Chapter 21
Digital Games for STEM in Early Childhood Education: Active Co-playing Parental Mediation and Educational Content Examination

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Abstract This study aimed to examine digital games with STEM content played by children aged 60–72 months from an educational point of view and determine how parents use the active co-playing strategy in playing these games. The study was carried out using a basic qualitative research design due to the nature of qualitative research. The participants in the study were volunteers and were selected according to specific criteria using purposeful sampling. The survey and questionnaire forms developed by (Gözüm and Kandır in Educ Inf Technol 26:3293–3326, 2021) were used in the study. Data on digital games were collected using the document analysis technique. Content analysis was used to determine the content of digital games. In contrast, descriptive analysis was used for the parents' data for the active co-playing strategy. Expert review was used to assess the reliability of the themes obtained from descriptive and content analysis. Themes were determined using the codes and categories derived from content analysis and expert review. According to the study results, it was concluded that the children of the parents who use the active co-playing strategy played at least one STEM game. These results also show which digital games with STEM content support the development of children's skills and explain how parents use the active co-playing strategy. Due to the nature of qualitative research, there are limitations to making generalizations in this study. Important suggestions have been made for parents, researchers, and digital game developers.

Keywords Parental mediation · Active-co playing · Digital game · STEM

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21.1 Introduction

An increase in mobile apps is being observed nowadays due to the rise in computer-based mobile devices with touch screens. While the rise of mobile applications is evident in all areas of life, many mobile apps in the field of education claim to have educational content (Zaranis et al., 2013). Children in early childhood can use touch-screen tablets and phones with ease, leading to a significant share of the mobile market being dedicated to children. Mobile apps developed for children can be set in different educational areas such as science, mathematics, early literacy, art, the environment, and STEM (Papadakis & Kalogiannakis, 2020). While some of the developed mobile applications do carry educational content, it has been determined that some of them do not and are apps that are purely for entertainment (Papadakis & Kalogiannakis, 2017). Parents and teachers who want to support children's development and learning have essential responsibilities. While the debate over mobile apps in early childhood education classrooms continues, children can use mobile apps at home. Parents have duties critical to fulfilling when their children use mobile apps at home. They use parental mediation strategies when their children use mobile apps. They can play the digital games children play and use the "active co-playing mediation" strategy by talking about these digital games with their children (Gözüm & Kandır, 2021). In this way, parents learn the contents of the digital games children play and can thus choose digital games to support their children's education. Parents prefer mobile apps with the STEM content mentioned in early childhood education to support their children. They may want their children to use these apps. This study focuses on the STEM content mobile apps chosen for their children by parents who use the "active co-playing mediation" strategy. The study aims to investigate the criteria parents use when choosing STEM content apps for their children, whether or not the mobile apps are suitable for STEM content, and how they use the active co-playing strategy when their children use mobile apps. Therefore, under the subheading "literature review," the study's importance and questions will be explained by discussing STEM in Early Childhood Education, Mobile Apps for STEM, and Parental Mediation.

21.2 Literature Review

21.2.1 STEM in Early Childhood Education

STEM is an acronym made up of the first letters of Science, Technology, Engineering, and Mathematics. Structurally speaking, the word STEM expresses a learning approach resulting from the interdisciplinary interaction of Science, Technology, Engineering, and Mathematics knowledge, skills, and understanding (Bilton & Watts, 2019; Gonzalez & Kuenzi, 2012). The most crucial point that should not be overlooked in the STEM learning approach is that merging different disciplines houses twenty-first century man's skills, such as creativity, problem-solving, and technology literacy, without focusing solely on knowledge (Charette, 2014; Yelland & Gilbert, 2018). However, debates continue over whether or not STEM content in early childhood is intended for children, and it is essential because it provides the basic skills that children need to acquire in early childhood in their future lives.

One aspect of this debate is that STEM education is subject to content. Teaching basic concepts to children is not appropriate to early childhood education (Gartell, 2016). Another aspect of the discussion is that although science and mathematics applications can be found in early childhood, engineering and technology are not suitable given the developmental characteristics of children (Sarama et al., 2018). However, it is accepted that STEM education should be implemented in early childhood to focus on children's conscious perception and awareness instead of teaching them subjects. For example, experimenting with certain stimuli so that children can experience gravity without teaching them the laws of gravity (Gibson & Pick, 2000). In this respect, STEM supports perception, thinking, and action through daily life experiences rather than teaching certain concepts or laws to children. In this context, when children act by perceiving the functions of the systems in the world and by thinking with an understanding of STEM, this can make for research that develops a basic level of scientific knowledge (Moomaw, 2013). From this perspective, STEM education is vital for children in early childhood.

It can be said that the teacher and the education program are two critical factors in providing quality STEM education in early childhood. Two priority factors expected here are for teachers to have high self-efficacy concerning STEM applications and an ability to adapt technology to fit the class environment. Therefore, there is a need for early childhood educators to receive technology training for STEM in the pre-service period (Estapa & Tank, 2017; Looi et al., 2011). Teachers apply STEM practices in early childhood education based on the education program, which is also very important (Margot & Kettler, 2019). The use of smartphones, tablets, digital audio and video recorders, and cameras provides essential opportunities for STEM education (Kallogiannakis & Papadakis, 2020). STEM stands out in the technology industry, and it allows children with active learning and learning across different disciplines to develop their academic and professional skills (Papadakis, 2018a). Accordingly, mobile apps for the STEM education of children have been developed by technology investors, and the use of mobile apps has increased significantly with children using smartphones and tablets. Teachers are responsible for implementing STEM applications in classrooms, while parents are responsible for this at home. Based on this, mobile apps developed for STEM are explained first, followed by the literature on parental mediation.

21.2.2 Mobile Applications for STEM

Mobile apps for STEM education have the potential to simplify teaching methods (Sung et al., 2016). Using mobile apps for STEM applications makes children's learning mobile and takes them out of traditional classrooms (Mundie & Hooper, 2014). According to Aladé et al. (2016), digital technologies such as tablets and smartphones with touch screens can support children's development in STEM education. Using tablets or phones to take photographs, watch videos and simulations, or play digital games can develop scientific understanding and discourse, which is the purpose of STEM for children (Sharrifnia et al., 2015). According to Sherry (2015), STEM-content educational digital games can instill an understanding of STEM in early childhood children by attracting their attention.

By playing digital games in the science, mathematics, technology, and engineering disciplines suitable for the development of children in early childhood, their experience can be increased, and problem-solving and concept development, which is the aim of STEM, can be achieved (Papadakis, 2018b; Papadakis et al., 2017a, 2017b). In this regard, the content of digital apps, the subject of this study, will be discussed by defining quality STEM content in early childhood that will support children's skill and concept development. Quality STEM content in digital apps has been examined in the literatüre. When the first concept of science is discussed in STEM content, it consists of life sciences, Earth and space sciences, and physical sciences (Bredekamp, 2015). The content of life sciences deals with living properties, cycles of life, and environmental content. It enables creatures' growth cycles in life, the characteristics of plants and animals to be observed, and their needs in life to be understood. Children consider plants and animals as living beings (Bredekamp, 2015; MacDonals, 2015; Moomaw, 2013). Earth and space sciences contain accurate observations from the child's immediate environment to far away, encompassing the movements of the Earth, the sun, and the moon and the natural phenomena caused by their positions concerning one another. In this regard, children can observe environmental phenomena and situations resulting from the Earth and the sun, such as the seasons, night and day, shadows, reflection, and refraction (Bredekamp, 2015; MacDonald, 2015; Moomaw, 2013). The physical sciences include the properties of matter and basic information about what is meant by dynamic and static (Bredekamp, 2015). The physical sciences allow one to observe the gravitational effects of objects and how magnetic objects interact (MacDonald, 2015; Moomaw, 2013). Concepts such as weight, force, heat, lift, thrust, floating, and sinking are examined (Moomaw, 2013).

On examination of the technology discipline in STEM, it is seen that it can be used as a tool to help learn the other STEM disciplines of science, mathematics, and engineering instead of simply presenting content to children in early childhood (Early STEM Matters, 2017). Using digital apps, children can learn to code directly related to STEM disciplines and develop programming skills using computers and tablets (Rushkoff, 2010). For a child to make a robot move, he needs to learn how to program that robot's instructions. When children do this coding, they can use counting processes and location-direction outcomes for the robot's movement mechanism (Bers, 2010). This is an example of technology as an intermediary in using science and technology content in STEM.

Examining the engineering discipline in STEM education, Lange et al. (2019) argue that this builds and improves children's ideas by modeling them on structures. Children can design their models or systems in early childhood by using building materials in digital apps. These design apps help children understand the content of science concepts such as gravity and balance, and they support the development of math skills such as counting, painting, and part-whole relationships (Lange et al., 2019; Texley & Ruud, 2018). In engineering applications, the building construction models that children will make in the classroom with blocks are reflected in digital apps. However, construct modeling in early childhood may be limited to materials to support the children's inventions (Clements & Sarama, 2016). In this context, digital apps increase the possibilities for children to use materials in different areas, shapes, and sizes to design construction models. This provides opportunities for children to develop visual-spatial skills such as area, shape, and size (MacDonald et al., 2015).

When the STEM education discipline of mathematics is examined, content such as comparison, classification, ordering, counting, geometry, graphics (reading, creating, interpreting), and measurement comes to the fore in early childhood (Clements & Sarama, 2016). Using mathematics for STEM education, children can perform operations such as counting and operations, measuring the length and area of small objects, comparing objects as being more or less, and calculating part-whole (dividing) (Moomaw, 2013). When children are doing operations for STEM, they can do basic addition, subtraction, and problem-solving (Bredekamp, 2015).

In the early years, children can be provided with the opportunity to develop their science, engineering, and mathematics skills by using mobile apps with quality STEM content according to the disciplines defined above for STEM (Kalogiannakis & Papadakis, 2020). However, for children to benefit from this opportunity, they need to use quality STEM mobile apps. The study conducted by Gözüm and Kandır (2021) reported that while some digital games do have educational content, some do not and even have violent content. Therefore, the digital games that easily attract children's attention must have educational content that includes STEM. It has been determined that many mobile apps that claim to be educational are not educational in content. This being so, this study asks: "Do the digital games played by children have quality STEM educational content?" The conclusion made by Gözüm and Kandır (2021) is beneficial in answering this research question. It has been stated that children play digital games possessing educational content when parents consciously use mediation strategies. The results of the study show that children of parents who use the active co-play mediation strategy benefit positively from digital games possessing educational content. The digital market is filled with countless iOS and Android apps.

In short, in the digital market, parents play a critical role in choosing educational games for children and supporting the development of these games. However, only after developing apps that attract children's attention and improve their problem-solving skills can their development and academic achievement be supported (Papadakis et al., 2017a; 2017b). It is crucial to determine what parents who fulfill their responsibilities think about digital apps with STEM content. In this context, according to the research results of Gözüm and Kandır (2021), parents who use the active co-play mediation strategy fulfill their parental responsibilities by consciously using the parental mediation strategy. Therefore, it is essential to find out what the parents who use active co-play mediation strategy think about STEM-oriented digital games. In this context, it is believed that the opinions to be obtained from the study group in which the parents who use the active co-play strategy will contribute significantly to the literature. Another of the study's questions will be addressed by explaining the mediation strategies used by parents for digital games.

21.2.3 Parental Mediation

The term *"parental mediation"* is used to describe the guidance given by parents to benefit from the positive aspects of online technology while minimizing the risks as a result of the increasing use of technology by early childhood children using touch-screen devices (Kirwil, 2009, p. 405). Parental mediation consists of parents restricting, monitoring, supervising, or guiding their children's use of technology (Warren, 2001, p. 212). The mediation strategies used by parents in different countries differ due to differences in media tools and cultural influences (Livingstone et al., 2017). In parallel with differences in the use of media tools, different parental mediation strategies have been observed for television (Valkenburg et al., 1999, p. 53), the Net (Eastin et al., 2006, p. 486), and digital games (Nikken & Jansz, 2014). The study implemented by Gözüm and Kandır (2020) reported that Turkish parents use viewing mediation, technical mediation, restrictive mediation, and "active co-playing mediation" strategies for digital games and that some parents adopt the laissez-faire mediation strategy of not using the parental approach at all. That same study reported that parents use the active co-playing strategy to allow their children to play educational games with conscious guidance. The "active co-playing mediation" strategy is the combination of active co-mediation and co-playing mediation. *"active co-playing mediation"* is when children play digital games together with their parents and discuss the game's contents with them (Livingstone et al., 2015, p. 4; Nikken & Jansz, 2014). Parents who prefer digital apps with educational content and who consciously use parental guidance use the "active co-playing mediation" strategy (Gözüm & Kandır, 2021). Vygotsky (1978) states that by transforming digital games into a scaffolding tool, parents can support their children's development areas and ensure they develop lasting learning and problem-solving skills. Parents who use the "active co-playing mediation" strategy can support their children's proximal zone by playing digital games with them and helping them with game-level levels that they cannot solve or pass. Vygotsky (1978) stated that the language used by parents with children when building this scaffolding is critical. In the "active co-playing mediation" strategy, the parent can talk about the digital game played by the children, both mastering the game's content and transforming it into a scaffolded structure that will support the child's development. The study's second question is: "*How do parents apply the "active co-playing mediation strategy when playing STEM-content digital games together with their children"?*

It is thought that this study will contribute to the literature by showing to what extent the educational content of digital games with STEM content is educational and how parents who use the "active co-playing mediation" strategy apply this strategy.

21.3 Method

The study was conducted using the primary qualitative research method appropriate to qualitative research (Merriam, 2009). This study focused on two situations. The first situation is parents using the "active co-playing mediation" strategy on their children who play digital games. The second situation is parents stating that children's digital games have STEM content. In this respect, this study is a qualitative study made to investigate "how parents use" the "active co-playing mediation" strategy and examine the "STEM education content" of the digital games that children play. To this end, criteria were determined for the study's working group participants. Interview and document analysis, which are qualitative research techniques, were used to collect the data for the study. Various data collection techniques such as observing, interview and document analysis can be used together in qualitative research method (Yıldırım & Şimşek, 2011). An interview form for parental guidance consisting of open-ended questions developed by Gözüm and Kandır (2021) was used. Digital games with STEM content played by children are examined as documents in the research. Digital games were downloaded online by the researcher, and document analysis was performed. The data collected in the study were transcribed, and descriptive and content analysis techniques were used. The findings obtained as a result of content and descriptive analysis in the research were combined and interpreted. The research design is explained in Fig. 21.1.

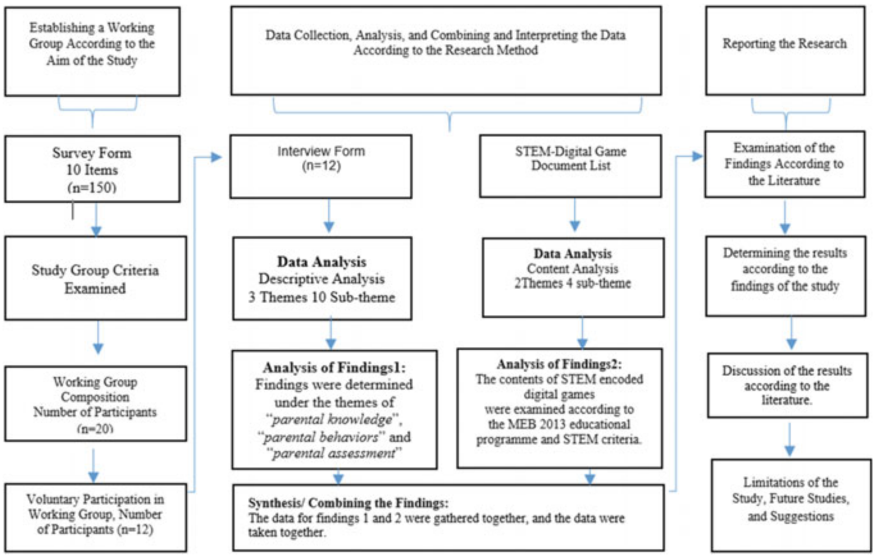

Fig. 21.1 Research design

21.3.1 Working Group

The study's working group consists of 12 children aged 60–72 months at an officially independent kindergarten in Turkey's Southeast Anatolia Region and parents. The study's working group was formed using criterion sampling, a type of purposeful sampling. The criterion sought was that children play STEM-content digital games and that their parents play these games with them. When forming the study's working group, the *"Parental guidance when children play digital games questionnaire"* was administered to 200 parents via e-mail. This questionnaire was developed by Gözüm and Kandır (2021) and consisted of 11 questions. Given the aim and scope of the study, the question about aggression was removed, resulting in the parents being asked ten questions. Parents can answer yes/partially/no to the questions in the questionnaire. Parents using the "active co-playing mediation" strategy were identified by looking at the yes answer given to all the questions in this questionnaire. The *"personal information form"* administered to the parents via e-mail asked about the content of STEM encoded digital games that children play. The names of the digital games with STEM encoded that children play were detected by the answers to the questions in this form.

> No limitations or conditions were imposed on the digital games mentioned by the parents who took part in the study in terms of price (paid or free), operating system (iOS or Android), the device on which they were installed, or the game's language.

A total of 20 parents were found that matched the research criteria according to the results of both the *"Parental guidance when children play digital games questionnaire"* and the administered *"personal information form."* This number fell to 12 due to the consent form that the parents had to complete to participate in the study voluntarily.

Table 21.1 gives the demographic information of the parents and children who participate in the study.

Table 21.1 shows that five of the parents participating in the study are female, and seven are male. The parents' ages in the working group ranged from 26 to 46 years. The parents have various professions such as worker, civil servant, teacher, engineer, doctor, or academic. Their education levels range from high school through undergraduate and master's degrees to Ph.D. Six of the children are girls, and seven are boys. The children play digital games on smartphones, tablets, and laptops.

21.3.2 Data Collection Tool

We used two data collection tools in the study. The first data collection tool was a personal information form containing the children's personal information. The second data collection tool is the unstructured interview form that consists of open-ended questions seeking the parents' opinions on parental guidance ("*Parental guidance when children play digital games questionnaire").*

Table 21.1 Demographic characteristics of participants

ID	Parent's				Children's		
	Gender	Age	Profession	Education level	Gender	Age	Digital tool
P1	Female	34	Civil Servant	Bachelor's Degree	Girl	6	Smartphone
P2	Male	46	Doctor	Ph.D.	Boy	5	Tablet
P3	Female	29	Teacher	Bachelor's Degree	Boy	6	Tablet
P4	Male	26	Engineer	Bachelor's Degree	Girl	6	Tablet
P5	Female	37	Academic	Master's	Boy	6	Tablet
P6	Female	26	Teacher	Bachelor's Degree	Girl	5	Smartphone
P7	Male	27	Worker	Bachelor's Degree	Boy	5	Smartphone
P8	Male	33	Civil Servant	Bachelor's Degree	Boy	6	Tablet
P9	Male	32	Academic	Ph.D.	Girl	6	Laptop
P10	Male	31	Engineer	Bachelor's Degree	Girl	6	Tablet
P11	Male	30	Teacher	Master's	Boy	5	Tablet
P12	Female	35	Doctor	Ph.D.	Girl	5	Laptop

"Personal Information Form": The researcher prepared this form to collect the personal information about the children and parents voluntarily participating in the study and the names of the digital games that children play. The aim of the study, consent to participate in it, and what STEM means were all explained in the personal information form. The parents completed the information form via Google Form. The personal information form includes two parts. The first part contains questions about the parent's personal information ("*parent's gender,*" *"age," "education level," "occupation," "whether or not they play digital games with their child"*). The second part contains questions about the child's personal information (*"the child's gender," "age," "digital device for playing digital games, "names of digital games that were played"*).

"Parental guidance when children play digital games questionnaire": Gözüm and Kandır (2021) developed the questionnaire and used it to add detail to the survey form. Using it in the study is to obtain detailed information about the active co-playing strategy. The questions in the questionnaire are included in the findings with the S1 code. The question about aggression, which was removed from the survey form, was also not used in the questionnaire.

21.3.3 Data Collection

We collected the study's data in three stages. The first stage of the study's data collection process is administering the personal information form and "*Parental guidance when children play digital games questionnaire.*" The second stage is administering the *"Parental guidance when children play digital games questionnaire." The third* *stage includes document analysis to collect the digital games with STEM content played by children.*

First stage: The personal information form and the *"Parental guidance when children play digital games questionnaire"* were completed on Google Form to create the study's working group. A Google form was e-mailed to the parents. The researcher e-mail 150 parents, of which 20 matched the criteria for inclusion in the working group. However, 8 of these parents were excluded from the study's working group because they stated they would not continue.

Second stage: *The "Parental guidance when children play digital games questionnaire"* was administered to collect the parents' opinions. While administering this questionnaire, the day and time of the synchronized online meeting with the parents were determined. Parents would be available to participate in the study was determined via e-mail. The day and time of the online one-on-one session were determined for each participant. The researcher informed participants that the online sessions would be recorded. The participants were told that the recorded videos would not be used for research purposes and would not be shown to third parties. The participants answered the parents' questions in the interview form in detail during the interview. The participants answered the questions, which were asked by the researcher precisely as written in the questionnaire, and no direction was given.

Third stage: *The researcher created a document list of the digital games that the children play. Each of them on this document list was downloaded from technology stores and played by the researcher in turn, and transcripts were made.*

21.3.4 Data Analysis

Descriptive analysis was performed on the records of the data obtained from the parents who had synchronized online one-on-one interviews. A thematic framework was created for the analysis, and the data were analyzed according to this thematic framework. The findings obtained from the analyzed data are defined, then the interpretation of the findings begins (Yıldırım & Şimşek, 2011). In this study, the thematic framework created by Gözüm and Kandır (2021) was used to code the parents' views, after which the findings for the "active co-playing mediation" strategy were defined and interpreted. When conducting the descriptive analysis of the active-co play strategy, parental views were included by adding verbatim quotes to the "*parental knowledge*," *"parental behaviors*," and "*parental assessment*" thematic framework. The parents' comments were codified and interpreted. For example, the fourth participant replied to the question "What is the purpose of the digital games your child plays?" in Table 21.2, saying, "For STEM education, for example, learning to code—P4." Two codes were derived from the parents' answers, namely, "STEM" and "coding" for the children's purpose in playing the game. The obtained codes were interpreted in light of the literature.

Content analysis was applied to the digital games with STEM content collected by document analysis, and codes and themes were created. Content analysis is the

Table 21.2 Content analysis of games and *"parental knowledge"* on purposes of STEM encoded digital games

S.1.1. "What is the purpose of the digital games your child plays?" "Developing skills for STEM—P1"; "To establish a foundation for STEM education. -P3"; "For STEM education, for example, learning to code—P4"; "… it uses the laws of physics but plays like a game within the game—P6"; "To create a foundation for coding in the future by coding the directions in the game—P9"; "… learning the foundations of the mathematical knowledge necessary for engineering and design—P21."
S.1.2. "How did you find out the purpose of the digital games your child is playing?" "I researched the game myself and found that STEM-oriented games would be beneficial for my child—P2"; "It was a game I played; young children normally play it, but being about engineering, it caught my attention—P5"; "When my son had trouble passing a level, he would ask me questions—P7"; "…we talk about the game because it attracts my attention and my child's—P11."
The content of the digital game encoded with STEM content When we made the content analysis of digital games, we coded the games' purposes as "STEM, coding, mathematical operations (counting, matching, comparison, ordering, classification), science (balance, matching, comparison, ordering, causality), engineering (design, part-whole relationship, matching, problem."

careful, detailed, and systematic examination and interpretation of content to determine themes, biases, and significances concerning the aim of the study. The purpose of the content analysis in this study is to reveal the concepts and relationships that can explain the STEM content of the data obtained through document analysis (Guba & Lincoln, 1994; Maxwell, 1992). When coding the content of digital games with STEM content in the study, Aronin and Floyd's (2013) principles to be considered when parents choose a mobile app with STEM content for preschool children were taken into account. Furthermore, we took the educational outcomes of the "*Turkish Ministry of National Education's [MEB] Preschool Education Program* (2013)" as the criteria for the educational support of digital games with STEM content. In the MEB 2013 preschool education program, attempts are made to make the children achieve the educational outcomes and indicators in different development areas through various activities (MEB, 2013). According to Erol and İvrendi (2021), the MEB 2013 preschool education program can be used to plan, implement, and assess STEM-related activities for children. In the study conducted by Gözüm and Kandır (2021), the MEB 2013 outcomes and indicators were used to examine the educational aspects of the digital apps applied to children. As a result, the codes to be made based on the educational outcomes and indicators of the MEB 2013 Preschool Education Program provide data to show how educational digital games with STEM content are. In addition, the STEM sub-themes related to the digital game theme were correlated and examined under the literature review subheading, Mobile Application for STEM. Accordingly, content analysis was conducted on 28 digital games that the parents indicated. The data, the descriptive and content analyses, were combined and interpreted for the aim of the study. Figure 21.2 shows the themes and sub-themes determined due to the qualitative data analysis.

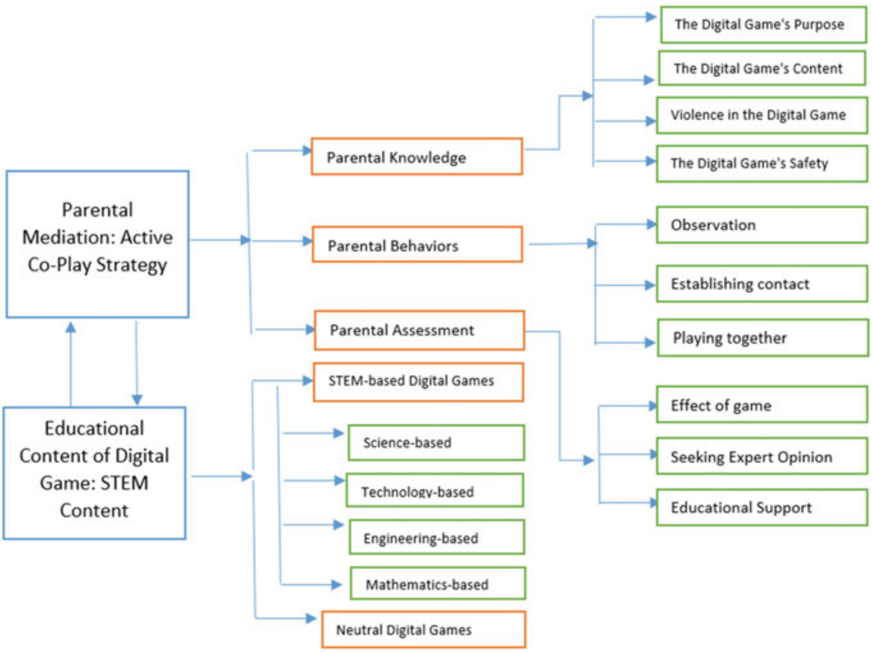

Fig. 21.2 Themes and sub-themes formed as a result of data analysis (Orange frames are the theme and green frames are the sub-theme.)

In Fig. 21.2, it is shown that the active co-play mediation strategy includes three themes in line with the views of the parents. The thematic framework discovered by Gözüm and Kandır (2021) consists of "parental knowledge," "parental behavior," and "parental assessment," respectively. Four sub-themes were described under parental knowledge, four under parental behaviors, and three under parental assessment. Relevant codes were assigned according to 11 sub-themes, and exact quotations were included in the findings section. Figure 21.2 shows that two themes were found for digital games due to the content analysis of STEM encoded digital games. The first of these themes is STEM-based digital games; the second is *"neutral digital games."* There are four sub-themes for STEM-based digital games. Gözüm and Kandır (2021) define neutral games as games that do not have educational content and do not contain violence. Accordingly, games that do not have STEM content and do not contain violence are grouped under the neutral theme.

21.3.5 *Qualitative Data Analysis Reliability*

The themes that emerged as a result of descriptive and content analysis were assessed using the expert review method, which is a method used in qualitative research to ensure validity and reliability (Yıldırım & Şimşek, 2011, p. 268). The themes that emerged from this analysis were examined by four faculty members working in preschool education, four faculty members researching digital games, and two faculty members studying STEM. After the examination, content analysis reliability was calculated using Miles and Huberman's (2016, p. 64) agreement percentage. The formula shows that *"Reliability = Agreement opinion/(Agreement opinion + Disagreement opinion) × 100,"* all themes which is the opinion of parents were found to be 100% in agreement. When the agreement percentage of the sub-themes for the content of STEM-based digital games is examined, it is found to be 100%, while for *"neutral games,"* it is found to be 95%.

21.3.6 Findings

This study sought parents' opinions on what they knew about the STEM-content digital games played by their children, their behaviors, and their assessments. Their opinions provided the findings to the research questions "*How do parents apply the "active co-playing mediation" strategy when playing STEM-content digital games together with their children?"* Results are also given for the research question: *"Do the digital games contain STEM education?"*.

Theme 1. *"What parents know"* about the STEM-content digital games children play.

We gave the findings for the theme *"What parents know"* about the STEM-content digital games played by children under "sub-themes." The sub-theme "*The STEM Purpose of the Digital Game Played by Children*" is seen in Table 21.2, the sub-theme "*The Content of the Digital Game*" is seen in Table 21.3 the sub-theme "*Violent Content in the Digital Game*" is seen in Table 21.4. The sub-theme "*Safety of the Digital Game*" is seen in Table 21.5.'

21.3.7 The Digital Game's Purpose

According to Table 21.2, the parents participating in the study explained the purposes of their children's games using the concepts *"STEM," "physics," "engineering," "coding," and "mathematics."* It was determined that when parents were finding out the purpose of the digital game that their children play, *"they did their research for STEM education," "their children played the games they do," and "they talked about the game."* According to the content analysis of the purposes of the digital games the children played, it was stated that they play STEM-content or STEM-related games.

Table 21.3 Parental knowledge on the content of STEM encoded digital games

S.2.1. "What is the content of the digital game your child is playing?" "The robot is actually going to the planet; however, to get the battery it needs right now, coding needs to be done…—P1"; "it is played with vans, but the vans' parts are put together, then a house is made using the stone and wood needed for the design (engineering)—P2"; "The child learns coding by listing instructions such as the number of steps left or right when he wants to make a character move—P4"; "… as a design, he creates a model by bringing children side by side, then that model is adapted to the design, the model made is tested for design suitability, these are physics-related…—P8"; "…a game that is up to the creativity of the child; they can design whatever they want but what they want to design depends on their imagination; essentially, it's not like it's science-related but it does have STEM content—P10"; "… he can make a bridge by combining the balls; he needs to calculate how many he needs to combine; then, when he reaches the objective, he goes through a pipe, but the important thing here is to calculate because if not, he might not be able to remove the obstacle…—P12."
S.2.2. "How did you find out the content of the digital game your child is playing?" "playing together—P2"; "I know because my child played with me—P6"; "He plays the games I choose, I have already played the game—P7"; "I have researched the content of the game before, but when we are playing together, I ask if it is interesting—P8"; "Some games are not in Turkish, they can be in English; I demonstrate the game first so that the child can understand the game…—P6"; "There are not many games with Turkish content, so I show it to my child; some games do not need much language, he finds it hard until he understands—P12"
The content of the Digital game encoded with STEM content When we analyze digital games' content, parents' opinions reflect game content. Games may be categorized as STEM, science, coding (technology), engineering, and mathematics. In this categorization, "mathematics" content was associated with almost every category

Table 21.4 Parental knowledge on violence in STEM encoded digital games

S.3.1. "How do you know if the digital game your child is playing contains violence or not?" "I know that there are violent games, but I research games, and I care about educational content—P1"; "I bought games with STEM content to support their education using technology, particularly those without violence—P5"; "It could not be violent; we play games together, I do not think there is any game I do not know about…—P4", "…I read the comments for playing STEM content games; the other parents were also satisfied; I think the child enjoys violent games more, but if you can find a good game…—P10."
S.3.2. "What would you do if you found out that the digital game your child is playing contains violence?" "If he is playing violent games, it means I have not checked the game. If he is going to play, I make him play a good game instead of the one he is playing—P7"; "He can play violent games, it attracts children's attention, but there are more interesting games to play. The main problem is finding those games… to do this, you have to talk, to get to know the child's interests…—P5"; "Firstly, I forbid him to play violent games, then I find a game that benefits my child instead of that game…—P4."
The content of the Digital game encoded with STEM content When we made the content analysis of digital games, no "games containing violence" were found

Table 21.5 Parental knowledge about the safety of STEM encoded digital games environment

S.4.1. "How do you know if the digital games your child is playing are safe?" "When we choose games for STEM with educational content, I read the reviews of the games, I want them to play the games that I believe to be safe…—P1"; "I check the PEGI classification, but the best thing to do is play games together to check whether the game is safe—P4"; "There are stars that show games' popularity ratings, so they are safe; if they have educational content, these stars are important for the quality of the game, I think that a game that is educational is safe…—P6"; "You can understand whether the games are safe or educational or not by playing the content—P10."
S.4.2. "What would you do if you realized it was not safe?" "If the game is not safe, if it is harmful to the child, I prevent him from playing the game…—P8"; "After analyzing the events in the game well, I restrict him from playing that game—P8"; "I intervene immediately and prevent him from playing that game—P9."
The content of the Digital game encoded with STEM content When we made the content analysis of digital games, we stated that the games contained different STEM and STEM-related contents; however, they were considered safe because they did not "advertise games of chance" or "redirecting to a different game" or have "sexual" content

21.3.8 The Digital Game's Content

According to Table 21.3, the parents participating in the study explained the purposes of their children's games using the concepts *"STEM," "physics," "engineering," "coding," and "mathematics."* It can be said that parents find out about the content of the digital games their children play by *"playing them together with their children and by communicating"* without leaving anything to chance, just as with the purpose of the game. It was also stated that the digital games did not have Turkish language settings. So the parents explained the game to their children by translating for them. It matches the contents and purposes of the digital games that children play. In games with STEM content, mathematics content was found to be associated with all fields—*"science," "engineering," and "coding"* (technology). However, only two games integrated these fields with STEM philosophy.

21.3.9 Violence in the Digital Game

According to Table 21.4, it was determined that the parents who participated in the study researched the digital games that their children play before playing them to see whether or not they contained violence and preferred games with educational content. In addition, one of the reasons why parents deliberately choose games with STEM content is. Hence, their children use technology and avoid violent content while playing educational games. In this context, it was stated by the parents that their children do not play violent games. Indeed, when the contents of the digital games that children play were examined, it was stated that there were not any violent games, just STEM or STEM-related games. However, the parents said that if their children play violent digital games, they can direct them to a beneficial game in line with their children's interests and development. Parents stated that they would first restrict their children's access to these games for violent games and then find beneficial games.

21.3.10 Safe Digital Gaming

According to Table 21.5, the parents participating in the study stated that they reviewed the comments about the game before playing the game to determine whether the digital games that their children played were safe and preferred educational games. It was stated that they monitored educational and secure games for their children using the star rating given to games, and they also checked them out by playing them. However, it was stated that parents would intervene and prevent their children from playing games that could be harmful or unsafe.

Theme 2. Playing Digital Games with STEM Content: *"Parental Behaviors"*

We give the findings for *"Parental behaviors"* when playing the digital games with STEM content played by their children under sub-themes. The sub-theme "*Observing Children*" is given in Table 21.6, the sub-theme "*Detection of Communication*" is shown in Table 21.7, the sub-theme "*Playing Together*" is given in Table 21.8.

Table 21.6 The behavior of parents who observe their children and content by STEM encoded digital games

S.5.1. "What is your reason for observing your child while playing digital games?" "When my child is playing, there is a time we set for him to play, even if he plays with me, I do not want him to go beyond that period, so I observe…—P11"; "There are times in the game where he asks me, and I observe because I want to give him an answer right then—P12"; "When the child interacts with the game, he may not realize how long he has been playing, then I warn him, but since we usually play together, I observe him for our goal of reaching a certain level per day—P6"; "I particularly want to observe to see what my child will ask when they play STEM or different educational games because I want to know are the questions educational or not, or is the game suitable for the child's level or not? All these come from observing, if the child quits a digital game, it is because they are bored, but they never get bored in STEM games—P10."
S.5.2. "What is the content of the digital game your child is playing?" "Sometimes the games whose reviews I read might not turn out to be educational, but STEM games are well designed, I think they work well together with the content…—P11"; "The content and educational content should enable them to learn technology, this is my goal, so the child should learn to code, I see this—P4"; "In fact, the child can design a house, but he should select stone and wood suitable for engineering, if the child selects these and designs the house, he will achieve his goal in the game—P2."
The content of the Digital game encoded with STEM content When we make the content analysis of digital games, it is understood that there are games with STEM content concerning the content of the games that parents observed

Table 21.7 Parental behavior and content analysis of the game for communication through the digital game

S.6.1. "Have you checked whether your child is communicating with others in the digital game he is playing?" "When I read the reviews for the game, I learned that the game was a single-player game. In STEM games, the child usually tries to solve a problem, there is no communication…—P2"; "When I say communication, I mean there is no commercial or occasional video in paid games, but there were videos or advertisements in a game he played, and that was for food; I do not think it was harmful—P3"; "There is no remote access or group chat games, so communication is not established. Even if it were to be established, I would see it when playing with my child—P1."
S.6.2. "What do you do when you realize that your child is being contacted in a digital game?" "I check what he is being contacted for, but I do not find it appropriate to communicate with the child from the outside for the game, I would likely not want him to play that game—P9"; "When contact is made through a game, if it is to direct the game or from a remote center, it can be dangerous, so I forbid him to play that game—P10"; "Communicating also means guiding, and in this case, I do not want my child to be guided as a tool for the game—P11."
The content of the Digital game encoded with STEM content The codes related to digital games are grouped into three sections. These sections are "non-verbal communication," "one-way communication," and "two-way communication." No game was found in the "two-way communication" category in the content analysis. However, advertisements were displayed on screen in the "one-way communication" category, and photographs for advertising purposes were displayed on screen in the "non-verbal communication" category

Table 21.8 The behavior of parents who play STEM encoded digital games with their children

S.7.1. "What is your reason for playing the digital game with your child?" "I want my child to benefit positively from technology, and I particularly want him to play educational games. These games include STEM games, but when children get stuck in STEM games, you have to help them. Otherwise, the game will not progress, and the child will lose interest—P4"; "I want my child to play digital games for his education…, as, for the content, STEM is critical, many areas are involved at the same time, and the child can learn without realizing it. … I like these games too…—P5."
S.7.2. "What is the content of the digital game you play with your child?" "Ostensibly, it only makes one robot progress, but that robot's progress depends on your coding, so the child learns basic coding for STEM—P4"; "Children can make a bridge with simple rods in science for inventions or a hanger to carry a load, but will the bridge or the hanger carry that load? While testing it, the game you are also playing attempts the scenario you make. If it is correct, the bridge will stand, but if it is wrong, it will collapse…—P7"; "The child needs to create a structure while placing the puzzle pieces; there is an element of balance in this structure, but for me, calculating the remaining distance in the structure is true engineering…—P9"; "When the child transfers the heterogeneous colors mixed in the glass bottles to the empty bottles and obtains homogeneous mixtures, he realizes which bottle to empty in which order; the important thing is to make the child think in this way—P12."
The content of the Digital game encoded with STEM content When we analyze digital games' content, parents' opinions reflect game content. The games ensure progress while creating a structure, doing a puzzle, or solving a problem as part of their content, STEM—science, coding (technology), engineering, or mathematics

21.3.11 Observing Children

According to Table 21.6, it was stated that the reasons why the parents participating in the study observed the digital games their children played were the time they played and helped their children achieve the goal of the game. Parents emphasized that the games played with STEM content were well designed, achieving the STEM goal. Content analyses of digital games coincide with parent observations, and it can be said that the games they told their children play have STEM educational value.

21.3.12 Detection of Communication

According to Table 21.7, when the parents' views in the study regarding communication in digital games that their children play are examined, they stated that there is no communication in the paid STEM games. Still, contact is made in the free STEM games for advertising purposes. Parents do not want the game in question to be played, thinking that communication with their children will be directed through the game. When the content of digital games was examined, parental views and content analysis of the game were similar. While there was no communication in paid games, *"non-verbal communication" and "one-way communication"* were detected in free games.

21.3.13 Playing Games Together

According to Table 21.8, the parents participating in the study play the digital games played by their children together. The reason for which parents play digital games with their children can be explained as supporting children's progress in STEM content games and parents keeping their children interested. Parents know that they are playing STEM games with their children, and they see the game's content right down to the last detail. Indeed, digital game content analysis and parent views support each other.

Theme 3. Digital Games' Effects with STEM Content: *"Parental Assessment"*

We give the findings for the effects of digital games with STEM content played by children under the sub-themes of the *"Parental Assessment"* theme. We offer sub-theme "*Effects of Digital Games*" in Table 21.9, "*Seeking Expert Opinion*" in Table 21.10, and a sub-theme of the educational support provided by digital games in Table 21.11.

Table 21.9 Parents' assessment of the effects of STEM encoded digital games children play

S.8.1. "What are the effects of the digital games your child plays?" "When the child does coding, this shows what task he will do in which order and what outcome it will produce… the most important effect is its reflection on daily life because what a child essentially needs to do in life is a plan and organize, I see the effects of coding on this—P4"; "It may seem like it has no effect at first glance, but it is very effective, it affects counting; when the glass is too close to the edge of the table, to predict that the glass might fall if the table is shaken is an important effect—P5"; "It affects the child because when I am arranging my bookshelf at home, I can see it affects his thinking when he says that book will not fit on the shelf because the shelf is too small and he describes laying the books flat like in the game—P12."
S.8.2. "What do you do to eliminate the effects that you consider negative?" "The child is not aware of what he is playing, sometimes I am not aware of what might develop by playing, but I want him to play good games to remove the negative effects; the problem is that most of the games are not in Turkish…—P6"; "Here, if you leave the child alone, they will be negatively affected, but I researched STEM games well, I think they are very beneficial, so the child needs to play games randomly for there to be any negativity…—P9"; "To avoid being negatively affected, children should be assisted until they gain experience, just as with everything else, the child cannot stop himself from playing and if he is not aware of the negative effects, I should intervene, the same as anything else…—P10."
The content of the Digital game encoded with STEM content The digital games mentioned by parents have been divided into two categories based on their effect on children. Categories specified by parents: "positive affect" and "neutral."

Table 21.10 Parental assessment of seeking expert opinion on STEM encoded digital games their children play

S.9.1. "What is your reason for seeking an expert opinion about the digital games your child plays?" "We are in a world where there are so many digital games and apps, games may be paid, they may be educational, but I search on sites where expert opinions are posted because games are complex things…—P1"; "I find out about games that support children's education by asking experts, but there are difficulties about this issue, experts recommend very few games; a computer programmer who is an expert in STEM games gave me recommendations…—P5"; "My brother teaches computing, he played that digital game to his children before me. His comments are critical to me because he also played the games and the games he suggested were useful for education, so you have to listen to people who know…—P12."
The content of the Digital game encoded with STEM content The opinion of parents who sought expert opinion is examined. They recommended games with STEM content or science, coding (technology), engineering, mathematics, language, or art

21.3.14 Effects of Digital Games

According to Table 21.9, according to the parents participating in the study, it is argued that digital games with STEM content positively support cognitive developments such as planning and organizing, estimating, establishing relationships, cause-effect, and reasoning. Since their children have low awareness, parents blame themselves for the adverse effects of digital games on children. It is emphasized that their games should not be left to chance for children not to be negatively affected.

Table 21.11 Parents' assessment of the educational support of STEM encoded digital games played by children

S. 10.1 "What is the content of the digital game that you think contributed to their education?" "Children's coding skills can be improved with digital games…—P4"; "For science and engineering, children need to use many skills, mathematics is the foundation and STEM can develop all of them…—P6"; "Skills that are important for children to develop in STEM… when solving a problem or placing a Lego brick, the important thing is to solve the problem faced, and to do this they have to count, match, and think …—P7."
S. 10.2 "What do you do to make your child play digital games that you think to support their education?" "Digital games already attract the child's attention and interest immediately, but you have to make him understand the game by playing with him; sometimes he may not want to play games with educational content, then you have to play together and show the game's processes…—P8"; "The child can play games by asking questions about the points they are curious about, but if he enjoys the game, he already plays on his own. You have to help him in the game's stages that he cannot pass. Children should be playing educational games without realizing that they are playing educational games. Still, if these games are didactic, they will get bored, he builds bridges in STEM games, but he learns so much…—P6"; "When I want to play an educational game for children, I first talk about its interesting aspects, for example, how we can make the robot walk; if we make the robot walk, we will eventually go to its planet; we can see this in practice when the child is playing the robot; in fact, he can learn the basics of coding…—P4."
The content of the Digital game encoded with STEM content The digital games preferred by the parents were examined according to their educational gains, and it was broken down into five sub-themes. These themes are: "STEM," "science-based digital games," "technology-coding-based digital games," "engineering-based digital games," and "mathematics-based digital games."

When the content analysis of STEM coded digital games is examined, it has been determined that although there are 24 games in the positive impact category, four games contain fixed and didactic instructions designed to pass the time rather than create a positive or negative impact. Based on this, it can be said that parents choose positive STEM games for their children.

21.3.15 Seeking Expert Opinion

According to Table 21.10, the parents who participated in the study sought expert opinions about the games their children play because they could not predict the effects of the complex content of the digital games and support their children's learning. On examination of the contents of the games for which expert opinion was sought, it is understood that they are related to STEM and its sub-fields. It was determined that expert opinion was sought for the content of 24 out of the 28 digital games examined and not aimed for the remaining four games.

21.3.16 Digital Games' Support for Education

According to Table 21.11, the parents stated that their children's mathematics skills improved in developing their coding skills and science and engineering skills. Their mental skills, such as problem-solving, also improved. Parents stressed that for children to play educational digital games, they have to ask questions that pique their interest, explain that part of the game that will attract their attention, and assist them in the levels where they are struggling. The digital games the parents said their children were played as "STEM," "science-based digital games," "technology-based digital games," "engineering-based digital games," and "mathematics-based digital games." In this regard, parents let their children play STEM-coded digital games that contribute to their learning. As a result of content analysis based on STEM content and educational gains, the digital games were listed under the "educational content of digital games."

21.4 Digital Games' Educational Content

According to the parent reports, digital games were coded by the researcher according to STEM content by playing the games and paired with the educational gains. The STEM-related sub-themes of digital games consist of STEM components. According to the reports given by the parents, the total number of STEM-coded digital games played by children is 28. While 24 of the digital games were STEM content, four games were determined neutral.

21.4.1 The First Theme is STEM-Based Digital Games

According to Aronin and Floyd (2013), the principles to be considered when choosing a tablet or computer app to provide STEM experience for preschool children are: The source of action should be the child, the child should be able to initiate the action. Children should be able to establish the cause-and-effect relationship within the digital game. Changes in the outcomes of situations in which children intervene should be observable. Children's effects in the game should be visible quickly to achieve the result and reinforce the cause-effect relationship. Parents' views in their selection of digital games were examined following the principles proposed by Aronin and Floyd (2013).

According to parents' opinions coded P2, P5, P7, and P11 (see Table 21.2), Table 21.2), the principal action is asking questions when the children play digital games. Furthermore, children can initiate the action by playing the parents' digital game (see Table 21.2, P2). However, parents P4, P6, and P8 emphasized the need to '*explain the game*,' '*ask questions*, or '*show gameplay'* that would arouse curiosity should the children be unwilling to play educational games with STEM content (see Table 21.11). According to the views of parents P6, P10, and P12, children continue in the game without getting bored, go through the game stages at different levels, and ask questions about the game content (see Table 21.6). In the light of parental opinions, it can be thought that children know the change in a situation when parents interfere during their progress in digital games, realize the consequences, and form a cause-and-effect relationship. In the light of the findings obtained, the principles to be considered known the selection of digital games according to Aronin and Floyd (2013) were found to be realized to the parents' views.

The digital games with STEM content played by children were examined according to the 2013 MEB preschool education program educational outcomes and indicators and the definitions of quality STEM application under the Mobile Applications for STEM subheading. Digital games with STEM content can combine STEM content and an area that includes science, technology, engineering, and math skills. It was determined that the science, technology, engineering, and mathematics skills of STEM are used together in building and construction games.

A bridge, a tower, sometimes a robot can be designed. Alternatively, it may be coding to solve a problem. In the games examined in this context, children make their designs to make a safe bridge. After the bridge is built, its durability is tested. When the skills acquired by the children are examined, it is clear that the games support their *"classification," "ordering," "guessing," "part-whole," "matching," "counting," "comparing,"* "*establishing cause and effect relationship,"* and "*problem-solving"* skills. When these skills are examined, content is seen that can support the skills of "*counting," "classification,"* and *"ordering"* for the number of parts needed to make a safe bridge, and the *"part-whole" and "matching"* skills for the suitability of the elements. Children can test the durability of the bridge after building it. During this test process, children can guess whether what they are doing is durable or not. If it is durable, it is understood that the children are solving problems. The educational outcomes in the game aimed at building bridges played by children match the content of 2013 MEB preschool education program educational outcomes and indicators ("*classification*," "*ordering*," "*guessing*," "*part-whole*," "*matching*," "*counting*," "*comparing*," "*establishing a cause-and-effect relationship*," and "problem-solving") (MEB, 2013). When the literature on digital games with STEM content is examined, according to Lange et al. (2019), children in early childhood can make designs using various materials. Children's self-made designs support their skills such as counting, matching, and part-whole relationships (Lange et al., 2019; Texley & Ruud, 2018). Apart from this example, since they mainly use the STEM sub-themes of science, technology, engineering, or mathematics, or a combination of these disciplines, it was found that the games are STEM-supported games. Below, the sub-themes of STEM-supported digital games are explained one by one under sub-theme headings since they stand out in specific areas. The reason for explaining sub-themes is to better explain the educational aspect of game content. However, it should be noted that the sub-themes are closely related to each other due to the nature of each STEM.

21.4.2 Sub-theme 1: Science-Based Digital Games

In the examination of the sub-themes, the content of the games will be explained first. The STEM content will be defined by establishing a relationship with the MEB 2013 Preschool Education Program. In this context, according to the parents' reports, when the STEM-coded digital games played by the children are examined, there is a game based on connecting gear wheels. Chains and pulleys are used to move the wheels in the game. This game was studied under science-based digital games. The game's content matches the "*classification*," "*ordering*," "*guessing*," "*part-whole*," "*matching*," "*counting*," "*comparing*," "*establishing a cause-effect relationship*," and "*problem-solving"* educational outcomes of MEB 2013. In another digital game, children play with a fish that left the aquarium back to the aquarium. Children who want to take this fish back to the aquarium can use pipes, wheels, spray, and blocks. The game's content matches such MEB 2013 educational outcomes as "*trial and error*," "*grouping*," "*comparing*," "*sequencing*," "*space-position-related planning*," and "*measuring objects.* "Children use square boxes to help a robot overcome the obstacles it runs into when getting it out of an enclosed area. The game's content matches such MEB 2013 educational outcomes as "*space-position-related planning*," "*measuring objects*," "*forming patterns*," "*comparing*," and "*ordering*."

It is observed that physics comes to the fore in the science-based digital games played by children. According to content analysis, STEM-based digital games come with science and engineering content together by combining science topics such as *"Gravity," "balance," "force," and "momentum"* with engineering design. In this sub-theme, children's skills such as *"grouping,"* "*comparing," "ordering," "space-position planning," "measuring objects," "pattern forming," "block design," "building design," "landscaping," "drawing," "trial and error,"* and *"expressing themselves in creative ways"* are coded as among the gains provided by these games. When the child wants to design a tower that he does not want to collapse under gravity, he may discover that the parts that fall due to gravity are out of balance, and the factors that do not fall are in harmony. Although this application example seems science-based, there is direct interaction with engineering due to the nature of its STEM content (Bredekamp, 2015; MacDonald, 2015; Moomaw, 2013).

21.4.3 Sub-theme 2: Technology/Coding-Based Digital Games

According to the reports of the parents, when the STEM coded digital games played by the children are examined, it is seen that children use ground-direction (right, left, forward, stop) commands so a robot, animal, or monster can follow the instruction given or reach the objective. This digital game was studied under technology-coding-based digital games. The content of the game is to move the robot or animal using commands; the outcomes of "*space-position-based planning*," "*sequencing*" commands in a specific order to reach the objective, "*counting*" at a basic level when calculating the route to be taken by the robot or animal, "*trial and error*" in getting the coded created to move, and solution suggestions for the problems encountered" matched the MEB 2013 educational outcomes.

In the technology-based digital games played by children, robot construction is observed as the interaction between engineering and design in STEM. In this sub-theme, skills such as *"question–answer," "directing the character," "learning symbolic digital code concepts,"* "*improving the implementation of the instructions given at the particular location," "trial and error,"* and *"improving suggested solutions for the problems encountered"* were coded among the games' gains. In addition, it was determined that the games that motivate players to solve a technology-based problem use coding to activate the main character. For example, the child who is asked to code the path that a robot must follow to get its battery should direct the character to answer the question as to how to obtain the battery; the symbolic codes for controlling the character should be put in order, and the implementation of the instructions given at the location according to these codes should be developed. Solutions will be developed for the problems encountered should the robot reach the battery. Although this application example seems technology-based, it supports coding, essential in STEM content. According to Bers (2010), children getting the robot to move is the basis for programming. Children can acquire coding and ground-direction learning outcomes by making the robot move.

21.4.4 Sub-theme 3: Engineering-Based Digital Games

According to the parents' reports, when the STEM-coded digital games played by the children are examined, a house can be left without a roof, and the child can be asked to design different roofs for it. Games were found where the child can make designs by choosing among various shapes such as square, triangle, and circle or combining shapes when designing the roof. This game was studied under science-based digital games. The content of the game matches such MEB 2013 educational outcomes as "*comparison*," "*sequencing*," "*part-whole*," "*matching*," "*trial and error*," "*counting*," "*space-position-related planning*," "*measuring objects*," "*forming patterns*," "*establishing cause-and-effect relationships*," and "*problem-solving*." Another game played by children involves organizing the place and position of objects such as rows, shelves, books, and cabinets that will act as blocks so that a ball that falls from the cupboard can land in a basket. The content of this game matches the same educational outcomes as the previous game. Another game is designed to support and balance by using a certain number of iron pipe blocks to help children lift a weight or stop a tree from falling over. The game itself tests whether the design provides support and balance. In this game, unlike the other two games, it has been determined that children gain the outcome of "expressing themselves in creative ways." Children can use their creativity to form endurance and balance using a set number of iron blocks. In engineering-based digital games, children are asked to make a house, an electronic device, a truck, or a design. Allowing the child to use their imagination to complete the design is a process that develops creativity. Engineering-based digital games are directly related to both science and mathematics. According to Lange et al. (2019) 34, when children construct by modeling their creative ideas on various structures, this supports their skills toward STEM education.

In the engineering-based digital games played by children, Lego, building, and construction games are observed for the engineering use of STEM. Since children can express themselves esthetically and creatively in these games, this is a critical effect of STEM-based digital games. In this sub-theme, it is coded that such skills as *"grouping," "comparison," "sequencing," "part-whole," "matching," "counting," "space-position related planning," "measuring objects," "pattern forming," "block design," "structural design," "landscaping," "drawing," "expressing themselves creatively," "trial and error,"* and *"suggesting solutions for the problems encountered"* can be improved during the game. The skills identified in the games can be developed, according to Lange et al. (2019), and acquired, according to Tuxley and Ruud (2018), through STEM activities. Furthermore, the use of materials in various areas, shapes, and sizes that children will prefer in mobile apps provides the opportunity to support children's visual-spatial skills (MacDonald et al., 2015).

21.4.5 Sub-theme 4: Mathematics-Based Digital Games

According to the parents' reports, when the STEM-coded digital games played by the children are examined, as a discipline, mathematics can be used in all the content of technology-, engineering and science-based digital games. However, although the analyzed games look like they are for children to practice engineering design, it was determined that they are essentially aimed at acquiring mathematical skills. For example, when a math-based digital game is examined because it is coded as an engineering-based game but has a lot of math content, a house's roof is left off, and children choose the triangle shape. The house door was left off, and the children were asked to place the rectangular shape where the door should go. The aim of the game is math-based as it focuses on acquiring concepts for geometric shapes. This game's content matched the "*comparison*," "*part-whole*," and "*matching*" educational outcomes of the 2013 MEB Preschool Education Program. In a different game example, when children make steps or a path according to the balance principle, which has science content, in a puzzle by using a set number of cubes, educational outcomes such as "*counting*" and "*forming patterns*" can be acquired with 5 or 6 objects. In the content of another digital game, the educational outcomes of "*measuring objects*," "*guessing*," and "*matching*" are used to move water from full containers to empty containers without spilling any into containers or pipes.

In mathematics-based digital games, children play, numbers, patterns, and operations are the expected uses of STEM mathematics. In these games, children start with basic skills such as counting, adding, subtracting numbers, forming part-whole, and pattern-making. Here, children lay the foundations of processes such as advanced probability. In this sub-theme, it is coded that such skills as *"grouping," "comparison," "ordering," "part-whole," "matching," "counting," "measuring objects," and "pattern forming"* can be improved during the game. For example, with an object, not only will a structure be built, but also a sufficient number of things to reach the objective will be made. A meaningful pattern is expected to be formed when performing this operation. When the codes are examined in light of the literature, it was determined that according to Moomaw (2013), it is appropriate for children to gain basic mathematical skills such as number and operation, measurement, part-whole, and comparison using apps with STEM content. In this example, the children perform operations using objects, create a structure, and make an engineering-oriented design. Mathematics is used in both technology and science games. According to Bredekamp (2015), children can gain basic math skills and skills in other areas of STEM in STEM-related activities.

21.5 Conclusion and Discussion

In this part of the study, the conclusions reached in light of the findings are discussed within the scope of the literature. The study's conclusion and discussion follow two tracks. The first track examines how parents use the "active co-playing mediation" strategy on their children who play digital games. The second track concerns the content of the digital games children play in terms of STEM and educational value. Based on this, to understand how parents use the "active co-playing mediation" strategy, the results obtained from the "parental knowledge," "parental behaviors," and "parental assessment" sub-themes and discussion are included.

It has been determined that children's academic skills are positively supported when parents engage in activities that support children's education in early childhood (Patrikakou, 1997; Reynolds & Clements, 2005). The involvement of parents in their children's activities has led to an increase in children's cognitive skills and a decrease in their problematic behaviors at school (Melhuish et al., 2001). During the early childhood years, young children spend most of their time at home and school, so the role of parents in support of their children's education is critical (Simpkins et al., 2005). Bus et al. (1995) determined that language and social cohesion are high due to the support given by parents to their children's education. Berkowitz et al. (2015) showed that math skills are high, while Fleer and Rillero (1999) indicated that science skills improve. According to Mullis et al. (2004), the positive effect of parents on the education of children in the early years is lasting. Today, the COVID-19 global pandemic has forced children to spend more time at home. When children spend time at home, it is even more important that parents support their children. Since their children use mobile apps at home, parents want to use them to meet their children's educational needs. In this context, parents use the study's subject of digital games with STEM content and the "active co-playing mediation" strategies in the process of their children who play these games will be discussed under the themes "*parental knowledge*," "*parental behaviors*," and "*parental assessment*."

Under the *"parental knowledge"* theme, it was stated that the parents whose children play digital games with STEM content know the purpose of the digital game, its content, whether or not it contains violence, and that the game is safe for their child (see Tables 21.2, 21.3, 21.4 and 21.5). The study by Gentile (2003) reported that one-third of parents know the digital games played by their children. It was determined that the parents participating in this study see the name and the purpose and content of the game because they play it with their children. According to Gözüm and Kandır (2021), knowing the scope and purpose of the digital games the children play indicates that they deliberately use parental guidance. Another situation known as laissez-faire mediation, which is not actual mediation, may occur when the parent does not knowingly provide advice. However, there was no evidence of laissez-faire mediation among the parents participating in the study. The content analysis of the games the children of the parents play and the views of the parents was found to be consistent. In this regard, it can be said that parents deliberately use the "active co-playing mediation" strategy. However, examining the findings of all themes as a whole will show us how the "active co-playing mediation" strategy is used. Based on this, the *"parental behaviors"* theme results are explained below.

When *"parental behaviors"* are examined in the process of playing digital games with STEM content, it can be seen that the reason parents use *"observation"* is to answer questions that the child may ask about the game, to monitor the child's digital game playing time, to track the game's progress daily, and to determine the appropriateness of the digital game for the child's development and age (see Table 21.6). In light of these findings, when parents check and monitor digital games to see if they are appropriate to their child's developmental level when choosing digital games for their child, this is known as "*viewing mediation*" (Hasebrink et al., 2011; Livingstone & Helsper, 2008; Livingstone et al., 2015; Valkenburg et al., 1999). It is thus understood that parents use the "*viewing mediation"* strategy when monitoring their children by transforming it into the *"active co-playing mediation"* strategy.

When parents' views on *"establishing communication"* via the digital game are examined, it is seen that even though communication is not established in educational games such as STEM, one-way or verbal communication such as advertising is established in free games. Since parents do not find it appropriate for digital games to communicate with their children, they do not want their children to play games that establish communication (see Table 21.7). Livingstone et al. (2015) say that *Restrictive mediation* is a situation where digital play is restricted when parents notice the harmful effects of the digital games children play. It is, therefore, understood that parents can use the restrictive mediation strategy for their children. Parents are aware that they are keeping children away from online risks while playing digital games, and they emphasized that there is no risk in games with STEM content. It is concluded that parents can keep their children away from online threats when using the active co-playing strategy (Livingstone & Helsper, 2008; Nikken & Jansz, 2014). Mesch (2009) states that the risk of children being exposed to cyberbullying decreases due to parents using the "active co-playing mediation" strategy. Piotrowski (2017) says that active and restrictive mediation can be used in early childhood.

When the reasons for the parental behavior of *"playing together"* are examined, they are seen to be to assist the child in play games the parent thinks have educational benefits for their child, to go up levels in the digital game with educational value, to support the child's latent learning in digital games with educational value such as STEM, and to stop the child losing interest in the educational digital game played by the child when they cannot progress (see Table 21.8). Vygotsky's (1986) theory on learning through socio-cultural interaction emphasized that children's learning can be supported by knowledgeable adults. According to Vygotsky (1978), an experienced adult can support a child's learning helping him/her gain knowledge and experience. Today, parents can use digital games as scaffolding to support children's learning in this context. The child can learn something by himself, but he may need to be supported by an adult in the face of problems he cannot solve. This helps the child's learning. From this point of view, parental support facilitates the child's teaching in cases where children cannot progress in digital games with STEM content. Considering Vygotsky's (1986) theory on social interaction and the fact that social interaction is formed between the child and the parent via the game, it can be said that this is the setting in which active co-playing is observed. Gözüm and Kandır (2021) reported that parents who positively support the development of their children aged 60–72 months use the *"active co-playing mediation"* strategy. Parents should use digital apps with STEM content for their children to benefit more from digital apps with STEM content. According to Vygotsky (1978), the adult language is critical in the scaffolding to be established between the adult and the child. For a parent to talk to a child about a digital game, it should be the most natural thing to know about the game's content.

Vygotsky's (1986) theory emphasizes that children may need adult guidance in solving the problems they face. This means the child's development will be supported by solving the problems he encounters with adult assistance. In the study, the views of parent P4 in the verbatim quotes uphold the need for parental support for STEM content (see Table 21.8, P4). I wonder how a parent who has not played the digital game with STEM content being played by their child can help when the child asks about a problem he is stuck on in the game. If the parent wants to help, they are expected to explore that game by playing it. If he does not want to help, this may indicate negligent mediation. This situation will introduce many online risks and the child's risk of not playing educational games with STEM content. The parents who participated in the study deliberately used the *"active co-playing mediation"* strategy to promote their children's positive development and prevent online risks. The assessments of parents who use the *"active co-playing mediation"* concerning the effects of digital games are explained below.

When *"parental assessment"* of the effects of digital games with STEM content is examined, they expressed the following views about *"the effects of digital games"*: Examples are given of how they affect children's cause-effect relationships, counting, guessing, and reasoning skills (see Table 21.9). In their thoughts on the adverse effects of children on digital games, the parents emphasize that the reason digital games are harmful does not have good content or not being well-chosen by the parent and that parents need to take responsibility (see Table 21.9). In early childhood, children cannot be expected to choose positive digital games for themselves. Indeed, the parents are responsible for selecting digital games that positively affect (Schofield Clark, 2011). However, it is difficult for parents to choose these digital games. According to Papadakis and Kalogiannakis (2020), determining whether the content of digital games is educational or not is not an easy and controversial issue even for experts, but what the games are missing or lacking can be determined. Parents can use the *"active co-playing mediation"* strategy to determine what is missing or lacking. However, even if they use this strategy, they must choose digital games for their children by seeking expert advice. The views of parents on getting specialist opinions on digital games in this regard are explained.

When the parents' views on *"seeking expert opinion"* for digital games with STEM content are examined, they stated that due to the complex aspects of digital games, they research experts' opinions, get ideas from experts for digital games with educational content, and seek the views of experts who are also relatives who have tried out the digital games children play (see Table 21.10). In their study, Gözüm and Kandır (2021) stated that the digital games played by children whose parents sought expert opinion and applied the *"active co-playing mediation"* strategy had educational value.

When parents' opinions on the *"educational support"* aspect of digital games are examined, the parents think that they need to have STEM content to support their child's education. Parents state that digital games with STEM content support coding, science, mathematics, and engineering (see Table 21.11). Parents stated that for their children to play games with educational content, they need to explain the game's processes by playing the games with their children and ask them questions about the game and said that the children's games needed to have non-didactic content and be able children's attention (see Table 21.11). The study conducted by Yelland et al. said (2017) reported that the educational apps developed for STEM have very little educational value. At the end of the study by Papadakis and Kalogiannakis (2017), parents and educators were given information about the educational value of mobile apps prepared for children. This information emphasized that mobile apps have more entertainment content than educational value. This being so, it is even more important that parents use the *"active co-playing mediation"* strategy to determine educational content. Acting on this, although the parents who participated in the study said that STEM content games have a positive impact on their children, the emphasis on the need for parents to play digital games with their children and explain the games' processes shows that parents have a critical role to play when it comes to the content of digital games. Indeed, parents' emphasized games attracted children's attention instead of didactic games. Parents do not consider didactic games educational using the "active co-playing mediation" strategy. Flewitt et al. (2015) emphasized in their study that most of the mobile apps that claim to be educational consist of didactic worksheets or puzzles. At this point, let us return to the second track of the study, namely, the examination of the content of the digital games children play in terms of STEM and educational value.

It has been stated that most applications that are developed for children in early childhood have low educational value and aim to entertain children (Papadakis et al., 2016a). However, technology can be used positively to support children's development. In their experimental study, Papadakis et al. (2016b) determined that mobile apps designed to improve children's mathematics proficiency can also be used to support their educational skills. Indeed, according to Yelland et al. (2017), STEM education in early childhood lets children fashion their curiosity about the world holistically. STEM education provides learning environments where children's thinking skills and scientific knowledge processes are actively used. Kalogiannakis and Papadakis (2020) emphasized the importance of developing mobile apps for STEM activities in preschool classrooms. According to the study results, improving the STEM skills of children studying in a STEM learning environment can increase their interest in STEM and their educational gains, making it important for career choices and academic achievement in later life. Therefore, there is a need to develop quality mobile apps for STEM. In this respect, it is good for their children that the parents participating in the study prefer digital games with STEM content. Even though children need to play games with STEM content in the literature, the educational design of mobile apps is under debate. On examination of the findings for the second track of the study *("Do the digital games children play enhance STEM education?")*, the digital games children play are grouped under the themes of STEM-based, science-based, technology/coding-based, mathematics-based, and engineering-based. The study found that the total number of digital games children play is 28. While 24 of the digital games were found to be STEM content, four games were determined neutral. It was determined that children's digital games, when expert advice was sought, have STEM content, and those games chosen without expert advice have no educational value. However, the children participating in the study play at least one STEM content game with educational value. According to Aronin and Floyd (2013), experts' opinions are effective in digital games analyzed according to the principles to be considered when choosing a tablet or computer app to provide preschool children with experience in STEM. The study by Papadakis and Kalogiannakis (2020) concluded that most mobile apps have entertainment content, not educational content. It is not easy for parents to choose digital games with educational content for their children. The four neutral games without educational content identified in this study were chosen by parents without seeking expert opinion, similar to the study results by Papadakis and Kalogiannakis (2020). Another finding of the study on digital games with STEM content is that parents translate foreign language games to their children due to the limited language choice of digital games played by children. Therefore, it is also apparent that the game developers with STEM content need to increase the options for different languages. In this regard, what parents should pay attention to when choosing digital games with STEM content needs to be discussed. Parents' assessment of the quality of digital games with STEM content requires much expertise and research. This discussion is moot because it is unrealistic to expect expertise from parents on many issues. According to the study results, parents' seeking expert opinion has a particularly acute effect. It has been determined that the content of the games based on expert opinion is of good quality. However, another important criterion when choosing games with STEM content is parents' interest in games. This is because parents research the games before their children play them. Parents are also aware of their children's interest in games and their requirements, so they predict at what stage of the game their child would get bored and quit. In this case, when we look at Aronin and Floyd's (2013) views of parents in terms of their principles in choosing digital games, it can be argued that parents reflect their experiences in digital games onto their children, and not by coincidence. Another important factor that was found when parents choose digital games for their children is the relationship between parents' professions and STEM. The finding that best reveals this relationship is the quotes taken from parent P4 and parent P10, who are both engineers (see Tables 21.2, 21.3, 21.4, and 21.5), showing that the games played by the parents and those played by their children have engineering content. In addition, parents also emphasize that their children's games should be selected according to the PEGI classification. The study results show that among the games with STEM content, parents focus on STEM content without focusing on digital games that are STEM brands. This is because the names of the games do not include the word STEM. Furthermore, it has been determined that parents focus on choosing a STEM app in line with their children's interests rather than a specific STEM discipline.

In light of the discussions above, the study reached the following conclusion: When parents deliberately use the *"active co-playing mediation"* strategy, they could choose appropriate digital games with STEM content for their children. Moving on from this, the critical question of the study, namely, "*how do parents use*" the *"active co-playing mediation"* strategy? It is summarized below after a discussion of the literature.

When the parental knowledge, behaviors, and assessment themes are evaluated as a whole, it is understood how parents use the active co-playing strategy. First of all, parents know that digital games are beneficial for their children. Children should play well-structured digital games to benefit from digital games educationally. Since parents play digital games with their children, they are aware of the game's content and how it affects their daily lives. It is understood that parents seek expert opinions on educationally beneficial digital games, do research, and seek the views of experienced friends and relatives. The reason why those parents who use the active co-playing strategy observe their children is to assist their children in the digital game in which they progress educationally. Parents who use the active co-playing strategy help their children progress in the digital game. When using the "*active co-playing mediation*" strategy, the parents block digital games that negatively affect their children and direct them to games that will positively affect them. They make an educated assessment of the content of digital games. Parents can chat with the child about aspects of the game's content that arouses curiosity and ask questions to pique the child's interest in STEM encoded digital games with educational content. It is thus understood that parents apply the "*restrictive*" and "*viewing mediation*" strategies in addition to the "*active co-playing mediation*" strategy to their children in the early childhood years.

Recommendations

Experts should organize parent training to choose digital games matching their children's interests and needs. The educational content of digital games selected by parents who seek expert opinion can significantly contribute to children. Furthermore, game developers need to improve the different language options in digital games with STEM content. As for the mediation strategy parents should apply to their children, if a case in this study is to be an example, parents should be trained in how to use *"active co-playing mediation"* strategies. Of course, projects for longitudinal research into this education can be planned considering the parents' working conditions, education levels, and technology literacy levels.

Limitations and Future Research

The parents participating in this study had undergraduate, master's, and Ph.D. levels of education. The lack of participants with lower education levels is an essential limitation of the study. However, the analysis can be applied to a broader range of participants by diversifying the education levels of those parents using the *"active co-playing mediation"* strategy. The results of this study are difficult to generalize due to the nature of qualitative research. However, the study has yielded significant findings regarding how the *"active co-playing mediation"* strategy is used and the content of digital games with STEM content. For future research, the results of this study can be compared with the results of studies made in different countries with different cultures and participants.

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