Mathematical Educational Games

Perceptions of Special Education Teachers

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Abstract:
Children lose 99 times out of hundred in almost every commercial game they play yet they do not stop playing games after such failures (McGonigal 2011). In fact, the more they fail the more they want to play games. The case is different when it comes to computer educational games. Children do not play them as often as these games are meant to be played. Therefore, the perceptions of the teachers who teach through such games are the focus of this study.

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1 INTRODUCTION

Many schools use educational games in classrooms. Schools train teachers and in return, teachers use educational computer games to enhance their teaching in the classes. This concept of gaming in schools started after the initial success of mainstream gaming industry. Children were taking increasing interest in commercial games and in an effort to keep them engaged in a classroom, educational games became part of many core curriculums. The current study takes both qualitative and quantitative approach to find out teachers' perceptions of mathematical games in mathematics classes in special education, since this is an area that calls for further investigation due to scarce research on this subject so far. In this study, the perceptions of special education teachers regarding digital mathematical games is investigated. The objective was to find out how much these professionals consider digital gaming bringing additional value to their teaching. Moreover, this study seeks to discover the special education teachers' insights to the immersivity of the digital mathematics games, and lastly, what makes a digital mathematical game good enough to return to? However, this study has some limitations. The results of this study are not transferrable as such, since the data collection has been made in the southern part of Finland, and the games that have been used are Finnish. Furthermore, games are developing constantly, and new and better games are coming to market all the time.

There is one main question that this study seeks to find an answer to.

1) What are the perceptions of the teachers on the use of mathematical educational computer games in special education context in Finland?

This study seeks to find out the perceptions of the teachers on their use of mathematical educational games in enhancing their teaching. The teachers that are focused in this study are teaching to special needs students in the special needs classes in groups or individually. To understand the main question, it was decided to divide the question into sub questions. Therefore, the following sub questions were used in a survey which was sent to the

participants. Furthermore, to answer the main question the author first explained the results based upon the sub-questions and wrapping up with the main question in *the results* section.

a) What is the additional value that educational computer games bring to teaching?
b) Is there an immersive behavior[1] seen by teachers among children during the interaction with educational computer games?
c) What makes a digital mathematical game good enough to return to?

The findings of this study will be of value to educators who are teaching in special needs classes as well as to the students in special needs classes. This study also aims to find out immersive nature of educational computer games.

The study begins with the background information on the system of special education in USA and Finland, games, and educational games. The theoretical framework consists of a literature review of the previous similar studies in the field of educational games, mathematics and special education, as well as the theory of optimal experience based on the concept of flow (Csikszentmihalyi 1992). This is followed by the explanation of qualitative and quantitative methods used in this study, after which the research results are explained together with a conclusion, limitation and further research.

[1] Children while playing video games forget about the surroundings and time.

2 METHODOLOGY

Research statement

The research will focus on the perspectives of teachers in special education, specifically in mathematics educational games.

Sample

In this study, the non-probability approach was used. This approach suits well with the snowball sampling or purposive sampling type. The key special education teachers are expected to pass the questionnaire onwards to their network of colleagues in their geographical area, therefore the adequate sample size for this research was thought to be 20 teachers.

Identification, Definition and Justification of choice

Teachers are the ones who are the first to interact with educational games in the classes. However, this study is not about teachers and their ability to use the games, but about their perceptions particularly in special education classes about mathematical educational games. Moreover, only few studies (Ekstram et al. 2015: 75&79 & Göransson et al. 2016: 183) have been conducted in this field, hence this can be an attempt to fill part of the research gap.

The study uses online survey questionnaire[2] for data collection method. Study will be focusing on teachers that are in the greater capital area of Helsinki, specifically in Vantaa, Kerava and Porvoo surroundings. The questionnaire was designed to take advantage of both qualitative and quantitative questions to get a holistic view of the teachers' perception on educational games effectiveness in their mathematics classes. The online questionnaire was to give teachers time to think and answer at their own pace.

Qualitative & Quantitative method

As a best practice, Metsämuuronen (2017) suggests that depending upon the research it is better to choose between qualitative and quantitative methods as one being the main

[2] https://goo.gl/forms/6S35rsu9MRosuNFy1

method. It is also important to use more than one approach, as one method sometimes is not enough to bring out significant results. In qualitative analysis, we do not hypothesize any statements, questions or results. By using this method eventually, we are looking at finding some truth to our research statements or be close to our research statements as possible. (Metsämuuronen 2017: 20,188, 194, 241-242.) This research investigates the perceptions of a teacher, therefore for this research qualitative approach will be used as the main method, however, the methodological triangulation attempts to bring more depth to the results.

This study focuses on specific group of teachers who use mathematical educational games to teach special education mathematic classes. Due to this specificity, inductive style of research was used. The objective was to find out if such games are economically viable to use, or promote, to developing countries. The data collection method was an online survey. The survey was sent to teachers and the answers were analyzed and conclusions were made to find out the perceptions of teachers about mathematical computer educational games. Additionally, attention has been given to the economic factors, meaning, whether it is necessary to purchase hardware and software and upgrade every now and then, which could be a significant factor in an economically under developed country's educational budget.

The survey questionnaire was made up of both qualitative and quantitative questions. The approach to use both qualitative and quantitative approach has been chosen because sometimes in qualitative data collection we come across information that is not asked in the questionnaire but is very relevant to the current topic and adds value to research results.

The results were analyzed and reflected upon in the light of the following theory: Theory of Optimal Experience with the concept of flow. Each research question was answered through the findings of the survey questionnaire. Both the qualitative and quantitative results completed each other and brought additional depth to the study and the research results. Quantitative and qualitative results found repeated answers and consistencies. The

repetitions were core factors that made the both qualitative and quantitative results trustworthy. Finally, the results were also compared to the previous research results that are mentioned in the literature review. (Metsämuuronen 2017.)

There is no consent form used in this study. However, there are some ethical rules that the author will follow. The author will not write down the names of the respondents at any stage, and the author will assign code numbers or code names to the respondents and use such codes when writing the results. The respondents' identity will not be revealed at any stage of the analysis, nor in the results. No children were involved in the study, therefore, there is no need for taking permissions from parents or guardians.

This study has some limitations worth mentioning. As the number of participants was small, an in-depth interview would have been a good method for data collection. In an interview, I would have been able to get answers one by one, and during analysis I would have the time to compare and analyze answers of all the participants and possibly find some patterns. However, special education teachers who use educational games in mathematics are not many, and not easy to bring in one place from different schools at the same time. If it was possible to do that, then it would be a very fruitful to do interviews. The results of this study are not transferrable as such, since the data collection has been made in Finland, and the games that have been used are Finnish. Furthermore, games are developing constantly, and new and better games are coming to market all the time.

3 THEORETICAL FRAMEWORK

Several different theories were considered for this study; The Theory of Optimal Experience based on the concept of Flow (Csikszentmihalyi 1992), Cognitive Theory of Multimedia Learning (Richard Mayer) and the Theory of Learning in Games (Fudenberg & Levine). As is discussed in the Background section, immersivity of games is the very thing that keeps people returning to them. This is one of the issues that this study aims to investigate regarding educational games, thus, Theory of Optimal Experience based on the concept of Flow seems to be the most appropriate for this purpose. The cognitive theory of multimedia learning or the theory of learning in games are not used here as this study is not about students' perceptions, nor it is about students' learning through games. In the current study teachers of special education will be given a survey questionnaire in which they will answers about their perspectives on the mathematical educational games in special education. The answers of the teachers should tell us whether this immersivity exists while students are interacting with the mathematical games in special education. Below is the brief introduction to the Theory of Flow.

3.1 Theory of Optimal Experience based on the concept of Flow

The theory of optimal experience is an immersive activity in which a person is involved in such a way that the surroundings or reality goes in the background and the person comes back to get that feeling of immersion again and again from the said activity (Csikszentmihalyi 1992: 4). In other words, an experience where a person is involved in an act and unaware of the surroundings (Liu and Chang 2012: 5). This optimal experience or flow consists of four key elements: Curiosity, intrinsic interest, attention focus and control (Liu & Chang 2012: 5 & Liu 2017: 141). In the context of commercial games, this seems to be the case. Gamers play again and again for the sheer pleasure of immersive activity, which we call it gaming. Furthermore, gamers lose track of their time while playing games. (Liu 2017: 141.) Csikszentmihalyi (1990) explains that to achieve flow, one must maintain the balance between ability of one's own together with the challenges that are being faced while playing. If the ability to move forward in the game is less than the challenges a gamer is facing, then the gamer faces stress and anxiety and if the game is

less challenging, than the gamer feels board. This explains the difference between a commercial game and an educational game, since in educational games children get less of a challenge and curiosity in the storyline context of the game and more boredom in the educational context of the game. Therefore, the question remains, do the mathematical educational games provide such experiences and challenges as are seen in the commercial games?

A person who wants to come back to get the feeling of immersion again and again is a flow, an optimal experience. In this context this study would like to test this theory out by asking a simple question to the teachers about the feeling of immersion. Teachers are helpful in finding this flow because they are observing and teaching children with and without games. They can tell us if they have seen this feeling of immersion in the students.

4 BACKGROUND

Throughout this thesis some important key terms and words are used. In this section, they are explained for the readers to understand the context and meaning of them in an effort to facilitate the reading of the thesis. Similarly, there is some explanation about special education and games.

4.1 Games and Educational Games

Majority of people have played computer video games in the last three decades, or at least tried. Some say that playing games is somehow beneficial, whereas others believe them to have no benefit whatsoever. Some might even say that playing games is harmful. Therefore, it is not surprising that there is a lot of literature available to read both in favor and against computer games (Bakker et al. 2015: 1000). Due to the popularity of computer games and the fact that they are digital and easy to share and reproduce after the first manufacturing, not to forget the reasonable research and development costs of course, it was not long before the games were introduced into classrooms. It was said that games would bring change to education, and that students along with the teachers would greatly benefit from them especially for their motivational factor and ability to provide instant feedback. Studies have confirmed that games provide useful skills that are quite necessary these days in schools as well as in work places, such as attention to task at hand, leadership skills, problem-solving, and communication and cooperation (Dicheva et al. 2015: 75). Furthermore, studies have shown that educational games have positive effect on learning (Shaftel et al. 2005: 25, 26; Bakker et al. 2015: 999 &1000). However, opinions about these beneficiary effects in general education are divided. Furthermore, research about digital educational games in special education is scarce, thus the need to see into the digital mathematical games in special education.

However, compared to main stream games, educational games are far behind in their ability to motivate and create the sense of immersion. They do not provide the ability of attraction and the ability of enjoying failure within the games (McGonigal 2011). In the case of commercial games, a player gets high level of challenges, together with attractive, mediated and immersive environment which in turn gradually increase the skill levels of

a game player (Liu 2017: 142). Additionally, educational games do not tend to get high priority from majority of the educational game developers in updating graphics (Dicheva et al. 2015: 75) or adding the immersive feelings as we can see in World of Warcraft, for example (McGonigal 2011). Moreover, to implement educational games with their full potential in classes require highly motivated and ICT (Information and Communications Technology) competent teachers, and beautiful aesthetically designed games (Dicheva et al. 2015: 75).

4.2 Differences in Games & Educational Games and new Genre of educational games

There are games, and then there are educational games. What is the difference? Children play games but tend to avoid educational games. Is this because there is a word education in it? Maybe. There is always more than one explanation to all of this. McGonigal (2011) proposed one reason for parents not to take educational computer games seriously, and it is the word *game* itself. McGonigal gives examples such as: Do not play games with me, are you playing games with me or he is a player (McGonigal 2011: 19-20). Another way to look at it is that computer games are immersive in nature and in fact games are made to be immersive (McGonigal 2011). Therefore, commercial games or immersive games take the child away from reality. Educational games are not providing that immersive feeling. Let us just say that educational games are based on reality. Reality and immersivity are opposite behaviors and this might be the reason why educational games are not attracting clear majority of children in schools and homes. Thus, there might be a need of a new term or genre, and the game designers and developers could start building that genre. This genre should combine the feeling of motivation, graphics and impressiveness to the realities of the subjects in schools. There is one genre that comes to mind and which game developers could start developing: *Immersive Educational Reality*. This means the Immersivity of commercial computer games are combined with the Educational Reality, bringing together the best of both worlds, game industry and education.

4.3 Special education system

Every child needs educational support, especially, if a child has special needs. Schools across the globe provide certain kind of support for their children, and in the USA the term for such support is widely known as Response to Investigate (RtI). RtI is a combination of processes known as instruction, intervention and assessment, or three-tier process. In the United States, RtI is used with the intention that the process will help special needs children in their learning. Thus, in tier 1 they determine the level of student performance. Students who do not pass the standards are then further assessed in tier 2 stage of RtI. Students get additional support in tier 2 in groups or in-class. In tier 3 students get one-on-one instructions from the special education teachers. The implementation of RtI in the middle and secondary schools in USA is facing challenges. Not all schools use the same methods of assessment and that causes problems for schools. Since this study focuses on mathematics classes, the mentioning of RtI is to be taken in connection with/to the children and teachers of special education mathematics classes. (see Ekstram et al. 2015.)

In Finland, schools used part-time and full-time support models for the special education children. Part-time support was provided in what was called resource rooms or pull-out model. The aim was to help children if they had had difficulties in understanding mathematics, reading or writing. Anyone that was considered in need of extra help was given it by teachers and there was no need to take an official decision to provide help to students, quite like in RtI's tier 2. Students who needed more help were provided that only after they were assessed by school psychologists or physicians. This is the tier 3 of RtI. In full-time special education, students follow individual plan created by teachers and student welfare group. Similar to RtI, the Finnish model also had some challenges, and to overcome them, new reforms were needed. (see Ekstram et al. 2015 & Fletcher et al. 2007.)

In 2010 the national core curriculum in Finland was designed with a three-tier support model on the grounds of RtI. The model included general, intensified and special support tiers. This model gives guidelines to find learning difficulties among students and intervene where necessary to provide additional support. Tier 1 is to provide support for all the students and students have a student plan. Teachers update student plan regularly, and

if they see that any student needs more help, then intensified support is provided. Teachers, welfare group, guardians and the student create a new study plan and in cases where even more support is necessary, a pedagogical statement document is created. Based on pedagogical statement document individual educational plan IEP is created for the special needs student, which ensures that the student receives a compulsory education together with the necessary assistance. (see Ekstram et al. 2015 & Fletcher et al. 2007.)

There are many methods in Finland that schools use to find out the learning difficulties of the students in reading, writing and mathematics. Some institutes, such as Niilo Mäki Institute[3]and Valteri Onerva[4] conduct research on learning difficulties, and produce research based standardized tests for the identification of learning disabilities in children such as LukiMat[5], MAKEKO[6], ALLU-test battery[7] and last but not the least FinRa[8]. These tests are very well known and widely used in Finland.

[3] https://www.nmi.fi/fi/oppimisvaikeudet
[4] http://www.onerva.fi/tukipalvelut/oppimisvaikeudet-oppimisen-ja-koulunkaynnin-tuki/
[5] http://www.lukimat.fi/lukimat-oppimisen-arviointi
[6] http://www.opperi.fi/10_testit/1032_lisainfo.html
[7] http://bit.ly/2zXTggb
[8] http://finnishreadingassociation.blogspot.fi/p/yhdistyksen-julkaisut.html

5 LITERATURE REVIEW

The literature review consists of previous studies that are different combinations of mathematics, educational games, and special education. Since teachers use different games and there are new games coming to market all the time we have only taken literature from recent years to stay up to date. The literature was also chosen because of the relevance to my research topic that is motivation, special needs students, training for teachers in digital material including video games for schools, work load: associated with time and motivation of the teachers, and the involvement of parents and teachers in the use of educational games in the classes by students. The *results* section has described the connection between literature review studies and the results from this study.

The understanding of mathematics varies from a child to child in early school years. Children who are better at numbers at young age tend to be better at mathematics later in their life too (Peters 1998: 50). In the past two decades, the research in mathematics learning disability MLD has been conducted on low level concepts such as whole number calculations and basic number processing. Out of this, only small amount of research is done on higher level concepts such as fractions. (Göransson et al. 2016: 182; Woodward & Tzur 2017: 147.) Special education students will need a lot more systematic and explicit instruction methods by teachers for them to be able to solve higher level concepts (Liu & Xin 2017:143). Some research has found that in special needs classrooms mathematics is taught in a teacher-oriented way which leaves little to no room for student's own initiative of learning and constructing meanings (Göransson et al. 2016: 183). Another study suggests that the differences among reading, writing and mathematics are not known (Fletcher et al. 2007). In general education, some studies have shown that learners with the ability to self-explain perform better in learning, whereas, in special education there is a need to do such study to learn the ways special children self-explain mathematical problems. To improve self-explanation in students it is advised not to use either student centered, or teacher centered approach. It must be a mixture of both or discourse-oriented instruction. (Liu & Xin 2017: 132, 133 & 134).

Teachers should not only use books to teach they should also use educational computer games at the same time. Games are just another activity in the classroom. Games have a

motivational characteristic; therefore, games should not be overused in classroom to keep the students interested in their subjects in the classroom. (Shaftel et al. 2005: 25; Bakker et al. 2015: 999 &1000.) We live in a time of digitized education era; therefore, it is also being recommended to develop computer-based instructions for MLD students (Woodward & Tzur 2017, p. 149) to help them understand higher level concepts in mathematics (Göransson et al. 2016: 183). The games in general help maintain focus on the goals while playing without the fear of failure. Thus, when a student plays a mathematical game the same approach of not fearing to the concept of failure should be present. The student will get an opportunity to try different strategies and build upon failures to learn. (Shaftel et al. 2005: 26.) As some studies in general education has shown that when students work in group and do self-explanation they perform better in explaining geometry theorems and definitions (Liu & Xin 2017: 133). Hence, it is important to give our special children an opportunity to not only learn basic skills but also higher-level skills (Woodward & Tzur 2017: 149). The studies to increase self-explanation and reasoning in special education mathematics students are mostly about explanations on the topics about animals and not so much on the reasoning processes (Liu and Xin 2017: 133 &143). Studies also suggest that there is a need of educational support in mathematics as one study conducted between 1999 and 2012 in the field of mathematics for special students showed that only 7 articles were written on special needs education. This clearly goes against the concept of inclusion and of learning for all (Ekstram et al. 2015: 75&79; Göransson et al. 2016: 183).

In Finland, the performance in mathematics has slightly decreased but it is still relatively better than in the other Nordic countries.

The study by Göransson, Hellblom-Thibblin & Axdorph (2016) investigates the issue of equality in education and especially to the equal access of the curriculum related questions regardless of disabilities. Their purpose of the study was how to provide conceptually-based mathematical curriculum to the special education students. The study was based on the theoretical framework that students only learn what they are given and taught by the teachers. To understand the results, the researchers used Mathematical Competency Research Framework (MCRF). MCRF further divides into six Competencies and four Competency Related Activities (CRAs). Through this framework, the researchers

wanted to see if the students are developing any one of the six or all the competencies of MCRF. Data was collected in 2011 from six schools of six counties from special education classes in Sweden. They filmed eighteen mathematics classes and audio recoded 21 interviews of the teachers. 35 participants were chosen from 60 special education mathematics classes. Researchers used qualitative content analysis approach to analyze the data. Interviews were taken to analyze the teaching strategies to look at how the content was accessible for the special education students. Three teaching strategies were found that were related to pedagogical mathematics activity, to students' perception of mathematical content and to dialogue. The study showed the researchers some limitations. The researchers were unable to find differentiation between CRAs and they realized that they should have discussed earlier video results with the teachers before getting into analyzing them. Furthermore, the researchers wanted to add more research into clarification of MCRF. Finally, the researchers reflected that their study purpose was to provide conceptually-based mathematical curriculum to the special education students. They found out that even though their research provides added value to the special education students but there was still a need for more development in understanding the teaching of mathematics to the special education students. (see Göransson et al. 2016.)

The study by Ekstram et al. (2015) investigates the work load of teachers (special education and mathematics) and practices of educational support provided in Swedish schools in Finland to special education mathematics classes. An online questionnaire both qualitative and quantitative was used. Special education teachers received 23 and mathematics teachers received 29 questions. The questions were about support methods, support in mathematics and what were the effects of new legislations that brought in new three-tier model (general, intensified and special support) system in affect. The questionnaire was sent in May 2013 to the 55 principals of the Swedish speaking schools in Finland. In reply 69 answers came back: 27 answers came from special education teachers, whereas, 42 answers came back from the mathematics teachers. 65% special education teachers preferred to use pull-out (resource room) method of teaching. similarly, 64% of the mathematics teachers preferred pull-out teaching as well. The study also asked the teachers about alternative approaches and few teachers mentioned the use of games. The study also brought to light that the support teachers are getting in mathematic teaching is sufficient, however, the extra support teachers did ask for complementary material such as

digital material. Teachers also mentioned that with the new legislation they are doing more paperwork. The study also found out that special education teachers spend 41% of their time in supporting learning mathematics. This study had some limitations such as small sample size of the teachers as the researchers sent the questionnaires to the principals and it was hard to know how many teachers in fact had received the questionnaire. Instead of the online questionnaire, researchers thought that interviews would have brought some deeper understanding of the questions. (see Ekstram et al. 2015).

Liu and Xin (2017) conducted a study to improve self-explanation among special needs students in mathematical understanding and explanation. The study focused on helping students to understand and explain the procedures while solving mathematics problems. Three research questions were focused during the study. Quality of self-explanation of special education students before and after intervention and the third question was about word problem solving performance of the students. Three fourth grade students were chosen from the public elementary school in United States. The participants did criterion *test* (with alternative forms) and *transfer test*. The results were analyzed with two dependent variables: problem solving accuracy and quality of self-explanation by the three-special-education fourth graders. The participants were taken to a quiet room for a whole working week and all the sessions were videotaped and transcribed. The researchers also invited independent observer for one third of the sessions. The data was analyzed using quantitative methods. The results for each student were extracted according to the research question: problem solving and quality of self-explanation. In case of quality of self-explanation, all the students started with low-level performance in the criterion test. The performance increased after the intervention to a satisfactory standard as it was observed that the participants could identify and solve the problems.

The authors came to conclusion that special need students could learn thinking behaviors and self-explanation. For the question of problem solving performance the participants started with low-level performance in problem solving in the criterion test. In the later stages after the intervention participants performed better in problem solving. This study suggests that teachers provide more support and opportunities to engage special needs students in reasoning and problem solving. The findings of this study also showed that the reasoning ability increased problem solving among three participating special needs

students. The limitations of the study according to the authors suggest that there should have been an explanation between addition/subtraction and multiplication/addition. The researchers focused on multiplication and addition only in this study. The researchers also saw the need for more studies in self-explanation. (see Liu & Xin 2017.)

A study conducted in New Zealand consisted of pre-study and post study. Pre-study was named Early Mathematics Improvement Project (EMI-5s). This pre-study was conducted to find ways to improve number concepts of five-year-old students. Two types of interventions were used. The children were grouped in pairs and they played games and read stories about numbers. In the second intervention parents were invited in the workshops to help them understand the routine of classrooms and teaching methods. The successful pre-study resulted in finding out ways to improve children's mathematic skills in numbers. In the main study, the researcher combined the two interventions from the pre-study to find out less cost-effective ways to teach numbers on larger scale. This was done with five-year-old children. The second study was conducted with seven-year-olds to find more ways of bringing mathematical games into the classroom and this study also invited parents to play with the children in class. Eighteen five-year-old students took part in first main study. The parents were invited once a week to play games with the children. Individual task-based interviews were conducted with students twice. Once after two months and lastly at the end of eight months long study. The second main study with seven-year-olds involved 128 students. Out of 128 students 39 were involved in a similar activity as of five-year-old students. Another 58 students were playing identical games with the supervision of adults. The final 31 students were not allowed to play games and they just went on doing the normal course studies according to the pedagogical model. The task-based interviews were also conducted in this study. Once at the start and finally after six months in the study. Furthermore, observations were also documented during the studies with five-year-old students and seven-year-old students. The five-year-old children outperformed in progress over the pre-study results. Initially the progress was slow but with the support of parents in game play helped in performing better after eight months of intervention. Furthermore, parents reported that helping in the class gave them better understanding of the teaching with games.

In the seven-year-old case study, the results were similar in all the three categories, playing with the parents, with the supervisors or just working without games. Parents also did not take interest as much as in the case of five-year-old students' parents involvement. Overall, games were liked because of their motivational factor that was observed by parents and teachers alike. The children liked the games because they provided them challenge. Some students did not play games if they were too easy or too hard to play. This ability to choose a challenging game was not the case for the students who were not given the games to play with during the study. This study overall suggests that children play and learn in pairs[9], however, not in groups of more than two. (see Peters 1998: 49-58.)

In conclusion, teachers need training. Göransson et al. (2016) suggested that there is a "need for more development in understanding the teaching of mathematics to the special education students". Games are motivating the children in learning mathematics. Parents are understanding the importance of the games and the study of Peters (1998) shows that the children who interacted with games under the supervision of teachers and parents performed better.

[9] See also Guberman & Saxe 2000 to read more about how students perform when they are paired. http://dx.doi.org/10.1207/S15327884MCA0703_08

6 RESULTS

6.1 General information derived from data collection

The survey questionnaire was the combination of questions both open ended and close ended. It consisted of questions about perceptions and additional values of the uses of mathematical educational games used in special needs mathematics classes. The survey questionnaire was made by the researcher of this study with the help of one special needs teacher of more than 15 years' experience in the field. It was also tested with two teachers. The purpose of this survey questionnaire is to find out the perceptions of the teachers on their use of educational mathematical games.

The survey questionnaire was sent to 206 teachers in Kerava, Vantaa, and Porvoo via email. The email was sent again after two weeks. However, only 12 replies came through. Further 2 replies came through special education teachers' Facebook group, where a notice was posted for the special education teachers of the above-mentioned cities to take part. This group has over 1900 members. In total 14 replies were received in five weeks' time. 11 females and 3 male teachers took part in the survey, all of them holders of a master's degree. 4 participants were in their 30s, 4 in their 40s and 6 participants in their 50s. 11 participants reported to be working as Special needs teachers and 3 reported to be working as Special primary class teachers. 6 participants had 11 and more years of teaching experience, whereas, 2 participants at the time of the study had been teaching between 7-10 years, 1 participant between 4-6 years and 5 participants between 1-3 years. The teachers' teaching experience and the years of using computer games in teaching as well as their ICT training is visible in the table 1 of demographics.

Table 1. Demographics

N14 (F11, M3)	0 years	1-3 years	4-6 years	7-10 years	11+ years
Teaching experience	-	5 (35.7%)	1 (7.1%)	2 (14.3%)	6 (47.9%)

Computer games use in teaching	1 (7.1%)	6 (47.9%)	4 (28.6%)	1 (7.1%)	2 (14.3%)
ICT training	8 (57.1%)	4 (28.6%)	2 (14.3%)	-	-

None of the participants have less than 1 year of teaching experience. Whereas, 1 participant is not taking advantage of the computer games. The ICT and computer training show some significant details. 8 participants have absolutely no training experience and none of the participants have more than or equal to 7 years of experience, even though we have 6 participants with teaching experience of 11+ years. Next, the participants were asked how much time does a child spend in classroom interacting with the games? The question was asked twice in the form of qualitative and quantitative questions. In the qualitative section many of the teachers said that the children spend on average 15-30 minutes at a time. None said it over 30 minutes in their response. The responses were quite similar, as can be seen below.

> *Two hours per week.*
> *Vektor is max 30 min/day, usually shorter time.*
> *30min every now and then.*
> *Not each class but sometimes 20min.*
> *three times a week about, 20 minutes at each time.*
> *15-30 minutes/lesson, max 15 minutes, 20 min, 5-10 mins, 15 - 20 min, about 15 minutes.*
> *In the beginning we first learn the times tables using the program strategies and then the end of the lesson is for practice. 10-15 minutes.*
> *Occasionally, depends on the child and lesson.*
> *Max 20 min daily*

Whereas, in the quantitative section 3 participants mentioned less than 15 minutes time, 9 participants mentioned the time between 15-30 minutes, 1 participant said the time is between 30-45 minutes and last participant went with 45 minutes and higher. Again, the average time is between 15-30 minutes which is quite similar to the qualitative replies.

6.2 What is the additional value that educational computer games bring to teaching?

To find out the additional value of educational computer games in special education classes the participants were asked few questions. There seemed to be few inspirational factors about the use of games in classes mentioned by the participants:

> *The students that are reluctant to do pencil and paper math are usually willing to use the games to learn.*

> *Getting variety in the classes, rewards pupils at once, concrete.*

The students who were reluctant to read and write or to use pencil and paper were willing to use games. Hence, the educational games bring additional value to the class both for teachers and students. Games give instant feedback, and since there are a variety of games available good results can be produced via games. Other inspirational factors mentioned were easiness of the use of computers, versatility to teaching methods, rehabilitation, results and most used word among participants; motivation. One participant mentioned the inspiration of using game in classes by pointing out the fact that the use of game helped the participant in ideation, planning and self-motivation to keep on teaching. Another participant mentioned about importance of repetition:

> *Usually kids don't like to as much as repetition as these games make them do.*

This shows that games make the children repeat enough times to remember their work. Children like to learn on their own pace and one participant confirmed this:

> *Learning with their own action (with the tablet) keep them active and vigilant. Nice graphics and images give them pleasure to play.*

Games keep the children active and alert in the classroom. The above-mentioned comment of a participant also indicates that the game graphics and images give the children pleasure to play. Therefore, the game itself brings additional value with graphics, repetition, and instant feedback.

One participant mentioned that a dry and painful topic can be fun and interesting with the use of computer game. Overall motivation, repetition, feedback in the form of rewards

are the most used terms used by the participants. On the opposite spectrum of the use of games in the classes our study participants mentioned few drawbacks.

> *Some hate it, they can't cope with the speed.*

One participant worried about children that they are not at the same level, therefore, few students learn fast with the game and few are just catching up. Few participants mentioned that if the game play is not monitored than the children will keep on playing in class which will reduce the time for other activities. Also, with the continues play a child might not know what is happening and may not be able to learn anything instead just keep on taping/swiping and randomly playing.

> *Too much screen time in general*

> *Child can just by tapping to get the right answers. She/he doesn`t understand anything about exercise or learn anything.*

Games are not always productive, sometimes games have some drawbacks. Many participants mentioned words to describe drawbacks such as computer games make the children robots and addicted. Furthermore, children learning via games were observed by some participants becoming impatient.

6.3 Is there an immersive behavior seen by teachers among children during the interaction with educational computer games?

To understand the immersive behavior, we need to remember that being immersive means to be in the zone and not aware of the surroundings. This feeling can happen in the classrooms as well as away from classrooms. If the child is playing games away from school that would be a hint of the child taking an interest in the game which leads to the believe that there is a feeling of immersion in a game that is making a child to play it away from school. Therefore, the study needed to know at first if the children are playing educational computer games at home or away from school. 10 participants admitted that the children do play games away from school and 4 participants replied No. As, the study focuses on the perceptions of a teachers, the author asked the participants whether they can tell if the children like the game that they use in the classes. This also helps us come one step close

to know if the feeling of immersion is somewhat present in the children. There was no reflective remark about what the children think about the games. Most of the participants said that the children like the game, enjoy the game, or prefer the game over books.

> *They are really focused and forget the surroundings.*
>
> *They often tell me that the lesson time goes by quickly.*
>
> *Most of them do. Some get frustrated when Vektor is too difficult for them.*

When asked the direct question if the children are immersed in games in the classrooms the majority of the answers were in the middle of yes and no spectrum. 4 participants said 'No' and 3 participants said 'Yes' and 5 participants replied with neutral opinions by using words such as seldom, it could be, or can't say. Finally, 2 participants claimed that they did not understand the question, therefore, simply did not reply.

6.4 What makes a digital mathematical game good enough to return to?

There were many games that the 14 participants mentioned. The top three mentions were Ekapeli, Vektor and 10 monkeys. The participants also recommended animal race, Bingel and Teen monkeys mathematical computer games for the children. Furthermore, participants also gave their reasons for which they use the games.

> *I use university designed games that adapt according to students' skills*
>
> *It´s easy to take on and you get feedback about your student*
>
> *They are easy and suits for Finnish education system and curriculum*
>
> *To motivate to learn a skill (lots of repetition)*
>
> *to make mathematics more interesting for students.*
>
> *… we practice the learning strategies using the games.*
>
> *They are good. Vektor gives results.*

Some participants used words to describe reasons such as *repetition*, *extra, practice*, *children like them,* and *students can learn English at the same time.*

The above-mentioned games that the participants were particularly using to help in their teaching had been used by 4 participants for 0-2 years, whilst 8 participants said they had been using the games between 3-5 years and 2 participants reported the use between 6-8 years.

6.5 What are the perceptions of the teachers on the use of mathematical educational computer games?

Children are willing to play games in the classes and one participant has described it as keenness that helps the participant as well in the planning of the lessons. Some participants get new ideas from games; hence they perceive games as help full planning and ideation tool. One participant mentioned that children like to play with games rather than using pencil and paper to do class work. Therefore, this participant perceives the importance of practical work rather than theoretical approach. Few participants perceived games as motivational, feedback driven, result oriented and educational tool to learn skills. Another participant perceives games as tools that change with the needs of a children.

One perception of the participants is that they have seen students liking the games that are used in their classes. Almost all participants agreed that the students like the games that they use. Only 2 out of 12 participants used the wording ‘it’s okay’ to describe their perception for the use of the games in their classes. From the 2 participants 1 also said that at least the games are better than the books.

It’s okay, better than math books

7 DISCUSSION

Results show that there is often a lack in teacher training for the use of games, which results in teachers not being able to find relevant games or not being able to recommend new games. There might be lack of teacher's interest in the research of finding new games as one participant expressed by saying that you should google the games by yourself.

Educational games that are better in graphics or the games that maintain the balance between challenges of games and abilities to overcome those challenges are performing better in the perceptions of the participants when asked about the games that they use in the classes. In the results section the most used games are mentioned and those are the kind of games that should be the starting point to continue moving forward in terms of better graphics and challenges. However, we should not forget that the games' challenges should not exceed the playing abilities of the children. Nevertheless, we can see from the responses of the participants that special needs children do like to play games and they play them away from schools as well. Participants are also mentioning the motivations of the students. Thus, a motivated student should not be hindered by a less challenging game or from a game that exceeds the abilities of a child to play such game. As few participants mentioned that some children just keep on pressing buttons to move forward. This shows that some games are not balancing between abilities of a child and challenges of the games that they are playing. In short, we discussed about new genre for such games *Immersive Educational Reality*. Developers can make the games with immersive nature of commercial games into the realities of educational subjects. They have the examples and the tools to build such games. This genre can help our special needs children to learn more and easily in schools.

There was one participant who mentioned that he/she is using games that adopt according to student's skills.

I use university designed games that adapt according to students' skills

This is another example of Immersive educational reality game where games evolve together with the child. This might be the reason why few participants said that special needs children like to play games.

We asked 3 sub questions to understand the perceptions of the teachers in their use of mathematical educational computer games. The sub questions that were asked were about immersion, additional value, and what inspires children to return to the games in their classes. These sub questions made it easy for the author to understand the perceptions of the teachers.

The bigger and even surprising issue which now was brought to light was the fact that teachers in Finland have little to no proper training in games, and that they use games that are either recommended by the school or another teacher. Thus, there is a lack of personal motivation to find new games and to train oneself. This is certainly a challenge realized by the author after the study results were analyzed. This will also bring more challenges such as no time for the teachers that are already teaching and are being asked to use games. Eventually we are talking about pedagogical model that would integrate ICTs and game training into the teacher training classes.

McGonigal (2011) have argued that commercial games bring out additional value, immersivity and keeps bringing back the children to play games again and again. The results showed that there are few games that children were immersed in, keep playing again and again and do bring out additional values in the learning process of the children. Hence, the genre of Immersive educational reality is happening in Finland to a small extent. This came as a surprise to the author. The common understanding of the educational games to the author was that the games were lacking behind in immersivity or adding any additional values. Participants did mention that many students play the games because they must. Then again this is very common in the non-playing classes where a child is just not interested in reading or writing. Therefore, the sub questions brought out positive side of the use of educational mathematical games for the special education students.

Theory of optimal experience and the results

The main theory used in this study is theory of optimal experience by the concept of flow. This theory is closely related to the feeling of immersion. Few participants did mention that children forget the time while they are playing the game in class. This is the same as in the main stream commercial games that children are so involved in the game that they

lose track of the time. Hence, we can assume at this stage that there are few games that were used by the participating teachers bring the same feeling of immersion from a mainstream game into the educational game play.

Another participant said that children want to play games rather than working with paper and pencil or with books. According to Liu & Chang 2012 the theory of optimal experience has four key elements: Curiosity, intrinsic interest, attention focus and control. Even though our data collection is not big, and we know that results are not significant. Out of 14 participants replies we can see that the children took interest in the educational games and they attended towards the games more than they gave attention to books. The results do not show any thing clear about curiosity in the children, but I can safely assume by looking at the results that the interest of children pointed out by their teachers about games cannot be without curiosity playing its role. Some participants did mention about Control. As one participant said they spend time with the children while they are playing to keep an eye on them and children are also allowed to play according to the given time.

The study's sub questions about the reasons of the returning to the games, additional values of the games and immersivity in itself provides some evidence that the optimal experience is present in the educational games. Like books, educational games have their value that is undeniable. All it comes to that the training of the teachers in using games and researching new games is what is lacking and is also shown through the comments of the participating teachers. The perception of the participants in the use of games is positive as no one suggested not to use games in the teaching in special education classes.

The lack of teacher training and interest in the research to find new games should be a priority of the teachers. No one can learn without practice and curiosity to learn more. This is true for the children and equally true for the teachers as well. One teacher said that you can google new games for yourself if you want a recommendation. This comment from a participant teacher just shows that he/she lacked the ability to research. If the teacher is not researching new and improved games to be used for teaching purposes than his/her students are not moving forward. We want our children to have the optimal experience of learning, therefore, we should teach them properly with good training and up to date information.

Previous Studies and the results from this study

The first previous study in the literature review by Göransson et al. 2016 discussed about the teaching approaches towards special needs students. The study concluded that there is still a need to understand the ways to teach mathematics to special needs students in the classes. The stress is on the teacher training and the current study results are also suggesting that teacher training is lacking in the research and game play. According to Göransson et al. (2016) the teachers are facing difficulty in teaching mathematics through books effectively. Hence, we can assume that based on the results of this current study even though games attract children but if teachers are not keeping themselves up to date with the ever-changing games it will not matter. My own assumption is that teacher training is going to cost a lot and there is obviously a lack of time thus the only way that seems to help teachers in this case is self-motivation. This self-motivation also came up short in this current study as mentioned in the results earlier.

Work load is a major part of a teacher's routine and the next study conducted by Ekstram et al. (2015) on work load points to the fact that majority of the teachers mentioned the work load affecting their teaching. The current study did not ask the question about work load, but the work load is associated with the motivation of the teachers which in our study is lacking in few of the teachers according to their comments received. Especially after the implementation of the new curriculum a lot of time is spent on the reporting. Therefore, even less time to prepare for the teaching material. The study also mentioned that majority of the teachers use resource rooms or pull-out approach for teaching special needs children and for that the use of games was rather helpful. The study concludes that the support for teachers in mathematics teaching was sufficient but not for the digital material. There is a lot of time spent in learning games and then preparing game related activities. Furthermore, as many teachers informed that they use resource rooms to teach special need students in small groups this also adds a pressure on the teacher.

The study of Peters (1998) involved both parents and teachers. They invited parents to come and play with the children. At the end of the study parents understood the importance of learning with games. The study found out that with the help of parents and eight months of work helped tremendously in achieving the goals of the study. Peters (1998) found out that games motivate the children and challenges them. In this current

study we received such comments as well from the participating teachers. The participating teachers used the games in classes for their motivational as well as challenging factors. Peters (1998) study and this current study both found out that children stop playing when the game is too hard or too easy.

8 CONCLUSIONS

Shaftel et al. (2005) suggested that overuse of the games leads to less interest in the game. The comments from the participating teachers in the current study also commented that the games are there to help steer the learning and they should not be overused by children. Parents should always be part of child's learning and as the children progress with the games so does the role of parents. Games are providing motivation, feedback and sufficient challenges to the children at school under the supervision of teachers and that should be continued at home under the care of parents.

The studies conducted in 2015 and 2016 by Ekstram and Göransson described the need of teacher training when it comes to the digital world. According to the participating teachers the educational games that they have used are motivating children. At the same time results also show that teachers on the other hand seem less motivated in their research of finding new and improved games for the children. Teachers talk about work load and less time for justification of their lack of motivation. The games are motivating children but when it comes to finding more games that can help teachers and students, then we get to see lack of motivation from the teachers.

After looking at the results it seems to me that the work load has increased and there is less time than before to prepare for the teaching and on top of it all there are only few teachers who are motivated enough to learn about new games and implement them in their classes. Therefore, I conclude that we should use pedagogies that involve educational games as part of the pedagogy. This will help teachers manage their time and at the same will be able to learn new games and implement them in their classes.

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