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Development and Validation of a Mobile Phone Photography Training Program (MobileGraphy) to Enhance Visual Perception Skills in Children with Specific Learning Disabilities

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Abstract

Background: Visual perception is a fundamental cognitive skill that significantly impacts the learning processes of children with specific learning disabilities (SLD). This study aimed to develop and validate a training program leveraging mobile phone photography to enhance the visual perception skills of children with SLD.

Methods: This study utilized a mixed-methods design, combining qualitative and quantitative approaches. The qualitative phase involved semi-structured interviews with 13 university faculty members specializing in SLD, art, and photography from public and private universities in Borazjan, Iran. Participants were selected purposively, and data were collected until theoretical saturation was achieved. The quantitative phase employed a quasi-experimental design with pre-test, post-test, and follow-up assessments, incorporating a control group. The research population comprised 30 primary school children with SLD in Borazjan, selected via purposive convenience sampling. The Frostig Developmental Test of Visual Perception (1963) was used as the data collection instrument for the quantitative phase. The qualitative data were analyzed using a three-stage coding process (open, axial, and selective), while quantitative data were analyzed using repeated measures ANCOVA.

Results: The analysis of the qualitative data revealed four critical components for the mobile photography training program: (1) foundational instruction in mobile phone photography, (2) strategies to enhance motivation and create cognitive challenges, (3) development of visual perception skills, and (4) development of attention skills. Quantitative findings demonstrated that the program yielded a significant and sustained positive effect on improving visual perception in children with SLD.

Conclusion: The mobile phone photography training program (MobileGraphy) offers a practical and effective intervention for enhancing visual perception skills in children with SLD. Its integration into educational settings can effectively support their cognitive development.

Keywords: Mobile phone photography training program (MobileGraphy), Visual perception skills, Learning disabilities

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Introduction

For many years, educators have recognized that, in addition to children with special learning disabilities (SLDs) such as hearing impairment or intellectual disabilities, there exists a group of children who, despite exhibiting normal or even superior visual acuity, experience difficulties in accurately interpreting certain written materials or visual symbols (1). Furthermore, some children with special educational needs, despite possessing average or above-average intelligence, are unable to comprehend specific academic content through conventional teaching methods (2). These children typically do not fit into standard special education categories and are often integrated into mainstream schools alongside their peers (3). However, they frequently encounter substantial challenges in areas such as language development, visual and auditory perception, spatial awareness, and in mastering fundamental academic subjects like reading, writing, and arithmetic (4). The existing literature employs various terms to describe these students, including minimal brain dysfunction, perceptual and information processing disorders, learning and perception disabilities, or visual perceptual skill deficits (5).

Among these challenges, deficiencies in visual perceptual skills are considered a major component of specific learning disabilities (SLDs). Visual-spatial relationships, a

critical aspect of visual perception, refer to the ability to accurately perceive the overall orientation of an object in space (6). This perceptual capacity enables individuals to locate an object or symbol (e.g., letters, words, numbers, or images) in relation to surrounding objects or symbols. This ability is associated with the specialized functions of the brain's right hemisphere and plays a crucial role in complex life skills (7). The visual perception of an object necessitates the integration of multiple visual features. Although visual-spatial perception is generally conceptualized as a unitary construct, it can be further subdivided into two components: visual perception (encompassing features such as color, shape, and size) and spatial perception (including spatial visualization and mental rotation) (8).

The foundation of spatial understanding lies in spatial visualization skills, which begin to develop during early childhood (9). Spatial visualization denotes the mental ability to orient oneself concerning the surrounding environment, while mental rotation is the capacity to mentally represent a two- or three-dimensional structure and envisage its appearance upon rotation around an imaginary axis. This process occurs in the absence of the actual object and facilitates the brain's ability to reconstruct, organize, and categorize visual images (10). Given their multifaceted nature, visual-spatial skills are essential for reading proficiency. These skills are influenced by factors such as the speed of visual-spatial processing and attention, with the latter being paramount in cognitive processing (11).

Considering that attention is a crucial determinant of learning—to the extent that without attention, individuals cannot effectively process, store, or retrieve information—there is compelling evidence suggesting that cognitive training can enhance visual perceptual skills (12). Supporting this perspective, Aburas, Hamouda, and El-Shafaei (13) demonstrated that cognitive rehabilitation targeting attention and memory significantly reduces learning difficulties and improves attention and visual perception in children with learning disabilities. Similarly, a study by Barzegar et al. (14) revealed that artistic education positively influences attention and concentration in children with learning disorders. Among the various methods impacting attention and visual perception in children with specific learning disabilities, photography emerges as a noteworthy tool. Photography is a unique art form that integrates multiple other artistic domains (15). While looking is a universal human behavior, photography involves framing, selection, and composition. This process allows individuals to observe the outcomes of their actions and make adjustments, which, in turn, stimulates and positively influences brain function (16).

Photography is an art form intrinsically and fundamentally intertwined with technology, particularly a type of technology renowned for its simplicity and speed. Photography represents an exploratory mode of perceiving the world. For this reason, a photographer's camera, as a tool for capturing this unique perspective, is often considered essential. However, in numerous instances, possessing a professional camera is not a prerequisite for professional-grade photography. With the considerable advancements in mobile phone technology, high-quality and professional-grade photographs can now be captured using a mobile phone camera (17).

When photography is coupled with focused attention and a spirit of inquiry, it can foster reflective thinking and heightened awareness in the photographer. When an individual decides to capture a specific subject, they endeavor to view their surroundings through the lens with a fresh perspective. This deliberate effort to perceive the environment differently can forge a meaningful link between learning and photography (18). As individuals engage enthusiastically and inquisitively in photographing scenes from their daily lives, they may discover new details that were previously overlooked. This renewed way of seeing can stimulate learning, generate novel ideas, and foster creativity, ultimately contributing to a deeper level of visual understanding and visual perceptual development (19).

Accordingly, it is evident that students with specific learning disabilities require targeted psychological and educational interventions. Numerous studies (14, 20, 21) have investigated the role of artistic therapies and perceptual difficulties in these students, employing approaches such as sensory integration therapy and perceptual-motor training programs. However, very few studies have explored the impact of mobile phone photography-based therapy on visual perception and attention skills in children with learning disabilities. This significant gap underscores the innovative nature of the present study and its potential to contribute substantially to the research literature in this domain. Therefore, the present study addresses the following two questions: What are the essential features of a mobile phone photography (MobileGraphy) training program designed for children with specific learning disabilities? Can such an educational intervention meaningfully enhance visual perceptual skills in children with specific learning disabilities?

Methods

This study employed a sequential exploratory mixed-methods design, integrating qualitative and quantitative approaches. Semi-structured interviews were conducted with 13 university faculty members specializing in specific learning disabilities (SLDs), art, and photography from both public and private universities. Participants were selected using purposive sampling based on their academic affiliation, possession of a Ph.D. degree, and a minimum of 10 years of teaching or professional

experience. Data collection continued until theoretical saturation was achieved. The qualitative data were analyzed using a three-stage coding process: open, axial, and selective coding. The insights garnered from this phase directly informed the design and content of the mobile photography training program.

A quasi-experimental design was utilized, incorporating pre-test, post-test, and follow-up assessments with a control group. The target population consisted of children aged 8 to 10 years diagnosed with SLDs in the primary schools in Borazjan. A total of 30 children were selected via purposive convenience sampling based on the following inclusion criteria: a confirmed diagnosis of specific learning disabilities by the educational department, documented parental consent, and no receipt of other psychological interventions within the preceding six months. Participants were then randomly assigned to either the intervention group (n = 15) or the control group (n = 15).

To enhance the internal validity of the study and control for potential confounding variables such as intelligence level, prior educational history, and family background, additional inclusion criteria were applied: a valid diagnostic file from the education department, no participation in rehabilitation interventions in the past six months, and an average intelligence level as determined by official assessments. Furthermore, efforts were made to ensure homogeneity between the two groups regarding socioeconomic status and parental educational attainment.

The primary instrument for quantitative data collection was the Frostig Developmental Test of Visual Perception (1963), which comprises five subtests: eye-hand coordination, figure-ground perception, form constancy, spatial position, and spatial relations. The mobile photography training program was delivered over 24 sessions, each lasting 60 minutes (twice per week). Quantitative data were analyzed using repeated measures analysis of covariance (ANCOVA).

Program Development

The mobile photography (MobileGraphy) training program was designed, implemented, and validated through thematic analysis of the qualitative interview data with the 13 aforementioned university professors. Their expert opinions guided the initial coding of main themes and subthemes, which are summarized in Table 1.

Following the program's development, 30 students aged 8 to 10 with a confirmed diagnosis of specific learning disabilities were recruited from the Comprehensive Center for Assessment, Education, Rehabilitation, and Early Developmental Interventions Dashtestan (Borazjan).. After obtaining parental consent, the students were randomly assigned to either the intervention (n = 15) or control (n = 15) group. Before starting the intervention, all participants completed the items in the Frostig Developmental Test of Visual Perception. The participants in the intervention group then attended the mobile photography training program, delivered over 24 sessions, each lasting 60 minutes, and conducted twice per week. Upon completion of the training, the research instrument was re-administered to the members of both intervention and control groups. Quantitative data were analyzed using

Table 1. Coding of main themes, sub-themes, and interviewee codes of the mobile photography training program (Mobilegraphy) based on the opinions of university professors in the field of specific learning disabilities and the field of art and photography.

Main themes	Subthemes	Interviewee Codes
Initial training in mobile phone photography	Training on different parts of the mobile camera	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	Training on manual camera settings	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	Basic and simple photography skills	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	Resolving issues of image blur and photo editing	2, 3, 4, 5, 6, 8, 9, 10, 11
	Correct positioning for taking photos	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
	Photography without image blur	2, 3, 4, 5, 6, 8, 9, 10, 11
Enhancing motivation and creating mental challenges	Motivating children to take photos	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	Creating mental challenges for photography	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
	Enjoyment of photography	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
	Addressing the motivations behind photography	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
	Viewing artists' beautiful photos to enhance motivation	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13
	Creating mental challenges to select the best photos taken by students	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Development of visual perception skills	Exercises on composition and framing	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13
	Working with lighting	5, 6, 7, 8, 9, 10, 11, 12, 13
	Macro photography	5, 6, 7, 8, 9, 10, 11, 12, 13
	Photography from different angles	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13
	Black and white photography	5, 6, 7, 8, 9, 10, 11, 12, 13
	Photography of movements	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13

repeated measures analysis of covariance (ANCOVA). Qualitative data were analyzed using a three-stage coding scheme to extract the main themes and subthemes from the interview data.

Findings

As shown in Table 2, the mean pre-test scores of the subscales, eye-hand coordination, figure-ground perception, form constancy, spatial position, and spatial relations, were approximately equal between the intervention and control groups. However, in the post-test and follow-up assessments, the mean scores gained by the intervention group on these subscales were higher than those of the control group.

The pre-test and follow-up scores of the subscales—eye-hand coordination, figure-ground perception, form constancy, spatial position, and spatial relations—showed that the mean scores of the intervention group were higher than those of the control group.

According to the data in Table 3, the mobile photography training program (MobileGraphy) for children with SLDs was developed around tree key areas: "Initial training in mobile phone photography," "Enhancing motivation and creating mental challenges," "Development of visual perception skills," "Initial training in mobile phone photography" focused on six subthemes: training on different parts of the mobile phone camera, training on manual camera settings, basic and simple photography skills, resolving issues of image blur and photo editing, correct positioning for photography, and skills for photography without image blurring. "Enhancing motivation and creating mental challenges" involved six subthemes: motivating children to take photos, creating mental challenges for photography, enjoying photography, addressing motivations behind photography, viewing renowned artists' photographs to strengthen motivation, and creating mental challenges for selecting the best photos taken by students. In the main theme "Development of visual perception skills," six subthemes emerged: exercises on composition and framing, working with lighting, macro photography, photography from different angles, black and white photography practice, and photography of movement.Thus, the mobile photography training program (MobileGraphy) for children with specific learning disabilities was structured around tree main themes (axial coding) and Eighteen subthemes (selective coding). Moreover, based on the open codes extracted, a plan of action was developed for implementing the mobile photography training program for children with SLDs.

To validate the intervention program, the triangulation method of interactive verification was employed, involving three expert groups: university psychology professors, specialists in specific learning disabilities, and professors in the fields of art and photography. The selected experts from these groups completed a five-item questionnaire, as presented in Table 4, based on the content of the training sessions.

The three expert groups responded to the items in this questionnaire using a 10-point Likert scale to provide their evaluations of session content, as detailed in Table 4. After data aggregation and analysis, the mobile photography training program (MobileGraphy) was validated. The reliability coefficient of criterion-dependent tests and inter-rater agreement were used to assess the reliability of the program.

Based on the findings in Table 5, the mean inter-rater score regarding all sessions was greater than 8. These figures were used to calculate the reliability coefficient, which is reported as percentages in the table above. The overall mean expert agreement score on the final session content was 9.19 out of 10; that is, the experts' agreement percentage on the final session content was 91%, indicating a high reliability of the mobile photography training program (MobileGraphy).

The content validity ratio (CVR), developed by Lawshe (22), was used to assess relative content validity, with a minimum acceptable CVR value of 0.85. To calculate this ratio, opinions from specialists in the program's content

Table 2. The descriptive statistics for the pre-test, post-test, and follow-up scores of visual perception skills in the children in the two groups

Dependent variable	Group	Pre-intervention		Post-intervention		Follow-up	
		Mean	SD	Mean	SD	Mean	SD
Eye-hand coordination	Intervention	24.06	4.06	25.93	5.14	27.46	6.73
	Control	23.53	4.27	23.66	4.46	23.80	5.05
Figure-ground perception	Intervention	13.26	5.14	16.40	6.36	16.26	5.67
	Control	12.00	2.82	12.06	3.75	12.13	4.65
Form constancy	Intervention	7.53	3.35	10.33	5.09	10.53	6.43
	Control	7.53	3.39	7.46	4.40	7.73	4.94
Spatial position	Intervention	6.53	2.89	9.40	4.62	9.93	4.90
	Control	6.46	3.04	6.73	4.23	6.66	4.74
Spatial relations	Intervention	5.60	4.30	7.66	5.35	8.26	5.57
	Control	6.00	3.92	6.20	4.45	6.20	5.28

Table 3. Assessment of the mobile photography training program (MobileGraphy)

Main themes (axial coding)	Subthemes (selective coding)	Open Codes Extracted
Initial training in mobile phone photography	Training on different parts of the mobile camera	Children should be taught the components of the mobile phone camera. Children need to gain a sufficient understanding of the mobile phone camera. Children must learn how to take photos using the mobile camera.
	Training on manual camera settings	Manual camera settings of the mobile phone should be taught to children. Complete camera settings should be introduced Children need to learn how to hold the mobile phone properly for photography.
	Basic and simple photography skills	Children need to acquire basic skills in mobile phone photography. Children should be trained in photo editing using a mobile phone.
	Resolving issues of image blur and photo editing	Children need to learn how to take high-quality photos Children should be taught photo editing skills. Children need to acquire skills for capturing clear and sharp images. Children must learn appropriate lighting techniques based on the situation.
	Correct positioning for photography	Children should learn various correct positions for taking photos with a mobile phone. Children need to understand proper angling for mobile photography. Children should learn framing techniques.
	Photography without image blur	Children need to be taught how to photograph without image blurring. The causes of image blur should be explained. Children should learn how to troubleshoot photography issues with their mobile phones.
Enhancing motivation and creating mental challenges	Motivating children to take photos	Motivation for photography should be fostered in children. Photography requires motivation for children.
	Creating mental challenges for photography	Competitive challenges to take good photos should be created. Discussions about photos should be used to stimulate cognitive challenges in children.
	Enjoyment of photography	Photography should be enjoyable for children. Discussing photos can enhance children's enjoyment.
	Addressing motivations behind photography	Discussions about photos should be used to cultivate motivation. Talking about the motivations for photography with children is necessary.
	Viewing renowned artists' photographs to enhance motivation	Showing children photographs by renowned artists helps strengthen motivation. Exhibiting artists' photos can boost children's motivation.
	Creating mental challenges for selecting the best photos taken by students	Holding exhibitions of children's photos to encourage cognitive challenges for better photography. Organizing the best photo contests for children.
Development of visual perception skills	Exercises on composition and framing	Children should learn elements such as symmetry, the rule of thirds, and the use of leading lines. Training should focus on understanding spatial relationships and organization within a confined space.
	Working with lighting	Children should develop an understanding of the effects of light and shadow on various subjects. Photography practice under different lighting conditions (natural, artificial, sunrise, and sunset) should be practiced to enhance skills in analyzing light and shadows.
	Macro photography	The focus on details should be strengthened. Children should be taught to identify finer details in subjects for photography.
	Photography from different angles	Children should learn to vary viewpoints and take photos from unusual angles. Spatial awareness and understanding object relationships in three-dimensional spaces should be taught.
	Black and white photography	Children should be trained in the presence of color, light reflection, shadows, and contrast. Teaching about composition and patterns in black and white images is required.
	Photography of movement	Children should practice identifying key moments in movement and dynamics. Training in processing and capturing high-speed images is required.

area were gathered. First, the program's test objectives and operational definitions related to content were explained. Then, experts were asked to classify each session based on a three-point Likert scale: "essential item," "useful but not essential," and "not essential". After collecting expert opinions, the CVR was calculated using the following formula:

$$CVR = ne - N / 2 \div N / 2$$

where *ne* is the number of experts who deemed the content of each session essential, and N is the total number of experts.

Furthermore, the content validity index (CVI) introduced by Waltz and Bausell was applied to determine content validity (23). The CVI was calculated both at the item/session level (S-CVI) and for the entire program (I-CVI). The overall content validity index of each session was obtained by averaging the total scores of three criteria for that session. It is important to note that items with CVI scores above 0.79 are considered appropriate; scores

between 0.70 and 0.79 require revision, and scores below 0.70 are unacceptable and should be removed. To assess the overall content validity of the program (S-CVI/Ave), the average content validity index was used, representing the proportion of items in the instrument rated as relevant (scores of 3 or 4) by experts. The relative validity coefficients and content validity indices for each session and the overall program are presented in Table 6.

Based on the findings presented in Table 6, the content validity ratio (CVR) and the mean item-level content validity index (I-CVI) for all sessions were 0.88 and 0.92, respectively. Given that higher validity indices—those closer to 1—indicate greater content validity, these results suggest that the mobile photography training program demonstrates a high level of content validity.

The findings from the repeated measures ANOVA (Table 7) demonstrated that the mobile photography training program significantly improved all components of visual perception skills in children with specific learning disabilities. The main effect of "time" was statistically significant across all subscales ($P<0.05$), signifying improved performance in both the post-test and follow-up stages compared to baseline (pre-test). Furthermore, a significant interaction between group and time was evident for the subcomponents of eye-hand coordination ($\eta^2=0.16$), spatial position ($\eta^2=0.18$), and spatial relationships ($\eta^2=0.18$). This interaction suggests that the intervention group made more substantial progress in these areas than the control group. While the effects on figure-ground perception and form constancy were also statistically significant ($P<0.05$), their effect sizes were relatively moderate. Consequently, it can be concluded that components associated with spatial processing, particularly the perception of object positioning and visual-motor coordination, were most responsive to the training intervention.

Discussion

The structured mobile photography training program designed for children with specific learning disabilities aims to enhance their Development of visual perception skills,. The qualitative phase of this study, employing axial coding, identified three core themes that guided the program's development: "Basic training in mobile phone

Table 4. Questionnaire on the content validation of the sessions

Item	Description
1	To what extent are the objectives and content of each session related? Low 1–2–3–4–5–6–7–8–9–10 High
2	To what extent is the content of each session presented clearly and simply? Low 1–2–3–4–5–6–7–8–9–10 High
3	To what extent is each session's program aligned with the strategies of the mobile photography training program (MobileGraphy)? Low 1–2–3–4–5–6–7–8–9–10 High
4	To what extent is each session's program appropriately designed to provide mobile photography training for students with specific learning disabilities? Low 1–2–3–4–5–6–7–8–9–10 High
5	To what extent is the mobile photography training program (MobileGraphy) designed appropriately for developing the visual perception skills of children with specific learning disabilities? Low 1–2–3–4–5–6–7–8–9–10 High

Table 5. Inter-rater reliability of the sessions assessed by experts

Group	Number	Sessions	1–6 (Initial Mobile Photography Training)	7–12 (Enhancing Motivation & Mental Challenge)	13–18 (Development of Visual Perception Skills)	14–24 (Development of Attention Skills)
Psychology Professors	1	Session Scores (1 to 10)	8	10	9	10
	2		9	8	9	9
	3		10	10	8	10
Specialists in Specific learning disabilities	1		10	9	10	10
	2		9	9	9	8
	3		9	10	9	9
Art and Photography Professors	1		10	9	10	9
	2		10	8	8	10
	3		10	8	10	8
Mean Score			9.44	9.11	9.22	9.20
Reliability Coefficient			0.94	0.90	0.91	0.92
Overall Mean Score			9.19			
Overall Reliability Coefficient			0.91			

Table 6. Expert ratings for assessing the content validity of the sessions

Session	Objective	CVR	I-CVI			Overall I-CVI	Interpretation
			Relevance	Clarity	Simplicity		
1	Teaching various parts of the mobile phone camera	0.89	0.95	0.89	0.94	0.90	Appropriate
2	Teaching manual settings of the mobile phone camera	0.93	0.94	0.97	0.98	0.93	Appropriate
3	Basic and simple photography skills	0.94	0.95	0.93	0.95	0.98	Appropriate
4	Addressing photo clarity issues and photo editing	0.89	0.99	0.92	0.93	0.90	Appropriate
5	Correct positioning (posture) for photography	0.94	0.97	0.94	0.95	0.95	Appropriate
6	Photography skills to avoid image blur	0.87	0.96	0.96	0.90	0.94	Appropriate
7	Motivating children for photography	0.89	0.98	0.98	0.95	0.94	Appropriate
8	Creating mental challenges for photography	0.92	0.97	0.98	0.95	0.96	Appropriate
9	Enjoying photography	0.89	0.96	0.95	0.91	0.93	Appropriate
10	Addressing motivations for photography	0.91	0.99	0.93	0.92	0.95	Appropriate
11	Viewing works of master photographers to boost motivation	0.93	0.94	0.97	0.98	0.93	Appropriate
12	Mental challenge in selecting the best photos by students	0.91	0.96	0.93	0.96	0.98	Appropriate
13	Practicing composition and framing	0.93	0.99	0.92	0.93	0.90	Appropriate
14	Working with light	0.94	0.97	0.94	0.95	0.95	Appropriate
15	Macro photography	0.97	0.96	0.96	0.90	0.94	Appropriate
16	Photography from different angles	0.89	0.98	0.98	0.95	0.94	Appropriate
17	Practicing black and white photography	0.92	0.97	0.98	0.95	0.96	Appropriate
18	Photography of movements	0.89	0.96	0.95	0.91	0.93	Appropriate
19	Photography of momentary changes in light	0.94	0.97	0.94	0.95	0.95	Appropriate
20	Photography of patterns and textures	0.94	0.97	0.94	0.95	0.95	Appropriate
21	Street photography	0.86	0.96	0.96	0.90	0.94	Appropriate
22	Portrait photography	0.89	0.98	0.98	0.95	0.94	Appropriate
23	Nature photography	0.92	0.97	0.98	0.95	0.96	Appropriate
24	High-speed photography	0.96	0.96	0.95	0.91	0.93	Appropriate
Overall relative content validity ratio of all sessions (S-CVR/Ave)							0.94
Average content validity index of all sessions (S-CVI/Ave)							0.95
Interpretation							Appropriate

Table 7. Results of repeated measures ANCOVA for the effectiveness of the mobile photography training program on children's visual perception skills

Variable	Source of variation	Sum of squares	df	Mean square	F value	Sig.	Effect size
Eye-hand coordination	Time	50.55	1.53	33.00	7.64	0.005	0.21
	Group × time interaction	36.95	1.53	24.12	5.58	0.01	0.16
Figure-ground perception	Time	50.15	1.37	36.39	4.34	0.03	0.13
	Group × time interaction	44.15	1.37	32.04	3.82	0.04	0.12
Form constancy	Time	44.82	1.48	30.13	4.98	0.01	0.15
	Group × time interaction	40.15	1.48	26.99	4.46	0.02	0.13
Spatial position	Time	57.48	1.26	45.36	8.63	0.003	0.23
	Group × time interaction	43.40	1.26	34.24	6.51	0.01	0.18
Spatial relationships	Time	34.28	1.44	23.77	8.81	0.002	0.23
	Group × time interaction	24.82	1.44	17.21	6.38	0.008	0.18

photography," "Motivation enhancement and cognitive challenge," "Development of visual perception skills,". "Basic training in mobile phone photography" involved six subthemes that emerged through selective coding: instruction on various mobile camera components, training in manual settings, fundamental photography techniques, strategies for resolving image blur and photo editing, appropriate body positioning for photography, and methods for achieving sharp images. In addition, the second primary theme, motivation enhancement and cognitive

challenge, encompassed six subthemes: techniques for motivating children to engage in photography, the creation of cognitive challenges during photo-taking, fostering enjoyment in the photographic process, exploration of the underlying motivations for photo-taking, studying works by renowned photographers to bolster motivation, and selecting the best student-captured images as a cognitive challenge. The third theme, development of visual perception, also included six subthemes: practice in composition and framing, working with light, macro photography, capturing different angles, black-and-white photography, and photographing movement. Thus, the mobile photography training program was systematically developed around three core themes (axial coding) and 18 subthemes (selective coding). A plan of action for implementation was also developed based on the open codes extracted from the qualitative analysis.

The qualitative findings identified these three foundational components for the training program: basic photography training, enhancing motivation and cognitive challenge, development of visual perception. The subsequent quantitative findings also confirmed that these same components significantly improved, as reflected in the subscales of the Frostig Developmental Test of Visual Perception, specifically eye-hand coordination, figure-ground perception, form constancy, position in space, and spatial relationships. This strong alignment between the qualitative themes and the quantitative outcomes indicates a robust theoretical and practical coherence within the designed intervention. Thus, the results from both the qualitative and quantitative components mutually reinforce each other, thereby enhancing the explanatory validity of the overall findings of the study.

The inter-rater reliability of the program was high, with the mean agreement score among expert reviewers across all sessions exceeding 8 out of 10. These scores, reported as percentages, were used to calculate the reliability coefficients. The overall mean expert agreement score regarding the final session content was 9.19 out of 10, indicating a 92% agreement rate and reflecting high reliability for the mobile photography training program. Furthermore, the program demonstrated strong content validity. Both the relative content validity ratio (CVR) and the mean content validity index (CVI) for all sessions were 0.92. Given that values closer to 1 signify higher content validity, these findings suggested that the training program possesses a high degree of content validity.

It was essential to scientifically validate the content of this researcher-developed program to support its future application by practitioners. To this end, the program was evaluated and validated using methods proposed by Lawshe (1986) and Waltz and Bausell (1981), informed by in-depth interviews and expert reviews. The analysis of the validation data confirmed that the calculated CVR and CVI values for each of the 12 sessions, as well as their overall means, consistently exceeded the acceptable thresholds for 13 reviewers. Accordingly, the objectives of each training session aligned well with the content in terms of relevance, clarity, and simplicity, thereby supporting the theoretical validity of the mobile photography training program.

Some studies have supported the effectiveness of photography-based training on variables related to children's development. For instance, Direh and Bahreini Motlagh found that photography improved children's visual perception, while Milasan (16) reported that phototherapy enhanced mental health. Tourigny and Naydenova (17) observed improvements in visual perception through photography-based interventions, Sigstad and Garrels (15) noted enhanced attention, and Vänskä, Sipari, and Haataja (24) reported the effectiveness of photography in improving perceptual processing and attention in children. This body of evidence suggests that photography training enables children with SLDs to enhance their visual perception and attention skills, as photography has a deep connection with and dependence on objective reality. Unlike other art forms, photography does not merely replace reality but actively maintains the relationship between the individual and the "object-ness" of phenomena. Its power lies in revealing a previously unconceptualized new reality embedded within the object. This process inherently demands heightened visual perception, focus, and sustained attention to capture the optimal image. Consequently, photography instruction encourages children to engage in focused and attentive practice, which directly contributes to improving their visual perceptual abilities.

The researcher was fully aware that photography, while serving as a recreational activity, also possesses significant educational and developmental value, recognizing its potential to enhance both cognitive and social skills in children. Engagement in photography exposes children to diverse scenes, environments, and natural settings that foster these skills. Furthermore, the discussion and reflection on captured photographs contribute not only to the development of verbal skills but also reinforce visual perceptual abilities, as photography inherently requires high levels of attention and focus. Throughout the photographic process, children are exposed to novel mental concepts and acquire broader, more refined skills. Based on these insights, the present study successfully designed and validated a mobile photography training program (MobileGraphy) for children with specific learning disabilities. This was accomplished through a rigorous qualitative method utilizing in-depth interviews, which facilitated the development of a precise, evidence-based intervention package scientifically validated for use by professionals working with children with learning disabilities.

The quantitative data in this study demonstrated that the mobile photography training program had a

statistically significant and sustained impact on various components of visual perception, including eye-hand coordination, figure-ground perception, form constancy, position in space, and spatial relationships. These findings are consistent with previous studies by Direh and Bahreini Motlagh (24), Tourigny and Naydenova (17), and Sigstad and Garrels (15).

The alignment between the qualitative results—where experts identified three core program components—and the quantitative outcomes—showing significant improvements in the Frostig Developmental Test of Visual Perception subscales—underscores the strong theoretical and practical coherence of the intervention. Specifically, components like visual-motor coordination, spatial relationship perception, and form constancy in space were notably influenced by the training program. These results confirm that simple, accessible technological tools like smartphone cameras, when used within a structured and purposeful educational framework, can serve as innovative and effective tools in cognitive interventions for children with special needs. However, it is important to note that generalizing these findings requires further studies involving more diverse populations and larger sample sizes.

In line with these findings, it can be argued that deficits in visual perception and attention are core characteristics of children with SLDs. These children often struggle to effectively use visual perception in learning processes, facing difficulties in segmenting words into syllables and phonemes or recognizing their combinatory nature. Such deficits can lead to challenges in distinguishing word segments or phonemes and in using phonological encoding strategies to improve attention capacity. The exercises embedded in the photography training program—such as capturing movement, changes in light, patterns and textures, and fast motion—enhance visual perception and attention, thereby enabling children to make logical and accurate associations between words, letters, and sounds (25). In essence, the program incorporates a range of techniques aimed at strengthening visual perception and memory capacity (3). These techniques help children retain essential information through visual, auditory, and sensory-based performance. They facilitate the creation of specific mental imagery, which, in turn, helps convert information into memorable visual representations. This process enhances both attention and visual perception (26), ultimately improving overall cognitive performance.

One of the limitations in the present study was related to the quantitative sample, which consisted solely of children with specific learning disabilities in primary schools in the city of Borazjan. Therefore, caution is advised when generalizing these findings to similar children in other regions. Moreover, the present study could not control for all potential confounding variables, and as such, the findings should be interpreted with care. The qualitative phase of the study was also conducted with some limitations, including a relatively small number of interview participants, which may have restricted the range of viewpoints obtained. Furthermore, there is an inherent risk of response bias, particularly when participants might offer responses aligned with perceived social desirability. Despite efforts to minimize such bias through the use of semi-structured interviews and ensuring confidentiality, these factors should be considered when interpreting the qualitative findings.

Based on the findings from this study, mobile photography training (MobileGraphy) can be utilized as an intervention strategy to mitigate learning and behavioral challenges in students. Preschool instructors are also encouraged to integrate this program into their curricula to enhance children's visual perception skills.

Conclusion

The MobileGraphy training program, developed and validated in this study, presents an innovative and effective educational intervention for enhancing visual perception skills in children with specific learning disabilities (SLD). Both qualitative and quantitative findings demonstrated that structured mobile phone photography training—through motivational strategies, cognitive challenges, and targeted visual exercises—can significantly improve cognitive functioning in these children. By leveraging accessible technology such as mobile phone cameras, the program offers a practical solution that can be integrated into formal and informal educational settings. Therefore, MobileGraphy holds strong potential as a supportive tool for promoting cognitive development and learning outcomes among children with SLD.

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Competing Interests

The authors declared no conflict of interest related to this article.
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Ethical Approval

This study was approved by the ethical committee of Islamic Azad University, Science and Research Branch, Tehran (Ethical code: IR.IAU.SRB.REC.1404.042).

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