İSTANBUL UNIVERSITY CERRAHPAŞA

HAYEF: Journal of Education, 18(3); 517-538

DOI: 10.5152/hayef.2021.21027

Received: April 8, 2021
Accepted: September 8, 2021

HAYEF: Journal of Education

RESEARCH ARTICLE

Testing the Effectiveness of PASS Theory-Based Cognitive Games on Students' Cognitive Processing Areas and Academic Performance

Tamer ERGİN

Department of Unit of Educational Sciences, Department of Guidance and Psychological, İstanbul University-Cerrahpaşa, Hasan Ali Yücel Faculty of Education, İstanbul, Turkey

Abstract

The goal of this research is to develop the "Cognitive Intervention Program with PASS Theory-Based Games" and to test it on the cognitive processing areas and academic performance of students with special learning disabilities. A pre-test/post-test control group experimental model was used in the study. This study was carried out on a total of 20 students who were diagnosed with a special learning disability, 10 of whom were in the experimental group and 10 were in the control group. The program was applied to the experimental group 1 hour per week for a total of 24 hours. Individually applied Cognitive Assessment System (CAS) and "Weighted Year-End Grade Point Averages (WGPA)" were used as data collection tools in the study. The children in the control group, on the other hand, continued their academic support activities within the scope of their current curriculum. In the analysis of the data, Unrelated (Independent) Group t-Test and Related (Dependent) Group t-Test were applied. As a result of the research, it was found that the cognitive processing areas and WGPA post-test scores of the experimental group were significantly higher than the pre-test scores, and the post-test scores of the experimental group were also significantly higher than the post-test scores of the control group. This finding shows that the program is effective in cognitive processing areas and academic performance of students with a diagnosis of special learning disability

Keywords: CAS, cognitive intervention, game, PASS theory, play, special learning disability, WGPA

Introduction

The word cognition refers to mental activities that involve learning and understanding our world. Cognitive development consists of all mental processes that enable a person to learn and understand (Yavuzer, 2011). All of these activities like using imagination, problem-solving, recalling information, turning to some stimuli and ignoring some stimuli, seeing the relationship between stimuli, etc., constitute the functional aspect of cognitive processes that are evaluated in cognitive development, in other words, cognitive functions. According to this definition, it is possible to consider cognitive functions as functions of cognitive processing areas. Developmental changes in these cognitive functions discussed also shed light on the formation of theories used to explain cognitive development (Kirby & Williams, 2000).

Corresponding Author: Tamer ERGİN **E-mail:** tergin@iuc.edu.tr

Cite this article as: Ergin, Ü. T. (2021). Testing the effectiveness of PASS theory-based cognitive games on students' cognitive processing areas and academic performance. *HAYEF: Journal of Education*, *18*(3), 517-538.

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Developmental changes in these cognitive functions are changes that occur sometimes depending on age and sometimes depending on the environment rich in stimuli, and they are effective in the development of cognitive processing areas. The effort to find a formula that creates high mental performance has made cognitive development a subject that is constantly studied and created a research ground on which various theories are formed (Clark, 2015). One of them is the PASS theory. PASS theory is based on the views of Luria (1973), which presents a working map of the brain. Das et al. (1994) established the connection between Luria's (1973) views and intelligence for the first time and suggested that the cognitive abilities, they call PASS, can be reinterpreted from a cognitive processing point of view. According to this theory, intelligence is considered together with the neuropsychological functions defined by Luria (1973) and is explained by these four basic psychological processes (PASS).

PASS theory deals with human cognitive functions according to four cognitive processing areas. These are Planning, Attention, Simultaneous, Successive. The processing area, which represents these four basic cognitive abilities, fulfills all cognitive functions related to human life. Planning is defined with functions such as providing cognitive control, choosing the appropriate function, and using effective strategies to achieve the desired goal, determination, and self-control. Attention is to be able to perform cognitive functions that provide cognitive activity in a focused and selective manner within a certain period of time. For this cognitive process, it requires staying on the stimulus line both during the reception of the stimulus input (perceptual attention) and during the output process (expressive attention). Simultaneous is to process separate stimuli as a single whole and to see the relationships between the stimuli and to make analytical inferences that can be the product of high-level thinking in this way. Successive, on the other hand, is considered as a cognitive process in which remembering the stimuli by putting in a certain sequential order, that is defined as memory. In addition, simultaneous and successive cognitive processes include two different forms of processing information (Naglieri et al., 2014). Interventions will be much more effective when the mental factors that affect the student's learning performance are associated with the academic skill areas that the student has difficulty with. Knowing which cognitive processing areas are associated with the academic problems experienced by the student will enable educators and families to be more effective in helping their children. When their children begin to have academic problems, families and educators usually spend most of their time managing and controlling all these variables that affect learning and finding alternative solutions, and they want to do this as soon as possible (Naglieri & Ashman, 1999). There is no educator who does not know that every student learns in a different way. However, students with different developmental characteristics, and therefore, have learning problems, are special children that need to be handled individually and require special attention because they have some different characteristics. In addition, educators, being

aware of the importance of the environmental factor in terms of cognitive development, should provide the necessary environmental arrangements for the child to develop in a cognitively healthy way. Play is the child's main occupation, main job, and the most basic way of learning. Through the game, the child communicates with his environment, socializes, expresses his feelings and thoughts, and can reflect his growth around him (Oktay, 2010). Play has an important place in children's physical, emotional, social, language, and especially cognitive development, because the child learns to think and explore through games, develops physical skills, gains confidence that he/she can do it, communicates with his environment, and gains the ability to make and implement self-decisions (Yavuzer, 2010).

While Piaget, Bruner, and Vygotsky put forward their theories about cognitive development, they especially focused on the effects of play on cognitive development. Their studies have been those that explain the intensity and magnitude of the relationship between play and cognitive development, explore the "causal effect" of play on development, or the educational aspect of play (As cites Yavuzer, 2011). A person with the game, incorporates events and objects into their existing mental structures (Nicolopoulou, 1993).

According to Piaget, play is an important way of assimilation and adaptation of what is received from the outside world in cognitive development. Piaget emphasizes the importance of the relationship between mental development and play. Play is an important element that is always present in human behavior and supports the mental development of the child throughout his/her life. As in the development of the mind, there are stages in the development of the play. For example, in adolescence, the rules of the game are as important as the game, and therefore play with rules is at the forefront (Baykoç Dönmez, 2000). According to the PASS theory, play can be considered as a supporting element in the development of cognitive processes. According to Luria, the cognitive process, which usually starts at the age of four, can turn into a comprehensive mental power with the effective use of various cognitive functions (Das et al., 1994). It can be aimed to reach this comprehensive mental power by choosing games that require effective use of cognitive functions as a tool. When a student uses effective strategies while playing games or supports game performance with new strategic approaches, when he/she can control his emotions, thoughts, and behaviors during the game, when the chosen educational game or game materials require strategic thinking, he/she will have used the cognitive process defined as planning in the PASS theory. For example, while doing jigsaw puzzles, he/she will start using strategy when he/she starts to classify the pieces according to their colors. Being aware of whether his/her strategy is effective or ineffective, he/she will continue the game and change the strategy with a new one when necessary. Planning performance as a cognitive processing area will be supported when educational games or game materials related to this organizing aspect of the planning process are selected.

He/she will have effectively used the cognitive process defined as Attention in PASS theory when the student selectively focuses on the game-related material during the game, can maintain this focusing performance throughout the game, can focus selectively on the details of the stimulus during the game, creates a balance of speed and power, focuses on more than one stimulus at the same time as per the game rule, and suppresses distracting stimuli. When a student uses the perception of place, direction, and space effectively with the selected game or game materials, especially when he/she plays the directed games in which topological explanations are used heavily, he/she will have used effectively the area defined as Simultaneous cognitive processes in the PASS theory. During the activities with educational games and toys that require the effective use of memory, the area defined as Successive cognitive processes in the PASS theory will be used effectively. For this reason, in our research, it is aimed to create a stimulus environment that supports cognitive processing areas defined by PASS theory during the game, which is one of the jobs that students take most seriously. In addition, it is aimed to make these cognitive processes related to each other in the academic field with in-class activities, and in this way, to build a bridge between academic skill areas and cognitive processing areas. Thus, it is aimed that students participate more in academic studies, cooperate and make their learning performance effective and permanent.

In this research, it has been tried to test whether PASS theory-based games are effective on students' cognitive processing areas and academic performance. When the research is over, it is thought that this research will guide experts who will work with children having learning disabilities to identify their strong and weak areas of cognitive processing, to define the relations of these areas with academic tasks, and to structure and implement a game-based program based on PASS theory to intervene in these areas.

Method

Research Model

Experimental research model (design) with a pre-test/post-test control group was used in this study. The experimental model reveals the cause–effect relationships of the variables to be measured after the applications are performed under certain rules and conditions. For this purpose, in the pre-test/post-test experimental design with the control group, the experimental and control groups were formed by unbiased assignment, and measurements were carried out in both the control group and the experimental group (Balcı, 2010; Karasar, 2000).

Working Group

The study group of the research consists of the students of Çiftehavuzlar Secondary School in Kadıköy, İstanbul, which is the application school of the Erasmus+ project

with the theme "Play with me – tradition and modernity in active teaching" no 2015-1-PL01-KA219-017178. The research was carried out on a total of 20 students, 10 of whom were in the experimental group, and 10 in the control group, who were referred to the Guidance Research Center (RAM) by the school guidance service due to their learning problems and were diagnosed with special learning disabilities. The students are between the ages of 10–13 and 14 of them are 6th grade students and the rest of them 7th grade students. Eight of the students are girls and 12 are boys.

Data Collection Tools

In this study, Cognitive Assessment System (CAS) Standard Battery was used to collect data. Cognitive Assessment System is an expert-structured cognitive assessment battery developed to evaluate the cognitive processes of children aged 5–17, applied individually by certified experts. Cognitive Assessment System was developed based on PASS theory. There are two forms of CAS: "Standard Battery" and "Basic Battery." In each of these two batteries, there are four separate scales (Planning, Attention, Simultaneous, Successive) containing the four areas of PASS theory. In the standard battery, each of these scales consists of three subtests (12 subtests in total). In the basic battery, each of these scales consists of two subtests (eight subtests in total) (Naglieri & Das, 1997).

The mean of the subtest score on each PASS scale is 10, and the standard deviation is 3. Each scale is combined to give a standard score with a mean of 100 and a standard deviation with a mean of 15. Cognitive Assessment System Turkish adaptation studies were started by Ergin in 2003 and continued with masters and doctoral theses (Akın, 2006; Dondurucu, 2006; Yılmaz, 2008). Reliability coefficients in studies vary between $r = .60–.99$. Considering the calculated Pearson product moments correlation coefficient, there was a significant relationship at $p < .001$ level between all subtests; again, the relationship between the four CAS scales was reported to be significant.

Development of Cognitive Intervention Program with PASS Theory-Based Games

It has been determined that the programs in which the game is used as a tool are generally related to pre-school children (Çağdaş & Yıldız, 2003; Türkoğlu, 2016). However, it is seen that games are also used in academic skills such as reading, writing, mathematics, and science at primary and secondary school level (Babayiğit & Gültekin, 2019; Bayat et al., 2014; Boz, 2018; Gedik, 2017; Kılıç & Karamustafaoğlu, 2020; Naglieri & Gottling, 1995; Tural, 2005). There are also game programs structured to develop thinking skills, especially creativity (Bulut, 2015; Bütün, 2017; Çelebi Öncü, 2018). While the rapid growth of research into gaming has produced some valuable results, the overall pattern of this research is disorganized and disconnected, and most of them do not appear to have been clearly thought through or

follow a promising theoretical agenda. Some research approaches often refer to a broader framework of interest, but whether researchers pay careful attention to the rationale and implications of this broader framework, use the strongest or most relevant elements that framework has, or make the most effective use of that framework's theoretical resources, it is not always clear whether these methods apply to specific problems that arise in relation to children's play (Nicolopoulou, 1993).

Likewise, it has been determined that games are used in many intervention programs developed for learning disabilities. It has been found that some of these are structured by focusing only on specific academic skills such as literacy. İlker and Melekoğlu (2017) emphasized that in the studies on the writing skills of students with special learning difficulties, the focus is mainly on writing strategies, whereas cognitive skills, which is one of the areas in which students with writing difficulties have the most problems, should also be supported. It is seen that some cognitive intervention programs were developed without fully representing all dimensions of the theory on which they are based, and some of them were prepared without any theoretical basis. When the literature is examined, it is seen that many cognitive intervention programs developed based on the PASS theory (Ashman & Conway, 1993; Ergin et al., 2011; Kirby & Williams, 2000; Peker et al., 2018; Tomporowski et al., 2008).

With this research, instead of adapting an existing program, the existing cognitive intervention programs, various researches on this subject, doctorate and masters theses conducted under the supervision of the researcher, and the findings of the projects on this subject were examined and then an original game-based cognitive intervention program was developed in accordance with the content of the "Play with me -tradition and modernity in active teaching" project based on the PASS theory. For this reason, the cognitive intervention program that has been developed has been named as "Cognitive Intervention Program with PASS Theory Based Games." PASS theory is a new theory based on a neuropsychological approach, including four cognitive processing areas and a measurement tool (CAS). One of the reasons why PASS theory was taken as a basis in the development of this program is that there is a measurement tool developed based on this theory. In this way, it will be possible to evaluate the effectiveness of the program. In addition, the four cognitive processing areas that make up the PASS theory represent general cognitive abilities, give the opportunity to look at the causes of learning problems from a wider perspective, and emphasize the importance of supporting these areas. Global (related to general cognitive ability areas) activities prepared for this study and aiming to support general cognitive abilities includes games or game materials that aim to create developmental change by interfering with cognitive development areas. Global activities are exercises about Planning, Attention, Simultaneous, and Successive cognitive abilities defined by the PASS theory that aims at the development of functions in special cognitive abilities,

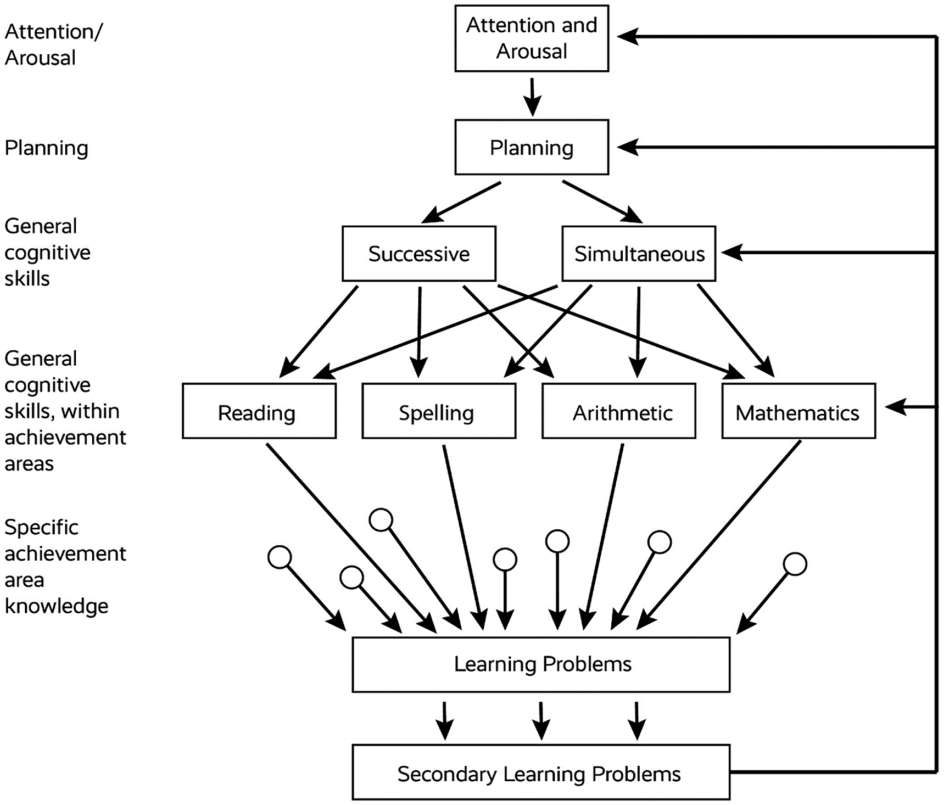

Figure 1.
The Emergence of Learning Problems (Kirby & Williams, 2000).

such as using strategies, selectively focusing, maintaining attention, seeing spatial relationships between stimuli, reasoning, visual memory, taking instructions, auditory memory, etc.

Kirby and Williams (2000) stated in Figure 1 that according to the PASS theory, cognitive processing areas and academic skills are related, and this plays a role in the emergence of learning problems.

It is known that general cognitive abilities affect student performance in general or in other words basic academic skills such as reading, spelling, writing, and mathematics. This effect can sometimes be from a cognitive processing area to an academic skill area, or it can be for more than one academic skill area. Performance loss in certain academic skill areas where success is expected can also cause secondary problems in cognitive processing areas.

For this reason, it is important to include studies that will bridge general and special academic ability areas as well as support general and special cognitive skill areas in a cognitive intervention program (Das, 2001; Kirby & Williams, 2000; Naglieri &

Pickering, 2010). For example, it will be important to support the spatial perception area from cognitive functions in order to bridge a general academic skill area such as mathematics to a specific academic skill area such as geometry. The bridge activities in the program include the techniques to be used by the educators and the studies that can contribute to the support of the performance in the fields of general and special academic skills.

For this reason, "Cognitive Intervention Program with PASS Theory Based Games" activities have been prepared as global and bridge activities. Four cognitive processing areas defined by PASS theory were taken as criteria in educational games or toys to be selected for global and bridge activities. Planning, one of the four cognitive processes, is a mental process in which an individual can use appropriate ways, methods, and strategies in order to control his/her emotions, thoughts, and behaviors, produces alternative solutions to problem situations, determines solutions, chooses, applies, evaluates his/her practices, and uses alternative ways, methods, and strategies for newly encountered situations. Therefore, while choosing educational games and toys for the planning process, attention was paid to include activities that require the use of effective strategy during the game or the production of strategic ways or methods, thus requiring strategic thinking and creative thinking skills, and making people think of effective strategies for speed and power balance during the game. Attention is a mental process that enables the individual to selectively focus on one or a few stimuli, to prevent other competing stimuli, to stay on the stimulus line while listening, to speak, to write, and to maintain focusing performance within a certain period of time. For this reason, while choosing educational games and game materials for the attention process attention was paid to include activities that include perceiving details in stimuli during the game, using the balance of speed and power, selectively focusing on a single stimulus, or focusing on more than one stimulus at the same time when necessary. Simultaneous cognitive processing is defined as a mental process in which the individual deals with separate stimuli by associating them with each other and in a whole, thus using the analytical thinking skill effectively. Especially this cognitive process is used effectively during the interpretation of visual stimuli and analytical relations between stimuli and the perception of verbal spatial relations. Therefore, while choosing educational games and game materials for simultaneous cognitive processing care was taken to ensure that it consists of visual/three-dimensional/built game tools, activities that require the use of place, direction, and space during the game, and activities that involve taking and giving instructions. Successive cognitive processing is a mental process in which the individual combines stimuli to form a chain-like special sequence and predominantly represents memory. For this reason, while choosing educational games and game materials for successive cognitive processing attention was paid to the effective use of memory during the game, the use

of sequential information, the use of patterns, and activities that require the use of rhythm studies such as poetry, songs, rhymes, and rhythmic counting.

In addition, attention was paid that the educational games and game materials to be included in the program were not based on competition but on cooperation. Then, by looking at the CAS results of each student, which was applied as a pre-test, it was determined which one or which of the cognitive processing areas had low performance. In addition, the academic skill area or areas that each student has difficulty in were determined. Then, educational games and game materials were selected with the teachers that will bridge the academic skill areas in the classroom and support the cognitive processing areas that need to be developed in the students. In this way, within the scope of bridge activities that contribute to both global and academic fields for developmental change, game, and game materials were selected and the program was structured by the researcher.

Implementation of Cognitive Intervention Program With PASS Theory-Based Games

The Cognitive Intervention Program with PASS Theory-Based Games was implemented within the scope of the Erasmus + project on "Play with me – tradition and modernity in active teaching," which was carried out for 36 months between 2015 and 2018, and in the last year of the project for the part of the project that constitutes the differentiation title. Before the implementation of the program, interviews were conducted with the families, and their consent was obtained. Voluntary participation of students in the project work was ensured with the project approval of the Ministry of National Education and with the permission of their families. Then, in September of the 2017–2018 academic year, a 16-hour training was given by the researcher to two psychological counselors who will implement the Cognitive Intervention Program with PASS Theory-Based Games and 21 teachers who will support the students by using differentiated bridge activities on the use of game materials and games selected according to the cognitive processing areas defined by the PASS theory in order to support the development of children's cognitive processing areas. Then, supervision support was provided to psychological counselors and teachers for 1 hour a week throughout the implementation process. The implementation of the "Cognitive Intervention Program with PASS Theory Based Games" started on 6 November 2017 and the program ended on 11 May 2018. The training program continued for 24 weeks (6 months) and was completed in 24 sessions. A make-up study was carried out at a different time with students who could not attend the session due to illness or other reasons.

Studies carried out by psychological counselors consist of educational games and game materials with global content targeting the developmental change of the

program in cognitive processing areas defined by PASS theory. With the experimental group consisting of 10 students, the program was carried out in two groups of five people. Two psychological counselors worked with each group of five students for one lesson per hour 1 day a week. Because as a result of the researches using cognitive intervention programs, Naglieri and Gottling (1995), recommended that cognitive intervention applications should be done in small groups or individually instead of the whole class in order to give effective results.

A holistic approach has been taken while working on the development of four cognitive processing areas defined by the PASS theory. Attention was paid to cover all cognitive processing areas of the 1-hour study, but particular emphasis was placed on cognitive processing areas where students performed poorly. Because according to Clark (2002), even if a student exhibits high performance in cognitive processing areas, he/she will not be able to show his/her real performance when there is asynchronization between these cognitive processing areas. One of the known characteristics of students with special learning disabilities is that although they have normal mental performance compared to their peers, their cognitive processing areas are not in consistent performance with each other. All of these ways and methods have been used in the execution of bridge activities as well as their global content studies. Differentiation-oriented bridging activities carried out by the teachers in the classroom were enriched with educational games selected in accordance with the PASS cognitive processing areas.

The students forming the control group were selected from the classes with teachers who were not involved in the project. These teachers, in order to find solutions to the problems experienced by the students in their academic skills, enriched their activities with academic studies and pursued more academic works through etudes. After the implementation of the program ended, CAS was applied again to the children in the experimental and control groups to collect the post-test data.

Data Collection

In order to collect the data in the research, CAS and the Weighted Year-End Grade Point Averages (WGPA) of the students for the 2016–2017 and 2017–2018 academic years were used. Cognitive Assessment System was applied to students diagnosed with special learning disabilities by RAM (Guidance Research Center) between October 16 and 27, 2017. In order to evaluate the effect of the applied program on the academic performance of the students, the criteria were taken as WGPA-2017, which was determined according to the basic courses of the 2016–2017 academic year, which was the academic year before the academic year in which the program was started, and WGPA-2018 at the end of the 2017–2018 academic year, which was the academic year in which the program was implemented.

Experimental and control groups were created as a result of statistical equating of groups based on CAS results and WGPA. Following the implementation of the game-based intervention program based on the PASS Theory, CAS was re-administered as a post-test between May 14 and 25, 2018 to experimental and control group students.

Analyzing Data

In order to determine which statistical analyzes would be used in the study, the distributions of the measurements of the experimental and control groups were examined and as a result of the Kolmogorov–Smirnov test, the difference between the distributions and the normal distribution was not found significant (CAS Full Scale Score Pretest: $z = .824$; $p > .05$; CAS Full Scale Score Posttest: $z = 1.051$; $p > .05$; WGPA-2017: $z = .670$; $p > .05$; WGPA-2018: $z = .933$; $p > .05$). Thereupon, it was decided to apply parametric statistical analyzes in order to test the hypotheses. The Independent (unrelated) Group t-test was used to compare the differences between the pre-test and post-test scores of the experimental and control group students, and the Dependent (related) Group t-test was used for the pre-test/post-test comparisons of both groups. The statistical significance level in the study was determined as .05.

Results

In this section, first, the results of the Unrelated (Independent) Group t-test, which is one of the parametric statistical techniques, in the comparison of the differences between the pre-test and post-test scores of the experimental and control group students are given. Afterwards, the results of the Related Group t-test, which was applied to test the significance of the difference between the pre-test post-test scores, were given after the application of the Cognitive Intervention Program with PASS Theory-Based Games to the experimental group.

As seen in Table 1, there was no statistically significant difference between the groups according to the results of the Independent Group t-test applied to determine whether the 2016–2017 academic year WGPA-2017 and the CAS Full Scale Score and scales pre-test scores of the students differed between the experimental and control groups. This finding indicates that the groups were initially equated.

As seen in Table 2, there was a statistically significant difference between the groups according to the results of the Independent Group t-test, which was applied to determine whether the students' 2017–2018 academic year WGPA-2018 and CAS Full Scale score and scales post-test scores differed between the experimental and control groups. It is seen that the post-test scores of the experimental group were significantly higher than the post-test scores of the control group in all scales.

Table 1.
Independent Group t-*Test Results to Test the Significance of the Experimental and Control Groups' WGPA-2017 and CAS Full Score and the Pre-test Scores of the Scales*

						t-Test		
Score	**Groups**	**N**	**M**	**SD**	**MSE**	***t***	***df***	***p***
WGPA-2017	Control	10	74.20	6.178	1.95391	.419	18	.680
	Experimental	10	73.10	5.546	1.75404			
Planning Scale	Control	10	83.70	6.929	2.191	.146	18	.886
	Experimental	10	83.30	5.208	1.647			
Simultaneous Scale	Control	10	91.60	8.044	2.544	.026	18	.979
	Experimental	10	91.50	9.046	2.861			
Attention Scale	Control	10	83.50	8.873	2.806	.153	18	.880
	Experimental	10	83.00	5.292	1.673			
Successive Scale	Control	10	87.70	6.832	2.161	.075	18	.941
	Experimental	10	87.40	10.627	3.361			
CAS Full Score	Control	10	82.20	5.554	1.756	.190	18	.851
	Experimental	10	81.70	6.201	1.961			

Table 2.
Results of the Independent Group t-*Test Applied to Test the Significance of the Difference Between WGPA-2018 and CAS Full Scale Score and Post-test Scores of the Experimental and Control Groups*

						t-Test		
Score	**N**	**M**	**SD**	**MSE**	***t***	***t***	***df***	***p***
WGPA-2018	Control	10	73.50	6.737	2.130	−3.500	18	.003
	Experimental	10	82.50	4.552	1.439			
Planning Scale	Control	10	83.20	3.048	.964	−4.671	18	.000
	Experimental	10	97.00	8.832	2.793			
Simultaneous Scale	Control	10	92.30	8.056	2.548	−2.288	18	.034
	Experimental	10	102.70	11.908	3.765			
Attention Scale	Control	10	83.90	6.967	2.203	−2.885	18	.010
	Experimental	10	95.30	10.371	3.280			
Successive Scale	Control	10	87.80	6.052	1.914	−2.121	18	.048
	Experimental	10	97.60	13.302	4.206			
CAS Full Score	Control	10	81.80	2.860	.904	−3.649	18	.002
	Experimental	10	97.50	13.302	4.206			

As seen in Table 3, there was not found a statistically significant difference between the pre-test and post-test scores of the control group as a result of the Related Group t-test applied to determine the difference between the control group students' WGPA-2017 and WGPA-2018, CAS Full Scale score and Scales pre-test/post-test scores.

As seen in Table 4, a statistically significant difference was found between the pre-test and post-test scores of the experimental group as a result of the Related Group t-test applied to determine the difference between the experimental group students' WGPA-2017 and WGPA-2018, CAS Full Scale score and Scales pre-test/post-test scores. In all tests, it is seen that the post-test scores of the students in the experimental group were significantly higher than the pre-test scores.

Table 3.
Related Group t-*Test Results Used to Test the Significance of the Pre-test/Post-test Scores of the Control Group WGPA-2017 and WGPA-2018, CAS Full Scale Score and Scales*

					***t*-Test**		
Score	**M**	**N**	**SD**	**MSE**	***t***	***df***	***p***
WGPA-2017	74.20	10	6.178	1.953	.509	9	.623
WGPA-2018	73.50	10	6.737	2.130			
Planning Scale Pre-test	83.70	10	6.929	2.191	.220	9	.831
Planning Scale Post-test	83.20	10	3.048	.964			
Simultaneous Scale Pre-test	91.60	10	8.044	2.544	−.805	9	.442
Simultaneous Scale Post-test	92.30	10	8.056	2.548			
Attention Scale Pre-test	83.50	10	8.873	2.806	−.256	9	.804
Attention Scale Post-test	83.90	10	6.967	2.203			
Successive Scale Pre-test	87.70	10	6.832	2.161	−.067	9	.948
Successive Scale Post-test	87.80	10	6.052	1.914			
CAS Full Score Pre-test	82.20	10	5.554	1.756	.281	9	.785
CAS Full Score Post-test	81.80	10	2.860	.904			

Table 4.
Related Group t-*Test Results Used to Test the Significance of the Pre-test/Post-test Scores of the Experimental Group WGPA-2017 and WGPA-2018, CAS Full Scale Score and Scales*

					***t*-Test**		
Score	**M**	**N**	**SD**	**MSE**	***t***	***df***	***p***
WGPA-2017	73.10	10	5.546	1.754	−5.704	9	.000
WGPA-2018	82.50	10	4.552	1.439			
Planning Scale Pre-test	83.30	10	5.208	1.647	−8.353	9	.000
Planning Scale Post-test	97.00	10	8.832	2.793			
Simultaneous Scale Pre-test	91.50	10	9.046	2.861	−4.162	9	.002
Simultaneous Scale Post-test	102.70	10	11.908	3.765			
Attention Scale Pre-test	83.00	10	5.292	1.673	−4.090	9	.003
Attention Scale Post-test	95.30	10	10.371	3.280			
Successive Scale Pre-test	87.40	10	10.627	3.361	−4.553	9	.001
Successive Scale Post-test	97.60	10	13.302	4.206			
CAS Full Score Pre-test	81.70	10	6.201	1.961	−6.163	9	.000
CAS Full Score Post-test	97.50	10	13.302	4.206			

Discussion, Conclusion, and Recommendations

It was determined that the post-test scores of the experimental group regarding the CAS Full Scale scores were significantly higher than the post-test scores of the control group. In addition, it was determined that the post-test scores of the experimental group regarding the CAS Full Scale scores were significantly higher than the pre-test scores. This finding shows that holistic development has been achieved in cognitive processing areas, which is one of the primary goals of the Cognitive Intervention Program with PASS Theory-Based Games, which was applied to the experimental group.

According to Languis & Miller (1992) and Reynolds (1981) for holistic development in cognitive processes, cognitive processing areas need to affect each other and be affected by each other. For example, it is accepted that a suitable level of stimulation is needed for the planning area, in other words, there is a need for effective use of attention. In the same way, an action plan is needed in order for the appropriate level of arousal and attention to be in the stimulus during an activity. Effective planning needs the appropriate degree of stimulation, as well as the suppression and control of inappropriate arousal. Optionally suppressing and controlling arousal or facilitating activity is one of the important functions associated with planning. In addition, the way an individual uses information is also affected by previous learning experiences, that are involved in memory (As cites Reynolds & French, 2005). The PASS theory, built on Luria's views, also argues that cognitive processing areas work together, but there can be changes at any time, each contributing to the achievement of specific goals.

It was determined that the planning, **s**imultaneous, attention, and successive cognitive processes post-test scores of the experimental group were significantly higher than the control group's post-test scores. Again, the post-test scores of the CAS scales of the students in the experimental group were found to be significantly higher than the pre-test scores. These findings are discussed in turn.

If a student's performance is strong in the “Planning” cognitive processing area; this student uses effective strategies to complete the activity, can change the plan if the plan does not work, monitors the effectiveness of the plan, rethinks the problems, is open to new ideas, uses feedback to produce new strategies, and can control his/her feelings, thoughts and behaviors. However, if the student's planning performance is weak; cannot produce effective strategies to achieve a goal, uses the same plan over and over again even if the plan he has made does not work, cannot think deeply for the success of the planned activity, cannot switch to a new plan when necessary, resists changes, is inflexible, is closed to feedback, and cannot benefit from feedback (Naglieri & Pickering, 2010).

During the “Cognitive Intervention Program with PASS Theory-Based Games” applications, each student was specifically asked to explain the strategies that he or she would use or uses before, during, and after the educational games, and time was spared to that conversations. In order to support the ability to produce alternative ideas, educational games that support creative thinking skills are also included. In this way, it is seen that students have made positive developments in functions such as; creating an action plan and implementing this plan, evaluating whether the activity is suitable for its goal, deciding whether the plan is valid, and determining whether it can change the plan when necessary, making decisions or decisions to produce solutions to new situations, using effective strategies, using strategic strategies when necessary making changes in the approach, developing new effective strategic

approaches, explaining the strategies used, etc. and this reflects positively on the students' WGPA, that is, their academic skills. According to Naglieri and Pickering (2010), planning studies in a cognitive intervention program aim to help students learn successfully with self-awareness. Those who are successful in learning know how to study well, use appropriate and effective learning strategies, and organize their own work. As a result of the study conducted by Naglieri and Gottling (1995), it was determined that students were more courageous in classroom practices during activities related to planning. In the study of Peker et al. (2018) on "Life Kinetic Cognitive Motor Coordination Training and Its Effect on Cognitive Processes," planning performance as a cognitive processing area was found to be significantly higher. Life Kinetic training can be applied to increase the sports efficiency of the players and athletes by enabling them to judge how correct their decisions are during the decision-making process and to learn how to use their intelligence throughout the entire competition. Life Kinetic is a training model that includes exercises that require continuous active thinking. Life Kinetic exercises help to create new neural connections in the brain by combining the intellectual contents as a whole simultaneously and in motion. In this way, athletes can reach the level where they can make quick decisions (Lutz, 2010). In this study, the planning scale post-test scores of the students are considered to be significantly high, as games that require strategy use, correct decision making, and speed-power balance were selected for planning performance.

The post-test scores of the experimental group on the "Attention" scale, which is another cognitive processing area, were found to be significantly higher than the pre-test scores. In addition, the post-test scores of the experimental group were found to be significantly higher than the post-test scores of the control group.

If students' performance in the cognitive processing area is conceptualized as attention is strong; it is observed that he/she can focus even in complex environments with distracting elements, can concentrate well during work, can focus on a single stimulus selectively when he/she needs to focus on a single stimulus and eliminates other stimuli, can work without losing his/her focus in environments with multiple stimuli or when he/she needs to focus on more than one stimulus, he/she can see and continue his/her working time until he/she completes the activity. If the student's attention performance is weak; it is observed that he/she cannot resist the distracting elements in the environment, has difficulty in situations where he/she has to focus on more than one stimulus at the same time, can focus on short-term studies, has a short attention span, has difficulty perceiving details (Naglieri & Pickering, 2010). This situation naturally reflects negatively on the learning performance of the students. It was determined that the students in the Attention Deficit (AD) diagnosis group got lower scores from the attention scale than the students in the Special Learning Disability (SLD) and Hyperactivity Disorder (HD) diagnosis groups. In addition, it was found that the students in the HD diagnosis groups got lower scores from the

attention scale than the students in the SLD diagnosis group. This finding supports the definition of planning and attention as cognitive processing areas as separate but intertwined cognitive processes. In a study conducted by Lutz (2011) on 34 children aged 9–12 and having learning problems, the effect of Life Kinetic training on the development of attention and orientation was examined. The post-test attention and fluent intelligence values of the experimental group who did Life Kinetic training were found to be significantly higher than the pre-test attention and fluent intelligence values. Life Kinetic training is organized in a way that sometimes requires focusing on a stimulus, focusing attention on more than one stimulus, blocking external stimuli, and resisting external factors that will disrupt attention. With this aspect, Life Kinetic training has a structure that can directly affect the flexibility of attention which is one of the components of attention, which requires concentration and focus on a single stimulus, which includes the prevention of external stimuli, maintenance of attention, and the separation of attention in a way that requires focusing on more than one stimulus at the same time. The significant improvements in the attention performance of the group doing life Kinetic Training show that it is due to this effect of the training. For this reason, the educational games and game materials selected for the Cognitive Intervention Program with PASS Theory-Based Games were selected with functions defined for attention. Considering the role of this cognitive ability in academic skills, it can be thought that the students in the experimental group also contributed to the increase in WGPA. When the literature studies were examined, supportive findings were also obtained.

On the other hand, in the results of "Simultaneous," another cognitive processing area, the post-test scores of the experimental group were found to be significantly higher than the pre-test scores. Likewise, the post-test scores of the experimental group were found to be significantly higher than the post-test scores of the control group students.

If students' performance is strong in the cognitive processing area conceptualized as simultaneous; they see the analytical relationships between the pieces of information in the given content, see the whole of the content given as information by making use of these relationships, understand the concepts, see the rules or rules and basic principles easily, remember the information with visual content easily, recognize the faces easily, are good at estimating distances. If the student's simultaneous cognitive processing performance is weak; he/she sees parts but cannot put them together, cannot see how the parts are connected to the whole, cannot see the relationship between given pieces of information, has difficulty remembering information, has difficulty in matching faces with names, and has poor spatial perception (Naglieri & Pickering, 2010). For this reason, while working with the educational games or game materials selected for the Cognitive Intervention Program with PASS Theory-Based Games, visual stimuli, visual reading activities, three-dimensional pattern blocks,

and cubes, instructional games that support the perception of verbal-spatial relations were chosen. As a result of this; it can be thought that with the increase in performance in the field of simultaneous cognitive processing, there are significant changes in the functions that require the synthesis of a group of separate but related stimuli with the use of both verbal and non-verbal content, and this reflects positively on the students' WGPA. Other research findings in the literature also support the findings of our study. In the study of Peker et al. (2018) on "Life Kinetic Cognitive Motor Coordination Training and Its Effect on Cognitive Processes," it was determined that the simultaneous cognitive processes post-test scores of the experimental group were significantly higher than the pre-test scores. Life Kinetic training consists of components that cover complex and variable movement patterns and visual tasks and are studied with simultaneous cognitive activities. When the structure and content of Life Kinetic training are examined, it is seen that it includes exercises such as determining the direction, semantic categorization, and selection of words or determining the appropriate one for the situation by comparing and evaluating the stimuli that have previously been loaded with some tasks. It was determined that the visual reading program carried out by Ergin (2015) had a positive effect on the shape memory performance of the students. Visual reading is the process of reading, understanding, interpreting, and structuring the mind with visuals such as pictures, sketches, graphics, symbols, shapes, and colors (Güneş, 2013). In many research findings, it has been determined that simultaneous cognitive processes are associated with specific learning disabilities (Canivez, 2011; Huang et al., 2010; Naglieri & Das, 1997; Naglieri & Goldstein, 2011).

It was determined that in the fourth cognitive processing area, "Successive," the pre-test scores of the experimental group were significantly different from the post-test scores. Likewise, post-test scores of the post-cognitive processing experimental group were significantly higher than the control group post-test scores.

If students' performance in the cognitive processing area conceptualized as successive is strong; they can complete their studies in sequential studies in accordance with their order, easily remembers the stages of the given information, the order of the sounds in the words, the order of the words in the sentences they have formed is correct, they explain their ideas in an organized and a certain integrity, their speech is fluent, and they remember more than one (double, triple) instructions. If the student's successive cognitive processing performance is weak; he/she confuses the order needed to complete work, has difficulty following and remembering consecutive instructions, explains ideas on a topic irregularly, speech flow is irregular, uses inverted sentences while speaking, may have difficulties in pronouncing words, and may mispronounce sounds in words (Naglieri & Pickering, 2010). For this reason, while working with the educational games or toys chosen for the Cognitive Intervention Program with PASS Theory-Based Games, for a student it is aimed to

remember the instructions given in the game, names, dates in order and to use his/her memory effectively, to increase the amount of remembering the given information, to be able to follow the order of the game, the instructions given, to use visuals, motor stimuli, and rhythmic stimuli effectively. As a result, it can be thought that there are significant changes in the functions that require the use of the posterior cognitive processing area, and this reflects positively on the students' WGPA. Other research findings in the literature also support the findings of our study. In the visual reading program implemented by Ergin (2015), it contributed to the short-term auditory memory function based on remembering the correct order of the words in the sentence given as a whole, and the function of remembering the successive syntax and being able to react rhythmically within a certain time limit. Visual information needs to be encoded in order to be transferred and stored in long-term memory. These are encoded in two ways as visuals and meanings and are stored in symbolic and semantic memory according to their type. In other words, the student gives meaning to the visual message and re-interprets it, then places it in symbolic and semantic schemes in long-term memory (Güneş, 2013). These schemas, which are formed by visual reading exercises, have a positive effect on the performance of recalling the successive syntax with the short-term auditory memory function based on remembering the correct order of the words in the sentence given as a whole. Also, the rhythmic aspect of memory is important for early years (Naglieri & Das 1997). Özkale (2010) found a significant relationship between rhythm studies and successive cognitive processing performance. Peker (2014) found in a study that Life Kinetic training has positive effects on rhythm ability which is one of the coordinative abilities.

One of the important results among the research findings is that there was no statistically significant difference between the WGPA-2017 and WGPA-2018, CAS Full Scale Score and Scales pre-test post-test scores of the control group students. Although the students in the control group were included in the etude studies to support their academic skills, the increase in their academic performance did not result in a significant change.

According to İlker and Melekoğlu (2017), it is emphasized that in studies on the basic academic skills of students with special learning disabilities have difficulty in writing, etc. predominantly academic skills development strategies are given priority, but cognitive skills, which is one of the areas where these students have the most problems, should also be supported. Our research findings support this emphasis.

For example, while there was a significant correlation between the mathematics scores of The College Board Scholastic Aptitude Test-SAT, an exam that measures academic ability and allows for university placement in the USA, and the CAS Full score and all four scales, there was found a significant relationship between SAT

verbal domain scores and only Simultaneous and Successive cognitive the processing areas. Simultaneous and Successive cognitive processes are directly related to reading comprehension (Naglieri & Das, 1997). In this study, a similar finding was obtained from the SAT exams. It was observed that the WGPA-2018 scores of the experimental group were significantly higher than the WGPA-2018 scores of the control group. Again, the WGPA-2018 scores of the students in the experimental group were found to be significantly higher than the WGPA-2017 scores.

As a result, it was determined that "Cognitive Intervention Program with PASS Theory-Based Games" was effective on planning, attention, simultaneous and successive cognitive processing areas, and academic skills of students with special learning disabilities. This program is structured based on a holistic approach emphasized in PASS theory. The fact that the four cognitive processing areas studied in this study and the CAS Full Scale score results were significant, and the positive results spread across the cognitive processing areas indicate that holistic development has taken place.

With this research, the application of the "Cognitive Intervention Program with PASS Theory-Based Games," which was determined to be effective on cognitive processing areas and academic skills, in schools, has a positive impact on students in different age groups and gifted, mentally retarded, emotional problems, and hyperactivity. It is recommended to examine the long-term effects of the program on the cognitive and academic skills of the students who participated in this research with longitudinal studies. In addition, the effect of this game-based program on social skills can be investigated.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The author have no conflicts of interest to declare.

Financial Disclosure: The author declared that this study has received no financial support.

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