Analysis of Digital Games Related to Mathematics Education with Deconstructing

Selçuk Alkan[1,*] & Ebru Korkmaz[2]

[1]Department of Educational Sciences, Faculty of Education, Hatay Mustafa Kemal University, Antakya, Turkey

[2]Department of Maths Education, Faculty of Education, Muş Alparslan University, Muş, Turkey

*Correspondence: Department of Educational Sciences, Faculty of Education, Hatay Mustafa Kemal University, Alahan, Antakya, Turkey. E-mail: selcukal4401@hotmail.com

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Abstract

In this study, the design and educational aspects of digital games on Steam (Digital Game Sales Platform) were examined. Case study, one of the qualitative research methods, was used in the research. Universal design model and principles, educational and game mechanics were used in the analysis of the games. The games were analyzed using the Deconstructing method. In parallel with the findings obtained, it is seen that game mechanics are more various than learning mechanics in games. Also in game designs, it is considered that entertainment is more important than educational use. It was determined that question-answer mechanics are used more frequently among learning mechanics in games. One reason for this may be the ease of construction of question-answer mechanics. The main goal is to establish an interaction between education and game mechanics. In addition, it was defined that another important mechanic used in games is "instant feedback". In addition, in line with the findings, it was detected that in-game rules, levels and awards facilitate learning and increase motivation.

Keywords: digital game, mathematical concept, game mechanics, learning mechanics

1. Introduction

In recent years, the use of digital games in the field of education and the increasing interest in this subject have paved the way for digital games to be regarded as an educational tool (Bui et al., 2020). The most important feature of digital games is that they provide instant feedback to students (Lee & Chen, 2009) and allow students to make mistakes (Lowrie & Jorgensen, 2015). Students are not punished severely when they make mistakes in games and they are given various tips. In this way, digital games increase the motivation of the students in conjunction with features such as awards and scoring. Many studies have shown that digital games have a positive effect on motivation. Digital games are very important in terms of storytelling and enriching subjects in mathematics education. However, as it is known, it is a very difficult process to create an enriched story mechanics especially with intermediate scenes in the play (Gee, 2003).

The most important reason why the digital game is successful in education is due to its design features. With the visual richness used in the game industry, the real world context can be visualized and authentic learning environments can be provided in this way (Admiraal, Huizenga, Akkerman, & Dam, 2011; Ke & Clark, 2020). In addition, due to the feature of providing instant and customized feedback existing in many digital games, students can reinforce their learning and develop reflective thinking skills (Lee & Chen, 2009). Digital games can only provide the aforementioned contributions if they are designed well. Problems in digital games and their designs are another factor that negatively affects learning. The game to be designed needs to be easily used by students. In-game instructions should be clear, simple, concise and free from in-game design errors. Apart from the goals to be achieved, students' different skills should also be supported (Hall, Meyer, & Rose, 2012). Another important point is that digital games should be easily understood and accessible by different environment (socio-economic level, ethnic structure, etc.) and culture (King-Sears, 2009). If the features of a game, in other words, the mechanics are not successful, the effect of the game on the users would be low (Arnab et al., 2015). Therefore, the mechanics of the designed games should be chosen very well and should be designed in an integrated way with education. High-level

thinking skills such as analysis, synthesis and evaluation, which are especially necessary for mathematics education, can only be realized with certain mechanics that provide users with freedom to use (Urban, 2019).

Transferring applications used in digital games designed for entertainment purposes to the digital games which will be designed for education lead to the emergence of new opportunities, especially in the field of mathematics education (Gee, 2003). The biggest problem seen in digital games in the field of mathematics education is that there are no experts in the field of mathematics education with regard to their design (Joung, 2018). Therefore, there are problems in providing authentic learning environments that enable conceptual development in digital games (Panoutsopoulos et al., 2015).

1.1 Purpose and Importance of the Research

Choosing an effective digital game for educative purposes is a difficult process (Gros, 2015). Despite the studies, the number of studies stating how an effective digital game should be is still limited (Boyle et al., 2016). In this study, it is aimed to examine the digital games related to mathematics education in the context of mathematics education with game and learning mechanics, universal design model and principles on Steam, the world's largest digital game sales platform. During this pandemic era when schools are closed, it is thought that the study about the preference of digital games related to mathematics education, which is a technological product for children at home, will guide the parents and researchers. In addition, it is thought that the games, which are evaluated with the universal design model and principles in order to overcome the problems, will guide the designers and those who want to use the games.

2. Method

2.1 Research Design

Case study, one of the qualitative research methods, design was used in the present study. The case study is used to examine an existing situation in depth (Yin, 2003). This pattern was used because the structural and educational aspects of the games on Steam were examined in the research. Deconstructing was used in the analysis of the games. Structural solution is the analysis of the content of the vehicle (software, material ... etc) and the analysis of the vehicle according to its properties (Varonis & Varonis, 2015). In this context, the contents of digital games were first examined with the structure solution. Then, the design features and educational features of digital games were analyzed and determined from these contents. At the last stage, according to the analysis results of digital games, the interaction of educational and design game features and the educational value of digital games in general were determined. In this way, digital games were tried to be determined by their educational value and the critical game features.

2.2 Data Collection Process

Steam is a platform where digital games are broadcast and sold. It ia a platform where only games that can meet very severe criteria can enter and thus only selected and successful games exist. For this reason, the games on the Steam platform were examined in the study. Of these games on Steam, 52 games were reached by first typing "educational" on the search button, and then the number reached a total of 109 when the keyword "math" was typed. In this way, it was tried to reach all games related to mathematics education on Steam. Later, games that provide education in other fields were removed from the list. Afterwards, 19 games meeting criteria such as working on the computer, being related to mathematical concepts, working on the PC, having educational content in the field of mathematics were included in the study. Then, contrary to mobile platforms, 3 more games working in VR (Virtual Reality) that did not work on the computer platform were removed from the list and 16 games remained. Finally, the number of games was reduced to 14 after removing two games that were found to be unsuitable for children (containing violence and fear elements).

2.3 Analysis of Games

The explanation parts of the selected games and the gameplay videos on YouTube were examined. In the analysis of the games, the universal design model and principles (Hall, Meyer, & Rose, 2012) and educational and game mechanics defined by Arnab et al. (2015) were used. The games were played one to one by two researchers, according to the criteria of the universal design model and principles, the structural and educational features of the game were determined and mathematically analyzed. In addition, the design aspects of the games were analyzed using the deconstructing analysis method. The selected 14 games were played by the researchers for 1 hour and the design analysis of the games was done in three stages. In the first stage, universal design model and principles were used. In the second stage, analysis was made using educational and game mechanics. In the third stage, games were

examined in terms of mathematical learning outcome. With the universal design model and principles used in the first stage, it is aimed that the material to be used in education can be used by everyone and to maximize the teaching. According to the universal design model and principles, in order for a material to be usable, it is expected to be easy to use, understandable, free from errors, low in cost or system requirements (King-Sears, 2009; Hall, Meyer, & Rose, 2012). Seven principles of the universal design model have been defined for better understanding by educators and designers (http://universaldesign.ie/).

The first of these principles is fair use. According to this principle, designers should take into account social factors such as socio-economic, ethnic and beliefs while designing the material and should be able to use the material regardless of its social structure (Hall, Meyer, & Rose, 2012). The second principle is flexibility, which requires the designer to pay attention to users' preferences and abilities (King-Sears, 2009). The third principle is easy and intuitive usability. According to this principle, users should be able to use the material easily and intuitively (Hall, Meyer, & Rose, 2012). The fourth principle is perceptible information. According to this principle, designers must effectively communicate the necessary information to users. This information can be provided using different sources in the material (King-Sears, 2009). The fifth principle is margin of error. Designers are expected to minimize in-game errors (King-Sears, 2009). The sixth principle is low physical effort. The material should be designed to be effective and easy to use. The last principle is the size and footprint of the material. After analyzing this principle with the universal design model and principles, in the second stage, both educational and game mechanics of the games were determined by considering digital mechanics. Game mechanics are defined as design decisions related to playing the game, winning or educational goals (Adams & Dormans, 2012; Arnab et al., 2015). Arnab et al. (2015) identified 42 game mechanics and 32 training mechanics. In the light of this information obtained in the literature, the games were analyzed and their mechanics were revealed. There are names related to game mechanics in Table 1 and learning mechanics in Table 2.

Table 1. Game Mechanics

Game Mechanics			
Entertainment	Break Stage	Challenge	Action Points
Behavioral acceleration	Levels	Reward / Penalty	Markers
Pavlovian approach	Question / Answer	Urgent optimism	Turn Based
Community discovery	Pick / Click	Strategy / Planning	Resource management
Story	Capture / Destroy	Cooperation	Instant feedback
Pareto availability	Goods / Information	Feedback	Time Restriction
Protection effect	Informational Section	Side Mission	Square and Grid
Design / Editing	Infinite playability	Realistic	Task
Owning	Movement	Role play	Evaluation
Recognition	Status	Stepped info	Representation / Response
Cooperation	Competition		

Table 2. Learning Mechanics

Learning Mechanics		
Educational	Repetition	Guide
Show	Participation	Introductory
Generalization / Discrimination	Action / Mission	Observation
Feedback	Search	Question / Answer
Definition	Experiment	Plan
Reflection / Discussion	Embody	Analysis
Hypothesis	Imitation	Motivation
Shading	Owning	Modeling
Responsibility	Simulation	Obligation
Evaluation	Reinforcer	Discover
Competition		

In the last stage, the educational aspects of the games were analyzed by two math educators. The compatibility of the game with the mathematics education program was evaluated according to features such as the teaching method used to achieve learning, individual or collaborative learning, conceptual or procedural learning.

3. Findings

The findings obtained as a result of the analysis were put into tables and interpreted by the researchers. The games evaluated within the scope of the research in Table 3 consist of information obtained through Steam. This information includes information about the games learned by watching the gameplay video of the game, the type of the games, their price and which concepts the games aim to teach. The games evaluated in this study and their contents are given below in the Table 3.

Table 3. Games Evaluated within the Scope of the Research

Digital Game Name	Fee	Platform	Concept	Type
Moves	2 ₺	PC	Numerate (Spatial)	Crossword
Goddess Of Math	2 ₺	PC, Apple	Solving Equations	Action -Crossword
The Counting Kingdom	13 ₺	PC, Apple	Four Operations	Strategy-Crossword
Odd‖Even	2 ₺	PC	Addition	Crossword
Zeus vs Monsters	11 ₺	PC, Apple	Four Operations	Action -Crossword
Rookie Math Pro	10 ₺	PC	Numbers (Data, Geometry, Measurement, Pattern),	Rpg
Math Path	2 ₺	PC	Four Operations	Crossword
Math RTS	10 ₺	PC, Apple	Four Operations	Strategy-Crossword
The Four Colour Theorem	2 ₺	PC, Apple	Permutation	Crossword
Math Combat Challenge	11 ₺	PC, Apple	Four Operations	Action -Crossword
A Percent Of A Pirate	2 ₺	PC	Percentage and Proportion	Action -Crossword
Color By Numbers - Animals	10 ₺	PC, Apple	Numbers	Crossword
Madu Maths	Free	PC	Four Operations	Crossword
Br Logic Pack	2 ₺	PC	Spatial Skill	Crossword

Table 3 shows that 7 games are only related to four operations and numbers, 2 games are related to spatial skills, 1 game to numbers, 1 game to solving equations, 1 game to permutation, 1 game to percentage and proportion, and 1 game to problems. It is seen that 7 games are puzzles as a game type, 5 games are action-puzzle as a type of puzzle, 1 game is a strategy puzzle which is also a puzzle type, and there is only 1 RPG (role-playing game) as a different type. It was observed that the prices of the games were reasonable and ranged between 2 ₺ and 13 ₺, 7 games were 2 ₺ and 1 game was free. In addition, some games are offered free trial packages. In this way, with the comments of other players playing the game, it is possible to have a wide knowledge about the game and it is seen that people can obtain sufficient information about the game without purchasing the game.

After obtaining extensive information about the games, the universal design model and seven principles were used to examine the games in more depth. The table below summarizes the extent to which the games match the universal design model and principles.

The examinations of digital games demonstrated that the games obey the fair use principle. There was no such thing as threatening security or stigmatizing users in games. The games are attractively designed in color and shape. Therefore, it will attract the attention of all students. Although two games (Rookie Math Pro and RTS math) mentioned the multi-player feature in the internet environment, currently these features of the games were not observed because they did not work. In addition, the low price range of the games and the low system settings increase their usability by families with low socio-economic status.

Table 4. Compatibility of Games with the Universal Design Model and Principles

Games	Fair Use	Flexibility	Easy and Intuitive Use	Detectable Information	Tolerance	Low Physical Effort	Size and Footprint of the Material
Goddess of Math	☑	☐	☐	☑	☑	☑	☑
Moves	☑	☑	☑	☑	☑	☑	☑
The Counting Kingdom	☑	☑	☑	☐	☑	☑	☑
Odd||Even	☑	☑	☑	☐	☐	☑	☑
Zeus vs Monsters	☑	☑	☑	☑	☑	☑	☑
Rookie Math Pro	☑	☐	☐	☐	☐	☑	☑
Math Path	☑	☑	☑	☐	☑	☑	☑
Math RTS	☑	☐	☑	☐	☑	☑	☑
The Four Colour Theorem	☑	☑	☑	☑	☑	☑	☑
A Percent of a Pirate	☑	☐	☐	☐	☑	☑	☑
Color by Numbers –	☑	☑	☑	☑	☑	☑	☑
BR Logic Pack	☑	☑	☐	☑	☑	☑	☑
Madu Maths	☑	☑	☑	☐	☑	☑	☑

The evaluatin on the basis of flexibility principle (except for four games) showed that most of the games are generally designed according to this principle. For all 10 games, only mathematical skills (especially arithmetic skills) are required to use the game. Games are flexible for users. In order to play the games, other skills are needed other than the mathematical skill to be developed. The content and interface of the other four games (Goddess of Math, Rookie Math Pro, Math RTS, A Percent of a Pirate) are related to different types of games. Respectively, these games are related to Platform, RPG, Strategy types. Each game type has similar interfaces and gameplay mechanics. Students who are not familiar with this interface and gameplay mechanics may have difficulty in playing these games.

Considering the easy and intuitive usage principle, students will not have any problems in terms of usage in most of the games (10 games). Only four games (Goddess of Math, Rookie Math Pro, A Percent of a Pirate, BR Logic Pack) have usage-related issues as a problem. In two of these games (Rookie Math Pro, A Percent of a Pirate), both a mouse and a keyboard can be used together. Using both of them can be difficult for students. The Goddess of Math game contains platform elements. As the keys used on the keyboard are different from other platform games while playing the game, players may have problems using different keys. Although the key-using combination in the BR Logic Pack game is not too difficult for students, some keys sometimes do not work may pose difficulties for the players.

When it is evaluated the perceptible information principle, most of the games (nine games) lack different language support or effective visual instructions may cause problems in student use. Only two of the games (Zeus vs Monsters and BR Logic Pack) have different language options. There is no language support for three games (Moves, Goddess of Math and Color by number), only the visual instructions and the informative section make the game's tasks understood. Six out of ten games for English speaking students present very good written and visual instructions. The guidelines are effective and easy to access. In the other four games, the instructions are not well presented and difficult to access and understand.

When the error principle is evaluated, it was observed that there are no errors in most of the games. In-game errors were detected in three games (Odd || Even, A Percent of a Pirate, Rookie Math Pro). In particular, errors in the Rookie Math Pro game negatively affected the gameplay. Errors were found in moving the character, performing side missions and leveling up. This situation weakened the playability of the game. The other two games did not pose a serious problem as there are not many in-game errors and they did not affect gameplay. Apart from this, when the

physical effort principle of games is evaluated, it is seen that 13 games did not require physical effort. In only one game (Goddess of math) it was observed that students need psycho-motor skills to take the character to certain places. There was very little space needed on the computer for all the games.

As a result of examining the games according to the universal design model and principles, both the educational and game mechanics of the games were determined. The mechanics of the games are summarized in Table 5.

Table 5. Analysis of Games in Terms of Mechanics

Game Name	Learning Mechanics	Game Mechanics
Moves	Plan, Question and answer	Levels, movement, action points, entertainment
Goddess of Math	Question and answer, mechanics outside of education	Levels, movement, action points, informative level, pavlovian effect, entertainment
The Counting Kingdom	Question-answer, instant feedback, Motivation, repetition	Levels, turn-based, informative level, pavlovian effect, cut scene, fun, Square and grid, story, Feedback, pick / click, time limit
Odd||Even	Question-answer, instant feedback	Levels, pavlovian effect, Feedback (not enough), pick / click
Zeus vs Monsters	Question-answer, instant feedback, Motivation, repetition, Reward-punishment	Levels, informative level, fun, pavlovian effect, pick / click, time limit
Rookie Math Pro	Question-answer, instant feedback, Motivation, repetition, Reward-punishment, Embodiment, exploration, reinforce, modeling, real world	Levels, informative level, fun, pavlovian effect, side quest, role play, select / click, status, cutscene, property / knowledge, story, movement, feedback, cutscene, time limitation
Math Path	Question-answer, instant feedback, repetition	Levels, informative level, fun, movement
Math RTS	Question-answer, instant feedback, repetition	Levels, fun, pick / click, Property / information, Capture / destroy, resource management, Strategy / planning
The Four Colour Theorem	Question-answer, instant feedback, Motivation, repetition	Levels, fun, pavlovian effect, select informative level, pick / click
A Percent of a Pirate	Question-answer, instant feedback, Motivation, repetition, Reward-punishment, Embodiment, exploration, reinforce, modeling, real world	Levels, informative level, fun, pavlovian effect, Capture / destroy, resource management, Fun, select click, story, time limit
Color by Numbers Animals	Question-answer, instant feedback, Motivation,	Fun, click selection
BR Logic Pack	Plan, Question and answer	Levels, entertainment, click selection, Strategy / planning
Madu Maths	Question-answer, instant feedback	Levels, fun, pavlovian effect, story (weak)

When the game mechanics of the games were examined, it was seen that 13 games used level and entertainment mechanics. Almost all of the games were divided into levels, and as the game progressed, it was requested to level up. Along with the levels, Pavlovian effect mechanics are used in 7 games. Pavlovian effect means that the game gets harder as the game level increases. In six of these games with Pavlovian effects, questions about mathematics became difficult, but the time duration was reduced in only one game (Zeus vs Monsters). Select / click play mechanics were used in 12 of the games. The story mechanics, which will be effective in terms of mathematics education and provide the formation of context, were observed in only 4 games, and in 2 games stories were enriched with intermediate scenes. 4 of the games had a time limit. In two of these games (Rookie Math Pro and A Percent of a Pirate), the time limitation was partially included in some side games. The other two games had time limits on all levels. In terms of game mechanics, 4 games (Rookie Math Pro, A Percent of a Pirate, Math RTS and The Counting Kingdom) stand out. The reason why these games were mechanically more different is that they are different from other games in terms of type.

The examination of learning mechanics showed that the games had mostly question-answer mechanics. In 10 of the games, instant feedback mechanics came to the fore. In 6 of the games, it was seen that motivation mechanics were predominant. Motivation was achieved by increasing the interest in the game with the assignment of new tasks and

scoring systems. In terms of game mechanics diversity, 2 games (Rookie Math Pro, a Percent of a Pirate) came to the fore. The math education aspect of games is examined in Table 6.

Table 6. Analysis of Games in Terms of Mathematics Education

Name of the game	Conceptual-Operational Learning	Single-Multi Player	Used Teaching Method	Teaching Program
Moves	Operational Learning	Single	Question-Answer	Not Compatible with the Curriculum
Goddess Of Math	Operational Learning	Single	Question-Answer	The game is suitable for high school achievements
The Counting Kingdom	Operational Learning	Single	Question-Answer	Primary School Level
Odd||Even	Operational Learning	Single	Question-Answer	Not Compatible with the Curriculum
Zeus vs Monsters	Operational Learning	Single	Question-Answer	Primary School Level
Rookie Math Pro	Conceptual-Operational Learning	Single (Multiplayer)	Question-Answer, Modeling, Realistic World Context	Primary School Level
Math Path	Operational Learning	Single	Question-Answer	Not Compatible with the Curriculum
Math RTS	Operational Learning	Single (Multiplayer)	Question-Answer	Primary School Level
The Four Colour Theorem	Operational Learning	Single	Question-Answer	Not Compatible with the Curriculum
A Percent Of A Pirate	Conceptual-Operational Learning	Single	Question-Answer, Modeling, Realistic World Context	Secondary school level
Color By Numbers - Animals	Operational Learning	Single	Question-Answer	Kindergarten-Primary School
Br Logic Pack	Operational Learning	Single	Question-Answer	Not Compatible with the Curriculum
Madu Maths	Operational Learning	Single	Question-Answer	Primary school

When games are examined, it is seen that there was an emphasis on procedural learning. It is seen that 2 games (Rookie Math Pro and A Percent of a Pirate) attached importance to conceptual learning. All of the games were individual games and were not suitable for playing in the classroom. However, although 2 games stated that they would provide a multiplayer environment on the internet, this feature did not work. Question and answer was the mostly used teaching method. Goddess of Math was primarily concerned with arithmetic operations in the first parts of the game according to the general standards of the USA for the 2nd and 3rd grade levels, and in the advanced levels, it is related to the equation solving questions at the high school level. Similarly, Zeus vs Monsters were associated with the arithmetic skill of the game, and the first levels included the sum of simple single-digit numbers up to grade 1 level according to American general standards. However, the game got more difficult at the advanced level and it was more suitable for 3rd and 4th grade students as it involved the sum of three-digit numbers or operations such as multiplication and division. When the Rookie Math Pro game was examined, it was seen that there were levels of difficulty. The game is said to be suitable for 7 years old at the easisest level, 8-9 years at the intermediate level, and the 10th age at the hardest level. In fact, when the game was examined, it was observed that there was not much difference between the levels. However, when the game was examined at the most difficult level, it can be said that the game was suitable for the 3rd grade according to the American general state standards. Since Math RTS, The Counting Kingdom and Madu Math games contained questions about four operations, they were arranged in accordance with the general standards of the USA for the 3rd grade level. In a percent of a pirate game, it was aimed to teach the concept of ratio, proportion and percentage. Therefore, this game was suitable for 6th and 7th grade students according to American general standards. Since Color By Numbers - Animals was intended to introduce numbers, it was more suitable for kindergarten level according to general standards in USA.

4. Discussion and Conclusions

In general, it was observed that all games are well designed and compatible with universal design models. It was determined that only Rookie Math Pro had a lot of in-game errors among the examined games. This may be due to the RPG genre that is very difficult to make and it contains too many different mechanical and mathematical concepts. RPG genre is a very comprehensive genre and a huge budget and personnel are needed to make a comprehensive game (Lowrie, & Jorgensen, 2015). A Percent of a Pirate game also contained a lot of mechanics and a genre similar to RPG was used. However, it is thought that in-game errors were reduced due to the presence of only the ratio-percentage concept in the game and the short duration of the game.

It is seen that game mechanics were more diverse than learning mechanics in games. In other words, it was observed that they attached more importance to the entertainment side than educational, in the design of the games. The reason why most question-answer mechanics are seen among learning mechanics may be the ease of construction. Because it is easy to put questions into a game. However, it is a difficult practice to embed learning mechanics that develop advanced math skills, such as exploring, modeling, embodying, and real-world context in a game, such as Rookie Math Pro, A Percent of a Pirate. For this, a lot of game mechanics is needed since enriching the game mechanics will cause students to be given different and interactive tools to explore and the students to interact with mathematical content with these tools (Brezovszky et al., 2019). However, it is not clear that increasing the variety of game mechanics (such as Math RTS and The Counting Kingdom) will improve training mechanics. What is important is that there is an interaction between the two mechanics (Arnab et al., 2015). Otherwise, as observed in Goddess of Math, the game mechanics and education mechanics are two different concepts and independent from each other (Urban, 2019). In terms of education, another important aspect of digital games is that they have mechanics such as reward-punishment and scoring. It can help students establish the relationship between game and mathematical reasoning in order to get a higher score or reward (Ke, 2019).

The most significant result of this study is that only two games seemed to attach importance to conceptual learning. An authentic learning environment was tried to be created in a real world context with mathematical concepts. As mentioned before, the two games, namely "Rookie Math Pro, A Percent of a Pirate", are different games with the most mechanical types. As can be understood, if we want to design a digital game for conceptual teaching, we should attach importance to game and learning mechanics (Arnab et al., 2015), try to ensure that they interact with each other (Urban, 2019) and try to provide an authentic learning environment that is embedded in the context of the game concept (Ke, 2019). However, if we do not have a very large budget and staff, the most logical thing to do is to focus on only one concept and not to make a very comprehensive game. Games that enable procedural learning are known to develop at most four operations, namely arithmetic skills (Castellar et al., 2014). Digital games not only improve students' affective skills but also their academic success. Many studies have shown that digital games are more effective than the traditional method (Tokac, Novak & Thompson, 2019). In particular, it positively affects learning academically in mathematics education (Bai et al., 2012; McLaren et al., 2017). Digital games have produced very good results in teaching the course contents in line with the curriculum (Hanghøj, 2015). In addition to academic success, it was observed that it also developed some skills such as creative and reflective thinking, which are very important for mathematics learning (Hwang & Wu, 2012; Kiili, 2005; Ravenscroft, 2007). On the other hand, Vanbecelaere et al. (2020) stated in their study that digital games that emphasize only the development of computational skills associated with mathematics education are not more effective than the traditional method.

As seen in the study, there are many games that improve arithmetic skills. Among these, the game that will increase the motivation of the students and the playability of the game should be selected. Student motivation is related to well-designed game mechanics. For example, the fact that the game is easy to use (Fernandez, 2008), has a well-designed story and a cutscene have an effect on motivation (Hefner et al., 2007). It has been observed that educational digital games designed and analyzed over time have positive effects on students' learning by having fun, increasing interest and participation in the lesson (Vlachopoulos & Makri, 2017) and in-class motivation (Gros, 2015). The Counting Kingdom game examined above is a very good example of this. It is easy to play the game and the story of the game is supported by intermediate scenes. As a result, it was observed that there were not enough games to support the conceptual development of students in terms of mathematics education. In addition, the absence of a second language option in most of the games found reduces the usability of these games for different countries.

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