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Children's Experiences on Learning the 21st Century Skills with Digital Games

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Abstract

Previous research on learning-related digital games has focused on studying learning outcomes with mostly adult participants. This study explores what children have experienced they have learned by playing digital games, how these learning experiences relate to 21st-century skills, and in which contexts do the children benefit from playing digital games. The data were collected from children's essays, which were analyzed using qualitative content analysis. Results reveal that children's learning experiences are often related to 21st-century core subjects and skills, but they also reported improved physical abilities and sports competences from digital games. Children felt that the skills they had gained were beneficial in the contexts of school, sports, and friendships. The results contribute to our understanding of digital games and children by providing children's perspective on digital games and learning.

Keywords: digital games, video games, 21st-century skills, learning experiences, game-based learning

Introduction

The popularity of digital games is increasing rapidly. In Finland, practically every fourth- to sixth-grade child has a gaming device at home (Suoninen, 2013). In the year 2015, 52.2% of Finnish 10 to 19 years olds played digital games daily and 81.6% at least once a week. Only 1.5% of people aged 10 to 19 did not play digital games at all. (Mäyrä, Karvinen & Ermi, 2016.) The importance of games in people's lives continues to increase. With the increased interest in games, the game industry is also growing at a high rate. Recent forecasts predict that the global gaming industry will generate over 115 billion dollars in revenue in 2018 (McDonald, 2017).

The growing popularity of digital games and violent behavior associated with digital games have kept the debate alive for a long time about the drawbacks and benefits of digital games (Ferguson, 2013). Educators have often emphasized the negative effects of games on children (Gee, 2007; Granic, Lobel & Engels, 2014) and there are numerous studies about the negative impacts of digital games. In these studies, digital games are potentially associated with aggressive behavior, depression, or hyperactivity in addition to other disadvantages (e.g., Anderson et al., 2010; Gentile, Swing, Lim & Khoo, 2012; Lemola et al., 2011; Tortolero et al., 2014).

Despite the reported disadvantages of digital games, there is a long history of research on the positive impacts of them (Wilkinson, 2016). Nowadays, games are more and more perceived as both motivating and social learning environments, where players work and learn together (Squire, 2006). Digital games attract educators' interest, and the use of games for educational purposes has increased worldwide (Nebel, Schneider, Schledjewski & Rey, 2017). For example, in Finland a curriculum for basic education emphasizes the use of digital learning environments, such as digital games, in teaching (the Finnish National Board of Education, 2016). Studies show that digital games provide an environment for learning problem-solving skills, communication skills, social skills, and ICT skills, as well as other skills needed to live and succeed in the modern world, often referred to as 21st century skills (Kickmeier-Rust & Albert, 2012; Prensky, 2006; Redecker et al., 2011; Sourmelis, Ioannou & Zaphiris, 2017). However, most research focuses on digital games and learning from the adult perspective and often in university settings, and less than one in ten studies have used underage children as participants (Przybylski & Wang, 2016).

This study contributes to the gap of knowledge by exploring children's experiences of digital games and providing a 'snapshot' of their experiences. The aim of this qualitative study is to outline what children themselves have experienced to learn from digital games and how their learning experiences relate to 21st century skills. In addition, this study explores the children's reports of the context of their learning experiences. We posed the following research questions:

1. What kinds of knowledge and skills have children experienced they have learned by playing digital games?
2. How do their learned skills relate to 21st century skills?
3. In which contexts do children describe playing digital games to be beneficial for them?

Theoretical Background

The theoretical framework of this study is derived from two partially overlapping research themes. The first theme draws from research results on digital games and learning. The second theme draws from research on 21st century skills.

Digital Games and Learning

In recent years, educators and scholars have begun to be more interested in benefits and opportunities of digital games as learning tools (e.g., Gee, 2007; 2011; Granic et al., 2014). Digital games have been found to provide strong emotional experiences and positive feelings to players (McGonigal, 2011; Russoniello, O'Brien & Parks, 2009). In addition to positive feelings, they offer a safe environment to face negative emotions such as frustration, anger, anxiety, and sadness, and help to develop the child's emotional regulation (Granic et al., 2014).

Because multiplayer games are often designed so that in order to succeed, players have to cooperate with other players (Ewoldsen et al., 2012), it has been argued that playing digital games has positive effects on the development of children's social skills, such as team working and cooperative skills (Granic et al., 2014). The social nature of digital games can also be seen in the game-related, but outside-game-social systems like game-related social media and internet forums. Some of learning takes place in these external-to-the-game social systems, which are often referred to as "meta-game" (Gee, 2011). The social nature of gaming is also associated with the theory of gaming capital, in which good gaming skills, ownership of a certain game, or good gaming knowledge can increase the player's cultural and social capital (Consalvo, 2007).

The positive impact of digital games has also been studied in other fields, such as language learning, cognitive science, and physical education. They have been found to foster new literacy skills – especially understanding visual symbols alongside traditional writing (Checa-Romero, 2015; Gee, 2003) – and to develop visual processing of spatial characteristics of information, attentional processing, executive functioning, inductive reasoning, and mental rotation (Green, 2014). According to Ventura, Shute and Zhao (2013), people who play digital games are also more persistent than non-gamers when solving difficult riddles. A recent study also argued that sports games can be used to learn sports knowledge and tactical skills such as sports rules, game sense, player positioning and sports terminology (Jenny, Chung, Rademaker & Schary, 2017).

In addition to game research in informal learning environments, there is educational research on serious games and educational simulations. Various studies indicate that serious games can increase excitement about learning and they can provide effective learning environments for students (e.g., Hamari et al., 2016; Koivula, Huttunen, Mustola, Lipponen & Laakso, 2017). Sitzmann's (2011) meta-analysis shows that simulation games helped trainees to learn declarative and procedural knowledge better than the comparison group. According to Sitzmann, simulation games can be an effective way to learn work-related skills and knowledge.

21st Century Skills

In today's knowledge-based society most work requires technological knowledge, information skills, smooth co-operation between different stakeholders, and teamwork. The new demands, both in working life and in other aspects of life, have also changed people's thinking in many ways (Griffin, Care, & McGaw, 2012; Prensky, 2001; 2004). All these changes have also put pressure on schools and educational systems to change their curricula to better provide the skills needed in the world of the future (Griffin et al., 2012; Voogt & Roblin, 2012). These skills are often referred to as 21st century skills. A number of scholars and educational organizations have published frameworks and definitions of these skills, but no consensus has yet emerged over what 21st century skills consist of (Binkley et al., 2012). The difficulty of defining 21st century skills is partly due to these skills being often vague and unclear by their nature, and in addition to traditional skills, they consist of, for example, abilities, meta-skills, and attitudes (Kickmeier-Rust & Albert, 2012). Often the term "competences" is used instead of "skills" in the context of educational needs of the future. In addition to skills, competences include attitudes, beliefs, and knowledge (Sue, Arredondo & McDavis, 1992).

The Organization for Economic Co-operation and Development (OECD), has defined 21st century competences in their Definition and Selection of Competences (DeSeCo) project. Ananiadou and Claro (2009) divided the competences into information, communication, and ethics and social impact dimensions. In Binkley et al.'s (2012) KSAVE framework, skills were grouped into four categories: Ways of thinking, ways of working, tools for working and living in the world. The US government-sponsored educational organization Partnership for 21st Century Skills (P21) has also published their own definition of skills, knowledge, expertise and literacies needed for succeeding in the 21st century. P21 groups skills into learning skills and innovation skills, communication and collaboration skills, and information and technology skills. In addition

to skills, the P21 definition also includes key subjects for life in the 21st century: English reading, world languages, arts, mathematics, economics, science, geography, history, and government and civics (P21, 2015). In the EU Commission's joint research report, skills are divided into three categories: personal skills, social skills, and learning skills. The EU definition includes "learning to learn" skills as important future skills (Redecker et al., 2011).

The different definitions of 21st century skills have some similarities between them. A meta-analysis by Voogt and Roblin (2012) studied eight frameworks for 21st century skills. Their analysis reveals that even though reasoning, terminology and grouping varies between those frameworks, collaboration, communication, ICT literacy, and social/cultural skills or competences were included in all frameworks, and problem solving, critical thinking, productivity, and creativity skills were included in most frameworks. Learning to learn, flexibility and adaptability, self-direction, and planning were included in a few frameworks as well as core subjects such as mathematics, history, and arts. Economics, geography, and government and civics were included as a core subject in only one framework (Voogt & Roblin, 2012). Many of those skills are the same ones which research have been shown to evolve by playing digital games (e.g., Ewoldsen et al., 2012; Gee, 2003; Prensky, 2006). According to Kickmeier-Rust and Albert (2012), digital games are a perfect environment for learning 21st century skills, since to succeed in these games, players need to collaborate, communicate, reflect their progress, and adopt a problem solving mindset, in addition to many other things. This study is based on Voogt and Roblin's description of 21st century skills.

There is a body of research on 21st century skills learned from digital games. Sardone and Devlin-Scherer (2010) have studied teacher candidates' attitudes towards the learning of 21st century skills through digital games. Sourmelis et al. (2017) focused on massive multiplayer online roleplaying games in their meta-analysis of 21st century skills learned from games, and in the meta-analysis of Romero, Usart and Ott (2015), they reviewed the learning of 21st century skills in the context of serious games. In this study, the aim is to explore children's perspectives on learning 21st century skills with digital games.

Method

Participants and Procedure

Participants in this study were sixth- and ninth-grade comprehensive school students from two urban schools located in central Finland. The convenience sample was two entire school classes yielding 41 participants in total, of which 20 participants (Female = 12; Male = 8) were sixth-grade students and 21 were ninth-grade students (Female = 12; Male = 9).

The two classes involved were from two different schools and were selected due to the authors' previous connection to those schools. Permission for research and informed consent were requested from the guardians of the students. Five students' guardians never responded to the request and two guardians denied it. Therefore, 7 out of 48 students were excluded from this study.

Research data was collected during a single class. First, participants were informed about the study, including a short description about what digital games are: "Digital games are games that are played on a computer, console, cellphone, tablet, or other digital devices. They can also be games played on the internet." Subsequently, the participants were given instructions to write about their gaming in general, or regarding some certain game. They were also instructed to write about their goals in games, difficult situations in the games, and how they have solved them. In addition, participants were instructed to write whether they felt they have learned something by gaming or otherwise benefited from gaming in one way or another. Instructions were provided in both spoken and written form.

This introduction segment lasted less than 10 minutes. At the end of the class, the researchers collected the essays and participants received a background information questionnaire. That questionnaire asked children for their name, gender, favorite games, whether they usually play together or alone, and weekly time used for playing digital games. The questionnaire ended with two open questions, asking directly what children have learned from digital games and how they have benefitted from games. During the data collection, the researchers helped the participants when they had difficulties understanding questions. Original data was collected and analyzed in Finnish, and citations in the following sections were translated by the authors.

Data Analysis

First, all of the data was transcribed into electronic form and participants were given pseudonyms so that the gender of the respondents remained visible. After that, essays were merged with the answers to the open questions of the questionnaire, and everything was imported to the atlas.ti software, which was used for analysis. The data analysis approach was qualitative content analysis, because it is well suited for analyzing and summarizing written data in exploratory research (Cohen, Manion & Morrison, 2011). Data analysis was performed by two researchers. The data was first analyzed from the perspective of the first two research questions concerning the children's learning experiences and their relation to 21st century skills. Subsequently, the data was analyzed from the perspective of the third research question regarding the contexts in which learned skills were found to be beneficial.

The initial analysis involved reading through all data several times to get a general sense of data. During the initial coding session, data was reduced to meaningful segments, which were given descriptive names. Initial coding was conducted without any pre-defined codes. At the end of the first phase of analysis, there were 26 codes.

In the second phase, codes were grouped into categories. The data was reviewed several times and the content and names of the categories were changed until both researchers agreed that the grouping corresponded with the data. At this point, researchers also consulted a content analysis expert in order to ensure the quality of the categorization. At the end of the second phase, there were 11 categories.

Subsequently, categories were aggregated into themes. Unlike the previous phases, which were data-driven, this phase was theory driven. The three main themes of learning experiences were 21st century core subjects, 21st century skills, and physical abilities and sports competences.

The third research question was analyzed using the same procedure as the first research question, except that there were only two phases in the analysis. Data was first read through several times to get a general sense of it, reduced to meaningful segments, and given descriptive names. Twelve initial codes were obtained from data without any pre-defined categories. During the second phase, categories were aggregated into themes and an external expert was consulted to ensure the quality of the analysis. At the end, there were three main themes: school, sports, and friendship.

Results

Learning Experiences

The results revealed a number of insights into the learning experiences that children have gained by playing digital games and into the relation of these experiences to 21st century skills. Learning experiences were divided into three different themes: 21st century core subjects, 21st century skills, and physical abilities and sports competences. Table 1 shows the categorization of learning experiences.

Table 1

Learning Experiences of Children When Playing the Digital Games

21st century core subjects	21st century skills	Physical abilities and sports competences
School subjects	Strategical learning and self-regulatory skills	Physical condition
Economics	Creative skills	Motor skills
Arts	Problem-solving and decision-making skills	Sports
	Concentration skills	
	Social skills	

21st Century Core Subjects

The first main theme is 21st century core subjects, which refers to subjects whose mastery is important for managing in the current knowledge society and in the world of tomorrow. These subjects also provide the basis for many 21st century skills. These subjects were three main types: school subjects, economics, and arts.

School subjects included history, mathematics, natural sciences, and the English language. The essays revealed that participants experienced that they had developed their English language skills by playing digital games. The participants also experienced that they learned other traditional school subjects, like mathematics, history, and natural sciences through gaming. Some participants stated their learning outright. Ninth-grader Laura wrote: "I've learned

some English words.” In addition to developing their vocabulary, participants wrote that they felt they had improved their reading comprehension via gaming: Ninth-grader Jodie wrote: “In some games it is important to understand English, so maybe I've got a little practice in it.” Participants also wrote that they have used words and idioms learned from games in English-language conversations.

Learning experiences in mathematics and history were mentioned only in passing, such as in Donovan's essay: "I have learned, for example, English. And from some games history and something else." Those participants did not describe the game contexts or their learning of mathematics or history in more detail.

Ninth-grader Everly wrote about her playing Hay Day, a mobile multiplayer game where a player runs a farm, makes purchases, and grows, refines, and trades their products. Everly wrote: “I have learned about, for example, recycling and nature, and growing plants.” Everly said Hay Day had taught her the natural sciences. In addition to the natural sciences, Everly experienced that she has also learned other skills by playing Hay Day, which will now be discussed.

The second category of 21st century core subjects was economics, which included various money management skills. Everly wrote: “In games one also learns more about money when you must buy new stuff, for example.” This example reveals how participants experienced the development of money management skills by playing games where they manage their own finances.

The last category of 21st century core subjects was arts. This category consisted of music instrument playing skills. Various band games were popular among participants. Some of the participants reported that they had learned musical instruments skills by playing such games. Ninth-grade girl Holly had played Rock-Smith, a game that uses real instruments (not mock-up instruments) as game controllers and wrote: “I might play my little brother's games at home (PS3) if I have time, for example, Guitar Hero or Rock-Smith (the feeling when you get difficult level done is awesome + in Rock-Smith you can really learn to play guitar/bass).” These experiences were related to 21st century core subjects, such as school subjects, economics, and arts reported by the children themselves.

21st Century Skills

The phrase "21st century skills" refers to skills required in today's knowledge society. These skills are often multidisciplinary and multidimensional by nature. In this study, 21st century skills were divided into strategic learning and self-regulatory skills, creative skills, problem solving and decision-making skills, concentration skills, and social skills.

Strategical learning and self-regulatory skills. Strategical learning and self-regulatory skills were the largest category of 21st century skills, and consisted of the following: executive functions and cognitive control, competitiveness and motivation, help seeking, time management, persistence, frustration tolerance, and emotion identification.

Some participants described exactly how difficult gaming situations cause them to react and explained what kind of methods they have learned for dealing with these situations. A number of essays showed that participants have learned executive functions and cognitive control skills from gaming. The sixth-grader Danielle, who played Kirby and Mario games, wrote: "If I cannot go through some level or complete some mission, I take a little break; go outdoors, for example. And when I come to try again, I can usually solve the problem. Playing is useful if you do not play too much." Danielle had noticed that taking a break in a difficult situation may help find a better solution to the problem.

The results of the analysis also showed experiences of learning competitiveness and motivation. Participants wrote how they had set goals for themselves in the games and how winning or playing the game motivates them. Some participants played multiplayer games and were motivated to defeat the other players, usually their friends. Some participants' goals were related to a certain difficult point or level in a game. The sixth-grader Tori was motivated to beat her big brother in a car game: "My goal is to beat my big brother. Shorter tracks are easy, difficult tracks are long and complicated. I once beat my brother on a difficult track, by luck." This example shows that the participant compared her skills to the skills of her older sibling and beating one of her elders meant that she had just got lucky, not because she was more competent than her older brother. Gaming can increase competition between players, which drives participants to put in more effort and work harder, and the success empowers them.

Despite the competition, it seems that players can also rely on each other when obstacles are too challenging, as the next results indicate. The following was sixth-grader Megan's experience of asking for help online: "Except when I was playing Little Big Planet, when I did not get through, then I went to play online, so that someone could help me, or if someone has

understood something that I did not." Help was sought when there was such a difficult situation in the game that despite numerous attempts, the player could not figure out how to proceed. Results reveal that help was asked from friends or family members, but also from previously unknown players of the same game.

Participants also wrote about their own time management with regard to playing digital games. Many of them had noticed that time runs fast when they were playing. Sixth-grader Hollie first mentions that she has learned "...how fast time goes by when playing games..." and continues later, "...I have learned to manage time." Participants easily forget the time when the task was challenging enough and usually it was quite difficult to manage time when playing. The essays also suggested that students learned not to give up easily when facing challenging tasks, as the next results reveal.

There were several references to how persistence helped children to progress in the game. Participants experienced that in difficult situations in games, solution is to try harder and make as many attempts as it takes. Ninth-grader Jodie, who played Angry Birds, wrote, "If there is a difficult situation in the game, I usually solve it after many attempts." Another ninth-grader, Holly, wrote: "In Guitar Hero, there have been difficult tracks/points, I have just been practicing for so long that I have managed the point." Learning takes time and effort and when playing, many participants learned by heart that progressing means persistence, which can also emerge as mixed feelings.

The essays also contained several references to participants developing their frustration tolerance skills. Players were often frustrated with their own weak performance in games or with their slow learning. The following example is written by a sixth-grader, Eva, who played Pou and Mario games, "...I always try to pass the level and develop my character. It's hard if I play some new game or level, and I cannot play it well or if I am winning but I lose and I have to start from the beginning." Eva's essay demonstrated that progress in the game requires persistence and involves feelings of frustration and disappointment.

In addition to feelings of frustration, participants wrote a lot about other feelings raised in various gaming situations. The essays presented many examples where children described a range of emotions and in some cases explicitly stated desirable and undesirable emotions; those were clear signs of emotion-identifying skills. The participants reported emotions in both single-player and multiplayer games, but especially in situations where a player either lost or won

against a human opponent. Defeating a friend was important for many participants. Some participants analyzed the emotions of gaming situations very closely. A ninth-grader, Tim, wrote the following:

“A feeling of relief and success arises when you reach a goal in the game. For example, in sports games (FIFA, NHL, NBA, Madden, etc.) if you are losing and at the last moment you catch up and/or pull ahead. There may also be a feeling of disappointment. If you are winning and an opponent catches up to or pulls ahead of you, then you may be very annoyed. Both feelings belong to all games, but the main thing is to get the feelings of joy and success. (...) There have been many difficult gaming situations in sports games. When I played in the NHL finals in an NHL game, I was behind 10 seconds before time ran out, and won in overtime. The feeling of success was great at that point.”
(Tim)

Participants' written essays had several mentions of them gaining strategic learning skills. Participants explained in several ways how their strategic learning skills are enhanced when playing digital games, in addition to that, several other skills were reported by the participants: creative skills, problem-solving and decision-making skills, concentration skills, and social skills.

Creative skills. Creative skills included imagination and creativity. The participants explained that some games had helped them develop their creativity or increase their imagination. A sixth-grader, Danielle, wrote about her experiences with imagination as follows: “Gaming has developed my brain, when I have played logic games. Once again, when I have played Kirby or Mario it has increased my imagination. “Danielle experienced a connection between gaming and imagination.

Learning experiences of creativity were mentioned only in passing, such as those expressed by Lara's writing: "... I have learned creativity." The participants did not describe creativity or creativity-related skills more accurately, except for the aforementioned imagination.

Problem solving and decision-making skills. Problem solving and decision-making skills category consisted of rapid tactical maneuvering skills, decision-making skills, and problem-solving skills. Some participants described that in fast-paced games, like first-person shooter games, they have learned to make tactical decisions very quickly. The researchers interpreted that these participants have learned the skill of rapid tactical maneuvering. Edward, a ninth-grader, had

been playing the game Counter-Strike and shared: "...I have learned to improvise and maneuver quickly." This rapid tactical maneuvering is a variant of decision-making.

Examples from the written essays showed more evidence about decision-making. For example, entries related to decision-making included the development of game characters and making decisions in strategy games. The following was ninth-grader Bella's experience: "...playing has helped a bit in making decisions, but in other ways it has been more of a disadvantage." She recognized few advantages from playing, but indicated some advantages, and learning to make decisions is one of them.

Many participants wrote that they have enjoyed the problem-solving activities in games. Some participants had learned problem-solving in single-player games. Other participants preferred to solve problems together, in multiplayer games via the internet, or, as Danielle stated in the following example, with either family members or friends in the same space. "I think it is the most fun to play with a friend or sibling, because then you can share fun experiences and think about how to get through the next level." Danielle experienced challenges in a positive way when she could share processes and experiences with a group.

Concentration skills. Participants wrote about how digital games – generally or in a certain game or situation – had required their concentration and developed their concentration skills. Donald, who played various sports games, said that the most important skills he had learned were English, but that he also improved his concentration skills and reflexes. In addition, some participants stated that they did not have time for the kind of concentration games require. Heidi wrote about the time her sports training takes: "I really do not play anything, because of the workouts, there is not enough time to properly concentrate on the game." Heidi linked time and concentration closely together, where having less time available distracts from concentration.

Social skills. Social skills included teamwork skills and empathizing skill. There were several references to how games developed participants' teamwork skills. Ninth-grader Tomas wrote: "I was losing 4-1, and I managed to score 3 goals with the team play, and in overtime I scored. In sports games, I have learned to score a lot of goals with team play and in war games what you should not do." Many participants wrote that they had achieved better results by teamwork, and the essays clearly showed how the participants had learned the benefits of cooperation.

Empathizing skill was also categorized as a social skill. Emilia, a sixth-grader, wrote: "In adventure games, it's nice to think that you are the character of the game." The essays reveal that for some participants their game characters were very important. Participants explained how they had empathized with their game characters and the game situations that their characters faced.

Physical Abilities and Sports Competence

In addition to skills related to 21st century skills and core subjects, analysis also revealed abilities and competences related to fitness and sports. In this study, these categories were aggregated under the physical abilities and sports competences theme. This theme consisted of physical condition, motor skills, and sports categories.

Some participants had played dancing games and workout games with the Nintendo Wii. Sixth-grader Danielle wrote about the development of her physical condition: "I like to play Wii. There are nice games, in which one can get also some physical training." Daniella felt that she can get physical exercise by playing digital games.

Learning related to motor skills consisted of perception and reaction time. Some participants wrote that they had developed their fine motor skills. Ninth-grader Edward wrote about how he experienced that playing the popular game Counter-Strike has developed his reactions and perception: "... I have learned to use the advantage of noises coming from various directions and my reaction time has improved because things must be noticed and done quickly, or you lose." Edward noticed that he learned to react to game sounds faster and more efficiently and thus experienced developing his fine motor skills by gaming.

The sports category included sports knowledge and sports skills. Sports games were popular among the participants and many of the learning experiences related to them. Participants wrote that they had learned real sports skills such as tactics and dekes by playing digital games. The following example comes from sixth-grader Alex's experience of how sports skills can evolve by playing a basketball game, which he also described as carrying over into real-life basketball play: "I threw it once in NBA2K13 from my own end (NBA2K13 is a basketball game) and it's really rare. From the same game, I have learned good moves for real-life playing." In addition to skills, there were also mentions of learning sports knowledge from games. Participants had learned sports rules, players, and team names by playing digital sports games.

The Context in Which Playing Digital Games Have Benefited Children

In addition to learning experiences, this study also explored in what contexts children experienced learned skills to be beneficial for them. Analysis revealed three contexts where learned skills were experienced to be beneficial: school, sports, and friendship. Table 2 shows the categorization of contexts.

Table 2

Contexts in Which Playing Digital Games Are Experienced Beneficial

School	Sports	Friendship
Mathematics	Sports skills	Common talk topics
English language	Sports knowledge	Common pastime
Arts		Finding friends
Physical education		Communication in English

School

Participants experienced that playing digital games had benefited them at school in general as well as in particular school subjects. Some of them were able to specify these benefits, while others were more vague. Benefits were experienced in mathematics, English, arts, and in physical education.

While Heidi first wrote that she does not have time for gaming, later in the open-ended questions, she did describe her learning experiences of math skills as follows: "At a younger age, I played some games where I learned to read and calculate," and continued to describe her perceived benefits: "English is needed at school and calculating skill is also quite important for the sixth-grader." There were also other mentions of experienced benefits linked to English classes. Benjamin, a ninth-grader, attributed his excellent English grades to playing games: "My English grade at school is 10. And I do not have to read for exams, and that's because of gaming." Similarly, Danielle wrote about improving her English vocabulary in school: "[Due to gaming] I have known some words in English class, and so forth." Some participants experienced that they had benefited from skills learned by gaming in arts, such as visual arts, music, and crafts. A sixth-grader, Lara, wrote: "...creativity is useful in visual arts and crafts, a bit in everything." In addition, there were also mentions that learned skills were experienced to be beneficial in school physical education. Ninth-grader Tim wrote: "...Finger and hand coordination, peripheral vision, attention, (...) they

can be useful in PE class.” Throughout their essays, participants often linked their learning to the school context, discussed the benefits in terms familiar from school, and measured their learning with the indicators set by the school. Children felt that the skills they had learned were valuable when they benefited them in a school context.

Sports

The second context of benefits was sports, where the benefits were experienced in two ways, sports skills and sports knowledge. A sixth-grader, Reuben, wrote: “I have noticed that I have learned English from games and also the tactics from NHL games for my ice hockey hobby (...) learned some dekes and all the good tactics.” The participant experienced that tactical skills and dekes learned from sports games have carried over into the real playing fields, making him a better player.

Another benefit of sports games was related to watching sports. For example, Gary, a sixth-grader, wrote: “...when I watch hockey, I know the rules.” Gary had learned sports rules from sports games and he felt that this was beneficial when watching real-life sports.

Friendship

The last context of benefits was friendship. Participants experienced digital games to be beneficial for providing common talking topics with their friends. In addition to topics, a common pastime spent with friends was also experienced positively. A ninth-grader, William, wrote how he has benefited from playing sports games: “...you can talk about sports with your friends.” In addition to topics and common pastime, some participants had found new friends via gaming, like sixth-grader Edward described: “... and there are some good memories of the game when in elementary school I went home with friends to play. Through the game I have found gaming friends from all over the country and even around the world.” Communicating in the English language was also found to support friendships and other social situations, as ninth-grader Elianna briefly describes: “Learned words/sayings can be used if you speak to someone who speaks English.” Participants had positive feelings about playing digital games in the friendship context, as a common hobby and topic with friends and as an opportunity to find new friends and communicate with them.

Discussion

Most previous studies of learning from digital games have focused on gaming from an adult perspective instead of investigating what children themselves experience they learn by

playing digital games. The aims of our study were to explore what kinds of learning experiences children have, how they relate to 21st century skills, and in what contexts they experience those learned skills to be beneficial. The results show that children had a multitude of learning experiences, some of them related to 21st century core subjects or to 21st century skills, but also to physical abilities and sports competences. Children experienced playing digital games to be beneficial for them in contexts of school, sports, and friendships.

Children's learning experiences in this study were often related to 21st century skills and especially to "learning to learn skills," which in this study were categorized as strategic learning and self-regulatory skills. This result is in line with previous studies that have shown games to be a good tool for learning 21st century skills (e.g., Sourmelis et al., 2017). Self-regulatory skills such as frustration tolerance and persistence emerged in children's essays. They shared how they have attempted to pass difficult levels or points in games repeatedly until they finally succeeded, and children wrote how they had developed their own ways to manage their frustration, for example, by taking breaks and doing something else before continuing to play. Ventura et al. (2013) studied digital gaming and persistence and found that gamers spend more time on solving difficult puzzles than non-gamers do. The results of their study indicate a similar connection between persistence and digital game playing as this study does. In addition, Granic et al. (2014) noted the potential of games as a developer of motivation and persistence, which is transferrable to the school context. Also their results are confirmed by the results of this study, where children themselves reported similar findings.

The results also revealed interesting experiences related to emotions. Children reported expressing, exploring, and identifying emotions through digital games, sometimes in a very detailed manner. This supports earlier research that has shown games to generate positive feelings (e.g., Russoniello et al., 2009; McGonigal, 2011) and providing a safe environment for experiencing negative feelings, thus facilitating the development of emotion regulation skills (Granic et al., 2014).

Previous results on the development of social skills by playing digital games have been mixed, while other studies have suggested that the impact of games is negative in that respect (e.g., Anderson et al., 2010), in recent studies many scholars have also found a positive impact. For example, games that reward collaborating with and helping others have also been shown to increase players' prosocial behavior also outside of the context of gaming (Ewoldsen et al.,

2012). The results of this study suggest that children themselves consider gaming a social activity and recognize the value and importance of cooperation and getting help from others in achieving better results.

The contrast between these two perspectives is affected by at least two things. Firstly, digital games and gaming have changed over in recent years. Based on the answers of the background questions, the majority (32 out of 41) of participants primarily played together with other people, either physically in the same space or over the internet. Modern games often combine playing alone and playing together, for example, so that it is very easy to search other players via the web, trade, share, and view the creative outputs of others, such as gameplay videos. The games are thus more social than ever before (e.g., Granic et al., 2014). Secondly, the image of a gamer sitting alone in a dark room with a computer may never have been very truthful. Although gaming technology did not allow social content in the same way before the era of Internet games, games were also played together in the past, for example, by players taking turns playing or watching others play. Digital games and game culture were also contexts for other activities. Thus, even though the pre-Internet and pre-social gaming era games themselves did not always contain social interaction, meta-game activities around games often did.

The study also found some interesting phenomena that were not related to 21st century skills. Some common learning experiences outside the gaming context were related to sports. Several participants mentioned that they had learned dekes or tactics from digital sports games and benefited from them in real-life sports. There are only a few studies on learning sports skills by playing digital games. For example, Jenny et al. (2017) studied how cricket can be learned by playing a digital cricket game. The results of their study are parallel with children's experiences in this study which show that such skills as tactics, game sense, player positioning, and rules can be improved by playing digital games.

As this was an exploratory study about children's learning experiences from digital games, there are some limitations. Since the study is about children's learning experiences, there is a gap between participants' self-reports of their own experiences and researchers' interpretation of what children had learned. Reporting one's own learning experiences is a subjective approach and some children might be motivated to justify their gaming by using arguments they have heard in the media. In this way, participants may have consciously or unconsciously projected onto games learning experiences where there were none. In this study,

such things could have been, for example, the reports of developing fine motor skills or peripheral vision. It is natural to assume that playing games develops manual dexterity witnessed by improved use of the game controller, and it is likely that hand-eye coordination develops at least in the gaming context. It is good to consider what children's reports about improved hand-eye coordination really mean. Have they really experienced improvement in their coordination, or is it more of an assumption that such improvement should happen? This distinction between real and assumed learning must be kept in mind when evaluating the results of this study.

Essays, as a data collection method, can provide participants a lot of freedom to express their views, schoolchildren are familiar with writing essays, and, as a less frequently used method, they can also provide a new vein of information about their applicability for this kind of research – but the method comes with its own limitations. As the results show, some of the themes emerged only in passing, while interviews, for instance, would have enabled further probing of those themes. Since this was a cross-sectional study, and all of its data was collected in a single session, this study does not provide information about causal relationships or longitudinal data about learning progress, but rather a snapshot of participants' current learning experiences. A single-session, snapshot method enabled a large number of responses suitable for an exploratory study that focuses on mapping the breadth and variety of experiences at the cost of depth and detail. This study did not measure actual learning but pupils' experiences of what they felt they learned. In addition, the sample size of the study is relatively small, and the results of this study alone cannot be generalized.

This study explored how children experienced learning through playing digital games as well as the contexts in which children experienced that gaming benefitted them. Children experienced that they learned a variety of 21st century skills and core subjects, and developed sports-related skills and physical abilities. They also found gaming to be beneficial for them in the contexts of school, sports, and friendship. The results of the study provide information about children's own learning experiences, through which many guidelines and perspectives can be obtained, for example, to different educational levels and learning environments for children.

In this study, children's learning experiences were viewed from a broad perspective of 21st century skills, including all digital games children played. Therefore, results provide an overview about children's learning experiences and benefits related to 21st century skills, and they provide a starting point for future research, such as the possibility to focus on separate

topics in more detail in order to gain a deeper insight into the processes of learning and the benefits of games.

Future studies on children's learning experiences could adopt different methodological and domain-specific approaches, for example, by focusing on learning experiences from a certain game, or specific subjects such as English or history. Additionally, instead of studying learning experiences, actual learning outcomes or learning processes could be explored through longitudinal research designs, by using control groups, or by using pre-test and post-test designs for measuring learning.

It turns out that in addition to playing digital games, children were also involved in other activities related to the games, and they experienced that gaming has helped them with strengthening friendships and finding new friends. This result confirms Consalvo's gaming capital theory, where, for example, good gaming skills would increase player's cultural and social capital (Consalvo, 2007). This study widens the view that learning from games does not happen only during gameplay, but a lot of learning takes place outside of the game mechanics, in social contexts related to games (e.g., Gee, 2011). There is a need for further research on children's learning related to this meta-gaming dimension of digital games. The ways children are meta-gaming, meta-games as a learning environment, children's own learning experiences, and children's awareness of their own learning on meta-gaming activities are phenomena that require more research.

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