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Children's social problem-solving skills in playing videogames and traditional games: A systematic review

Eyüp Yılmaz[1] · Mark D. Griffiths[2]

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Abstract

Playing games can be one of the most important activities for children to improve their social problem-solving (SPS) skills. Studies that have examined the empirical evidence of playing games concerning children's SPS skills have tended to focus on the function of a single game. Therefore, an overview study is needed to generalize the data by the game content and production purpose. Twelve databases were systematically searched. Four basic criteria were sought for studies to be included. A total of 35 studies meeting all the inclusion criteria were reviewed. The results showed that (i) experimental designs were the most utilized, and (ii) more studies using active control groups are needed to compare the effectiveness of the game playing. In non-traditional games research, half of the videogames used in the studies reviewed and classified, were primarily produced for educational purposes, followed by serious games (30%) and entertainment games (20%). These three types of videogames were effective in promoting children's SPS skills. Moreover, simulation games were the most preferred videogame genre utilized by the researchers. In studies using videogames, children's SPS skills did not differ significantly by gender, whereas in a study using traditional games (non-video games), male participants' problem-solving ability progressed significantly more than that of females. Almost all the studies concluded that playing both videogames and traditional games positively influenced children's SPS skills. However, only three studies utilizing traditional games were conducted during the two-decade period (2000–2019) and more studies are needed for comparable and generalizable results.

Introduction

Individuals face many simple or complicated social problems in their daily lives. While some of these problems can be solved easily, some require advanced problem-solving skills. On the other hand, skills such as coping with multiple tasks, having influential interpersonal communication abilities, and adapting to unexpected situations are increasingly demanded from individuals in the modern business society (Care et al., 2016; Csapó & Funke, 2017; OECD, 2020). Therefore, individuals are expected to have sophisticated social problem-solving (SPS) skills to be able to survive successfully. Researchers (e.g., Araiza-Alba et al., 2021;

Bozkurt-Yükçü & Demircioğlu, 2021; Jurdi et al., 2018; Kim & Hannafin, 2011; Nopembri et al., 2019; Valadi et al., 2020) have drawn attention to the importance of acquiring SPS skills during childhood. Being able to solve problems encountered in daily life makes children socially skilled and therefore increases their social acceptance among peers (Fettig et al., 2016; Merrill et al., 2017). This is associated with lower depression (Eskin et al., 2014), strengthens mental health and quality of life (Chinaveh, 2010; Eskin et al., 2014), enables them to behave more independently (Matthys & Schutter, 2022), and decreases the frustration arising from daily life (Frey et al., 2000). Furthermore, poor SPS skills may constitute risk factors for the development and maintenance of psychiatric disorders (Brüne, 2005; Inoue, 2006).

Playing games is considered an important activity in which children can improve their SPS skills (Hewett et al., 2020; Jurdi et al., 2018; Quwaider et al., 2019). Children face various social problems during gameplay such as analyzing the solutions, making decisions, and solving the problems by simulating real-life situations in their mind (Hromek, 2009; Yılmaz et al., 2022a). However, the playing of videogames has increasingly replaced more traditional types of play over decades (Deleuze et al., 2019). This has meant researchers have increasingly focused on the effects of videogames among individuals. In related literature, there are many studies (Craig et al., 2016; Dindar, 2018; Eseryel et al., 2013; Kang et al., 2017; Sun et al., 2011; Yılmaz et al., 2022a) that have been conducted to determine the effects of videogames on children's SPS skills, while a few studies (e.g., Li et al., 2016; Piscalkiene, 2009; Petty & de Souza, 2012) have been carried out concerning the effects of playing traditional games (i.e., non-video games) on children's SPS skills. However, most of these studies focus only on the influence of a single game on children's SPS skills. Considering there are thousands of videogames and traditional games known in the market, and new products (especially videogames) continue to be released day by day, this is a significant limitation. Based on a single game, it is almost impossible to determine which type of videogame or traditional game is more effective regarding children's SPS skills. Therefore, by categorizing games according to specific characteristics and primary production purposes, better systematic and generalizable data can be obtained.

Theoretical framework: Social problem-solving skills among children

Social problems are those frequently encountered in daily life practices, and such problems have multiple solutions or solution paths and require the integration of various content areas to be solved (D'zurilla &

Goldfried, 1971; Jonassen, 1997). Therefore, a prompt effective response is not available for individuals confronted with this situation, as there are many obstacles that prevent an immediate response (D'Zurilla et al., 2004). Social problems are also characterized as ill-structured, un-structured, ill-defined or wicked (Brown et al., 2010; Jonassen, 1997; Mienaltowski, 2011) and unlike well-structured or structured problems (Laxman, 2010), they may contain many other social problems or lead to emergence of them (i.e., poverty leading to lack of healthy food leading to malnutrition) (Ruggiero & Green, 2017).

The term of 'SPS' refers to the process of problem-solving when it occurs in the natural environment or the real-world with no immediate way or method to solve the problem (D'zurilla & Nezu, 1982; Shute et al., 2016). In other words, SPS is the use of cognitive-behavioral process to find successful solutions to problems encountered in daily life (Nezu, 2004). The adjective 'social' is not meant to limit the situation to any particular type of problem. Consequently, the process of SPS deals with all types of problems, including impersonal problems (e.g., stolen property), personal or intrapersonal problems (emotional, behavioral, cognitive and health problems) and interpersonal problems (e.g., marital conflicts), as well as broader community and societal problems (e.g., racial discrimination), which might affect an individual's functioning, including impersonal problems (D'Zurilla et al., 2004). There are various stage models regarding the SPS process. For instance, Gick's (1986) problem-solving model consists of four stages that are (i) constructing a representation, (ii) searching for solution, (iii) implementing the solution, and (iv) monitoring the solution. Another four-stage model (problem definition and formulation; generation of alternative solutions; decision-making; and solution implementation and verification) was posited by D'Zurilla and Nezu (1990). Wallace et al. (2012) posited a seven-stage model of problem-solving (gather and organize; identify [problem]; generate [solutions]; decide [which are the best]; implement; evaluate; and communicate). Although specific key differences exist among the models, most of them were developed based on the five-stages model developed by D'Zurilla and Goldfried (1971) (general orientation or "set"; problem definition and formulation; generation of alternatives; decision making; and verification).

There is no consensus among researchers on whether children's SPS skills are innate or not. White (1987) asserted that SPS skills are innate, while other researchers (e.g., Brounstein, 2011; Shute & Wang, 2015) refute the proposition that individuals are born with SPS skills. However, there is an agreement on the

fact that SPS skills can be cultivated when opportunities are created for children. In other words, the more stimuli (in this case, social problems) they face during childhood, the more they will develop themselves. Furthermore, it has been noted that children's SPS skills can be developed by allowing them to face social problems in low-risk situations even in digital world (Anderson Butcher, 1999; Wu et al., 2021). Therefore, parents and educators play a crucial role in children dealing successfully with problems in social communities/environments, and it is vital to use the right equipment with proper attitudes and behavior to make children better problem-solvers (Webster-Stratton, 1999; Webster-Stratton et al., 2001). However, this process may not work properly in all situations. For instance, Brown (1988) asserts that adults intervene with children by solving their problems in most cases, which causes them to fail to solve problems when trying to get on without help. Another important criticism concerns formal education. The problems presented to students in formal education are clearly defined and structured (i.e., have a specific solution path and a definite answer), whereas those encountered in the real world are generally ill-structured/social (Csapó & Funke, 2017; Greiff et al., 2014; Shute et al., 2016). Moreover, if an individual is trained to solve problems in only a single way, then they may struggle to transfer their knowledge of skills to new contexts or problems (Hilliard et al., 2018). Therefore, children's games are considered another important education opportunity where children can improve their SPS skills (Li et al., 2016; Martinez et al., 2022; Quwaider et al., 2019).

Children's games and social problem-solving skills

Children clearly get more things from games beyond pleasure and satisfaction. Playing games has the potential to improve all aspects of children's wellbeing whether they are physical, emotional, social and/or cognitive benefits (Griffiths, 2002; Khowaja & Salim, 2019; Lee et al., 2020). The term 'tradition' represents a custom that has been passed down from one generation to the present (Thalib & Ahmad, 2020). In this respect, traditional games can be defined as all the games that children voluntarily participate in, have specific cultural characteristics, and that are not played via the screen of an electronic devices. These games can be played indoors or outdoors, and may have rules as well as types without rules (i.e., children under three years usually prefer to play games without rules). Moreover, these rules can be both written and unwritten (oral) (Pic et al., 2019; Storli & Sandseter, 2015). Engaging in traditional games aids children to gradually expand their world, improve their skills, develop strong friendships, and enhance personal freedom besides having fun (Bishop,

2013). Therefore, the game process is also regarded as an effective activity for acquiring SPS skills (Hurwitz, 2002; Hromek & Roffey, 2009; Plummer, 2008). For instance, in a traditional game "hide and seek" (which can slightly differ from country to country), it can be played by all children over the age of three years. In the game, seeker has the task of finding and tagging their hiding playmates. The seeker develops and implements solution-based strategies in their own way to deal with this problem. A child who plays traditional strategy games (e.g., chess, draughts) has to constantly develop new strategies and make decisions which are two important sub-skills of problem-solving skills in order to defeat their opponent (Günüç & Yılmaz, 2021).

On the other hand, with the technological advances and widespread use of the internet, videogames have rapidly become one of the most preferred leisure time activities among children and adolescents (Akbari et al., 2023; Anderson et al., 2007; Yılmaz et al., 2017). While the first generation of videogames were commonly produced for amusement, more contemporary games include those that aim to train, as well as provide knowledge and experience to the players while entertaining them. These games, which are typically categorized as either educational, serious or entertainment according to their primary production purpose, have fundamental distinctions in some aspects as well as featuring similarities (Boyle et al., 2016; Choi et al., 2020; Lamb et al., 2014). For example, irrespective of the primary production purposes, all videogames are designed to entertain and give pleasure to players. However, while this is the primary production purpose in entertainment or casual videogames (e.g., *Grand Theft Auto*), the priority of educational and serious videogames is not to entertain. There is no clear distinction between educational and serious videogames but while serious games (i.e. *Euro Truck Simulation*) are mainly designed for training, simulation, and education in virtual environments by using real life examples (Eichenberg & Schott, 2017; Lamb et al., 2018; Susi et al., 2007), the main action in educational videogames (e.g., *Endless Alphabet A-Z*) is to provide content knowledge by incorporating specific pedagogical approaches or figuring out new ways to use information (Annetta, 2010; Dindar, 2018; Funk & Buchman, 1996).

Videogames are categorized not only by their primary production purpose, but also by their genres. To date, although various classifications have been developed by researchers, there are some basic classifications (e.g., role-playing, simulation, action, adventure, strategy, sport) that are widely accepted in the field (Apperley, 2006; Arsenault, 2009; Braun et al., 2016; Choi et al., 2020; Lee et al., 2007). The realistic scenarios

in life are imitated in "*simulation games*" (Braun et al., 2016) while in "*strategy videogames*", players generally play in the global view by focusing on visual information (Apperley, 2006). "*Action games*" are reaction-based games (Nelson & Strachan, 2009) while "*adventure games"* focus on navigating a world by solving key and combination lock puzzles. (Clanton, 1998). "*Sport games*" are based on sports and those played with *Lego* or involve puzzles are termed "*puzzle games*". An imaginary world is the setting in "*role-playing games*" in which players can freely choose how to explore the created and relatively large game world and try to progress by solving the problems they encounter (Hitchens & Drachen, 2009).

A growing body of studies claims that playing videogames creates experiences which allow gamers to develop their SPS skills by facing complex problems and solving increasingly difficult problems (i.e., Adachi & Willoughby, 2013; Craig et al., 2016; Griffiths et al., 2003; Kang et al., 2017; Sánchez, & Olivares, 2011; Sun, Chen, & Chu, 2018; Yılmaz et al., 2022a). However, it is unclear which type of videogames (educational, serious or entertainment) is more preferred by researchers and more effective in helping children to develop and/or gain SPS skills. The present systematic review study aimed to bring novel insight and contribute to the literature by filling this gap.

Gender has been one of the most accentuated variables in studies investigating the effect of videogame playing on children. Many studies have shown that males like playing videogames more than females, and that videogame genre preferences of children can vary by gender (e.g., Ferguson, 2015; Homer et al., 2012; Jackson et al., 2012; Kovess-Masfety et al., 2016; Monacis et al., 2020; Shoshani et al., 2021; Tatli, 2018; Yılmaz et al., 2017; Yılmaz et al., 2022b). Furthermore, the effects of videogame playing on children may diverge by gender (Jackson et al., 2011). From this perspective, it allows the possibility that videogame playing may have different effects on participating children's SPS skills. Furthermore, although the studies recruiting children were reviewed in the present study, the review also goes into more detail and investigates whether any patterns emerge for different children's age groups. According to the Convention on the Rights of the Child (UNICEF, 2022), childhood lasts from birth to until the age of 18 years. Therefore, all studies within this age range were included in the present review. However, it should be noted that the children included in scientific studies vary greatly from those in kindergarten (e.g., Danby et al., 2018; Lorusso et al., 2018) to high school (e.g., Kim et al., 2009; Yang, 2015).

The present study and research questions

Many decades ago, Huizinga (1949) stated that the phenomenon of playing was older than human history because pre-human animals did not wait for mankind to teach them how to play. The games children played have survived until today with various types and features. However, newer forms of play that allow children to play screen-based games emerged during the second half of the 20th century (Bowman, 2010; Griffiths & Pontes, 2020; Shaffer, 2006). These electronic games have become popular among young individuals in the early 1990s (Fromme, 2003), and researchers have increasingly focused on the effects of playing videogames on children, especially since 2000. Thereby, the present study aimed to systematically review the papers published from the year 2000.

Playing videogames has been one of the much-debated issues in terms of its benefits and harms, especially for children (i.e., those aged below 16 years). Many studies (e.g., Chow et al., 2020; Franceschini et al., 2013; Green & Seitz, 2015; Griffiths et al., 2020; Lobel et al., 2017) have shown that videogames can have positive effects on children. However, some researchers (Naik, 2014; Pérez-Latorre, 2012) emphasize the use of playing traditional games especially in education, compared to videogames. In the literature, there is not much research on the comparison of the effects of game types (videogames or traditional games) on children. Therefore, the present study contributes to this discussion by comparing the effects of videogames and traditional games on children's SPS skills. Moreover, no previous systematic review has examined the effects of traditional games and videogame playing regarding children's SPS skills. Therefore, the aim of the present study was to systematically review all the empirical studies covering a wide range of research methodologies including experimental, correlational, mixed methods, and qualitative methods. Five key research questions were explored:

Q1. Which research design did the researchers mostly conduct their studies? Is there any association between the preferred research design and children's SPS skills?

Q2. Which type of videogames (educational, serious, or entertainment) is more preferred by researchers and more effective in helping children to develop and/or gain SPS skills.

Q3. Is gender an important variable in determining the effect of using videogames or traditional games regarding children's SPS skills?

Q4. Regarding the games used in the studies, is there any pattern that emerges for different age groups?

Q5. Are videogames and traditional games used in studies effective in gaining and/or developing children's SPS skills?

Method

Study design

The present study was conducted based on literature review. To ensure that the systematic inclusion of all the relevant information and that all reporting processes were strictly followed and reviewed, the PRISMA checklist (Page et al., 2020) was utilized.

Databases searched

The electronic databases used in locating relevant studies included: *Web of Knowledge, PsycINFO, PubMed, Science Direct, Scopus, and EBSCO (consisting of Academic Search Complete, British Education Index, Child Development & Adolescent Studies, Education Abstracts, Educational Administration Abstracts, Library, Information Science & Technology Abstracts,* and *Educational Research Information Center [ERIC]).*

Search terms

The following search terms study were used in the present study: "videogames" OR "computer games" OR "video gaming" OR "online gaming" OR "digital games" OR "game-based learning" OR "non-videogames" OR "traditional games" OR "outside play" AND "problem-solving" OR "problem-solving skills" OR "social problem-solving skills" OR "fundamental skills" OR "daily life problems" OR "everyday problems".

Selection of studies

Five criteria were used to determine the appropriate studies for review. The published papers had to (i) be written in English, (ii) be published in a peer-reviewed academic journal, (iii) be published from January 2000 to December 2019 (inclusive), (iv) be conducted in an experimental, correlational, mixed methods, or qualitative design, and (v) include children (studies including children from birth to 18 years old). Papers were excluded from further analysis if they did not meet these criteria. Furthermore, four studies (i.e., Eseryel et al., 2013; Eseryel et al., 2014; Hofferth & Moon, 2011; Sánchez & Olivares, 2011) were excluded from the study

because the whole or a large part of data were also used in other published studies by the authors already included in the present review.

Inter-rater reliability (IRR) and consistency of coding

Transparency and reproducibility are two definitional strengths of well documented systematic review studies (Brunton et al., 2012). Unless detailed information is provided about how screening and coding decisions were made, and how disagreements (if any) were resolved between coders, the review cannot be replicable and IRR results are often reported summarily as a percentage of agreement between various coders (Belur et al., 2021). However, Feng (2014) suggests that percentage of agreement should not be used alone to report IRR, especially if the coding task is too complicated. Therefore, Cohen's Kappa (κ) was calculated for inter-rater reliability with the help of statistics software (https://datatab.net/statistics-calculator/descriptive-statistics). Because the data were nominal variables and coded by two coders, Cohen's Kappa (κ) was calculated as 0.72 which is accepted as substantial level of agreement (Landis & Koch, 1977). To ensure consistency, both researchers who took part in the whole coding process had previous experience in qualitative research methods. In cases where researchers had disagreement while coding, an experienced third researcher was consulted and was coded in line with the common view of all three researchers. If a consensus among three researchers could not be obtained, then the decision of the majority (two researchers) was applied. However, this rarely happened.

Data analysis process

A data evaluation form was developed by the authors based on other previous forms developed for similar purposes. The form comprised seven sections: (i) author(s) surname(s), (ii) publication year, (iii) research purpose(s), (iv) participants, (v) research design, (vi) instrument(s) used, and (vii) main findings. The studies were categorized as either survey design, experimental design, qualitative design, or mixed-methods design according to their methodology. The game's primary purpose was classified according to whether it was an entertaining game, educational/learning-based game, or a 'serious' game.

Results

Search results

A comprehensive search was implemented within the selected databases, and a total of 35 papers meeting the inclusion criteria were reviewed using the data evaluation form. A total of 11,932 papers including at least one search term in the title were identified during the initial search. After the removal of the duplicates and the preliminary examination based on the title and abstract, 51 papers were identified as being potentially relevant and with a full text available. These relevant papers were evaluated for suitability of aforementioned criteria. Of all the 51 papers, 35 were included in the study for further review, while 17 were excluded from the study for several reasons. The process of determining the papers that met the criteria is detailed in Figure 1.

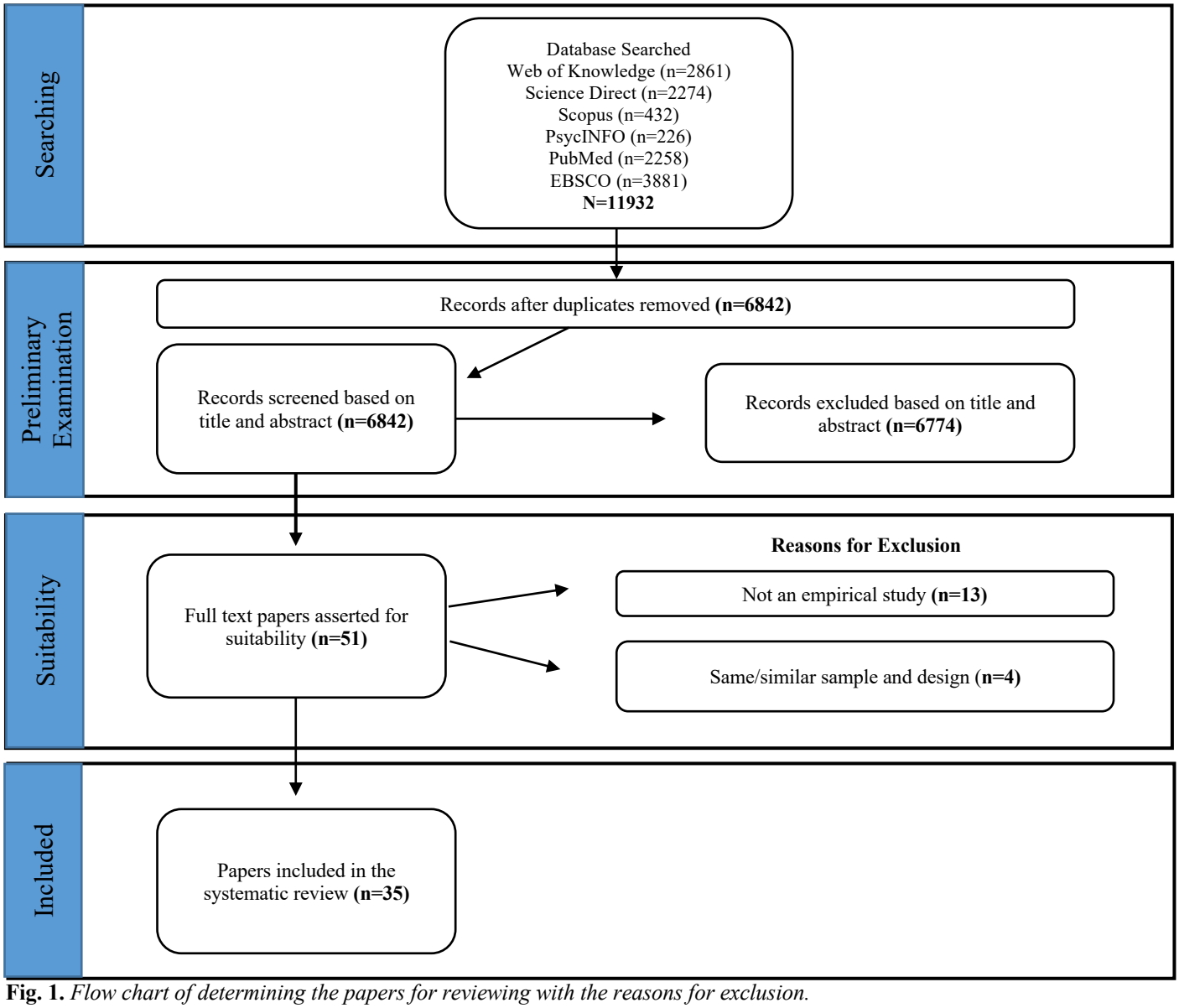

Fig. 1. *Flow chart of determining the papers for reviewing with the reasons for exclusion.*

Study design

The methodological designs of the studies were categorized into four main research designs (experimental design, survey design, qualitative design, and mixed-methods design) except one of them. One study conducted by Kang et al. (2017) did not fit any of these categories because the data were collected using tracking data while children were actually playing the videogame. Consequently, this was considered as a standalone study. The results showed that experimental designs were the most preferred design (n=21; 60%) while the other three research designs (survey [n=5; 14.3%], mixed-methods [n=5; 14.3%], and qualitative studies [n=3; 8.6%]) were utilized less frequently. Almost all the studies conducted using an experimental design (n=20; 95.2%) reported that the videogames or traditional games investigated had a positive effect on children's SPS skills. Only one study by Eseryel et al. (2011) reported that students' complex problem-solving performances decreased significantly after playing an educational MMOG videogame. Eleven studies had no control group. Although seven studies had a control group, an active intervention framework was not utilized for these groups. Only four studies had an intervention program for the control group to compare with experimental group that played a videogame.

In the studies conducted in mixed method design and qualitative design, it was found that videogames and traditional games used in the studies improved children's SPS skills. However, various findings were obtained in studies conducted using a survey design. A study by Shute et al. (2016) reported a positive correlation between videogame playing and SPS skills, but no relationship between videogame playing and complex problem-solving skills was found in another study (Dindar, 2018). Hofferth (2010) reported that increased videogame play was associated with an improved ability to solve applied problems for Black girls only, and Hamlen (2013) found that time spent on videogames positively predicted children's practical skills but less so for creative problem-solving skills. In self-reported survey designs, it was found that students who reported higher sustained strategic videogame play also reported steeper increases in self-reported problem-solving skills over time than those who reported less sustained strategic videogame play and that sustained fast-paced videogame play did not significantly predict self-reported problem-solving skills (Adachi & Willoughby, 2013).

The primary purpose and genres of the games

Videogames may have multiple purposes such as education, exercise (sports), and entertainment. For instance, a game created for educational purposes may also entertain individuals as well as develop some of their skills. However, all videogames have a primary purpose that underpins the creative purpose of the game. The videogames used in the studies focused on three primary purposes: (i) entertainment, (ii) educational/learning-based, and (iii) serious. Videogames used in the studies were classified into seven different categories by genres. These were: (i) simulation games, (ii) MMORPGs, (iii) strategy games, (iv) adventure games, (v) puzzle games, (vi) quiz games, and (vii) trivia games. However, some games in the studies (Dindar, 2018; Hamlen, 2013; Hofferth, 2010) could not be categorized in terms of the primary purpose and game genre for one of two reasons: (i) no information at all was provided about the game(s) used in the study; or (ii) minimal information was provided which was not enough to categorize the game(s) used in the study. Furthermore, in a study by Sánchez et al. (2009), three different videogames (two of them trivia games and one a strategy game) were used and the primary production purpose of all of them was serious. In four studies (Kang et al., 2017; Liu et al., 2016; Lorusso et al., 2018; Rubin-Vaughan et al., 2011) the videogames developed by researchers were classified based on primary purpose but could not be categorized by genre due to the aforementioned reasons. In three studies (Li et al., 2016; Petty, & de Souza, 2012; Piscalkiene, 2009), traditional games were preferred by the researchers. In a study by Jurdi et al. (2018) both traditional and digital versions of the board-based *Quizbot* game was played by students. A detailed overview of the distribution of studies by primary purpose and videogame genre is shown in Table 1.

Table 1
Distribution of studies addressing the videogame genre by the primary purpose

Game Genre	Primary Purpose			Total
	Educational/Learning-Based	Serious	Entertainment	
Simulation game	5	4	-	9
MMORPG	2	-	1	3
Strategy game	1	1	1	3
Adventure game	1	1	1	3
Puzzle ame	2	-	2	4
Quiz game	1	-	1	2
Trivia game	1	1	-	2
Unidentified	2	2	-	4
Total	15	9	6	30

As seen in Table 1, simulation games (n=9; 30%) were the most preferred game genres in the studies reviewed and these videogames were either educational/learning-based or serious. In total, half of the videogames that could be classified (n=15; 50%) were primarily education/learning-based, nine videogames were primarily produced for training (serious) (30%), and six videogames were primarily produced for entertainment (20%). It was determined that all but two videogames (both in terms of primary production purposes and genres) and traditional games used in the studies reviewed were effective in the development of children's SPS skills or had a positive relationship with it. A study by Eseryel et al. (2011) reported that the complex problem-solving scores of students decreased after playing an educational MMOG videogame. Another study by Dindar (2018) reported no significant association between videogame playing and children's complex problem-solving skills. Jurdi et al. (2018) reported that students who played *Quizbot* game in a physical space (traditional version) perceived the game easier and more fun than counterparts who played the screen-based game, and that playing the game physically may also provide additional benefits for collaborative problem-solving skill in comparison to playing with the digital version.

Gender and age

In seven out of 35 studies (20%), children's SPS skills were compared by gender. Videogames were utilized in six of these seven studies, while traditional game was preferred in only one study. In the studies using videogames, two were surveys (Adachi & Willoughby, 2013; Dindar, 2018) and found that there was no significant association between children's SPS skills and gender. Similarly, in experimental studies (Craig et al., 2016; Lester et al., 2014; Rubin-Vaughan et al., 2011), no significant gender differences were found. However, Hofferth (2010) found significant assocations between increased videogame playing hours and increased score on the applied problems test for Black girls. The one experimental study using a traditional game found that male participants' problem-solving ability progressed significantly more than that of females (Li et al., 2016). The studies investigating the effect of traditional games on children's SPS skills were carried out with primary school children (aged 7-10 years), whereas the age range in studies using videogames varied from pre-school to high school (aged 3-17 years).

Outcomes and impact of game playing

Social problem-solving skills outcomes of videogames

Most of the studies reviewed examined videogames (31 out of 35; 88.6%), and a majority of these (19 out of 31 studies; 61.3%) used an experimental design. These studies focused on whether playing videogames affected children's SPS skills. In 18 studies out of 19, it was reported that videogame playing enhanced or positively affected children's SPS skills or executive functions including SPS skills. For instance, Craig et al. (2016) found that children's (aged 7-11 years) knowledge of social skills and their confidence in using this knowledge developed significantly using the *ZooU* game-based training program compared to children who did not have access to *ZooU* games during the period. Kim et al. (2009) reported that combining "thinking aloud strategy", which is one of meta-cognitive strategies with videogame play had an effect on children's SPS ability and SPS ability had an effect on their achievement of both in gaming and learning. Yang (2012) reported that digital game-based learning effectively promoted students' SPS skills while the control group showed no improvement. In another study, Sun et al. (2011) used the *Professor Sudoku Game* to investigate its effects on fifth-grade learner's behaviors. Findings indicated that playing the game increased the level of puzzle-solving, and encouraged the development of solving strategies of participants. Lester et al. (2014) reported that the students' SPS skills developed significantly in the post-test after playing the game for four weeks when compared to the pretest results, and Dourda, et al., (2014) reported that students' SPS and critical thinking skills and reading skills were enhanced after playing videogame *Whodunit?* However, Eseryel et al. (2011) reported that students' complex problem-solving performances significantly decreased after playing an educational MMOG videogame.

In a few studies (five out of 31 studies; 16.1%), a survey was used. Four of them comprised a correlational survey design which were used to examine the relationship between videogame playing and SPS skills. Three of these studies found positive correlations between videogame playing and SPS skills while the other one did not find any significant results. Hofferth (2010) reported that increased videogame playing between 1997 and 2003 was associated with an improved ability to solve problems among Black girls. Hamlen (2013) indicated that spending a greater time playing videogames was related to practical but less creative SPS skills. Shute et al. (2016) reported that a significant positive correlation between playing game-based

assessment (a game system that involved problem-solving model and developed by the authors) and children's SPS skills. However, Dindar (2018) reported no practical significant relationship between any of the videogame playing variables (game experience, average gaming frequency, average gaming time, etc.) and children's complex problem-solving skills. A self-report survey was used in the other study. Adachi and Willoughby (2013) administered surveys to high school students five times between 2003 and 2008, and they found that students who reported higher sustained strategic videogame play also reported steeper increases in self-reported problem-solving skills over time than those who reported less sustained strategic videogame play. Furthermore, sustained fast-paced videogame play did not significantly predict self-reported problem-solving skills.

Three ethnographic case studies (out of 31; 9.7%) examined the perceptions of participants regarding their SPS skills among those who played videogames. It was reported in all the studies that playing videogames improved and/or positively influenced SPS skills. Monjelat et al. (2012) reported that commercial videogames can be used in an educational setting and can be valuable in developing children's SPS skills. Jamaludin and Hung (2017) found that youth gamers' disquisitional problem-solving practices increased in time by playing *World of Warcraft*, an MMORPG. In another study (Danby et al., 2018), video record analyses demonstrated that young children's actions during videogame playing made it possible to formulate problems to be solved, which is one of the specific interactional strategies.

Three studies (out of 31; 9.7%) utilized a mixed-methods design by combining quantitative and qualitative methodologies. These were carried out to examine the effects of videogame playing on children's SPS skills. Chen et al. (2015) indicated that game-based collaborative learning can enrich the learning experience and collective problem-solving. Jong et al. (2010) reported that students perceived their problem-solving generic skills were moderately enhanced after playing an educational videogame. Lorusso et al. (2018) reported that *Giok the Alien* involving various problem scenarios had positive effects on kindergarten children's communication and SPS skills in a cooperative framework.

Finally, one study (out of 31) collected data by utilizing in-game tracking data. In this study, Kang et al. (2017) reported that students with low game performance who scored 0-5 in the *Alien Rescue* videogame spent much more time to find information and struggled to find solutions to ill-structured central problems provided

in the game when compared to students with high performance who scored 6 or more in the *Alien Rescue* videogame. Here, high videogame performance allowed gamers to find solutions more easily and quickly to social problems.

Social problem-solving skills outcomes of traditional games

Three of the 35 studies (8.6%) used traditional games and found positive effects of traditional games on children's SPS skills. Two of these (Petty, & de Souza, 2012; Piscalkiene, 2009) utilized experimental designs, and one (Li et al., 2016) utilized a mixed-methods design. Li et al. (2016) compared the effects of commonly used science pedagogy with *Lego* bricks and an engineering design-based pedagogy with *Lego* bricks on children's SPS skills and found that children's problem-solving skills and their ability to identify optimal solutions to the problems developed with engineering design-based pedagogy while there was a decrease in problem-solving skills of children after using the commonly used pedagogy. One study (Petty, & de Souza 2012) found that playing traditional games (e.g., *Mastermind*, pick-up sticks, dominoes, etc.) in the context of professional intervention enhanced children's executive functions such as problem-solving, self-control, and/or demonstrating attention when compared to their initial levels. Piscalkiene, (2009) found that fairytale creation games had educational consequences while developing attention, creative thinking, problem-solving, memory, and linguistic functionality among primary class pupils with ADHD. A study by Jurdi et al. (2018) examined both digital and physical (traditional) versions of the same game (*Quizbot*) played by students. They found that the *Quizbot* game encouraged the use of skills associated with collaborative problem-solving skills and that the physical spaces platform was perceived to be as easier, and more fun and effective than screen-based platforms in collaborative problem-solving tasks. Since the results were in favor of the traditional game model, the study is included in this section.

Discussion

The present systematic review focused on papers empirically examining the relationship and/or effect of playing videogames or traditional games on children's SPS skills. A total of 35 relevant studies that recruited children as participants were identified among the original 11,932 papers located in the search process. Most studies (n=31, 88.6%) examined the effects of videogames on children's SPS skills while the other three studies used traditional games. In one remaining paper, both videogames and traditional games were utilized

together. Nearly two-thirds of the studies (n=21) were conducted using experimental designs. Fewer studies used survey designs (n=5), mixed-methods designs (n=5), qualitative designs (n=3), and in-game behavioral tracking design (n=1).

The majority of the 35 studies were conducted utilizing quantitative methods (n=26) and majority of them (n=21) utilized experimental designs. These results do not seem to be exclusive to the present study, but rather reflect a general pattern in the general field of studies investigating game playing research (e.g., Boyle et al., 2016; Eichenberg & Schott, 2017; Reynaldo et al., 2021). The fact that experimental designs give the researchers greater confidence than surveys or qualitative designs in knowing whether the variables manipulated and/or the hypotheses tested were effective or not, are likely to have played a key role in their preference. However, many of the studies reviewed (17 studies out of 21; 80.9%) conducted utilizing experimental design, either had no control group, or the control group had no intervention. More comparable and interesting results were obtained in studies where an intervention program for control groups was developed. For example, Eseryel et al. (2011) reported that students who had dynamic modeling program (control group) exhibited better performance in complex problem-solving skills than treatment group in which a videogame was played alongside the dynamic modeling. Conversely, Yang (2015) found that while problem-solving scores of the control group decreased after technology-enhanced learning implementations, the experimental group had significantly greater improvements in problem-solving than control group after playing educational videogames. Based on these findings, it is clear that a passive control group may not be sufficient in assessing how effective videogames or traditional games are in facilitating problem-solving skills. However, the studies using an active control group were few (only 4 out of 21; 19.1%). More studies using active control groups are needed in order to demonstrate whether intervention designs utilized for control group are effective regarding children's SPS skills and to compare their effects with the videogames or traditional games that children play. Furthermore, it was found that the implementation process of the studies reviewed varied between a few minutes (i.e., Chen et al., 2015; Huang et al., 2010) to a few weeks (Kim et al., 2009; Yang, 2015). However, there was no information about how children's SPS skills would be affected (significantly or not) or what the effect size would be if the games were used by children over a long period

(a few months or years). Therefore, long-term longitudinal empirical studies (of which there were none), are needed to answer these questions.

In the studies reviewed, educational videogames (50%) were preferred more than the games primarily produced for entertainment (20%) or training (serious) (30%), and all studies (bar one) indicated educational videogames were effective in developing children's SPS skills. The researchers wanted not only to examine the effects of these games on children's SPS skills but also to understand their teaching potential. Furthermore, it is not surprising that all the serious games used in the studies reviewed made a significant contribution to the development of children's SPS skills or had a positive relationship with it because one of the main production purposes of serious games is to train players and gain skills by imitating real-life situations. In the studies reviewed, nearly half of simulation games (four games out of nine) which were designed to simulate real-world activities or situations for training, analysis or prediction purposes (Shliakhovchuk & Muñoz García, 2020) were included in the serious games category. The outcomes of the studies reviewed showed that the games primarily produced for entertainment also appeared to be effective in enhancing social-problem-solving skills. For instance, in the study conducted by Jamaludin and Hung (2017), it was found that playing the *World of Warcraft* increased the participants' problem-solving practices in time. Again, in a study by Danby et al. (2018), the video record analyses showed that children's actions during the videogame playing made it possible through specific interactional strategies, including the formulation of the problems, to be solved. However, in the extant literature, many studies (e.g., Chang & Bushman, 2019; Coyne et al., 2012; King et al., 2013; Lobel et al., 2017; Montag et al., 2012; Saleem et al., 2012; Yılmaz et al., 2018) addressing the negative effects of videogames (that are primarily produced for entertainment) have been conducted, and this may cause a negative perception of entertainment games. Therefore, these findings can be regarded unique in terms of partially altering the negative perception of entertainment videogames. Furthermore, it was found that simulation games (n=9) were the most preferred videogame genres by researchers. The feature of simulation games in that they imitate realistic scenarios from real life to upskill gamers or support learning by providing virtual activities may play an important role in researchers' preference for using such games in their studies.

In only a small number of the studies reviewed (for videogames, six studies out of 31 and for traditional games one paper out of three), children's SPS skills were examined by gender. Almost all the studies using

videogames reported that gender was not a variable that significantly differentiated or affected children's SPS skills. In a study utilizing traditional games, it was concluded that males' problem-solving ability progressed significantly more than that of females (Li et al., 2016). However, this is just one finding from a single study and therefore cannot be generalized. More studies are needed to evaluate the effects of traditional games on children's problem-solving skills by gender. It should also be noted that the studies evaluating traditional games were carried out with primary school pupils while the studies with videogames were conducted with a much wider age range of samples from pre-school to high school. The two main reasons for this are thought to be that the decrease in children's interest in traditional games as they grow older and that there are hundreds of videogame types developed for each age group.

The majority of the studies showed that playing games (both videogames and traditional games) had a positive influence on SPS skills and/or positively influenced executive functions including critical thinking, decision-making, and problem-solving skills, except for two studies. Eseryel et al. (2011) reported that students' complex problem-solving performances were decreased significantly after playing educational MMOG videogame. Dindar (2018) found no significant relationship between any of the videogame playing variables and complex problem-solving skills. Therefore, based on the studies reviewed, it could be argued that almost all the studies (33 out of 35) reached similar results and that this indicated high validity across the studies.

Although most of the studies (n=31) examining the effects of videogame playing on children's SPS skills were performed between 2000-2019 in various countries of the world, only three studies that assessed the effects of traditional game-playing and a study comparing the effects of both videogames and traditional games were found during this period. In this respect, to obtain more generalizable results, there is a need for more studies that empirically investigate the effects of traditional games on children's SPS skills. In addition, to the best knowledge of the authors, there is only two studies (Jurdi et al., 2018; Yılmaz et al., 2022a) that have directly compared the effectiveness of videogames and traditional games on children's problem-solving skills. Such studies would be useful to understand which types of children's games are more effective in developing problem-solving skills. Consequently, the number of studies involving videogames (n=31) was ten times higher than the number of studies evaluating traditional games (n=3) during the two-decade period.

Limitations

The present review determined the effects of game types (videogames and traditional games) on children's SPS skills by identifying relevant studies. However, the study had some limitations. Only papers published in the English language and peer-reviewed journals were considered. Furthermore, only papers produced between 2000 and 2019 (inclusive) were included in the study. Although videogame playing has become prominent since the mid-2000s (Kafai, 2006; Parker, 2013), the studies produced before 2000 were not be included in the review (and may have included more traditional games). Despite the use of a rigorous and wide range of search terms in 12 databases, it is possible that relevant studies may have been missed due to a lack of fit with the inclusion criteria.

Conclusions and future research

Most of the studies reviewed were conducted by examining the impact of videogame playing on SPS skills. An increasing preference by children and adolescents for playing videogames (Griffiths et al., 2012; Griffiths & Pontes, 2020; King et al., 2013) may have led to an increase in the studies on the effects of videogame playing. However, there are few empirical studies addressing traditional game playing and SPS skills of children and many more studies are needed in order to compare the findings with videogame playing. Although the majority of studies reviewed were those utilizing an experimental design, there were either no control groups or the studies used passive control groups. However, the studies in which intervention programs were developed for both groups (treatment and control) benefited by assessing whether the intervention design for control group was effective in developing children's SPS skills and if so, how effective it was compared to the game used for treatment group. Consequently, the studies using active control groups are more beneficial in providing comparable and unique findings.

Approximately one-third of the videogames utilized in the studies were simulations and all of them were primarily produced for either 'educational' or 'serious' purposes. Findings show that simulating real-life situations in videogames can be useful for improving children's' SPS skills. Additionally, it was re-confirmed that 'educational' and 'serious' videogames are effective in skill acquisition. These findings could be useful for educators and parents. In school and out-of-school settings, these games can be of benefit in supporting children's SPSS. However, studies have shown that videogames primarily produced for serious or educational

are not preferred or played much by children (e.g., Chou & Tsai, 2007; Connolly et al., 2012; Yılmaz et al., 2022b). The finding that all the entertainment videogames used in the studies were found effective in promoting SPS skills of children is important. Considering that many studies emphasize the more negative aspects of video gaming (i.e., violence, aggression, health issues), these results can be valuable for partially switching the perception toward entertainment videogames.

In studies investigating the gender effects of videogame playing (n=6), children's SPS skills did not differ significantly by gender whereas in the one study using traditional games, it was found that boys' SPS skills improved more than girls. However, this finding cannot be generalized and further studies are needed comparing the games' effects by gender. All but two of the studies concluded that playing both videogames and traditional games positively affected and/or enhanced SPS skills of children. However, despite the relatively large number of studies that focused on the effects of videogames playing on SPS skills, very few studies address the playing of traditional games. Further studies should be carried out focusing on the effects of playing traditional games on children's SPS skills. Additionally, further comparative studies could be carried out in order to compare the effectiveness of videogames and traditional games.

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Appendix 1

Table 2 Knowledge of content and outcomes of studies

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Goldsworthy, Barab & Goldsworthy	2000	Examining a computer game that aids the development of learners' social problem-solving skills.	59 adolescents diagnosed with Attention Deficit Hyperactivity Disorder (M=12.8).	Experimental	1. Demographic Questionnaire 2. Gresham and Elliott Social Skills Ration Scale 3. Video-based problem-solving scenario 4. Text-based problem-solving scenario 5. The videogames package.	Participants in the experimental group showed a significant increase in performance compared to their pre-test scores and this increase was significantly greater than that of the attention-placebo control group.
Chuang & Chen	2009	Investigating whether computer-based videogames facilitate children's cognitive learning.	115 Taiwan Grade 3 students (61 males and 54 females).	Experimental	1.Computer-assisted instruction 2. Computer-based videogames 3. Pan-European Game Information (PEGI) age rating system	Computer-based videogames playing improved participants' problem-solving skills by recognizing multiple solutions for problems.
Kim, Park & Baek	2009	Exploring the effects of the meta-cognitive strategies on academic and gaming achievements and exploring the effects of these achievements on the social problem-solving of students.	132 Grade 9 students (15–16 years) from South Korea.	Experimental	1. The online game 2. Social Problem-Solving Ability Inventory 3. Achievement test 4. Game level scores	Social problem-solving ability of students was statistically significant in relation to the achievements in both gaming and learning.
Piscalkiene	2009	Testing if supplementary education (e.g., fairytale games, games in the sports hall etc.) would help the primary class pupils with ADHD to develop psychomotor and cognitive abilities and social behavior.	22 primary class pupils who had ADHD diagnosis confirmed.	Experimental	1. Fairy-tale creating games. 2. Cognitive behavior tasks 3. Graphical-logical task 4. Games in the sport hall	Fairy-tale games helped the children with ADHD by creating positive psychosocial content and by developing their creative thinking and problem-solving skills.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Sánchez, Mendoza & Salinas	2009	Developing a series of learning activities based on Mobile Serious Games (MSGs) to develop problem-solving and collaborative abilities.	206 Grade 8 students.	Experimental	1. *Evolution* videogames 2. *BuinZoo* videogames 3. *Museum* videogames 4. Problem-solving Scale 5. Collaborative Scale	The experimental group who played videogames achieved a significantly higher problem-solving score than the control group.
Hofferth	2010	Examining how the utilization of new media is associated with other aspects of children's lives.	6- to 12-year-old American children living with their mothers.	Survey (correlational)	1. The self-designed online interview instrument 2. Behavior Problems Index 3. Test of basic achievement measured cognitive achievement	Increased videogame play was associated with better problem-solving skills only for Black girls, and it caused behavior problems for boys.
Huang, Yeh, Li & Chang	2010	Evaluating the effectiveness of a collaborative and online brainstorming game.	54 Grade 11 students from a public senior high school in Taiwan.	Experimental	1. Domain-Specific Knowledge Test and the Reasoning Skill Test 2. *Idea Storming Cube* game	A game-based learning environment improved students' brainstorming activity by encouraging their thinking skills as the ISC game-agent group was better in a problem-solving task.
Jong, Shang, Lee & Lee	2010	Investigating the educational realization of Virtual Interactive Student-Oriented Environment (VISOLE).	28 teachers and 254 students from 16 secondary schools in Hong Kong.	Mixed method	1. *Farmtasia* videogames 2. Knowledge manual teacher console 3. Blogging platform	Students perceived their problem-solving generic skills were moderately enhanced after the VISOLE process.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Eseryel, Ge, Ifenthaler & Law	2011	Determining whether a game-based learning environment can facilitate complex problem-solving skill acquisition.	***Study 1***: 251 grade nine rural high school students (47% males) in the US. While 156 students were randomly assigned to treatment (game) group, remain 95 students were assigned to control group. ***Study 2***: Out of 280 grade nine students who did not participate in study I, 137 (48.9%) were in the treatment group and 143 (51.1%) were in the control group.	Experimental	1. *McLarin's Adventures game* 2. Complex and Ill Structured Problem-Scenario	***Study 1***: Students' complex problem-solving performances were decreased significantly after playing an educational MMOG videogame. Similarly, the scores of control group students who received specifically developed STEM program decreased significantly after post-test. ***Study 2***: It was found that while students in the dynamic modeling (control group) exhibited significantly higher positive gains in their complex problem-solving skills development, students who had dynamic modeling + McLarin's Adventure videogame (treatment group) exhibited a slight decline.
Rubin - Vaughan, Pepler, Brown & Craig	2011	Exploring the efficacy of *"Quest for the Golden Rule"* gaming modules on how much children learned (about bullying and preventing it) through interacting with the modules.	The number of participants ranged from 226 to 438 depending upon the gaming modules from grades 2 to 6.	Experimental	1. Bark Academy: Fairness Scale 2. Mission to Mars: Friendliness Scale 3. The Ghoul School: Attitudes and Strategies Scale	Children's knowledge of bullying and the identification of strategies to prevent bullying was improved significantly with the interaction of gaming modules. The game was found effective in promoting problem-solving for bullying prevention in schools.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Sun, Wang & Chan	2011	To assess the *Professor Sudoku* games' effects on player/learner behaviors.	64 students from grade 6 classes	Experimental	1. *Professor Sudoku* game	The results showed that scaffolding support (*Professor Sudoku* game) increased the level of puzzle-solving and encouraged the development of solving strategies.
Monjelat, Mendez-Zaballos & Lacasa	2012	Analyzing the processes involved in the problem-solving situation within the classroom context, where the commercial videogame *Sim City Creator* was used.	10 students in their third year of compulsory education and their teacher	Qualitative	1. *Sim City Creator* videogames	It was concluded that commercial videogames can be used in an educational setting and can be valuable in developing problem-solving skills.
Petty & De Souza	2012	Discussing executive functions of playing games, considering Piaget's (1967) work and the neuropsychological framework.	12 children aged 7 to 11 years	Experimental	1. The games *Mastermind*, pick up sticks, dominoes, etc.	The results showed that playing games in a context of professional intervention contributes to developing executive functions (problem-solving, demonstrating attention, self-control, and organization).
Yang	2012	Investigating the effectiveness of digital game-based learning on students' problem-solving, learning motivation, and academic achievement.	44 students from two classes.	Experimental	1. New Nest of Problem-Solving 2. Motivated Strategies for Learning Questionnaire: Motivation Scale 3. Civics and Society Test	Both approaches (Digital Game-Based Learning and Traditional Instruction) were effective in problem-solving but experimental group students scored significantly higher than the control group in problem-solving skills.

Table 2 (continued)

Author(s) Surname	Year	Research aim (s)	Participants/Study group	Research design	Instrument(s)	Main findings
Adachi &Willoughby	2013	Examining whether strategic videogame play (i.e., role-playing and strategy games) predicted self-reported problem-solving skills.	1,492 high school students (M = 13 years 10 months; 50.8% female) in Canada	Survey (self-reported)	1. Single-item questions 2. Five-point scale to assess self-reported problem-solving skills	Students who reported higher sustained strategic videogame play also reported steeper increases in self-reported problem-solving skills over time than those who reported less sustained strategic videogame play. Furthermore, sustained fast-paced videogame play did not significantly predict self-reported problem-solving skills.
Hamlen	2013	Re-examining the trends in videogame play by exploring factors that predict greater time spent playing videogames.	4th and 5th -grade students (N = 105) from four US elementary schools.	Survey (correlational)	1. Torrance Tests of Creative Thinking 2. Self-report survey	Students who spent the greater time playing videogames related to practical but less creative and flexible methods of thinking and problem-solving.
Dourda, Bratitsis, Griva & Papadopoulou	2014	Exploring the teaching potential of Game-Based Learning (GBL) and Content and Language Integrated Learning (CLIL) approaches in terms of learning context.	17 students (9 girls) age between 11–12 years in a Greek Public School.	Experimental	1. The Knowledge Test 2. The Satisfaction /Feedback Questionnaire 3. Researchers' journal and video recording	Students' problem-solving and critical thinking skills were enhanced after playing the videogames.
Lester, Spires, Nietfeld, Minogue, Mott & Lobene	2014	Presenting the design of the *Crystal Island* learning environment, and describing the evaluation through a series of pilots and field tests.	Approximately 800 students (49% male)	Experimental	1. *Crystal Island* game 2. Experimental field tests	After using software for four weeks, students' scores on skill-based assessment significantly increased which meant playing videogames developed students' abilities to approach problems in an organized manner.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Chen, Wang & Lin	2015	Investigating and comparing solitary and collaborative modes of game-based learning in promoting students' science learning and motivation.	50 grade seven students (M = 13.4)	Mixed-methods	1.Science learning performance test 2. The motivational survey 3. The interview form	Findings showed that collaborative learning can enrich the learning experience and collective problem-solving.
van de Sande, Segers & Verhoeven	2015	Examining how attentional and action control benefit the in-game behaviors of young children while playing a serious video game.	106 kindergarten children (M = 6.2 years).	Experimental	1. In-game behaviors 2. Executive control (attentional and action control that assessed with computer tasks).	The findings suggest that attentional control (assessed with video-game playing) positively affected the children's task performance and problem-solving behavior.
Sung, Hwang & Yen	2015	Developing contextual digital games by integrating authentic contexts of health problems and learning content of the health education course into gaming scenarios and evaluating the effectiveness of the proposed approach.	104 fourth grade students from an elementary school in Taiwan.	Experimental	1. The Problem-Solving Questionnaire 2. Questionnaire of Learning Motivation and Flow Experience. 3. Interview form.	The contextual game-based learning approach highly motivated the students and provided them better problem-solving ability by applying effective problem-solving sceneries comparing conventional e-learning approach.
Yang	2015	Evaluating the use of Blended Digital Game-Based Learning for promoting Higher Order Thinking Skills, while simultaneously evaluating creative and critical thinking, and problem-solving skills.	77 grade 11 students (16–17 years) from high school in Taiwan.	Experimental	1. Torrance Test of Creative Thinking 2. Critical Thinking Test-Level I 3. New Test of Problem-solving	The findings showed that the experimental group who had Blended Digital Game-Based learning [DGBL] approach had a significantly higher score than the comparison group in creative thinking, critical thinking, problem-solving skills.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Craig, Brown, Upright & DeRosier	2016	Investigating the efficacy of *Zoo U* (tailored videogames) on elementary-age children's social behaviors, social literacy, social self-efficacy, and peer relations.	59 parents and 47 children ranged in age from 7 to 11 years (M = 9.65, 59% male) from US.	Experimental	1. Behavior Assessment System for Children 2. *Zoo U* game for children	Playing the *Zoo U* game significantly improved children's social skills knowledge, their ability to behave more prosocially as well as their adaption skills in the real world. Similarly, parents and children thought that the *Zoo U* game provided meaningful improvements in children's social skills and behavior.
Li, Huang, Jiang & Chang	2016	Investigating whether engineering design-based learning changed student problem-solving abilities and science knowledge.	30 fourth-grade students (10 years old; 20 male) from a primary school located in China.	Mixed-methods	1. Physics Test 2. Problem-Solving Ability Questionnaire. 3. The Rubric	It was found that engineering design-based pedagogy program developed students' problem-solving ability and improved their ability to identify optimal solutions to the presented problems.
Liu, Lee, Kang & Liu	2016	Examining students' learning patterns in interacting with a serious game environment.	Sixth graders from two middle schools in the south-western part of the US.	Experimental	1. *Alien Rescue* videogames 2. Science Knowledge Test 3. 8-point Rubric 4. Questionnaires	The students with high performance of *Alien* and Solar System Databases (containing critical information for solving the central problem) increasingly used the later stages of the problem-solving process which provided insights of advanced problem-solving skills.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Shute, Wang, Greiff, Zhao & Moore	2016	Using "*Use Your Brainz*" videogame to assess the problem-solving skills of middle school students.	47 Grade 7 students (20 males).	Survey (correlational)	1. Raven's Progressive Matrices which assess reasoning and simple problem-solving skills. 2. *Micro DYN* which is a simulation system that tests participants' ability to acquire and apply information in complex problem-solving environments	The findings indicated that playing videogame (*Use Your Brainz*) significantly correlated with both Raven's Progressive Matrices and *MicroDYN*.
Gürbüz, Evlioğlu, Selçukcan Erol, Gülseçen & Gülseçen	2017	Examining the effect of the *Weather Forecast Game* on problem-solving, algorithmic thinking, reasoning, association, and communication abilities of children.	45 primary school children ages were ranging from 8 to 10 in İstanbul, Turkey.	Experimental	1. *Weather Forecast Game* 2. The Problem-solving Test	According to results, the *Weather Forecast Game* had 2.07 times a positive effect on the problem-solving skills of children.
Jamaludin & Hung	2017	Investigating how a MMORPG affords problem-solving skills acquisition among youth learners.	A male local public school student (14 years old).	Qualitative	1. *World of Warcraft* videogame 2. Field observation notes 3. Instant massaging transcripts 4. Social media postings.	The findings indicated that participant's problem-solving disquisitional practices were increased over time.
Kang, Liu & Qu	2017	Identifying students' learning behavior patterns of problem-solving.	202 Grade 6 pupils from a middle school in the USA.	Tracking data	1. *Alien Rescue* videogame	The findings demonstrated that the students who used the game tool patterns more strategically (high performing students) were more effective in solving complex problems than low performing students.
Danby, Evaldsson, Melander & Aarsand	2018	Exploring children's situated collaboration and problem-solving practices during videogame play.	The young children (3 to 8 years) from different countries (Australia – Sweden – Norway).	Qualitative	1. Video recordings.	The video record analyses showed that children's actions during videogame playing made it possible through specific interactional strategies to formulate the problems to be solved.

Table 2 (continued)

Author(s) Surname	Year	Research aim(s)	Participants/study group	Research design	Instrument(s)	Main findings
Dindar	2018	Investigating the relationship between video gaming, academic success, and complex problem-solving skills.	479 high school students (M_{age}=16.1, 270 males) from western Turkey.	Survey (correlational)	1. Open-ended questions 2. Videogame Play Self-Concept Scale 3. PISA 2012 Complex Problem-Solving Test	No significant relationship was found between any of the video gaming variables and complex problem-solving skills.
Jurdi, Garcia-Sanjuan, Nacher & Jaen	2018	Analyzing the experiences of primary school children through a game-oriented approach based on physical spaces to enhance collaborative problem-solving skills.	80 primary school pupils (36 girls) ages are between 9–10. Students were utilized in three different implementations areas (tabletops, tablets and physical spaces).	Mixed-methods	1. The *Quizbot* game 2. Fun Toolkit Questionnaire	Students reported that playing a game based on physical spaces was more fun and easy than screen-based sedentary activities, and that it was most desirable to use again both inside and outside education.
Lorusso, Giorgetti, Travellini, Greci, Zangiacorni, Mondellini, Sacco & Reni	2018	Examining the impact of the application on both cognitive and social processes and strategic behavior.	25 kindergarten children (4–5 years; 12 males) from Italy.	Mixed-methods	1. *"Giok the Alien"* AR software application. 2. Structured Observation Grid 3. Questionnaire	The findings indicated that the AR software application used can be effectively used to promote kindergarten children's communication and problem-solving skills.
Sun, Chen & Chu	2018	Investigating the effects of scaffold presentation and reward mechanism on students' problem-solving behaviors.	193 grade 6 students (11–12 years; 101 male) from northern Taiwan.	Experimental	1. *Professor Sudoku* game 2. Game behavior questionnaire	The reward mechanism promoted students' problem-solving skills and encouraged them to overcome the limitations of existing rules, and to develop more complex learning strategies.
Sung & Hwang	2018	Testing if educational computer games that were equipped with collaborative knowledge construction strategy facilitate students' knowledge sharing and organizing during the game-based learning process or not.	186 sixth grades students (M_{age}=12).	Experimental	1. Repertory grid-based educational game 2. The Problem-Solving Awareness Test 3. Group self-efficacy	The educational videogame improved the students' awareness of problem-solving and fostered their awareness of applying the acquired knowledge to deal with problems.