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ORIGINAL ARTICLE

Secondary School Students' Cognitive Structures Regarding Educational Games

Havva Yaman[1]*, Şeyma Nur Bekar[1], Hakan Yildiz[2], Salih Koyun[2], Sibel Er Nas[1]

[1]Department of Mathematics and Science Education, Trabzon University, Trabzon, Turkey, [2]Ministry of Education, Trabzon, Turkey

***Corresponding Author:** havvayaman@trabzon.edu.tr

ABSTRACT

To employ educational games in education as intended, it is required to show students' cognitive structures for this concept. As a result, the purpose of this research was to reveal the cognitive structures of secondary school students regarding educational games. The research was a survey-based descriptive study. A total of 340 secondary school students were included for this research, which included fifth graders (n = 80), sixth graders (n = 95), seventh graders (n = 69), and eighth graders (n = 96). Simple random sampling was used to choose the participants. Data were gathered using the Word Association Test and a drawing test. Six categories are used to organize the students' responses to the educational game's concept. "Individual gains," "lessons," "sports," "lesson tools/applications," "games," and "features of games" were all of these. Four categories were used to categorize the drawings made by the students to represent the concept of educational games: "physical ability games," "intelligent and strategy games," "puzzle," and "mixed games." As a result of this research, it is possible to conclude that students' cognitive structures for the concept of educational games include games played in classes, and educational games highlight the game aspect more. Besides that, there was little vocabulary diversity in their cognitive structures for the educational dimension. To enhance students' cognitive structures toward educational games, focus should be given to the instructional feature of educational games in research to be undertaken in the relevant field.

KEY WORDS: Cognitive structures; educational games; secondary school students

INTRODUCTION

Games that foster children's social development create a connection between reality and imagination, giving children the chance to widen their world (Vygotsky, 1978). Children may be themselves while playing, which encourages creativity (Bruner, 1983). Plato asserted that games allow parents to observe children's talents (Rousseau, 2016). Games, according to Piaget (1962), are essential to and change along with children's stages of cognitive development. The game, which serves as the child's learning environment, aids in the child's ability to make connections to the past and build resources for the future (Aral et al., 2001). New information then becomes a coordinated experience with prior information (Hall, 1912).

Through games, children learn about themselves and the world they live in, find their greatest forms of expression, and develop critical thinking abilities (Ministry of National Education, 2013). Learning through games is one of the most natural methods to learn, and games help learning get better with time (Uluğ-Ormanlıoğlu, 2013). By interacting with others and having fun, a game gives the child the chance to learn things that no one else can teach her/him on her/his own. Since games keep children engaged physically and mentally, they foster an active learning environment (Moyles, 2012). The previous indicates that games should be strongly positioned in the educational environment and should have a significant impact on education. One of the primary theoretical foundations for incorporating games into the educational environment is that educational games include game mechanisms that provide an active learning environment, fun (Lameras et al., 2017), and encourage knowledge and skill acquisition (Qian and Clark, 2016). Games are used in education to facilitate situations that make education difficult, such as negative prejudices and attitudes toward the lessons, to make the lessons more interesting and enjoyable, to reinforce the learned concepts and to repeat them in a more comfortable environment.

A game utilized in a learning context is referred to as an "educational game" (De Freitas 2006). According to some sources, terminology such as "gamification," "game-based learning," and "instructional games" can all be used to refer to or define educational games. Educational games are defined as interactive learning in an exciting environment (Prensky, 2005). The structuring of the information to be learnt in a comfortable setting, the connection and reinforcement of the learned information with one another, and the development of abilities in a fun way are all supported by educational games as a teaching approach. Plass et al. (2020) defined educational games as learning tasks that are rebuilt into games with a full range of game features to make learning tasks more engaging and successful. Games typically feature clear rules of play, are demanding, and encourage players to play, which are traits that are generally acknowledged as being typical (Plass et

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al., 2020). Educational games are recognized as an effective teaching method that allows students to build knowledge through game play while applying their learning to real-world issues. Educational games can provide students more structure and context to help them develop the critical thinking abilities (Lester et al., 2014) required for STEM education (Klopfer and Thompson, 2020). In addition, educational games are believed to be a successful strategy for giving students the chance to learn by making mistakes (Chen and Wang, 2009).

Research has looked at how educational games affect students' academic performance (Sung and Hwang, 2013; Şentürk, 2020; Yıldız and Şimşek, 2020; Wang and Zheng, 2021), retention of information (Şentürk, 2020; Yıldız and Şimşek 2020), attitudes about the subject matter (Bayırtepe and Tüzün, 2007; Soydan et al., 2022), motivation (Yenice et al., 2019; Yıldız et al., 2017), and scientific innovation (Dadaylı and Pekbay, 2021). The educational game approach is an active learning strategy that tries to encourage student participation in a pleasant setting while still acquiring the required information (MacKenzie, 2014; Michael and Chen, 2005; Yıldız and Şimşek, 2020). When the literature is evaluated, research reveals that educational games should be enjoyable (Açıkgöz-Ün, 2003; Altınbulak et al., 2006; Özdemir, 2006; Özyürek and Çavuş, 2016; Selvi and Öztürk Çoşan, 2018; Senemoğlu et al., 2001; Yurt, 2007). Educational games are often appealing because of characteristics such as cooperation, sharing, encouragement, creativity, game complexity, and the uncertainty of the game's outcome (Demirel et al., 2003). Furthermore, educational games create an enjoyable and pleasant learning environment for individuals (Şen-Gümüş, 2009; Yılmaz, 2013).

One of the crucial things to remember about educational games used in education is that they are provided with a focus on a specific objective or are utilized in line with certain acquisitions. The effectiveness of the game depends on how closely it relates to the subject's objectives, how well it fits the student's age, gender, and developmental features, and how interesting and entertaining it is (Dağbaşı, 2007). The impact of educational games on student outcomes has been the subject of several research reviews and meta-analyses. Which concluded that educational games enhance students' learning outcomes (Riopel et al., 2019) and increases their motivation and engagement (Zainuddin et al., 2020). It is also critical to consider how students perceive the concept of educational games, as well as the importance of designing, implementing, and evaluating educational game studies. Because revealing students' conceptual structure of educational games will reveal how those games appear to them when they are seen through the lens of education.

In students' long-term memory, conceptual links are represented via theoretical frameworks known as cognitive structures (Shavelson, 1974). According to Balbağ (2018), cognitive structure is the sum of all descriptions produced by mind concepts. The learning outcomes and the creation of successful teaching methods will both benefit from knowing the students' cognitive structures during the teaching process (Tsai and Huang, 2002). Determining the cognitive structure also facilitates better learning processes (Jonassen, 1987). The "word association test" (WAT) can be applied throughout this procedure. It is a technique that shows the links between the concepts in the students' cognitive structure and aids in determining whether such links are sufficient (Bahar et al., 1999; Ercan et al., 2010). It is possible to provide effective instruction if the students' cognitive structures are known. The educational games instruction may be adjusted in that manner if the cognitive structures of the students are given. Therefore, it is believed that revealing the cognitive structures of the students will aid instructors or researchers in developing lessons and activities for educational games. In fact, the scope of the games to be adopted and developed in the field of education as well as the researchers and educators will be guided by how students see educational games. A preliminary measure of how frequently educational games are employed in the classroom will also be revealed by the cognitive structures of students. To employ educational games in education as intended, it is required to show students' cognitive structures for this concept. As a result, the purpose of this research was to reveal the cognitive structures of secondary school students regarding educational games. The following research question guided the current study:

- What are the cognitive structures of secondary school students regarding educational games?

METHODS

This research was a survey-based descriptive study. Descriptive studies aim to describe the current condition. The goal of descriptive approaches, according to Simon and Burstein (1985), is to categorize and characterize actions in accordance with their common traits. "How is the situation now?" "What are we doing?" as well as "Where shall we go?" are the three main questions in descriptive method research (Kaptan, 1998).

Participants

A total of 340 secondary school students were included for this research, which included fifth graders (f = 80), sixth graders (f = 95), seventh graders (f = 69), and eighth graders (f = 96). Simple random sampling was used to choose the participants. Students voluntarily participated in the research. Gender distribution according to grade levels is shown in Table 1.

According to the students' grade level, the distribution of the lessons in which educational games are played is shown in Graph 1.

Table 1: Gender distribution according to grade levels

Grade Levels	Girls	Boys	Total
5th grade	39	41	80
6th grade	54	41	95
7th grade	39	30	69
8th grade	45	51	96
Total	177	163	340

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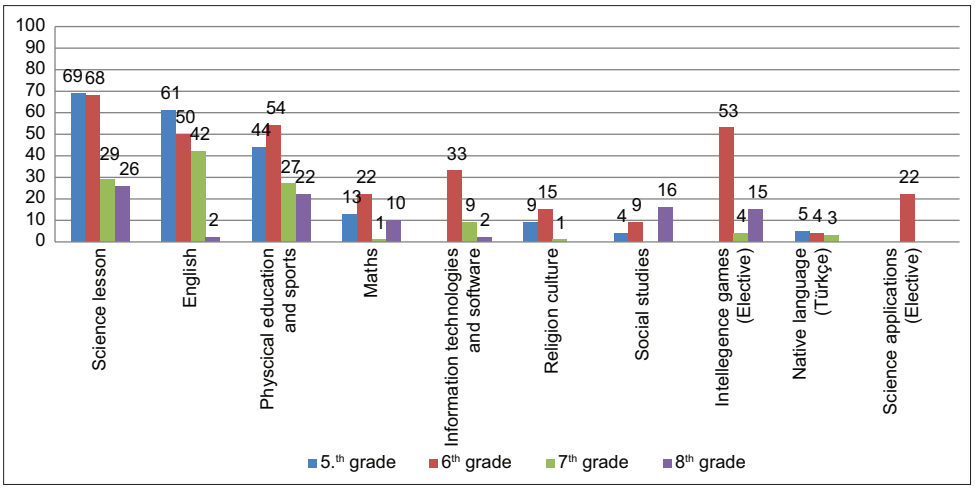

Graph 1: Distribution of the lessons in which educational games are played according to grade levels

Most educational games were played in science, English, physical education, and sports lessons, according to students in grades 5 through 7, but 6th-graders also reported playing in science applications and intelligence games lessons, which are electives, along with the information technologies and software course. The 8th graders, on the other hand, claimed that they played educational games mostly in lessons on science, social studies, physical education, and sports, as well as in lessons on intelligence games.

Data Collection Tools and Process

Data were gathered using the WAT and the drawing test. In the WAT, the keyword "educational games" was present. The keyword was repeated 10 times on each page in sequence, and students were given blank lines to fill in with the about certain (Figure 1). Moreover, "Show by drawing what the concept of educational game means to you," was the question that was posed to the students during the drawing test. Drawing tests that do not restrict the students' response and enable them to model what they have in mind were also included during the procedure. Drawings are a method for disclosing dimensions that cannot be discovered by open-ended or other methods of comprehending assessment (White and Gunstone, 1992). The students' views and insights can be presented without the use of words by using the drawings tests. As a result, in the study, drawing tests were utilized to expose the students' thoughts and details about the concept of educational game without the use of words. Before beginning the application, the students received instructions of how to use the WAT and examples of use in different areas. Before the WAT and drawing test was administered, instructions on how to use the test and examples of use in other fields were presented to the students. Two of the researchers had an active role in gathering the data. The researchers were advised of the procedure prior to data collection. Also, they provided the students with explanations and conducted a brief sample exercise with the students to demonstrate a distinct concept. The researchers handled the timing control

Dear students,

- Read the keyword provided and wrote down any associated words that come to mind.
- When you see a keyword, fill in the blanks next to it with the words that immediately come to mind.
- You have 60 seconds to write the words.
- The words that the keyword makes you think of don't have exact right responses. This allows you to write whatever comes to mind concerning the keyword without having to make a decision.

Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……
Educational games ……

Figure 1: The WAT page layout

and advised the students to stop writing at the conclusion of the allotted time. For the keyword, students had 1 min. It has been noted in the literature that different studies are allotted different amounts of time depending on the grade level. Based on the grade levels to be investigated and comparable studies in the literature, it was determined to keep the duration constant at 1 min for there to be no variation (Alaca et al., 2020; Ercan et al., 2010; İnel et al., 2016; Kaya and Taşdere, 2016). The students then typed the words they believed to be connected to the keyword in the answers. The keyword is listed one after the other on a single page in the prepared WAT.

Data Analysis

The researchers carefully studied the answer words that were associated with the keyword, and a table displaying the

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frequency of repeat of these words was produced. The amount of student-generated answer words was taken into consideration during the data analysis by two researchers to guarantee that the findings were consistent. The analyses conducted independently of one another were combined by two distinct coders. In the evaluated data, the features that stand out and deemed significant were identified. Researchers independently developed answer words, which were compared and explained. The answers to the keyword were carefully investigated in order to assess the results. The frequency of words or concepts related to the keyword was displayed in a frequency table (Appendix 1). The quantity and quality of words used in association with a keyword determines whether or not it is understood, therefore concept network that reveals the cognitive structures of students was built based on the frequency table. The cutoff technique was utilized when creating this concept network (Bahar et al., 1999). All the answers were ordered to produce a frequency table. These response words were grouped into categories based on which ones were most similar. Different cutoff points were established for each category since the frequency with which the words in each are repeated varies from category to category. The cut-off point was set 3–5 units below the answer revealed for the keyword in the frequency table. The interconnection lines were connected to the concepts or answer words above this frequency, and they were drawn to the initial section of the concept network. The cutoff point was then lowered at certain intervals. The correlations proceeded until all of the important concepts and answer words were identified (Ercan et al., 2010). In comparison to Bahar et al., (1999)'s work, which included a variety of concepts (gene, mutation, chromosome, etc.), our study mainly focused on one concept—educational games—and the cognitive structures of the students. Therefore, the relatedness coefficient between concepts was not calculated in this study. However, the common words produced for the related concept were grouped and categories were created. Then, for each category, the concept network was tried to be drawn by considering the grade levels. Hence, it is aimed to reveal the cognitive structure of each grade level for the concept of educational games. The categories of "individual gains," "lessons," "lesson tools/applications," "sports," "games," and "features of games" were used to categorize the answer words created throughout the data analysis. The answer words generated for each category were repeated at different rates. As a result, various cut-off points are established for each category. For instance, the cut-off point 6 units lower (24 and above) was chosen as the most repetitive "playing a game" under the category of individual gains since it was repeated 30 times (Figure 1). The process was repeated until all of the answer words were visible in the concept network created for each category (Eren, 2012; Ercan et al., 2010). It was taken into account how many words developed throughout the process of identifying the cognitive structure, how many associations there were in the concept networks, and how well-suited and effective the associated terms were to the keyword. The drawings created by the students were categorized into four categories during the examination of the drawing test data: "physical ability games," "intellectual and strategy games," "puzzle/crossword," and "mixed games." The game frequencies for each category are displayed. Sample drawings for each code are also presented to the reader. Participants were classified according to research ethics. For instance, the 8th-grade student from the 15th secondary school was designated as 8S-15.

RESULTS

Results from WAT

Six categories are used to organize the students' responses to the educational game's concept. "Individual gains," "lessons," "sports," "lesson tools/applications," "games," and "features of games" are all of these. Figure 2 shows the concept network created for the concept of "individual gains."

While the 5th grader students used the term "learning" the most frequently, the 6th grade students mostly used the word "playing a game." Figure 3 displays the concept network created for the "lessons" category.

The most repetitive word "gym lesson" was stated by 6th grade students. The cut-off point was 30 and above, 6th grade students associated educational games with "science lesson" and 5th grade students "gym lesson." 8th grade students did not produce any answer words under this category. The concept network created for the category of "sports" is presented in Figure 4.

Three separate terms were created with this category in mind. Football and volleyball are its main keyword associations. Students in the 7th grade did not come up with any answer words for this category. Figure 5 below shows the concept network developed for the category of "lessons tools/applications."

Under this category, three distinct words were created. The word "experiment" was frequently used by 6th grade students to refer to the key word. There were no answer words

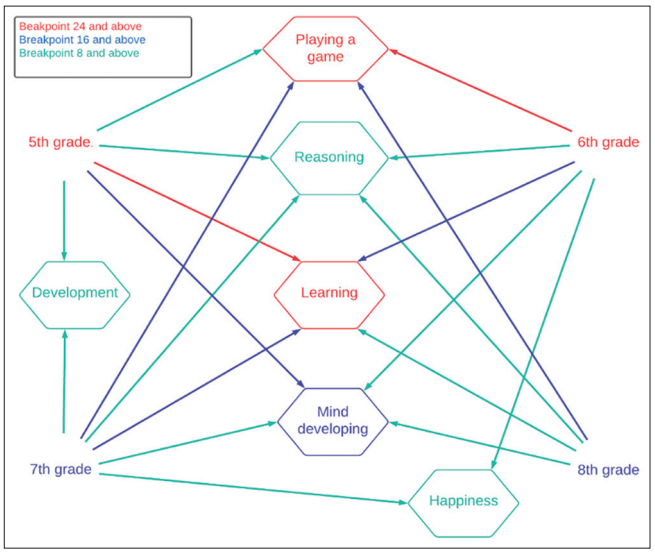

Figure 2: Concept network created for the category of "individual gains"

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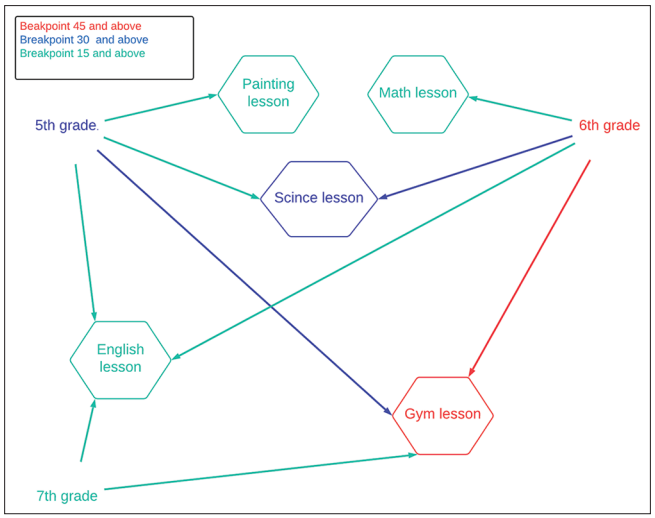

Figure 3: Concept network created for the category of "lessons"

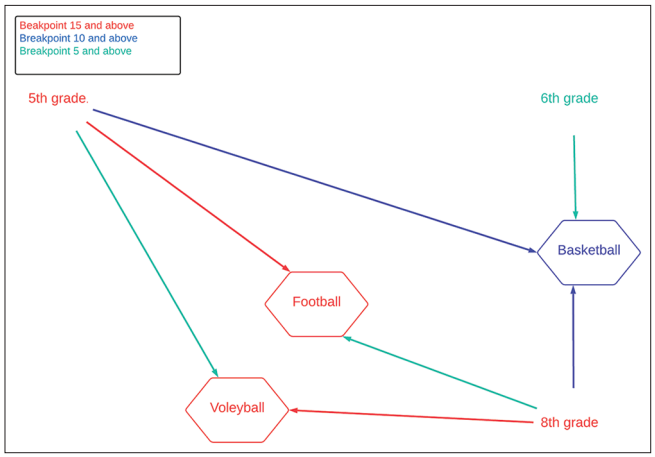

Figure 4: Concept network created for the category of "sports"

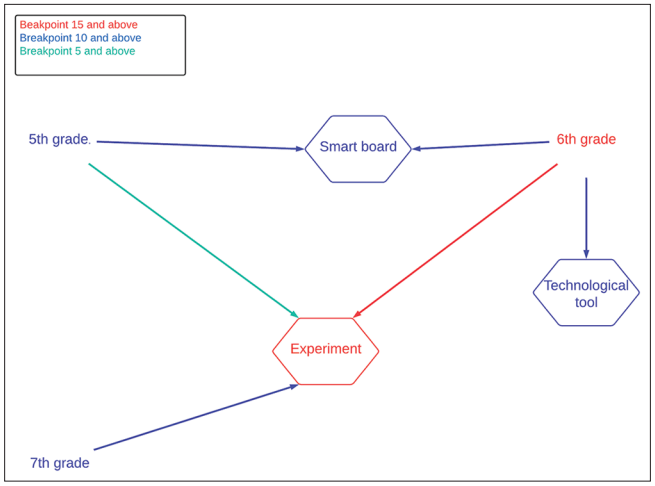

Figure 5: Concept network created for the category of "lessons tools/ applications"

generated by 8th grade students for this category. Figure 6 displays the concept network developed for the category of "games."

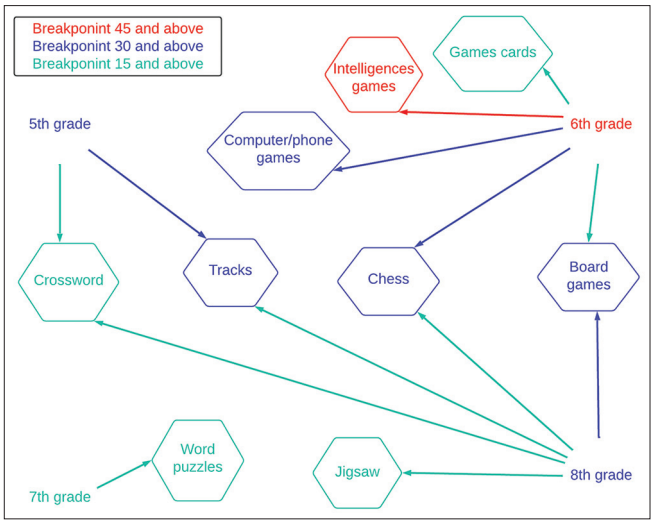

Figure 6: Concept network created for the category of "games"

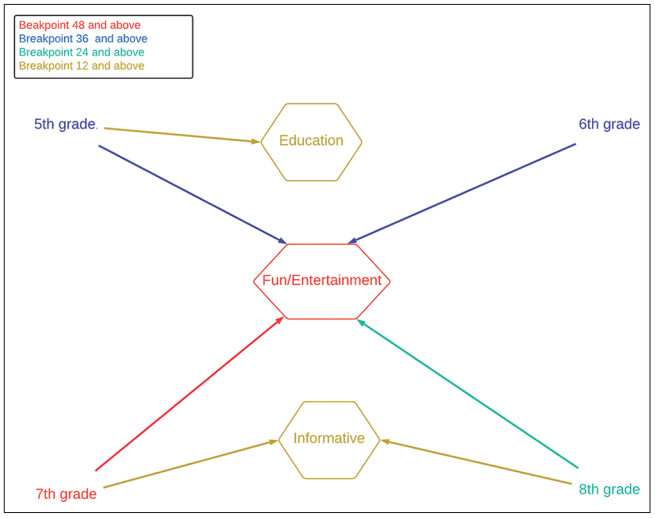

Figure 7: Concept network created for the category of "features of games"

Under this category, nine distinct words were generated. Students in the 6th grade generally connected the key word with the name "intelligence games." It is clear that the 7th grade students only created one word (word puzzle) for this category, and this word was located the cutoff point of 15 and above. Figure 7 displays the concept network built for the "features of games" category.

Three separate words were created with this category in mind. All grade levels related the concept of an educational game with the word "fun/entertainment," and students in the 7th grade used this term the most frequently. Other words associated with this category were "informative" and "educational."

Results from the Drawing Test

Four categories were used to categorize the drawings made by the students to represent the idea of educational games: "physical ability games," "intelligent and strategy games," "puzzle," and "mixed games." The categories of the drawings

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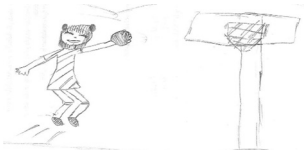
Table 2: The categories of the drawings for the "educational game" and their distribution in accordance with the codes

Category	Codes	5th grade (n)	6th grade (n)	7th grade (n)	8th grade (n)
Physical ability games	Basketball	3	3	3	-
	Football	4	10	3	12
	Skipping rope	2	1	-	2
	Rope pulling	-	11	-	-
	Parkour game	23	9	9	2
	Hide and seek	3	-	-	-
	Playing ball	6	4	1	3
	Volleyball	-	2	2	3
Intelligent and strategy games	Mangala	1	3	-	7
	Chess	7	18	7	17
	Sudoku	1	4	1	14
	Card matching	2	3	1	5
	Uno	1	1	1	2
	Jigsaw	-	-	1	10
Puzzle	English word game	2	4	16	1
	Word puzzles	5	3	7	1
Mixed games	Science concept/experiment game	5	12	8	7
	Math operations game	8	4	1	9
No drawings		9	8	10	7

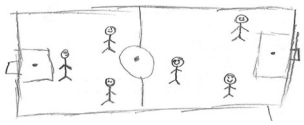
Table 3: Examples of student drawings on the category "Physical ability games"

Basketball



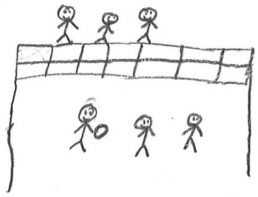
6S-16

Football



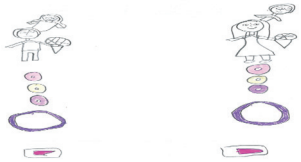
5S-12

Volleyball



7S-23

Parkour game



5S-22

Playing ball

6S-41

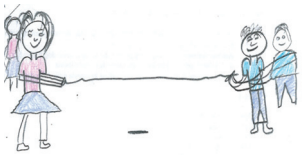
Skipping rope

6S-58

Hide and seek

5S-31

Rope pulling



6S-61

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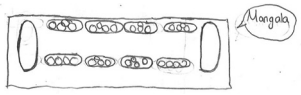
Table 4: Examples of student drawings on the category "Intelligence and strategy games"

Mangala

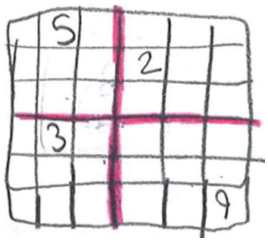


7S-14

Chess

8S-10

Sudoku

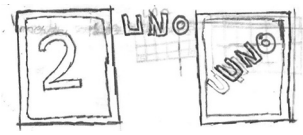


6S-53

Card matching

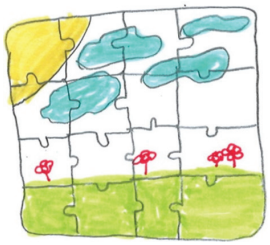
7S-20

Uno



8S-9

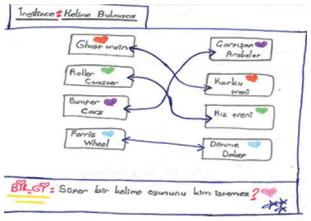
Jigsaw



8S-5

Table 5: Examples of student drawings for the category "Puzzle"

English word game



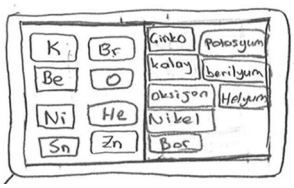
7S-55

Word puzzles

7S-62

Table 6: Examples of student drawings on the category of "Mixed games"

Science concept/experiment game



8S-11

Math operations game

5S-72

for the "educational game" and their distribution in accordance with the codes are shown in Table 2.

While 5th-grade students primarily depicted "parkour game" in their drawings, 6th and 8th grade students depicted "chess," and 7th grade students depicted "English word game." Table 3 provides examples of student drawings on the subject of "Physical ability games."

Examples of student drawings on the category of "intelligence and strategy games" are presented in Table 4.

Examples of student drawings for the "Puzzle" category are presented in Table 5.

Examples of student drawings on the category of "Mixed games" are presented in Table 6.

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DISCUSSION AND CONCLUSION

The purpose of this study was to reveal the cognitive structures of secondary school students regarding educational games. By employing the drawing tests, the students' thoughts and opinions may be presented without the need of words. Drawing tests were used in the study as a result to reveal the students' thoughts and details regarding the concept of educational game without the use of words. Under the category of "game characteristics," 7th and 8th grade students identified the concept of educational games with the word "informative." Although this demonstrates that students value the informative aspect of educational games, the fact that this word is only used by a small number of them suggests that the concept of educational games is not embedded in the cognitive structures of most students. The fact that students in the 5th and 6th grades did not include the phrase "educational" and instead focused on the keyword "fun/entertainment" can be read in a similar way. But educational games are educational games that allow the player to take use of their skills, pay attention, challenge, and think while also enhancing their cognitive and physical talents to achieve new benefits (Tezel and Karacalı, 2018). Although educational games offer a variety of properties, according to definitions in the literature, students only express a small part of these traits, indicating that educational games do not fully take place in students' cognitive structures. In other words, rather than learning something through educational games, students were more interested in the game. The fact that 8th grade students are studying for an exam may be the reason they place less emphasis on the word "fun/entertainment" while discussing this category. Yalçın (2019) asserts that students preparing for high school entrance exam engage in less social and cultural activities. Due to this, 8th grade students who participated in less social and cultural events may have given the word "fun/entertainment" less significance.

According to the WAT, the other words that students most frequently link with the concept of educational game are "gym lesson" and "parkour games" in the drawing test. The exercises they completed in physical education classes could have been viewed as educational games by the students. Since students unintentionally obtain the benefits while having fun during the lesson, it is believed that they identify the educational game with the physical education lecture. Therefore, "educational" component of educational games may have been missed by students. In addition to this, this data can also suggest that the students are not able to connect this concept with the educational component and instead are thinking about typical games rather than a teaching strategy. Students also associate the words "computer/phone games," "crossword," "word puzzle," "board games," "game stamps/card," "chess," "jigsaw," and "intelligence games" with the concept of educational games. The association of the words "puzzle" and "intelligence games" strengthens the idea that students concentrate primarily on the game aspect of the educational game concept. In addition, Figure 2 shows that students in the 6th grade more frequently than students in other grade levels relate the words "educational game" with "gym lesson." Similarly, the 6th grade students play educational games in the gym lesson, according to the demographic data of the students (f = 54) (Graph 1). This leads one to believe that the name "gym lesson" is connected to the concept of an educational game. Students also seem to relate the words "science lesson," "painting lesson," "math lesson," and "English lesson" with the concept of an educational game. This result could indicate that the mentioned lesson's teachers used the educational game technique in their instruction. In addition, teachers frequently include educational games into these courses based on the demographic information of the students (Graph 1). Similarly, the sixth graders said that they spoke more about intelligence games and computer/telephone games in the WAT and that they played more educational games in the information technologies and software course and intelligence games, which is one of their elective courses. Because of this, it is possible that students' cognitive structures correlate the concept of educational games with the lessons in which they participate in games. Because having experiences with an idea directly affects how that concept shapes a person's cognitive structure (Matthews, 2002; Ünal, 1999). From the 5th grade to the 8th grade, it is evident that fewer students are highlighting these words. Eighth graders may not be emphasizing any lessons because they are focusing on studying for the high school entrance exam. It is believed that during the exam preparation period, teachers who instruct their classes with a question-solving emphasis do not have time for educational game applications.

Under the category "games," it can be noticed that the students named a lot of game categories. The purpose of providing examples of games is maybe to help the concept acquire a meaningful cognitive structure through exemplification. The fact that the "word puzzle" game was the only one the 7th grade students provided as an answer word and that term was barely repeated is a surprising result. Because the person can explain and describe the idea s/he has created in her/his head more readily. Only 6th graders mentioned computer/phone games when asked about the diversity of games; students in other grade levels did not place as much emphasis on this word. This finding would suggest that students do not consider technological games in an educational dimension. When the students' drawings are looked at, it is parallel with this finding that they do not exhibit any technical games. As a result, it can be concluded from this research that students' cognitive structures for the concept of educational games include the games they have played in lessons, that educational games emphasize the game aspect more, and that there is little vocabulary diversity in their cognitive structures for the educational dimension. To enhance students' cognitive structures toward educational games, focus should be given to the instructional feature of educational games in research to be undertaken in the relevant field. The WAT can be used to identify secondary school students' conceptual structures.

This allows for the adaptation of educational processes to the cognitive frameworks of the students. As a consequence, more effective teaching methods could be found. In addition, it is advised that while developing educational games for secondary school students, the instructional component should be emphasized similar manner to the enjoyment component.

Ethical Statement

This research was conducted by the approval of the Social and Human Sciences Ethics Committee, Trabzon University, Türkiye, and numbered E-81614018-000-2200054633. The researchers obtained a written informed consent form from all the participants to conduct this study.

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APPENDIX

Appendix 1: Frequency table of codes and categories

Categories	Codes	5th grade	6th grade	7th grade	8th grade
Individual gains	Reasoning	8	9	9	12
	Development	9		12	
	Happiness		13	11	
	Mind developing	16	8	8	10
	Playing a game	11	30	16	18
	Learning	26	23	22	9
Lessons	Gym lesson	31	52	15	
	Science lesson	24	38		
	English lesson	20	27	15	
	Math lesson		19		
	Painting lesson	15			
Sports	Basketball	10	5		12
	Football	16			9
	Volleyball	5			15
Lessons tools/applications	Smart board	14	12		
	Experiment	7	15	14	
	Technological tool		10		
Games	Computer/phone games		35		
	Crossword	16			28
	Word puzzles			17	
	Board games		16		34
	Games card		23		
	Tracks	33			17
	Chess		38		22
	Jigsaw				25
	Intelligence games		45		
Features of games	Informative			16	13
	Fun/Entertainment	37	36	50	32
	Education	12			