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The Effectiveness of a Computerized Program in Developing Visual Perception Skills among Preschool Children with Specific Learning Difficulties

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Abstract

The current research aimed to design an educational computer program that helps develop visual perception skills (visual discrimination, visual closure, and figure-ground discrimination) among children with specific learning difficulties at the preschool level. A pictorial scale was designed to identify children with difficulties in visual perception skills. Five prospective participants from the study's target group were excluded because their referenced scores exceeded the study's criteria. Thus, the study's educational program was designed and used to train a sample of 13 children four to five years old who were affiliated with the Royal Commission Kindergartens in Jubail City, Saudi Arabia. The participating children were trained for a period of no fewer than four weeks, for three days per week. Each training session took two hours, totaling 24 hours of training across the sessions. This study's results showed statistically significant differences between participants' average pre-training and post-training scores, suggesting an improvement post-training (p = 0.05, 0.01).

Introduction

Visual perception skills are fundamental to children's learning, and they play an essential role in their cognitive development (Pienaar et al., 2013; Hellendoorn et al., 2015; Bellocchi et al., 2017; Tarrasch et al., 2017). Visual perception skills should be understood beyond simply a "passive behavior of absorbing information through one's eyes" (Yu, 2012, p. 293). Many researchers and psychologists regard perception as an active cognitive process that involves the interpretation of information from the senses to the brain, a process in which previous experiences allow individuals to analyze external stimuli and with their correct meanings (Angell, 1906; Maund, 2003; Heald & Nusbaum, 2014; Rogers, 2017). Therefore, visual perception can be defined as a "cognitive component of interpreting visual stimuli, or more simply, understanding what is seen. It involves the ability to mentally manipulate visual information as needed to solve problems and to take action in response to environmental demands" (Kurtz, 2006, p. 33). Children's development of visual perception skills is crucial for their learning language, understanding concepts, and reading as schools require (Pienaar et al., 2013).

Problems with these skills are among the most common difficulties among children with specific learning difficulties (SpLD) (Pieters et al., 2012; Johnston et al., 2017; Cheng et al., 2018). For example, after comparing visual perception between two groups of 36 preschool children with and without a risk of dyslexia from seven preschools in Spain, Ortiz et al. (2014) found that the first group's visual perception of linguistic and nonlinguistic stimuli was impaired. Visual perception and reading impairment also correlate; children with visual perception problems tend to read poorly (McCloskey & Rapp, 2000; Baluoti et al., 2012). While researchers have widely found phonological awareness to be essential in literacy development (e.g., Bus & van IJzendoorn, 1999; Blaiklock, 2004; Anthony & Francis, 2005; Hogan et al., 2005), visual perception deficits have also been considered a leading cause for reading difficulties among students with SpLD (Shovman and Ahissar, 2006; Meng et al., 2011).

Researchers have increasingly focused on computer technology's use in special education to support children with SpLD across many areas—such as the implementation of individual educational plans, helping with homework, and assisting children to overcome comprehension difficulties in reading, writing, and math (Al-Qaryouti, 2002). Such technology's multimedia features can more effectively train children with developmental difficulties in visual perception skills than similar paper-based programs (Chen et al., 2013). Modern technologies' rich and interactive features can attract and engage individuals with SpLD, encouraging independent learning (Zikl et al., 2015). Therefore, the current study sought to examine a computer program's effect on the development of visual perception skills among preschool children with SpLD.

Visual Perception and Learning

Visual perception describes the ability to interpret information and the surrounding areas of visible light that reach the eyes (Finger, 1994). It is a mental ability involving many cognitive processes—including conformity, visual discrimination, cognitive stability, spatial relationships, visual closure, visual-motor synergy, and figure-ground discrimination(Rosenquist et al., 2003). The current study focused on three of these skills: visual discrimination, visual closure, and figure-ground discrimination. Visual discrimination is the ability to recognize a shape's distinct boundaries from other similar shapes by color, shape, pattern, and size (Suleiman, 2002). This ability is essential for children's learning to read, write, do arithmetic, and draw (Hafez, 2006). Children with SpLD tend to exhibit behaviors suggesting visual discrimination difficulties, such as an inability to distinguish between things, potentially due to a lack of awareness of images' similarities and differences vis-à-vis color, size, area, or pattern (Sisalem, 2002). These children can struggle to distinguish between basic colors or similar shades, as well as recognizing different shapes and numbers. Visual closure denotes the ability to recognize shapes even when they are incomplete (completion) (Mithqal, 2000). It is an essential ability for children to learn arithmetic, writing, and reading. For instance, children require visual closure skills to read printed text when covering the upper or lower half of the text, recognizing complete forms through hinting (Al-Zayat, 2017). Visual closure difficulties among children with SpLD can also cause an inability to define a quantitative formula through a partial formula or to understand a whole when presented with some parts. Meanwhile, figure-ground discrimination refers to the capacity to recognize specific stimuli among many in the same image, distinguishing something from its background or surroundings. Children with learning difficulties, for example, struggle to distinguish written paragraphs from the paper they are written on (Melhem, 2013). This difficulty can prevent such children from focuses on questions or figures independently.

Visual perception skills play an important role in children's development during early education because a lack of these skills may disrupt the learning processes—especially in reading, arithmetic, and writing (Clark, 2010; Baluoti et al., 2012). Researchers have shown that deficits in visual perception skills are common among preschool children with SpLD. For example, Abdullah and Nasser (2020) recently compared visual perception skills between 45 fifth-grade children diagnosed with writing difficulties and 45 fifth-grade students without these difficulties. These researchers tested participants' visual discrimination, visual memory, awareness of visual-spatial relations, visual stability of shapes, memory of visual sequences, relationships between shapes and visual ground, and visual closure. Their results showed statistically significant differences in writing between students with learning difficulties and their typically developed peers for each of these skills. A gender-based statistically significant difference in these skills was also identified, as female participants performed better. This research also revealed an inverse correlation between degrees of visual perception skills and writing difficulties. A similar study investigated eye movement and visual perception among 30 children with dyslexia (Wong, 2020). It found that 56.67% of participants had eye-movement deficits and 46.67% had eye-movement deficits and impaired visual perception. The study emphasized the need for professionals and parents' increased awareness of eye movements and visual perception among children with dyslexia. Further, the author recommended that any child showing signs of visual difficulties be referred for in-depth visual evaluations to determine their cause.

Educational Software to Support Students with Specific Learning Difficulties

The educational use of computer software is no longer a luxury but, rather, a necessity imposed by tremendous technological developments in the twenty-first century. Educational software is increasingly used for a wide range of purposes, such as supporting teaching practices, addressing learners' individual differences, and supporting self-learning (Jancheski, 2017; Odadžić et al., 2017; Pardanjac et al., 2018; Kukey et al., 2019). It can play an important role in special education by helping individuals with SpLD learn through multimedia. Such features effectively convey reality to students and engage multiple senses (Hidayat&Hidayatulloh, 2017; Raheel et al., 2019). The use of colors, music, and animation can also make learning more enjoyable. Importantly, educational programs are particularly effective at continuously attracting the attention of students with learning difficulties, increasing their motivation, and encouraging their participation (Cardona et al., 2000; Abu Shouk, 2016). Such software can also provide safe learning environments that encourage learners to scaffold their peers' learning, helping them stop relying on traditional learning methods (Salem, 2017).

Studies have shown that multimedia software can be effective among students with (or at risk of) SpLD developing their learning skills and encouraging positive attitudes toward learning (Benmarrakchi et al., 2017; Wong et al., 2017; Xin et al., 2017; Ouherrou et al., 2019; Khasawneh, 2021). In a study of first-grade students at three US primary schools, Torgesen et al. (2010) examined the impact of two educational programs—Read, Write, and Type (RWT) (Herron, 1995) and The Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech (LIPS) (Lindamood&Lindamood, 1998)—in preventing early reading difficulties among students at risk of dyslexia. Torgesen et al. found positive impacts among students who were taught using the two programs versus the control group who received regular teaching in various skills, such as spelling, phonological awareness, fluency, accuracy, and reading comprehension. Similarly, a synthesis and meta-analysis by Swanson et al. (2011) of 18 studies examined the effects of storybook read-aloud interventions among primary and preschool students (three to eight years old), revealing stronger effects of computer-assisted interventions on reading comprehension compared to dialog reading interventions. The computer program (*Headsprout Early Reading*) also improved oral language skills and phonological awareness while minimizing future reading difficulties among preschool children, perhaps because the majority of participants were motivated during this intervention (Huffstetter et al., 2010). Additionally, a recent meta-analysis by Benavides-Varela et al. (2020) of 15 papers investigated digital interventions' effectiveness for primary and preschool children with mathematical learning difficulties, revealing improvements in mathematical performance. Benavides-Varela et al. attributed their positive results to the software's specific design to meet the remedial needs of individuals with mathematical difficulties. The software also afforded children more opportunities to solve mathematical problems in alternative instructional contexts.

Meanwhile, Poon et al. (2010) investigated the effect of a visual perception and visual-motor integration computer training program to improve Chinese handwriting amongchildren with handwriting problems. The study sample comprised 26 primary school children diagnosed by educational psychologists and occupational therapists with having difficulties in handwriting. The students were then divided into two groups: a control group and an experimental group. The experimental group (n = 13) underwent eight sessions of computer training in visual perception and visual-motor integration, supplemented with a home training program. In contrast, the control group (n = 13) received traditional handwriting training from teachers who mainly focused on therapeutic handwriting exercises. The study's analysis of variance (ANOVA) results revealed that the experimental group's visual perception skills and handwriting control improved compared to the control group. Additionally, no statistically significant differences were observed in visual-motor integration skills or handwriting clarity between the two groups, indicating the program's effectiveness. However, though computer-based software could improve visual perception skills (Kang et al., 2009; Meijer & Lubbe, 2011; Chen et al., 2013) such software's development can be challenging due to the complexity of effective early visual perceptional activities and individuals' varying needs. Therefore, research on software's role in improving visual perceptional skills among preschool children with SpLD is lacking.

Research Problem

Studies have shown that children with SpLD and visual processing problems often perform poorly in visual tasks (Al-Zayat, 2017). Preschoolers with SpLD lack software to develop visual perception skills that parents can effectively use, especially now that distance education has become widespread (Sharonova&Avdeeva, 2020; Poddubnaya et al., 2021). Accordingly, the current study sought to fill this gap by designing software to develop visual perception skills among preschool children with learning difficulties, since this stage has lacked scholarly attention. Therefore, this research project designed an interactive, educational computer program to develop select visual perception skills (discrimination, closure, and figure-ground discrimination) among preschool children with learning difficulties. This study principally sought to answer: How effectively do computer programs develop visual perception skills among preschool children with SpLD?

This study also answered the following research questions:

1. Did participants' mean pre- and post-training scores suggest a statistically significant difference in their visual discrimination skills?
2. Did participants' mean pre- and post-training scores suggest a statistically significant difference in their visual closure skills?
3. Did participants' mean pre- and post-training scores suggest a statistically significant difference in their figure-ground discrimination skills?

Rationale

This study aimed to help children with SpLD and visual discrimination, visual closure, and figure-ground discrimination difficulties, based on the following considerations:

1. Research has shown that modern technologies can support individuals with learning difficulties, improving their performance and increasing their motivation (Cardona et al., 2000; Abu Shouk, 2016; Wong et al., 2017; Ouherrou et al., 2019; Khasawneh, 2021). Therefore, a computer program should be designed to develop visual perception skills among preschool children with SpLDin order to maximize learning opportunities.
2. A pictorial scale could be used to identify preschool children with visual perception difficulties in discrimination, closure, and figure-ground discrimination. Early identification of children with visual perception difficulties is important to help educators pay extra attention to these children and improve their skills to reach their academic potential.

Methods

Participants

A random sampling method was used to select this study's participants. The pictorial scale was implemented with 17 children, of whom four were excluded since they lacked visual perception difficulties. Therefore, the study population comprised 13 children. Participants attended six preschools in Jubail, Saudi Arabia (Table 1).

Table1. Distribution of the research sample

n	Name of preschool	Number of participants	Percentage
1	Alnakheel KG	2	15.4%
2	Alfardoos KG	1	7.7%
3	AlFaruq 1 KG	3	23%
4	AlFayha KG	2	15.4%
5	AlKhuzama KG	1	7.7%
6	Dareen KG	4	30.8%
	Total	13	100%

Tools

This study used an experimental design to select one group of preschool children among which to identify (pre- and post-training) the effect of the independent variable (the computer program) on the dependent variable (visual discrimination, visual closure, and figure-ground discrimination skills). The following subsections describe the study's specific methods.

Visual Perception Scale (Designed by the Current Study's Researchers). The current study's researchers designed a visual perception scale based on similar designs for visual perception skills in earlier studies (e.g., Al-Jabri, 2005; Hamida, 2007; Al-Bayh, 2012). Additionally, the researchers reviewed a set of measures, questionnaires, and research papers concerning visual perception skill measures or key related concepts. The current study's scale was informed by the following previously published visual perception scales:

- The *Frostig* developmental *test* of visual perception (Maslow et al., 1964)
- The Bender visual motor gestalt test (Bender, 1938)
- The Benton visual retention test (BVRT) (Benton, 1945)
- The scale of the growth of visual perception skills among preschool children (Al-Juhani & Al-Zahhar, 2010)

The current study's scale uses images, geometric shapes, numbers, letters, and words to measure visual perception skills among children aged five to six years. It comprises 108 items as multiple-choice, matching, and short-sentence picture-describing questions. The scale is divided into three main dimensions: discrimination, closure, and figure-ground discrimination.

Visual Discrimination. The study's visual discrimination category comprised 62 scale items. For these items, the examiner presented pictures to participants and asked them to identify similarities and differences, as well as to distinguish between linguistic symbols, shapes, sizes, lengths, directions, numbers, and words.

Visual Closure. The study's visual closure dimension comprised 30 scale items. The examiner asked participants to look at two lists of incomplete images and shapes for these items. Then, they were asked to match the shapes and images to create a complete picture.

Figure-Ground Discrimination. The figure-ground discrimination category comprised 16 scale items. For these items, the examiner asked participants to look at pictures and extract required images or words from a field of items. The examiner also presented pictures and asked participants to indicate the most important events that they showed, measuring children's ability to focus on one related stimulus while ignoring others.

A score of 1 was assigned to correct answers, versus 0 for wrong answers. Children who obtained scores < 50 were considered to have a severe visual perception disorder, while 51–70 indicated a moderate visual perception disorder, 71–90 indicated a mild visual perception disorder, and 91–108 indicated no visual perception disorder.

*Validity and Reliability.*The study's scale was sent to 11 academic professionals specialized in psychology and special education. Initially, the scale comprised 115 items. However, based on the specialists' recommendations and opinion that some items were inappropriate for preschool children, some items were removed or reformulated. Finally, the test comprised 108 items. The scale was piloted with four randomly selected children, checking its clarity for both the examiner and participants. Its items were rearranged according to these four children's rankings, from easiest to hardest. Pearson's correlation coefficient was used to ensure that each dimension was consistent with the scale's total score (Table 2).

Table2. Person's Correlation Coefficients for the Visual Perception Scale's Dimensions and Total Scores

Dimension	Scale correlation coefficient
Visual discrimination	**0.894
Visual dlosure	**0.861
Figure-ground discrimination	**0.731

** p ≤ 0.01.

Table 2 shows that the correlation coefficient values for each scale dimension were positive (p ≤ 0.01). This finding indicated the scale's validity, with internal consistency between the scale items and their suitability to measure the intended variables. Cronbach's alpha and the Gettman equation for half-segmentation were also used to measure the scale's reliable indication of the visual perception dimensions (Table 3).

Table3. Cronbach's Alpha and the Gettman Equation for Half-Segmentation, Measuring the Visual Perception Scale's Reliability

Dimension	Number of items	Cronbach's alpha	Gettman equation for half-segmentation
Visual discrimination	62	0.922	0.902
Visual Closure	30	0.787	0.774
Figure-ground discrimination	16	0.786	0.869
Scale's total reliability	108	0.966	0.845

As Table 3 shows, the scale's reliability measurements yielded a high reliability score, achieving the psychometric properties of a reliable scale.

*Educational Computer Program.*The current study's researchers designed an educational computer program to develop visual perception skills among preschool children with SpLD across five main stages, which are outlined in the following subsections.

First Stage: Analysis. The analysis stage targeted preschool children (aged five to six years). Its education goals were for children to:

1. Identify similarities between object
2. Classify objects according to their shapes
3. Classify objects according to their size
4. Classify objects according to their colors
5. Distinguish between shapes' directions
6. Solves puzzles of seven to 10 pieces
7. Complete pictures' missing parts
8. Complete the missing parts of geometric shapes
9. Complete the missing parts of animal pictures
10. Complete missing colors when shown colored pictures that are then partially hidden
11. Point to the hair in an image of a human when asked
12. Identify a requested geometric shape from a group of geometric shapes
13. Identify a picture of an animal from a board containing a group of animal pictures
14. Describe the details of a presented picture
15. Tell a story based on presented pictures

As a teaching aid, this stage used a computer device to run the program and educational pictures.
Visual perception skills were pre-measured using the visual perception scale and parents' assistance. Post-training measurements were obtained over the course of 18 hours (during three sessions per week). Each session lasted for 45 minutes, divided as follows:

- 15minutes for the first dimension (visual closure)
- 15minutes for the second dimension (visual discrimination)
- 15minutes for the third dimension (figure-ground discrimination)

Second Stage: Design (Program Flowchart).

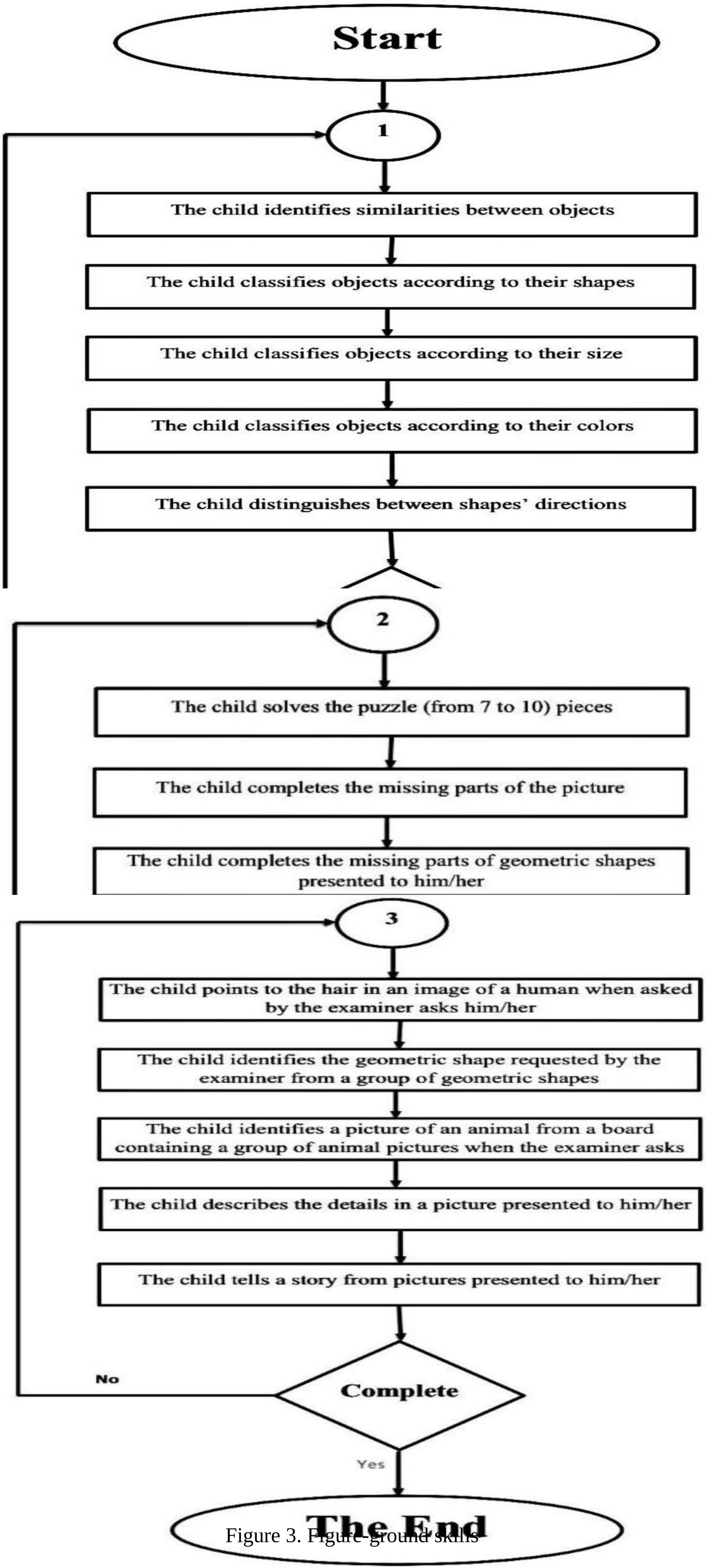
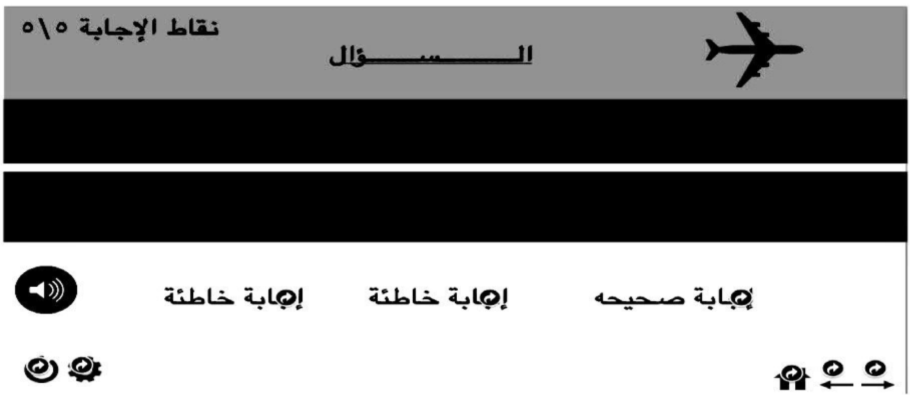


Figure 3. Figure-ground skills

Third Stage: Development. The following software was used to develop the study's program: Photoshop, Illustrator, Keynote, an audio recording and automatic optimization, a flowchart, and a free pie chart (Figures 4–5).

Figure 4. Screen design



Fourth Stage: Implementation.

Figure 5. Story board

Item	Description
Text properties	Font type: Helvetica, Normal Font size: 44 Font color: Black Text alignment: Center
Still pictures	A picture of a baby crying and pictures of toys
Motion pictures	None on this screen
Videos	None on this screen
Sounds	If the answer was correct: “Well done,” “great answer,” and “good start” If the answer was wrong: “Wrong answer” and “try again”
Mobility	Button signs for the following functions: next, previous, exit, help, and main menu

Designing educational program to develop visual perception skills in preschool		
Main Menu	**Comments**	
	Appearance	**Sound**
	• The aims of the program.	When the child completes each lesson, the reinforcement appears and the page closes. This happens with all of the lessons.
	• List of lessons: visual discrimination, visual closure, and figure-ground discrimination.	
	• Exit button	

Figure 6. Designing educational program to develop visual perception skills in preschool (Main menu)

Fifth Stage: Evaluation.
1. Content criteria:

Table5. Content Criteria for the Program

Criteria	0	1	2	3
1. Achieving general goals and objectives	No goals were achieved.	Only one goal was achieved.	Some goals were achieved.	All goals and objectives were achieved.
2. The appropriate use of pictures, videos, and sounds	All media items were used inappropriately	Two media items were used inappropriately	One media item was used inappropriately	All media items were used appropriately
3. Dividing information purposefully	Information was scattered and difficult to understand.	Information was somewhat organized but difficult to understand.	Information was somewhat organized and easy to understand.	Information was organized and easy to understand.
4. Control in displaying information	Users were not allowed to control the display	Users had limited control over the display	Some screens did not allow users to control the display	Users could control the display on all screens
5. Correct spelling, grammar, and punctuation	More than four grammatical, spelling, or punctuation errors	Three or four grammatical, spelling, or punctuation errors	One or two grammatical, spelling, or punctuation errors	No errors

2. Technical criteria:

Table6. Technical Criteria for the Program

Criteria	0	1	2	3
1. Navigation links	More than two links did not work properly	Two links did not work properly	One link did not work properly	All links worked properly
2. Pages or tabs	More than two pages did not work properly	Two pages did not work properly	One page did not work properly	All pages worked properly
3. Media items	More than two media items did not work properly	Two media items did not work properly	One media item did not work properly	All media items worked properly
4. Ease of opening the blog or running the program	Not at all easy to run	Not generally easy to run	Fairly easy to run but required a manual	Easy to run

5. Using the resources identified in the decision-making stage	The program lacked more than two resources	The program lacked two resources	The program lacked one resource	The program used all resources

3. Designcriteria:

Table 7. Design criteria for the Program

Criteria	0	1	2	3
1. Compatibility	The program was incompatible with the storyboards or flowcharts	The program was compatible with some of the storyboards and flowcharts	The program was compatible with all of the storyboards but not all of the flowcharts	The program was compatible with all the storyboards and flowcharts
2. Background	The background was unclear and inappropriate	The background was clear but inappropriate	The background was appropriate but unclear	The background was appropriate and clear
3. Clarity of the text	The text was difficult to read and did not contrast against the background	The text was difficult to read but contrasted against the background	The text was easy to read but did not contrast against the background	The text was easy to read and contrasted against the background
4. Navigation buttons	No navigation buttons were easy to understand	Some navigation buttons were easy to understand	Most navigation buttons were easy to understand	All navigation buttons were easy to understand
5. Reverse feedback	The reverse feedback was unstable and inappropriate	The reverse feedback was stable but inappropriate	The reverse feedback was unstable but appropriate	The reverse feedback was stable and appropriate

Statistical Methods. The SPSS Statistical Package for Social Sciences (Version 24) was used in this study with the following methods:

- Descriptive statistics of the study's variables and results
- Blake's modified gain ratio (Blake, 1966)
- A Wilcoxon test (NPar Test) to determine the difference value (Z) for a paired sample for each math skill, determined before and after using the computer program

Results

The use of this study's educational software yielded statistically significant differences (p = 0.05) between the mean degree ranks of participants' pre- and post-training scores, showing a post-training improvement.

Table8. Differences between Participants' Pre- and Post-Training Scores of Visual Perception as a Whole

Pre- and post-training scores	Mean	Standard deviation	Standard error	Variance	Degree of freedom	Z value	Asymp. Sig.	Correlation	Deduction
Pre-training scores	60.53	8.27	2.29	68.43	12	-9.772	0.000	0.297	Statistically significant

Post-training scores	100.00	4.88	1.35	23.83					difference

Table 8 indicates that the arithmetic mean of participants' pre-training scores (before using the study's educational program) across its three components (discrimination, closure, and figure-ground discrimination) was 60.53. By contrast, this corresponding mean after training was 100.00, and the calculated Z value exceeded the tabular Z-test value (0.05 and 0.01, respectively; $p \leq 0.000$). This finding indicates a significant statistical difference between participants' average scores pre-training and post-training, indicating a post-training improvement. Thus, the results of this study demonstrated the program's positive effect on improving participants' visual perception skills.

Table 9. Blake's Modified Gain Ratio to Determine the Application's Effectiveness

The minimum acceptance level set by Blake (1966) for the effectiveness of any training program is 1.2. Therefore:

- The scale's score for reading numbers of 1.16 ≈ 1.2 is acceptable.
- Its numerical comparison score of 1.39 > 1.2 shows that it is acceptable and effective.
- Its score for rounding numbers of 1.48 > 1.2 shows that it is acceptable and highly effective.
- Its score for adding and subtracting numbers of 1.42 < 1.2 shows that it is acceptable and highly effective.
- Its probability description of 1.02 < 1.2 shows that it is ineffective for this skill.
- Its total mathematical skills' score of 1.29 <1.2 indicates that it is acceptable and effective.

Table 9 shows the program's effectiveness through the post-training score's mean of 100.00 and standard deviation of 4.88. Blake's modified gain to detect the application's effectiveness exceeded 1.2, suggesting the categories of acceptable and highly effective.

Visual Discrimination Skills

Statistically significant differences were found ($p = 0.05$) between the mean scores of the children in the experimental group pre-and post-training in visual discrimination skills.

Table 10. Differences between Participants' Pre- and Post-Training Visual Discrimination Skills

Visual discrimination skills	Mean	Standard deviation	Standard error	Variance	Mean rank	Z value	Degree of freedom	Asymp. Sig.	Deduction
Pre-training	40.15	7.58	2.10	57.47	11.00	-4.10	12	0.000	Statistically significant difference
Post-training	57.69	3.96	1.10	15.73	28.54				

Pre- and post-training scores	n	Minimum	Maximum	Mean	Standard deviation
Pre-training	13	48.00	76.00	60.53	8.27
Post-training	13	88.00	106.00	100.00	4.88
Blake	13	0.86	1.45	1.19	0.161
Valid n (listwise)	13				

Table 10 illustrates that differences between participants' mean scores pre- and post-training in visual discrimination skills, with an arithmetic mean of 57.69 and a standard deviation of 3.36 favoring the post-training results ($p < 0.05$). This finding indicated significant differences favoring participants' arithmetic mean post-training. Additionally, the value of the calculated Z score exceeded the tabular Z-test value (0.05 and 0.01, respectively) at a significance level of $p \leq 0.000$. This findingindicated a statistically significant difference between participants' average scores pre- and post-training, favoring the post-training results. Therefore, the software effectively improved participants' visual discrimination skills.

Visual Closure Skills

Statistically significant differences ($p = 0.05$) were also found between experimental-group participants' mean pre-and post-training scores in visual closure skills.

Table 11. Differences between Participants' Pre-and Post-Training Visual Closure Skills

Visual closure skills	Mean	Standard deviation	Standard error	Variance	Mean rank	Z value	Degree of freedom	Asymp. Sig.	Deduction
Pre-training	20.15	3.53	0.979	12.47	11.06	-3.59	12	0.000	Statistically significant difference
Post-training	28.53	1.12	0.312	1.26	29.54				

As Table 11 shows, differences were found between participants' mean pre- and post-testing scores for skills in the visual closure dimension, with an arithmetic mean of 57.69 and a standard deviation of 3.36. Thus, the post-training scores indicated a significant improvement ($p < 0.05$). Furthermore, the calculated Z value exceeded the tabular Z-test value (0.05 and 0.01, respectively; $p \leq 0.000$), indicating a statistically significant difference in favor of the post-training scores. Thus, the program was clearly effective in improving participants' visual closure skills.

Figure-Ground Discrimination Skills

Statistically significant differences ($p = 0.05$) were also found between the experimental-group participants' mean pre-and post-training scores for figure-ground discrimination skills.

Table 12. Differences between Participants' Pre- and Post-Training Figure-Ground Discrimination Skills

Table 12 presents the differences between participants' mean pre- and post-training scores in the figure-ground discrimination dimension. The arithmetic mean of 14.92 and standard deviation of 0.95 favored the post-training scores ($p < 0.05$). Thus, a significant difference was found favoring the arithmetic mean of the post-training score. Moreover, the calculated Z value exceeded the tabular Z-test value (0.05 and 0.01, respectively; $p \leq 0.000$)—which indicated a statistically significant difference favoring the post-training results. This finding shows program's effective improvement of participants' figure-ground skills.

Figure-ground discrimination skills	Mean	Standard deviation	Standard error	Variance	Mean rank	Z value	Degree of freedom	Asymp. Sig.	Deduction
Pre-training	9.23	1.87	0.520	3.52	11.06	-5.62	12	0.000	Statistically significant difference
Post-training	14.92	0.95	0.264	0.910	29.54				

Discussion

This study aimed to examine the effectiveness of a computer program to develop visual perception skills among preschool children with SpLD in preschool in order to help such children (e.g., with visual discrimination, visual closure, and figure-ground discrimination).

Before designing a significantly effective computer program, the researchers reviewed previous related studies. The researchers found that the use of modern technologies supported individuals with learning difficulties in improving their performance and increasing their motivation. Accordingly, the researchers designed a computer program to develop visual perception skills among preschool children with SpLD. The researchers selected this age group to increase learning opportunities through our program, thus helping children benefit from school experiences throughout their education.

Additionally, this program provided a pictorial scale that can identify children of preschool age facing difficulties with visual perception skills (discrimination, closure, and discrimination based on shape). Accordingly, our study used illustrated activities with 14 children who were proven to have visual perception difficulties.

This approach differed somewhat from previous research, such as Finger's (1994) study of visual perception, which emphasized the importance of visual perception as a mental ability that includes many cognitive processes. These processes were noted to include matching, visual discrimination, cognitive stability, spatial relationships, visual closure, visual kinetic synergy, and discrimination between shapes and the ground. Meanwhile, Rosenquist et al. (2003) also focused on three of these skills: visual discrimination, visual closure, and discrimination between shape and ground. The current study's program applied these skills to a set of computer activities that help children learn with the help of their parents or guardians. These abilities are necessary for children to learn reading, writing, arithmetic, and drawing (Hafez, 2006). Therefore, building on previous research (Clark, 2010; Baluoti et al., 2012; Abdullah & Nasser, 2020; Wong, 2020), the current study developed an educational computer program that young children with visual perception difficulties can use to develop these skills.

Interestingly, our program achieved significant effects as such an intervention. Our results demonstrate a potential to improve the mean of the ranks of such children's pre- and post-training scores across all the targeted visual perceptions skills (discrimination, closure, and figure-ground discrimination). This result aligns with the initial results of the program's testing, demonstrating that the software fulfills its intended aims. Moreover, this positive result can be explained by the program's successful integration of multimedia features, such as sound effects, pictures, graphics, and colors. The researchers also noticed that the program helped solve one of the most important problems facing teachers who work with children with SpLD: their lack of focus, attention deficit, or short attention span. The current study's positive results can be interpreted as evidence that the program helped students learn the targeted skills effectively, at their own pace. Exercises and questions were presented gradually manner, from easy to difficult questions, allowing children to progress between screens and exercises according to their own interests and at a pace that suited their learning needs. Immediate feedback was another important factor that may have contributed to participants' development of visual perception skills through the program.

Conclusion and Recommendation

The current study provided insights into the role that computer programs might play in the development of visual perception skills (discrimination, closure, and figure-ground discrimination) among preschool children with SpLD. The Blake's modified gain (MGR) to detect the program's effectiveness indicated that the program effectively improved participants' visual perception skills.

Based on these findings, the researchers offer several recommendations. First, training courses should be provided to teachers who are specialized in SpLD, supporting their use of modern technology. Accordingly, educational computer programs should be designed to present lessons in exciting and effective ways for students. Second, schools should be equipped with different types of educational software, such as practice programs, simulation programs, and educational games. Third, learning content should be presented flexibly, in different ways and at different times, and students should be able to repeat lessons as often as they wish via a computer program. Finally, such software should be designed to present various types of questions, such as multiple-choiceand true-or-false questions.

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