design and its learning potentials
15:20–16:10	**Workshop section 3**: Development of a teaching activity including the chosen game appl
16:10–17:00	**Workshop section 4**: The groups present their teaching activity to the other groups, including justifications of design choices. Closing and evaluation of the workshop

the choice of including game apps within these subject areas. Tables 2 and 3 illustrate the specific game apps used in Case 1 (Sweden) and Case 2 (Denmark) respectively.

Table 2. Game apps used in case 1 (Sweden).

Swedish language	Mathematics	Science
Spelling game (Stavningslek)	Math bakery 1, 2, 3 (Mattebageriet)	Chemist
School writing (Skrivstil)	Critter Corral	Twitter (Kvitter)
Letter puzzle (Bokstavspussel)	Scratch Jr	Butterflies (Fjärilar)
Yum letters (Yumbokstäver)		

Table 3. Game apps used in case 2 (Denmark).

Danish language	Mathematics	Science
Leo & Mona reading fun (Leo & Mona Læsesjov)	GOZOA - Play & learn mathematics (GOZOA - Leg & lær matematik)	The hero of nature (Naturens helt)
The letter school (Bogstavskolen)	Pixeline - The labyrinth of the number master (Pixeline - Talmesterens labyrint)	

While Case 1 included a mixture of digital games and digital tools (e.g. Scrach Jr.), Case 2 included only digital games. In the workshop Sect. 1, the participants had time to test the different game apps and choose one of them to further evaluate and design a teaching activity including this app. This was followed by a longer session, workshop Sect. 2, where the participants had time to test and evaluate the design of the game to get ideas

and reflect upon how the game app could be used for a specific teaching activity. This part of the workshop was assisted by a list of questions to guide the evaluation:

- What is the goal and value of the game app - is it pedagogically clear and convincing? Why or why not? What are the learning goals of the game app?
- The interface of the game app - is it easy and efficient to navigate?
- What are the rules, control and other mechanisms of the game app? How can the player learn and understand those rules and other mechanisms?
- Is the game balanced by for example, offering different game levels? If so, in what way?
- What kind of mechanisms or values would encourage a child to play this game app more than once?
- In what way has the game an aesthetic value?
- What kind of game - is it based on exploration, problem solving, contesting, or a mixture?
- In what way is the game engaging and motivating?
- As a pedagogical expert, would you use this app in your teaching activities? Why or why not?

In Sect. 3 of the workshop, the participants should develop a teaching activity which should be based on the chosen app. They did not receive any guidelines for this activity but were told that they should apply their pedagogical expertise, in particular related to the learning goals that would apply to the chosen game. This was followed by workshop Sect. 4, where the groups presented their digital game-based teaching activity for each other and justified their included choices, game design features and pedagogical benefits.

The participants were informed about the study in writing and agreed to the video recording of the workshop sessions by signing informed consent forms, including approval of using the visuals for academic purposes. In line with ethical guidelines, all names of the participants and their workplaces are anonymised (Fig. 4).

Fig. 3. Some of the participants from the Danish case preparing their DGBL teaching activity (Sect. 3 of the workshop).

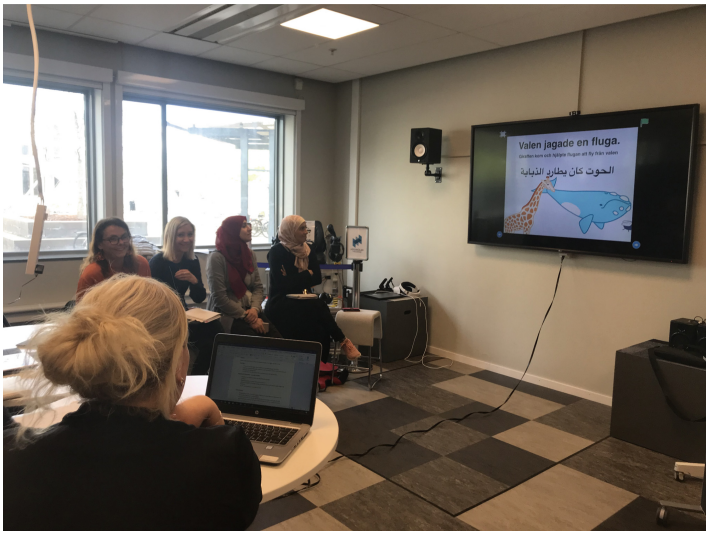

Fig. 4. Some of the participants from the Swedish case presenting their DGBL designs (Sect. 4 of the workshop).

4.3 Analytical Approach

Engeström's [27] activity system was applied as an analytical tool when analysing the video recordings. Figure 3 shows how Engeström's activity system model was used to form a tool for the analysis of the participants' evaluation of educational digital game

apps and their design of digital game-based teaching and learning activities. By using this as a conceptual model for the analysis, we could unfold complexities of concerns, contradictions, and opportunities (Fig. 5).

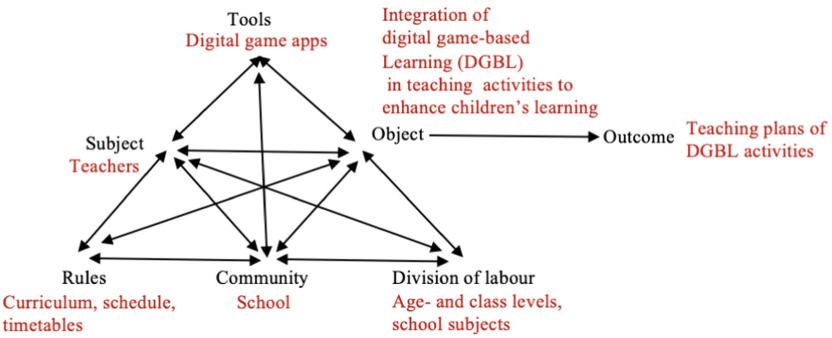

Fig. 5. Teachers' activity system analysis model as implemented in the study (adjusted from Engström [27]).

Teachers' activity system model depicts the participating teachers as *subject* and the school as their *community*. The activity as such targets the *object*, to work with how digital game-based learning (DGBL) can be implemented in their teaching activities in respective schools, which result in concrete teaching plans of digital game-based activities applied in different school subjects as an *outcome* of the activity. The corners of the model are mediating to the subject, object and community and represent the *tools* in terms of different DGBL apps, the *rules* including the curriculum, schedule, and timetables and, finally, l*abour division* which represent school subjects and age- and class levels. We did not analyse all elements of the teachers' activity system in detail, but the model allowed us to identify triangulations in relation to the participants' activity (evaluation of a digital game app and design of a teaching activity including this app). We were interested in what in their discussions and game app explorations gave rise to concerns, which we, then, systematically analysed. However, we iteratively considered less examined incidents to avoid missing out on configurations that could have bearing on the overall activity. In particular, we were interested in:

- The subjects' motivations when evaluating the digital game app and designing a teaching activity including this app.
- The subjects' use of the digital game apps.
- The interconnections between the subjects and the mediating game apps, rules (curriculum, schedule, timetable) and labour division (school subjects, age- and class levels).
- The interdependence between the subjects and the school community.
- The potential development of common understanding among the subjects in the group.

This means that we did not analyse each of the elements in depth, but had the subjects in focus when triangulating their motivations, interconnections, interdependencies etc. Our

systematic analysis of (i) identifying the incidents that were of concern by the participants and (ii) understanding the meaning of these concerns was inspired by Interaction Analysis (IA) and carried out in x different steps, as described by Jordan and Henderson [40]. Interaction analysis is used for empirical studies of human interaction, between people and with the environment and the objects in it. This includes expressions such as verbal and non-verbal interaction and the use of artefacts and technologies. This is helpful to identify routines, problems and resources used for solving problems [40]. For this, video documentation is crucial, i.e. to have the opportunity to play and replay a series of events. The video recordings were transcribed and analysed according to the principles of IA and presented in Table 4.

Table 4. Analytical steps in the interaction analysis.

Steps	Activities undertaken
Step 1	Overall view of the material
Step 2	Identifying events
Step 3	Transcribing events
Step 4	Analysing events in relation to the activity system model
Step 5	Identifying themes

After the first three steps, as described in Table 4, we related the events to the activity system model (as described in Fig. 3) and finally, based on the analysis of the events, it was possible to identify three emerging themes: (1) *Formation of pedagogical functions of the digital games*; (2) *Discovering gaps in the digital games*; and (3) *Constructive resistance*. These themes are further elaborated in the below sections.

5 Analysis

The analysis unfolded constraints and opportunities while the teachers were evaluating their educational meaning and relevance of the games. Moreover, by focusing on the games' design, the teachers identified how they could support or hinder children's learning. This is described in the following subsections where the themes are unpacked.

5.1 Formation of Pedagogical Functions of the Digital Games

The first theme, *Formation of pedagogical functions of the digital games*, embraces how the teachers considered the digital games as mediating tools in their teaching activities. The design and structure of the games were in focus when the teachers tried to identify their pedagogical functions, with emphasis on how the game designs supported learning. Considering this, the discussions about what a game is or could be in an educational context were necessary for the teachers to clear out before considering their pedagogical

functions. The below excerpt describes how teachers explore a game's pedagogical function by translating its content.

Excerpt 1
Case 1, group 3. The three teachers in this group discuss the app 'Scratch Junior', which is more of a programming app than a game app - it is not a game in itself, but it admits people to make and play games with it. They are discussing what the game app is actually about, what is possible to do with it, and whether or not it can be considered as a game.
Teacher 1: It is probably more problem solving… But there are no given problems. It is not the case that you go into the app and have to solve different problems and advance to different levels. That is not the case.
Teacher 2: And you should not collect points or… It is more like an educational tool. Perhaps more that than a game.

In this excerpt, the teachers referred to basic game design criteria while assessing the game that they had chosen. Through this process, they identified that the game perhaps was not a game due to having other pedagogical qualities compared to a game. The latter should include, for example, a clear goal, levels, and rewards. Here, the teachers explored a common language to first understand what a game is and then, consider its pedagogical potentials. Engeström and Pyörälä [36] identified that establishing a common language and understanding between members in a group is essential in order to avoid fragmentation of a topic.

The next excerpt exemplifies how the teachers tried to find out how a game could enhance children's learning. They did this by identifying that the game as such could not stand by itself as a learning tool, but they as teachers needed to take on a mediating role to establish a pedagogical relevance in relation to a specific subject (in the case of this excerpt, the subject refers to mathematics).

Excerpt 2
Case 1, Group 2. The teachers are talking about how to introduce the game app they have chosen to evaluate to their students in a teaching activity. The three of them have tried out the game apps Math bakery 1–3 and are discussing how these apps can be integrated in a learning context.
Teacher 1: For our third graders, we would say that here you have the opportunity to rehearse differently, because here [in math bakery 1] you do not have to go through line-up and such, but if it had been new, you would have had to talk about how to set up … and have a lesson first, or if you have never worked with multiplication before. Then you would have had to go through it. But multiplication is not put in the hands of someone who has not done it before.
Teacher 3: …if you have a lesson and say 2×6 or 6×2, it does not matter because it is the same. I think it's good here [in Math bakery 3], it explains a lot, you can clearly see that it does not matter.
Teacher 1: You need to connect it to a smartboard and show them [the school children], or that you as an adult explain. So they know what they can get out of it. Otherwise it will just be like, now you can play a little, that they focus on the game.
Teacher 2: Here you want them to test, so they can see how to line up.
Teacher1: Yes, but then you have to show them and explain.

In this excerpt, the teachers highlight in what way the game app can be introduced in a meaningful way depending on the previous experiences of the children. In doing so, they put forward the importance of their own mediating role so that the students do not just 'play around'. This is in line with Hebert and Jenson [24] who underline that it is critical for teachers to recognise their role in facilitating DGBL. The excerpts show how the pedagogy of the game design is constructed when teachers act as mediators between the students' learning and the game content [21]. This is in line with previous research stressing that teachers' perception of digital games relate to how they consider its usefulness in a pedagogical context [22, 23].

5.2 Discovering Gaps in the Digital Games

In the second theme, *Discovering gaps in the digital games*, there is a focus on what the teachers are doing when they are "translating" the games. Gaps are types of breaks or holes causing in continuities as well as breaks in understanding what is going on. In the following excerpt, the teachers identified gaps between their own pedagogical beliefs, which are also expressed in the Danish curriculum, and the games' design. They stress that the game cannot be used to enhance children's learning as they represent a completely different pedagogical angle. The curriculum related to early years' education emphasises children's play and exploration of the world, while games directed to this age group do not any of these matters.

Excerpt 3

Case 2, group 1. The teachers discuss game mechanics and state that digital games for young children are based on simple mechanics and, even though the technique is available, they do not offer the needed aesthetics or explorative narratives to be regarded as a 'real' game. They discuss this in relation to game criterias. As detailed in the method section, case 2 teachers participated in a follow-up interview and this excerpt is an extract from this interview.

Teacher 1: It is a challenge to find good games that not only focus on learning, but also have explorative opportunities. Most of what we find includes that the child shall manage a level in a game and if you do not manage it, then, it is just a pity. You have to find something else to do. This creates a bit of an A and a B team of game players. If you cannot manage a level, you are out and not part of the playing team. Beside this, you cannot be curious about something in these kinds of educational games. A game consists of rules, that's how it is, you cannot be curious about something, I mean, on something that you jump into while playing.

Teacher 2: Something that we discuss a lot, in relation to how, that you on the one hand have the necessary technique [to develop games that are more explorative] and, on the other hand this about right or wrong answers or choices when you play this kind of game. And if you transfer this to pedagogical thinking, then we come to that while playing this kind of game the child will do something right or wrong. And the more you make the wrong choice or answer wrong on a question in relation to what is expected from the game design, the less explorative you become. You'll stop exploring. What we lately have talked a lot about in relation to level-based games is what is called sandbox-games. This kind of game offers exploration for you to take your own initiatives towards what

you yourself think would be exciting to do or explore. There are no right or wrong answers. Not anything that needs to be solved in a certain way. If you cannot solve it you leave it to another time and move on. Unfortunately, there are not so many games in this genre. They are coming though. But where they are coming is in relation to adult players, not children.
Teacher 1: Yes, that's right. It is like this. In relation to technical issues, there are many high quality, complex game alternatives for adult game players, but if we look at it in relation to children, these games are simple, very simple. Regardless what game you choose. There are no details like in adult games. So, children miss out on this extra dimension, the aesthetics. Adult players can be involved in aesthetically designed games, but not children.

The teachers underline that when a game does not offer exploration or encourage curiosity, a game's design becomes simplistic, and children lose their interest. What they express here is that there is a gap between game mechanics and a game's pedagogical relevance and usefulness. From an activity theory perspective, this excerpt highlights teachers' interpretive repertoire as inflected by regulations and perspectives that inflect on children's interest and curiosity. Thus, this excerpt draws attention to significant gaps between educational game designs and pedagogical regulations expressed in the curriculum topic.

However, earlier studies have shown that both teacher students (i. e preservice teachers) as well as practicing teachers have an ambiguous stance regarding the use of DGBL in the classroom: on the one hand they believe that there is a great potential in using games in educational settings and they considered games to be important educational tools, but on the other hand they were reluctant to use them themselves in their own teaching because they were unsure of how to incorporate, or if they wanted to bring DGBL into their future classrooms [e.g. 18, 19, 20].

5.3 Constructive Resistance

The third theme, *Constructive resistance,* shows how the teachers' initial resistance to the games they have chosen to evaluate changed over time while assessing the games. While resistance often is considered as holding back change in educational activities, Kindred [8] suggests that resistance in learning is not only to be against something, but also an exploratory pathway that can generate learning. In our findings, the unknown territory of appropriating digital educational games was at start in the form of questioning their relevance. By trying out the games, they became more familiar with the content and could identify properties in the games that potentially could be adopted to be used in learning situations. The following excerpt shows how the teachers at first considered a math game as too complex to use, it was hard to identify the tasks and how to progress from one level to another.

Excerpt 4
Case 1, group 2. In this example, the four teachers in this group have individually been trying the game app 'Math bakery' (a math game app) for a while and are now discussing their experiences of that as well as the advantages and disadvantages with the game app

in relation to learning. They explore what happens when they move cookies to learn the multiplication table and how their actions are visible on the screen of the game.
Teacher 1: If you move the cookies, you get results that are shown on the number line in a clear way…
Teacher 2: So, yes, it [the game] is not totally dumb…
Teacher 3: Should I show mine too? I think it is clear, to… [she points to the screen]…here we train multiplication, here I choose…different kinds of cookies, so here I can actively choose which Table 1 want to train on. Then it goes on as you also have with stars and so on. And here it's great, here they show the different ways.

Here, their resistance, through a process of exploring, changed from considering the game as nontransparent and closed to becoming transparent and open for making choices. This is in line with Martin et al. [35] stressing that contradictions also offer dynamics in an activity system as they generate disturbances but also initiate innovative thinking and thereby contributing to potential change. The essential turning point within the teachers' discussions emerged through their intense exploration of the games.

In case 2, the resistance was pretty strong and led to productive thoughts about alternative game designs as expressed in their discussions. In case 1, there was resistance when the game did not fit at all, that they were tied to their traditional view of the material used, but still they started redesigning the game and were excited about it. By means of the model of knotworking [38] the teachers could overcome fragmentation of the object by discussing and combining their different viewpoints of expertise.

6 Conclusive Discussion

Since the research focusing on teachers' views on the integration of DGBL in teaching activities is rather scarce [5], we wanted to carry out a study that could contribute to filling this gap. The workshop was approached as an activity where not only the teachers' assessment of the games, but also the processes and context of use were investigated [27]. The workshop structure used in both cases in this study was designed to support professional learning and their processes of evaluating the games were thus captured as processes of learning. The input given to the teachers (i.e. the questions to ask about a game) was intended to be used not only during the workshop but also after. Furthermore, the workshop itself provided the participants greater insight into games, what games could be and how they could be used in teaching, etc. Given the fact that teachers have an ambiguous stance towards DGBL [e.g. 18, 19, 20], we wanted to find out more about the teachers' actual view of why this is, since the teachers' role is crucial for an effective use and support of DGBL [24].

The results show that when the teachers tried to find out how a digital game could enhance children's learning, they uncovered the importance of the teacher as a mediating tool, since the game alone could not stand by itself in the educational situation. Furthermore, when a game does not offer exploration or encourage curiosity, a game's design becomes simplistic and children lose their interest, revealing a gap between game mechanics and a game's pedagogical relevance and usefulness. Additionally, findings show that in order for the teachers to appropriate digital educational games, they needed to start out with questioning their relevance. During the process of trying out the games

and hence getting more familiar with them, they were able to identify properties in the games that potentially could be adopted to be used in learning situations. In line with Engeström and Pyörälä [36], they extended their understanding not only about games' pedagogical functions, but also about game design and how it could contribute to a game's value. Their translations of the games thereby went from concerning snippets of a game to a more holistic look at the games, for example in relation to a subject or the curriculum. The key turning point for this to happen emerged from the teachers' joint discussions and exploration of the games. This supports Kindred's [8] and Martin et al.'s [35] suggestions about contradictions as dynamic resources in activity systems, which not only disturb but also generate new ways of thinking.

The contribution to the field is twofold: first, the results have shown that in order for teachers to implement DGBL in teaching activities, they need to have knowledge about games. We could identify this through the teachers' conversations, where they could be more specific about opportunities and challenges the more they explored the games and learned about their design mechanics and pedagogy. This knowledge is of great importance for practitioners in the field when implementing DGBL in classrooms. Second, the workshop design included that teacher should assess a game that was specific to a school subject. The outcomes of the study showed that the teachers were confident in discussing a game's subject-specific value, which enabled them to apply their pedagogical expertise. This seemed to influence their interest and motivation to understand the games' subject specific value.

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