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Investigating The Effectiveness of Puzzle Teaching in Learning Disorders of Students with Learning Disabilities

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ABSTRACT

Objective: Specific learning disorders represent one of the most intricate challenges encountered within the disciplines of psychology and the education of exceptional children. Learning disorders constitute one of the primary contributing factors to students' academic underachievement.

Methods: This study seeks to evaluate the efficacy of puzzle training in addressing learning disorders among students with disabilities. Our research was conducted in Tehran. The present study employed a semi-experimental design. The population under investigation encompasses all children with learning disabilities residing in Tehran. A sample of 32 individuals was randomly selected and allocated into two groups of 16 participants each, namely the experimental group and the control group. Data were collected utilizing the NAMA Reading Assessment (2005) and the writing assessment designed by the researcher. The analysis of the data was performed through one-way analysis of covariance (ANCOA).

Results: The findings of the investigation indicated that the instructional strategy utilizing puzzles yielded an effect size of 0.82, 0.926, 0.213 and 0.90 on reading and writing, in first and second grades students respectively. In other terms, 82 percent and 92 percent of the variability in the reading and writing scores of the experimental cohort were attributable to the influence of the puzzle-based activity.

Conclusions: These results substantiate the efficacy of the puzzle methodology in enhancing the reading and writing competencies of children diagnosed with learning disabilities.

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Introduction

A learning disability is intricately associated with the neurological functioning of an individual's brain. This condition significantly impedes one's capacity to acquire knowledge, comprehend information, or perform various tasks (Nkoana et al., 2020). It represents a deterioration in cognitive capabilities and presents challenges in performing daily activities – such as household chores, social interactions, or financial management – that persist throughout an individual's lifetime (Thapliyal et al., 2022). Learning disabilities manifest in very early childhood; however, they typically remain undiagnosed until the child attains school age (Scanlon et al., 2021). These disabilities can represent enduring conditions throughout one's life (Köse et al., 2022). Certain individuals may experience multiple coexisting learning disabilities, while others may exhibit a singular, isolated learning challenge that minimally influences their daily existence (Köse et al., 2022). The etiology of learning disabilities is attributed to genetic and/or neurobiological determinants that disrupt brain functionality in a manner that impacts one or more cognitive processes pertinent to learning (Shakespeare et al., 2021). Such processing impairments can obstruct the acquisition of foundational skills, including reading, writing, and/or mathematics (Georgan et al., 2023). Furthermore, these challenges may also impede the development of advanced skills such as organizational abilities, time management, abstract reasoning, both long- and short-term memory, and attentional control (Thapliyal et al., 2022). It is crucial to acknowledge that learning disabilities extend their impact beyond the educational sphere, influencing interpersonal relationships with family, peers, and colleagues (Dutt et al., 2022). On a global scale, approximately 5% of the overall population of school-aged children is currently receiving special education services, with this figure experiencing a substantial increase. The proportion of students benefiting from special education has escalated from 30% of all learners since 1977 to over 50%. The prevalence of these disabilities within the Iranian student demographic has been documented to range between 4% and 12%. Various theoretical frameworks have been employed to elucidate the emergence of learning disabilities, each endeavoring to account for a multitude of contributing factors. Some of these factors are identified as primary contributors to academic failure, while others may serve as mitigating elements, thereby necessitating comprehensive evaluations for each child to ascertain their classification. It is posited that learning disabilities arise from anomalies within the nervous system, whether attributable to

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structural abnormalities in the brain or dysfunctions in neurochemical processes. Variations in the nervous system led to distinctive modalities through which a child with a learning disability receives, processes, or transmits information (Ward et al., 2019).

Certain scholars assert that over 25 percent of the academic decline observed among elementary school students can be attributed to deficiencies in reading and writing skills (Akhavan Tafti & Zolfagharian, 2015). As anticipated, individuals with learning disabilities encounter challenges across all academic subjects as a consequence of their reading and writing impairments.

Despite possessing average cognitive abilities, these students exhibit suboptimal academic advancement and encounter challenges in persisting with their education, often resulting in withdrawal; this predicament may inflict economic, social, cultural, emotional, and psychological detriment upon both the individual and their familial and societal contexts (Alizadehfard et al., 2016). In the present investigation, drawing inspiration from the methodology of mastering alphabetic characters, a novel pedagogical approach was conceptualized wherein letters are constructed and organized in a manner that facilitates their facile reproduction by students exhibiting learning disabilities, thereby influencing their recoding mechanisms and enhancing retrieval ease. This pedagogical strategy, which incorporates gamification elements, engenders moments of enjoyment in conjunction with educational experiences for learners with dyslexia or dysgraphia, thereby fostering letter acquisition. The primary objective of this research is to evaluate the efficacy of this innovative approach in mitigating learning challenges and augmenting students' competencies in reading and writing. Consequently, within the applied domain, the findings of this study, along with analogous research, if demonstrative of the effectiveness of intervention strategies in enhancing students' reading and writing proficiencies, may facilitate the implementation of preventative measures aimed at curbing the proliferation and exacerbation of this disorder during childhood. Additionally, it has the potential to catalyze timely and effective interventions within authentic educational settings, thereby alleviating the adverse repercussions associated with this disorder in both individual and societal contexts.

Material and Methods

This investigation employs a quasi-experimental design incorporating both pre-test and post-test assessments. The statistical population encompasses all first and second grade elementary school

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students exhibiting reading and writing impairments within the confines of Tehran. A cohort of 30 individuals was derived for the first grade through a process of simple random sampling. The identities of the students were cataloged, and each student was allocated a unique three-digit identification code. From this pool of codes, 30 individuals were selected at random. Subsequently, 15 individuals from this group were chosen using the same randomization approach, thus designating 15 participants for the experimental group and 15 for the control group. This identical methodology was applied to second grade students. The NAMA test was employed for data collection. This assessment tool was devised by Karami Norio Moradi (2005) and was administered to a total of 1614 students (770 males and 844 females) across five educational grades in Tehran, Sanandaj, and Tabriz, and subsequently underwent standardization. Upon the compilation of data and the execution of statistical analyses, both raw scores and normative scores were computed for each grade across the various cities. The subscales engaged in the dyslexia assessment encompass the word reading test, the text reading comprehension test, the word chain test, the word comprehension test, the rhyme test, the sound deletion test, the nonsense word reading test, the picture naming test, the letter symbol test, and the word symbol test. The alpha reliability coefficient for the reading and dyslexia assessment was determined to be 0.81.

Spelling assessment: This researcher-developed evaluation comprises complex vocabulary tailored for first and second grade elementary students. Each assessment contains 30 words designated for the first grade and 30 words for the second grade, both of which have received endorsement from three psychology professors and three educators specializing in learning disorders.

Puzzle training sessions: The implementation of puzzle training sessions received validation from the faculty of the Art and Graphics Department following the development of accompanying letters and illustrations. Upon securing approval for these puzzles, endorsement was also obtained from three professors specializing in psychology and educational management, leading to the formulation of ten instructional sessions that were subsequently delivered to the students.

For the purpose of data analysis, analysis of covariance was utilized to ascertain the disparities between the experimental and control groups, and the statistical methodology of analysis of covariance was employed to evaluate the research hypotheses.

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Ethical considerations: This study was conducted with the utmost attention to ethical principles, ensuring the protection of participants' rights and well-being throughout the research process. Informed consent was obtained from the parents or guardians of all participants, clearly outlining the purpose, procedures, and potential risks associated with the study. Participants were assured that their involvement was voluntary and that they could withdraw at any time without any consequences. Confidentiality was maintained by anonymizing the data, and the information collected was used solely for research purposes.

Results

After confirming that the assumptions underlying the analysis of covariance were upheld, the research hypotheses were subjected to scrutiny through one-way analysis of covariance (ANCOVA).

First hypothesis: Puzzle teaching has an effect on reading performance and writing disorder of first-grade students.

To investigate this hypothesis, one-way analysis of covariance was employed, with the findings delineated in Tables 1 and 2.

Table 1. Results of analysis of covariance for the post-test scores of reading performance in first-grade students

Source	SS	DF	MS	F	P	Effect size	Power
Constant	216.39	1	216.39	22.85	0.001	0.458	0.996
Pretest	17.38	1	17.38	11.01	0.002	0.79	0.971
Group	2.21	1	2.21	15.72	0.001	0.82	0.991
Error	255.65	27	9.46				

Table 2. Results of analysis of covariance for the post-test scores of writing disorder in first-grade students

Source	SS	DF	MS	F	P	Effect size	Power
Constant	0.034	1	0.034	0.023	0.88	0.001	0.051
Pretest	225.43	1	225.43	152.68	0.001	0.864	1
Group	2.14	1	2.14	17.15	0.001	0.926	1
Error	38.38	26	1.47				

As illustrated in the aforementioned tables, following the adjustment of pre-test scores, a statistically significant disparity was observed between the two groups—experimental and control—regarding the mean scores in both reading performance and writing disorder (refer to the

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values corresponding to the fifth row in Tables 1 and 2 (group)). Consequently, the primary hypothesis of the investigation is substantiated. More specifically, puzzle training, when considering the adjusted mean reading performance scores of the experimental group (82.24) and the writing disorder scores of the experimental group (73.7) in comparison to the adjusted mean scores of the control group (22.1) and (13.6), respectively, resulted in elevated reading scores and diminished writing disorder scores among first-grade elementary school students in the experimental cohort. The effect sizes for reading and writing were determined to be 0.82 and 0.926, respectively. This indicates that 82 percent and 92 percent of the individual variances in the reading and writing disorder scores of the experimental group can be attributed to the influence of the puzzle game.

Second hypothesis: Puzzle training exerts an influence on reading performance and writing disorder scores among second-grade elementary school students.

To evaluate this hypothesis, one-way analysis of covariance was utilized, with the resultant data encapsulated in Tables 3 and 4.

Table 3. Results of analysis of covariance of reading performance in second-grade students

Source	SS	DF	MS	F	P	Effect size	Power
Constant	7.06	1	7.06	4.68	0.039	0.148	0.55
Pretest	24.16	1	24.16	16.01	0.001	0.372	0.97
Group	11	1	1.5	7.29	0.012	0.213	0.74
Error	40.73	27					

Table 4. Results of analysis of covariance of writing disorder in second-grade students

Source	SS	DF	MS	F	P	Effect size	Power
Constant	0.078	1	0.078	0.033	0.857	0.001	0.054
Pretest	111.91	1	47.25	47.25	0.001	0.636	1
Group	576.20	1	576.20	24.28	0.001	0.90	1
Error	93.95	27					

As demonstrated in Table 4, following the adjustment of pre-test scores, a significant difference was noted between the two groups—experimental and control—concerning the average scores in reading performance and writing disorder (refer to the values corresponding to Tables 3 and 4. Therefore, the second hypothesis of the study is corroborated. In other words, puzzle training, when examining the adjusted mean reading performance scores of the experimental group (341.23) and writing disorder scores (26.17) in comparison to the adjusted mean scores of the control group

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(43.20) and (53.20), respectively, has led to an enhancement in reading and a reduction in writing disorder among second-grade elementary school students in the experimental group. The effect sizes for reading and writing are quantified at 0.213 and 0.9, respectively. This implies that 22 percent and 90 percent of the individual differences in the reading and writing disorder scores of the experimental group are attributable to the impact of the puzzle game.

Discussion

Based on the findings derived from the analysis of covariance, we shall proceed to scrutinize the results. In accordance with the study's objectives, a primary aim was to ascertain the impact of puzzle-based educational interventions on reading and writing impairments. In the evaluation of the study's findings, due to the absence of prior research in this domain, which is novel in its subject matter, there exist no antecedent studies; however, we will assess research that bears relevance to these findings.

Principal hypothesis: Puzzle-based education exerts an influence on the reading and writing impairments experienced by first and second-grade students.

Research findings indicate that following the adjustment of pre-test scores, a statistically significant distinction was observed between the experimental and control groups concerning the mean performance in reading and the prevalence of writing disorders. The effect size for reading and writing was determined to be 0.82 and 0.926, respectively. In other terms, 82% and 92% of the individual variances in reading and writing disorder scores within the experimental group can be attributed to the influence of the puzzle-based activity. The effect size for reading and writing was further reported as 0.213 and 0.9, respectively. This suggests that 22% and 90% of the individual variances in the reading and writing disorder scores of the experimental cohort are connected to the engagement with puzzles. The findings of this research align with those of Havaei et al. (2010), Jalil Abkenar and Ashori (2013) and (Ranjbari et al., 2013). In elucidating this theoretical framework, it can be posited that multiple competencies are essential for engaging with puzzles, including but not limited to visual memory, manual dexterity, and working memory. According to investigations conducted by scholars, children experiencing reading and writing disorders demonstrate diminished capabilities in these areas compared to their typically developing peers (Scanlon et al., 2021). Engaging with puzzles has the potential to enhance perceptual-motor

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performance. Deficiencies in perceptual-motor processes may manifest as challenges in visual perception, auditory perception, tactile-motor perception, and motor difficulties encompassing gross motor skills, fine motor skills, balance, aspect recognition, and spatial orientation (Shakespeare et al., 2021). Romani and Galluzzi (2005) assert that the progression of spelling skills is indicative of two interrelated processes: one that encompasses phonological processing at the lexical level and another that pertains to challenges associated with appropriate and sequential memory related to a lexical pattern, ultimately resulting in considerable difficulties in the accurate spelling of words. In light of this assertion, puzzles may serve to reinforce these cognitive mechanisms, given that the representation of a letter must initially be internalized mentally and subsequently manipulated through hand movements, based on working memory, thereby ultimately enhancing performance in reading and writing impairments.

This study acknowledges several limitations that may impact the generalizability and interpretation of the findings. First, the sample size of 32 participants, while statistically adequate for the analysis, is relatively small and limited to children in Tehran, which may not represent the broader population of children with learning disabilities across different regions. Second, the semi-experimental design does not allow for complete randomization, which may introduce potential biases in the group allocation. Additionally, the study relied on a single type of intervention—puzzle-based training—limiting the comparison to other potential methods of addressing learning disabilities. The reliance on two specific assessments (the NAMA Reading Assessment and a researcher-designed writing assessment) may also limit the scope of the results, as they may not fully capture the complexity of learning disorders. Finally, the duration of the intervention and the follow-up period were not specified in the abstract, which raises questions about the long-term sustainability of the observed effects. These limitations suggest the need for further research with larger, more diverse samples and more varied methodologies to better understand the efficacy of puzzle-based interventions for children with learning disabilities.

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Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of Islamic Azad University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection, and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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