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Investigating the Relationship between Reading Skills of Students with Autism Spectrum Disorder and Mathematical Verbal Problems Solving

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ABSTRACT

Objective: Reading proficiency and problem-solving capabilities represent two distinct yet significant cognitive faculties that exert a considerable influence on both personal and societal dimensions of individuals' lives. Problem-solving constitutes a fundamental component of cognitive processing. In the absence of an accurate delineation and comprehension of the problem, selecting an appropriate method for its resolution becomes untenable. A critical competency requisite for the accurate interpretation of the problem is reading proficiency. This study aims to examine the correlation between the reading capabilities of students diagnosed with autism spectrum disorder and their aptitude for solving mathematical verbal problems.

Methods: The methodology employed in this research is descriptive (non-experimental) quantitative and correlational in nature. The statistical population comprises high-functioning autism students (level one) attending both regular and specialized educational institutions within Khuzestan province. Data acquisition was facilitated through the use of a standardized reading skills questionnaire alongside a researcher-developed questionnaire focused on verbal and mathematical problems. The analytical approach adopted involved regression analysis and hierarchical methods.

Results: The results indicated a significant correlation between the reading proficiency of students with autism spectrum disorder and each of its respective dimensions with the ability to solve mathematical verbal problems.

Conclusions: Furthermore, enhancing each of these competencies is likely to concurrently bolster the verbal problem-solving capabilities of students with autism spectrum disorder.

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Introduction

Pervasive developmental disorders were delineated in 1980 as a unique classification of disorders within the realm of child psychiatry(Mohammadi et al., 2023) . The diagnostic statistical manual for mental disorders has established categories that encompass five distinct disorders. One such disorder is childhood autism. Indeed, the term "autism" serves as the English rendition of the original term. Individuals diagnosed with autism typically exhibit specific characteristics, which include: 1) an impairment in social behavior; 2) a delay in verbal and linguistic skills; 3) a proclivity for monotony, characterized by a persistent preoccupation with colors, numbers, and geometric configurations; 4) an excessive engagement in diverse stimuli, often described as "self-absorbed" tendencies; 5) a propensity for peculiar and repetitive actions; 6) a potential for self-injurious behaviors that may result in self-harm; and 7) an inability to express suitable emotional concepts.

In light of the increasing number of children diagnosed with autism spectrum disorder and the expectation for them to achieve comparable educational outcomes to their peers, the imperative for implementing effective pedagogical strategies for this population is underscored (Schaefer Whitby, 2013). A considerable number of students with autism spectrum disorder encounter academic obstacles and challenges. These difficulties are particularly pronounced in the domain of mathematics. Research indicates that students with autism spectrum disorder exhibit significantly lower performance metrics in mathematics compared to their non-disabled counterparts (Karal et al., 2022). The performance in mathematics is intricately linked to reading competencies (Ackerman & Dykman, 1995; Light & DeFries, 1995). Genetic investigations have demonstrated a correlation between mathematical abilities and reading skills, as well as between mathematical and reading impairments (Plomin & Kovas, 2005). Research focusing on children with learning disabilities has revealed that challenges in reading and mathematics frequently co-occur (Geary, 1994; Geary et al., 2000; Jordan et al., 2003).

Reading constitutes a foundational skill and a pivotal element of an individual's achievement in academic settings, as well as throughout life (Connors-Tadros, 2014). The National Reading Panel (NRP) has identified five broad indicators of reading proficiency: phonics, phonological awareness, vocabulary, comprehension, and fluency. As articulated by the National Reading Panel (Shanahan, 2005), phonological awareness is intrinsically linked to the advancement of word

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recognition capabilities. Furthermore, vocabulary and comprehension are interconnected as integral components of understanding. Additionally, psychic reading is regarded as a distinct element. Proficient readers demonstrate automaticity in recognizing and differentiating words (Garrod & Pickering, 2016). Automaticity, precision, reading velocity, and prosodic structure have been proposed as four fundamental components of fluent reading. Fluency should encompass not only rapid and automatic processing but also the accurate and contextually appropriate allocation of meaning in conjunction with reading speed (Grabe & Stoller, 2019). Fluency, quantified in terms of words correct per minute, serves as a reliable indicator of overall reading proficiency (Fuchs et al., 2001).

According to MacArthur et al. (2010), in a theoretical framework, fluency is conceptualized as the outcome of relative automaticity in the process of word recognition, which subsequently liberates working memory resources for the allocation of attention towards comprehension. Teele (2004) articulated that the primary objective of readers should be to attain understanding of the material they engage with. This assertion underscores the fundamental aim of reading, which is to elucidate the underlying significance of the content and to assimilate the information presented. In contrast to reading, the educational environment is ostensibly the sole context wherein students receive instruction in mathematics (Van de Walle et al., 2022). The most prevalent challenges encountered in the resolution of mathematical problems pertain to the comprehension skills associated with problem contexts (Pearce et al., 2013). Engaging in mathematical problem-solving exercises within educational contexts may augment individuals' capacity to employ acquired mathematical competencies in real-world situations (Spooner et al., 2017). Facilitating the development of problem-solving competencies among students with autism spectrum disorder is likely to enhance their vocational prospects, recreational activities, and overall daily functioning (Root et al., 2021). Experiences related to problem solving in educational environments are typically organized in the format of story problems. Within the realm of verbal problem solving, narratives depict scenarios that necessitate a mathematical resolution (Stein et al., 2005). Acquiring the skills to resolve verbal problems constitutes the foundational basis for addressing real-world problems (Van de Walle et al., 2022). The successful resolution of mathematical word problems necessitates not only mental representation skills but also comprehension abilities. Despite the fact that, in the context of mathematics education, students predominantly learn to utilize the former skills (i.e.,

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representational skills) within the domain of verbal problem solving, empirical findings have indicated that comprehension skills ought to be accorded a more significant emphasis in the pedagogy of verbal problem solving (Boonen et al., 2016).

As posited by Kintsch et al. (Nathan et al., 1992), verbal problem solving represents an interplay between problem-solving strategies and processes of language comprehension. For students diagnosed with autism spectrum disorder, impairments in working memory, executive functioning, and language serve as impediments to conceptually grasping the dynamics of word problems, as well as to formulating and executing a procedural strategy for problem resolution. This is attributable to the presence of deficiencies in crucial component skills such as word decoding, mathematical vocabulary, computational abilities, and practical mathematical knowledge (Bae et al., 2015).

Students diagnosed with Autism Spectrum Disorder (ASD) may demonstrate exceptional abilities in numeracy and procedural skills; however, they often encounter difficulties with more intricate competencies, such as resolving word problems (Kim & Cameron, 2016). A comprehensive review of existing literature and contemporary research (Bullen et al., 2020; Dowker, 2020) indicates that individuals with autism spectrum disorder exhibit inferior performance in problem-solving tasks in comparison to straightforward calculations. Indeed, comprehending the material and selecting suitable strategies for addressing mathematical word problems can pose considerable challenges for these individuals (Cox & Root, 2020; Root et al., 2017). Conversely, verbal proficiency plays an essential role in mathematical success, particularly in the context of solving word problems that necessitate reading or oral understanding (Oswald et al., 2016). Consequently, this study aims to explore the correlation between the reading competencies of students with autism spectrum disorder and their ability to solve verbal problems. Grounded in theoretical frameworks and prior research, the study hypotheses are articulated as follows:

-The word recognition dimension of the reading capabilities of students with autism spectrum disorder is correlated with their proficiency in solving mathematical verbal problems.

-The reading fluency dimension of the reading capabilities of students with autism spectrum disorder is correlated with their proficiency in solving mathematical verbal problems.

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- The reading comprehension dimension of the reading capabilities of students with autism spectrum disorder is correlated with their proficiency in solving mathematical verbal problems.

Material and Methods

The current methodological approach employed in this study is characterized as descriptive (non-experimental) quantitative and correlational in nature. Given the objectives of this investigation and its implications for the field of mathematics education, this study is classified as applied research. The statistical population encompasses high-performing autistic students (level one) who are enrolled in both regular and specialized educational institutions within Khuzestan province. Due to the restricted statistical population of individuals diagnosed with high-functioning autism, a non-probability sampling method was utilized to select the sample. Following oral discussions with the administrators of regular and specialized schools in Khuzestan province, a total of 32 seventh-grade students were ultimately chosen as the sample for this research.

The bibliographic method was employed to establish the theoretical foundations and to gather pertinent information concerning the background and literature relevant to the research. Data collection was conducted through field methods utilizing two overarching questionnaires. The analysis of the data was performed utilizing regression analysis, in accordance with the hypotheses and the theoretical framework of the study, by employing a hierarchical analytical approach.

The objective of the research is to examine the correlation between the reading capabilities of students diagnosed with autism spectrum disorder and their proficiency in solving verbal mathematical problems. Consequently, in pursuit of this objective, it is imperative to assess the students' reading abilities and their aptitude for solving mathematical verbal problems through the application of appropriate instruments.

In summary, two questionnaires were developed:

1 -The reading skills questionnaire, which was constructed based on York Assessment of Reading for Comprehension (YARC) (Martin, 2011).

2 -The mathematical verbal problems questionnaire, which was tailored to align with the educational levels of the students.

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In accordance with the research literature and referencing the general criteria for assessing reading skills as reported by the National Reading Panel, three fundamental dimensions—word recognition, reading fluency, and reading comprehension—were identified as the core components of reading skills. By adapting the secondary Yark assessment, instruments were designed to measure reading skills along with each of its three dimensions as specific indicators.

Word recognition: Drawing upon Foster's single word reading assessment (2007); a compilation of 70 lexemes, arranged from elementary to advanced levels, was meticulously assembled and presented to the participants. The students articulated these lexemes vocally, and meticulous observations were systematically documented.

Reading fluency: Three distinct sentences were presented to the students, who were instructed to articulate the corresponding sentences accurately, audibly, and expressively (for instance: "The numbers 1, 2, 3 and ... are classified as natural numbers").

Reading Comprehension: Grounded in the Yark Secondary Test; three texts exhibiting varying degrees of complexity were made available to the students. Following the silent reading of a text, students were administered four inquiries pertinent to the text for response. To mitigate the influence of the students' memory variable, they were permitted to reference the text as needed.

Ability to solve mathematical verbal problems: Two verbal problems extracted from the 7th-grade mathematics textbook were assigned to the students, who were required to solve them and submit their written responses.

Coding and criteria: The data pertinent to students' reading competencies were systematically coded and evaluated according to the Yark assessment framework for reading comprehension (Martin, 2011). Concerning word recognition; the metric utilized for scoring involved the ratio of correctly articulated words to the total number of words (70). In relation to reading fluency; the quantity of accurate, loud, and expressive words articulated per minute was employed as a metric to assess this proficiency. With respect to content understanding; the ratio of correct responses to the total number of inquiries (four) pertaining to each text was utilized as a criterion. The cumulative scores were expressed as a percentage and categorized into five tiers ranging from excellent to poor, as per the Likert scale. Pertaining to the dependent variable (solving mathematical verbal problems), five criteria were established as follows:

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1 -Comprehension of the problem; 2- Diagrammatic representation; 3- Articulating the perimeter of the rectangle for the initial question/estimating the distance for the subsequent question; 4- Inserting numerical values into the formula for the initial question/summing the distances up to the third encounter for the subsequent question; 5- Delivering a comprehensive answer.

A student who successfully fulfilled all five criteria while addressing two inquiries related to verbal mathematical problem solving attained the highest classification, whereas a student who failed to meet any of the stipulated criteria received the lowest classification.

Validity and reliability

As articulated in comprehensive detail, in alignment with the objective and subject matter of the research, the instrument for data collection was structured in the form of a questionnaire and an assessment. Initially, the questionnaire included inquiries aimed at gaining a more profound understanding of the sample participants, such as the type of educational institution, grade point average, and the grade received in the most recent mathematics lesson, among others, which could assist the researcher in analyzing the data and deriving insights. This information can also be regarded as one of the criteria for the generalizability of the research findings.

To ascertain the validity of the measurement instrument, the reading skill questionnaire alongside the queries associated with mathematical verbal problem-solving were presented to two expert evaluators, who were requested to respond to the inquiry, "Does each question effectively measure the pertinent components?" For this analysis, a four-point scale corresponding to each component and its respective ratio was employed. Content validity was established based on the evaluations provided by both expert assessors, who assigned scores of 3 or 4, indicating relevance or high relevance. The reliability of the test items was computed utilizing Cronbach's alpha formula, yielding a coefficient of 0.86, thereby confirming the internal consistency of the test components.

Results

Data analysis was conducted utilizing the SPSS statistical software and was organized into three distinct phases:

1. Acquainting oneself with the data and preparing it for subsequent analysis;
2. Performing validity and reliability assessments of the established standards;

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3. Evaluating the proposed research hypotheses.

Initially, by considering the indicators of descriptive statistics and to attain a comprehensive understanding of the sample members, we shall scrutinize the data concerning the students' mathematical scores (refer to Table 1) and their GPA status (refer to Table 2). This information serves as a basis for generalizing the results.

Table 1. Distribution of students' final grades in mathematics

Score category	Frequency	Percentage	Cumulative percentage
(Less than 12)	4	12.5	12.5
(12 to 15)	11	34.4	46.9
(15 to 17)	10	31.2	78.1
(17 to 20)	7	21.9	100

An analysis of the final grades in mathematics reveals that among students diagnosed with autism spectrum disorder, the predominant number of students (11 individuals) achieved grades ranging from 12 to 15, suggesting that these students are experiencing challenges in mathematics. Furthermore, only 7 students managed to attain scores exceeding 17.

Table 2. Distribution of students' most recent average scores

Score category	Frequency	Percentage	Cumulative percentage
(Less than 12)	0	0	0
(12 to 15)	4	12.5	12.5
(15 to 17)	12	37.5	50
(17 to 20)	16	50	100

An assessment of the grade point averages indicates that among the students with autism spectrum disorder, the GPAs of 4 individuals fall within the range of 12 to 15, the GPAs of 12 individuals are situated between 15 and 17, and the GPAs of 16 individuals exceed 17. These statistics imply that the overall educational performance of students with autism spectrum disorder is satisfactory; however, their achievements in mathematics remain limited. The prerequisite for administering correlation and regression analyses involves examining the distribution of the variables. The distribution characteristics of the variables, as assessed by the Kolmogorov-Smirnov test, are presented in Table 3.

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Table 3. Distribution of variables according to the Kolmogorov-Smirnov test

Variable	K-S value	P
Word recognition	0.602	0.142
Reading fluency	0.684	0.737
Comprehension	1.111	0.169
Mathematical verbal problems solving	1.038	0.231

Given that the significance levels for all variables surpass the conventional threshold of 0.05, it can be concluded that these variables adhere to a normal distribution. In essence, the null hypothesis is dismissed and the normality of the variable distributions, as well as the prerequisites for regression testing, are substantiated.

The first hypothesis posits that the word recognition component of the reading abilities of students with autism spectrum disorder is correlated with their capacity to solve mathematical verbal problems. The findings pertaining to the evaluation of the model associated with the first research hypothesis are illustrated in Table 4.

Table 4. Fitting the regression model pertaining to the first hypothesis

Independent variable	Dependent variable	T value	Beta	R^2	P	D-W test
Word recognition	Mathematical verbal problems solving	3.997	0.603	0.363	0.000	2.152

Second hypothesis posits that reading fluency dimension pertaining to the reading competencies of students diagnosed with autism spectrum disorder exhibits a correlation with the resolution of mathematical verbal problems. The results obtained from the analysis of the model associated with the second research hypothesis are presented in Table 5.

Table 5. Fitting the regression model associated with the second research hypothesis

Independent variable	Dependent variable	T value	Beta	R^2	P	D-W test
Reading fluency	Mathematical verbal problems solving	5.516	0.722	0.521	0.000	1.611

The third hypothesis posits that comprehension dimension of the reading competencies of students diagnosed with autism spectrum disorder is correlated with the resolution of mathematical verbal problems. The results derived from the analysis of the model associated with the third hypothesis of the research are presented in Table 6.

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Table 6. Fitting the regression model associated with the third research hypothesis

Independent variable	Dependent variable	T value	Beta	R^2	P	D-W test
Comprehension	Mathematical verbal problems solving	3.108	0.507	0.257	0.004	1.682

The findings from the regression analysis pertaining to the first, second, and third hypothesis models of the research indicate that each of the competencies: word recognition, reading fluency, and reading comprehension; exert a statistically significant influence on the resolution of mathematical verbal problems faced by students diagnosed with autism spectrum disorder; as the absolute value of the T test statistic in each of these regression models exceeded the threshold of 1.96. As a consequence, the null hypotheses are rejected, allowing for the assertion that within the statistical population under investigation, the dimensions of word recognition, reading comprehension, and the overall reading competencies of students diagnosed with autism spectrum disorder are correlated with the resolution of mathematical verbal problems.

Based on the variable coefficients, it was determined that the effects of word recognition, reading fluency, and reading comprehension on the resolution of mathematical verbal problems for students diagnosed with autism spectrum disorder are quantified at 0.603, 0.722, and 0.507 units, respectively. Furthermore, given the positive sign of the variable coefficients, it can be inferred that the impact of the independent variable on the dependent variable is direct; as the independent variable increases, the corresponding value of the dependent variable also increases. The coefficients of determination, which are equal to 0.363, 0.521, and 0.257 respectively, suggest that the explanatory power of the fitted models is 36.3%, 52.1%, and 25.7%. Additionally, the Durbin-Watson statistic reflects a favorable level, indicating that the assumption of autocorrelation among the residuals of each model is rejected.

The main hypothesis posits that proficiency in reading among students diagnosed with autism spectrum disorder is correlated with their ability to resolve mathematical verbal problems. The results derived from the assessment of the model pertinent to the primary research hypothesis are presented in Table 7.

Table 7. Fitting the regression model related to the main research hypothesis

Independent variable	Dependent variable	T value	Beta	R^2	P	D-W test
Reading proficiency skills	Mathematical verbal problems solving	5.467	0.719	0.516	0.000	1.699

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In relation to the primary hypothesis of the study, the fit indices of the model suggest that the reading proficiency of students diagnosed with autism spectrum disorder exerts a statistically significant influence on their ability to solve mathematical verbal problems; Given that the absolute value of the T test statistic exceeds 1.96, the null hypothesis is dismissed, thereby allowing the assertion that within the statistical population of the study, the reading proficiency of students diagnosed with autism spectrum disorder is indeed correlated with their ability to solve mathematical verbal problems. The coefficient of the variable indicates that the impact of the reading proficiency of students diagnosed with autism spectrum disorder on their ability to resolve mathematical verbal problems is quantified at 0.719, exhibiting a direct relationship, whereby enhancements in reading proficiency correspond to an increase in the capacity to solve mathematical verbal problems. The coefficient of determination index reveals that the explanatory power of the fitted model stands at 51.6%, which is deemed significant. Durbin-Watson's statistic is calculated to be 1.699, falling within the range of 1.5 to 2.5, and thus is regarded as favorable, indicating that the hypothesis of autocorrelation among the model's residuals is rejected.

Discussion

Numerous learning difficulties are associated with reading and spelling, which manifests as an inability to read or dyslexia. Issues related to reading and the capacity to articulate words accurately represent significant challenges that impact the competencies of children on the autism spectrum. These impairments in children with autism frequently arise due to a linguistic delay experienced by the individual. Proficiency in reading encompasses a collection of skills that form the essential foundation for success across all academic disciplines. Mastery of reading skills constitutes one of the paramount educational requirements for students in contemporary society. The findings derived from the analysis of the hypotheses in the present study indicated that each reading skill, including word recognition, reading fluency, and reading comprehension, exerts a positive and significant influence on the resolution of mathematical verbal problems encountered by students with autism spectrum disorder. Accurate word identification and recognition will positively impact the student's comprehension of the entire sentence, thereby enhancing the student's capability to tackle mathematical verbal problems. To effectively respond to each inquiry,

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it is imperative to first accurately identify and comprehend the question and its constituent elements (words).

A student lacking a precise understanding of the terminology presented in the form of a question will inevitably struggle to provide a correct response to that question. The skill of reading fluency signifies that the student can articulate the words and sentences of the lesson accurately, audibly, and distinctly. A student possessing adequate vocabulary knowledge can read the words of a question or sentence accurately, audibly, and distinctly. Such a student is more likely to succeed in problem-solving compared to a peer who fails to grasp the words correctly and cannot pronounce them fully. Comprehension represents a crucial dimension of reading proficiency. During the reading process, the student must endeavor to comprehend and derive meaning in order to attain a more comprehensive understanding of the material being read. By grasping the content of the reading material, the student can extract the meaning from the text and discern the intent behind the question posed by the inquirer. As the research outcomes also indicated, students exhibiting a heightened understanding of the subject matter demonstrate enhanced problem-solving capabilities.

The interplay of reading and comprehension is the most fundamental, and at the same time, the most transformative approach to fostering students' interest in reading and improving their performance across all subjects and contexts (Zaccoletti et al., 2020). This is predicated on the notion that unless the learner is able to read and comprehend a text, they will be unable to derive enjoyment from it or effectively engage with it to resolve problems. An elevated level of comprehension facilitates improved understanding and interaction with the presented materials, both in the realms of reading and writing. Numerous students experiencing difficulties in written assessments or in solving mathematical problems often suffer from a deficient level of comprehension.

In general, the findings of the study indicated that all three facets of reading proficiency (word recognition, fluency, and reading comprehension), whether considered individually or as a composite skill, can enhance the problem-solving capabilities of students diagnosed with autism spectrum disorders. Students exhibiting elevated reading proficiency typically demonstrate greater academic advancement compared to their peers. They possess the ability to articulate their

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challenges and concerns with ease, perform more effectively in confrontational scenarios, and resolve their issues with increased efficiency.

Reading proficiency constitutes a critical skill that must be regarded as a fundamental instrument for both the academic and personal development of students within educational institutions. A primary characteristic of children with autism spectrum disorder is a pronounced deficit in both verbal and non-verbal communication skills, which results in significant impairment in their application. Acquiring various life skills, including reading proficiency, is imperative for children with autism to enhance their autonomy at home, in educational settings, and within the broader community. Through the early introduction and training of such skills, children with autism acquire the necessary tools to bolster their self-esteem and overall happiness across all aspects of life. Among the most vital competencies that can assure the academic advancement of these students is reading proficiency, which was the focus of investigation in this study.

The study reveals a significant correlation between reading proficiency and the ability to solve mathematical verbal problems in students with autism spectrum disorder (ASD). These findings suggest that reading skills, which are essential for accurately understanding and interpreting problems, play a crucial role in problem-solving abilities. Specifically, the research indicates that as the reading proficiency of students with ASD improves, their capacity to solve mathematical verbal problems also strengthens. This underscores the importance of developing reading skills as a foundational step in enhancing broader cognitive and problem-solving competencies among students with ASD.

This study's limitations include its focus on a specific subgroup of students with ASD—those classified as high-functioning (level one) within a particular geographical area (Khuzestan province). This narrow scope may limit the generalizability of the findings to other populations, including students with varying levels of ASD or those in different cultural and educational contexts. Additionally, the reliance on self-reported questionnaires, while useful, may introduce bias, as responses could be influenced by the students' perceptions or understanding of the questions. The cross-sectional design of the study also restricts the ability to draw causal inferences, as it only captures a snapshot of the relationship between reading proficiency and problem-solving abilities at a single point in time.

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Future research should aim to include a more diverse and representative sample of students with ASD, encompassing various levels of functioning and educational backgrounds, to enhance the generalizability of the findings. Longitudinal studies could provide deeper insights into the development of reading and problem-solving skills over time, allowing for a better understanding of how improvements in reading proficiency may lead to long-term gains in problem-solving abilities. Additionally, employing a mixed-methods approach that includes qualitative data, such as interviews or observational assessments, could provide a more nuanced understanding of the cognitive processes underlying the relationship between reading and problem-solving in students with ASD. Finally, educational interventions that specifically target the enhancement of reading skills in students with ASD should be developed and tested for their efficacy in improving mathematical problem-solving abilities.

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 the Shahid Rajaee Teacher Training 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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References

Ackerman, P. T., & Dykman, R. A. (1995). Reading-disabled students with and without comorbid arithmetic, disability. *Developmental Neuropsychology*, *11*(3), 351-371.

Bae, Y. S., Chiang, H.-M., & Hickson, L. (2015). Mathematical word problem solving ability of children with autism spectrum disorder and their typically developing peers. *Journal of autism and developmental disorders*, *45*, 2200-2208.

Boonen, A. J., de Koning, B. B., Jolles, J., & Van der Schoot, M. (2016). Word problem solving in contemporary math education: A plea for reading comprehension skills training. *Frontiers in Psychology*, *7*, 191.

Bullen, J. C., Swain Lerro, L., Zajic, M., McIntyre, N., & Mundy, P. (2020). A developmental study of mathematics in children with autism spectrum disorder, symptoms of attention deficit hyperactivity disorder, or typical development. *Journal of autism and developmental disorders*, *50*, 4463-4476.

Connors-Tadros, L. (2014). Definitions and approaches to measuring reading proficiency. *Ceelo Fast Facts*.

Cox, S. K., & Root, J. R. (2020). Modified schema-based instruction to develop flexible mathematics problem-solving strategies for students with autism spectrum disorder. *Remedial and Special Education*, *41*(3), 139-151.

Dowker, A. (2020). Arithmetic in developmental cognitive disabilities. *Research in developmental disabilities*, *107*, 103778.

Fuchs, L. S., Fuchs, D., Hosp, M. K., & Jenkins, J. R. (2001). Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. In *The role of fluency in reading competence, assessment, and instruction* (pp. 239-256). Routledge.

Garrod, S., & Pickering, M. (2016). *Language processing*. Psychology press.

[DOI: 10.22034/3.3.113]

Geary, D. C. (1994). *Children's mathematical development: Research and practical applications*. American Psychological Association.

Geary, D. C., Hamson, C. O., & Hoard, M. K. (2000). Numerical and arithmetical cognition: A longitudinal study of process and concept deficits in children with learning disability. *Journal of experimental child psychology*, *77*(3), 236-263.

Grabe, W., & Stoller, F. L. (2019). *Teaching and researching reading*. Routledge.

Jordan, N. C., Hanich, L. B., & Kaplan, D. (2003). A longitudinal study of mathematical competencies in children with specific mathematics difficulties versus children with comorbid mathematics and reading difficulties. *Child development*, *74*(3), 834-850.

Karal, M. A., Riccomini, P. J., & Hughes, E. M. (2022). Effects of video modeling on addition word-problem performance of students with autism spectrum disorder. *International Journal of Developmental Disabilities*, *68*(5), 756-765.

Kim, H., & Cameron, C. E. (2016). Implications of visuospatial skills and executive functions for learning mathematics: Evidence from children with autism and Williams syndrome. *AERA open*, *2*(4), 2332858416675124.

Light, J. G., & DeFries, J. C. (1995). Comorbidity of reading and mathematics disabilities: Genetic and environmental etiologies. *Journal of Learning Disabilities*, *28*(2), 96-106.

MacArthur, C. A., Konold, T. R., Glutting, J. J., & Alamprese, J. A. (2010). Reading component skills of learners in adult basic education. *Journal of Learning Disabilities*, *43*(2), 108-121.

Martin, C. (2011). York Assessment of Reading for Comprehension (YARC). *Educational Psychology in Practice*, *27*(4), 437–439. https://doi.org/ https://doi.org/10.1080/02667363.2011.629456

Mohammadi, K., Samavi, A., Mehdiabadi, F. Z., & Samavi, S. A. (2023). Psychometric validation of concerning behavior scale in Iranian children and young people with autism spectrum disorder. *Frontiers in psychiatry*, *14*, 1153112.

[DOI: 10.22034/3.3.113]

Nathan, M. J., Kintsch, W., & Young, E. (1992). A theory of algebra-word-problem comprehension and its implications for the design of learning environments. *Cognition and instruction*, *9*(4), 329-389.

Oswald, T. M., Beck, J. S., Iosif, A. M., McCauley, J. B., Gilhooly, L. J., Matter, J. C., & Solomon, M. (2016). Clinical and cognitive characteristics associated with mathematics problem solving in adolescents with autism spectrum disorder. *Autism Research*, *9*(4), 480-490.

Pearce, D. L., Bruun, F., Skinner, K., & Lopez-Mohler, C. (2013). What teachers say about student difficulties solving mathematical word problems in grades 2-5. *International Electronic Journal of Mathematics Education*, *8*(1), 3-19.

Plomin, R., & Kovas, Y. (2005). Generalist genes and learning disabilities. *Psychological bulletin*, *131*(4), 592.

Root, J. R., Browder, D. M., Saunders, A. F., & Lo, Y.-y. (2017). Schema-based instruction with concrete and virtual manipulatives to teach problem solving to students with autism. *Remedial and Special Education*, *38*(1), 42-52.

Root, J. R., Ingelin, B., & Cox, S. K. (2021). Teaching Mathematical Word Problem Solving to Students with Autism Spectrum Disorder. *Education and Training in Autism and Developmental Disabilities*, *56*(4), 420-436.

Schaefer Whitby, P. J. (2013). The effects of Solve It! on the mathematical word problem solving ability of adolescents with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *28*(2), 78-88.

Shanahan, T. (2005). The national reading panel report: Practical advice for teachers. Learning Point Associates. In.

Spooner, F., Saunders, A., Root, J., & Brosh, C. (2017). Promoting access to common core mathematics for students with severe disabilities through mathematical problem solving. *Research and Practice for Persons with Severe Disabilities*, *42*(3), 171-186.

[DOI: 10.22034/3.3.113]

Stein, M., Kinder, D., Silbert, J., & Carnine, D. W. (2005). *Designing effective mathematics instruction: A direct instruction approach*. Pearson.

Teele, S. (2004). *Overcoming barricades to reading: A multiple intelligences approach*. Corwin Press.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2022). *Elementary and middle school mathematics: Teaching developmentally*. ERIC.

Zaccoletti, S., Altoè, G., & Mason, L. (2020). The interplay of reading-related emotions and updating in reading comprehension performance. *British Journal of Educational Psychology*, *90*(3), 663-682.

[DOI: 10.22034/3.3.113]