

Investigating the Structural Model of the Effect of Problem-Solving Skills on Learning Difficulties by Separating Male and Female Students with Attention Deficit Hyperactivity Disorder (ADHD) with the Mediating Role of Social Cognition

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Abstract

Background: Neurodevelopmental disorders manifest as a range of conditions during development, impacting the brain's function, structure, and growth.

Objectives: resulting in cognitive deficits and challenges in adaptation for children. This study examines how problem-solving skills contribute to learning disabilities in children with attention deficit hyperactivity disorder, distinguishing between boys and girls and considering the mediating influence of social cognition.

Methods: The current study employed a descriptive-correlational approach with a cross-sectional research design, utilizing structural equation modeling (SEM) and multi-group analysis techniques. The study aimed to explore male and female students with attention deficit hyperactivity disorder (ADHD) in Tehran from July to October 2023. A sample of 134 adolescents was selected using purposive sampling. The research tools included the Problem-Solving Inventory (PSI), Colorado Learning Difficulties Questionnaire (CLDQ), and Student Social Cognition Questionnaire (SHAD). The researchers performed descriptive statistics analysis with SPSS version 27 and utilized SmartPLS version 4 for path analysis and Multi-Group Analysis (MGA). The study considered a significance level of 0.05.

Results: According to the research findings, Problem-solving skills had a significant negative impact on Learning Difficulties, with girls being affected more than boys. The difference between the two genders was statistically significant ($p = 0.029$). Further analysis revealed that Social cognition only acted as a mediator in reducing Learning Difficulties in girls.

Conclusion: Based on the results of this study, it appears essential to focus on problem-solving skills to decrease learning disabilities and enhance social cognition in students diagnosed with attention deficit hyperactivity disorder.

Keywords: Problem-solving, Learning difficulties, Attention deficit hyperactivity disorder, Social cognition

1. Background

Attention-deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental psychiatric disorder characterized by

deficits in attention and hyperactivity-impulsivity. These symptoms have been connected to negative impacts on academic performance, self-esteem, career success,

social skills, and behavior (1). Estimates suggest that around 5% of children and adolescents worldwide are affected by ADHD, with the disorder often co-occurring with other psychiatric conditions such as affective disorders, defiant behavior, antisocial personality disorder, self-harm, and substance abuse (2). The prevalence of ADHD is reported to be 7.1% in children and adolescents, 2.5% in adults, and 2.8% in older adults, with higher rates of clinical referrals for boys compared to girls (3). Research has shown that girls generally do not meet as many diagnostic criteria for ADHD as boys do. Females are more likely to show symptoms of inattention and internalizing issues, whereas males tend to exhibit hyperactivity-impulsivity and externalizing problems (4). Studies have also indicated that boys receive ADHD diagnoses more frequently than girls (5).

Children with ADHD experience fundamental cognitive difficulties related to processing speed, working memory, and long-term memory, which are crucial in their cognitive and educational development (6). As a result, ADHD and specific learning disorders often occur together, either as primary conditions impeding academic skill acquisition or as secondary conditions alongside other developmental disorders like ADHD (7). Learning disabilities, a neurodevelopmental disorder, involve significant challenges in reading, writing, spelling, and math problem-solving despite average intelligence. Potential causes include delayed development, nervous system disorders, or early-life injuries (8). Research suggests that children with ADHD frequently exhibit co-occurring specific learning disorders, with girls showing higher comorbidity rates than boys (9). A notable percentage of children with learning disorders also display emotional and behavioral issues, such as anxiety and ADHD, regardless of their specific learning

difficulties. "Although gender and the specific learning difficulties do not have a major impact on these behavioral issues, there are concerns about the susceptibility of boys with mathematics disabilities (10)."

Children with attention-deficit/hyperactivity disorder face more challenges in learning compared to other children because they struggle in various areas of development, including problem-solving skills. Those with specific learning disorders also experience delays in problem-solving skills (6). These skills are crucial for the learning process as it involves recognizing a problem, finding a solution, and understanding the components of the problem through experiences (11). Research has indicated that in various nations, girls typically excel over boys in collaborative problem-solving skills and reading (12). Research has shown that problem-solving can positively impact the self-concept, self-esteem, and self-regulation of students with learning disabilities (13). Studies have revealed that improving the cognitive-social problem-solving skills of students with learning difficulties can result in better social adjustment and reduced academic burnout (14).

"A group of children with ADHD also face significant challenges in paying attention, using gestures, engaging in imaginative activities, and often encounter difficulties in social interactions and relationships, which may be connected to deficiencies in social cognition (15). Social cognition involves self-awareness, understanding others (interpreting their thoughts and feelings through voice tone, facial expressions, body language, empathy, comprehending behavior, etc.), social adjustment, implementing social norms and knowledge in social situations, and effectively managing emotions in interpersonal relationships (16). Research has shown that children with learning

disorders and ADHD exhibit lower levels of social cognition skills compared to their peers without these conditions (17). A study focusing on social cognition impairments in young individuals with specific learning disorders revealed significant deficits in recognizing angry facial expressions, emotion recognition, and executive functions in these patients (18)."

ADHD significantly impacts various aspects of life, resulting in academic underachievement, unemployment, divorce, and involvement in criminal activities, among others, and is also correlated to a wide array of mental health disorders (2). Both children and adults with ADHD struggle to form and maintain friendships. However, social interaction is crucial for their overall development, and individuals with social cognition deficits often struggle in social situations, hindering their communication, social, and occupational skills (15). Therefore, evaluating social cognition in children with ADHD is essential to address issues related

to this deficiency. Despite the significance of this issue, there is a lack of research in this area, making the current study one of the first to examine the structural model of the impact of problem-solving skills on learning difficulties separately in boys and girls with ADHD while considering the mediating role of social cognition. Therefore, the study explores how problem-solving skills influence learning difficulties in hyperactive boys and girls, with social cognition as a mediator. The researcher illustrated the conceptual model of the study in Figure 1.

2. Objectives

resulting in cognitive deficits and challenges in adaptation for children. This study examines how problem-solving skills contribute to learning disabilities in children with attention deficit hyperactivity disorder, distinguishing between boys and girls and considering the mediating influence of social cognition.

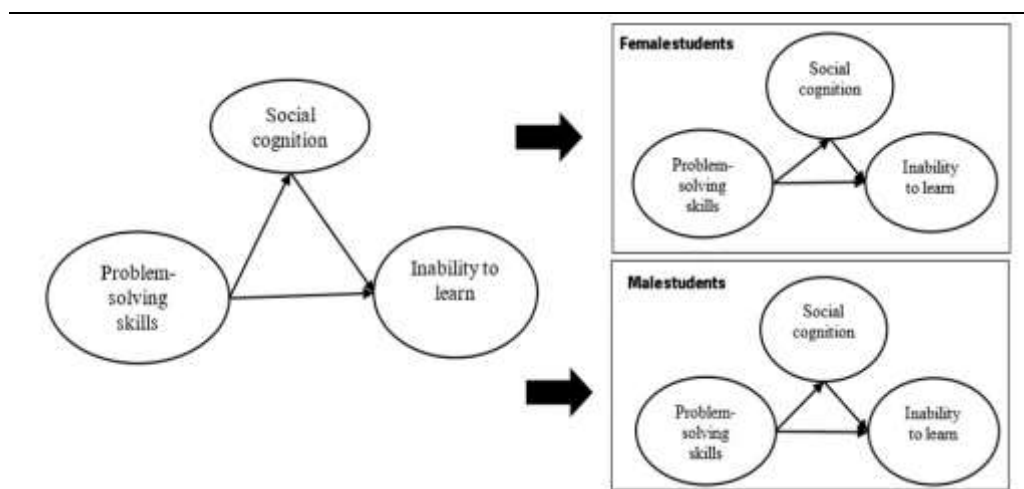


Figure 1: Conceptual framework of the research

3. Methods

This study utilized a descriptive-correlational research design and cross-sectional research method, employing structural equation modeling (SEM) and multi-group analysis. The statistical

population consisted of all boys and girls with attention deficit hyperactivity disorder (ADHD) in Tehran from July to October 2023, diagnosed by specialist psychologists at the research site clinics. The statistical sample included 134 teenagers selected through purposive sampling.

The adequacy of the sample size was assessed using Cohen's formula from 2013, taking into account the number of observed and latent variables, anticipated effect size, the desired probability, and statistical power (19). With an anticipated effect size of 0.3, the desired statistical power level of 0.8, 3 latent variables, 74 observed variables, and a probability level of 0.01, the calculated sample size was 119. To account for potential attrition, the researcher increased the sample size to 150 to maintain statistical power and prevent sample size reduction.

To be eligible for the study, participants had to be attending psychology clinics specializing in attention deficit hyperactivity disorder, obtain informed consent from the teenagers and parents of the teenagers to take part in the research, possess adequate literacy and comprehension skills to engage in the study, and fall within the age range of 10 to 13 years old.

The research included exclusions for individuals over the age of 13, those with physical limitations that affected participation, respondents who left more than ten questions unanswered on the surveys, those who had not started drug treatment before the study, and individuals going through withdrawal. The research was conducted by first obtaining the necessary approvals from the researcher's university (I.R.IAU.CTB.REC.1402.121). Then, with the assistance of professors, contacting ten psychology and counseling clinics in Tehran (clinic names withheld for confidentiality reasons). These clinics were selected using convenient methods.

The researcher then visited the clinics and, following necessary coordination, sent a message to families who had a child with a history of ADHD and had recently visited the clinics on behalf of the psychological clinics, inviting them to participate in the study. Subsequently, detailed information about the research, including its objectives,

permissions, and ethical principles, was shared with families through social media platforms. Due to parental limitations, the research process and online questionnaire completion took four months. From a sample of 150 questionnaires, 134 were used for analysis after disregarding 16 that contained incomplete or deliberately inaccurate information. The questionnaires, self-reported and online, were implemented in a manner that ensured the privacy of participants and the option for teenagers to withdraw from the study if desired. All adolescents had their problem-solving skills, learning difficulties, and social cognition measured. Families were encouraged to assist teenagers in answering the questions for the online assessment due to the young age of the participants.

Problem-Solving Inventory (PSI):

In 1982, Heppner and Peterson developed a self-report questionnaire to evaluate problem-solving skills, how individuals approach problems, and their problem-solving skills (20). The questionnaire consists of three components: confidence in problem-solving (11 items), approach-avoidance style (16 items), and personal control (5 items). A few questions are not included in the scoring process. The questions assess behavior, emotional responses, use of relationships, adaptation to challenges, self-sufficiency, self-esteem, self-confidence, and emotional control. The questionnaire comprises 35 questions rated on a 6-point Likert scale ranging from completely agree to disagree (scores of 6 to 1), with a total score range of 32 to 192. Higher scores indicate superior problem-solving skills. Heppner and Peterson reported internal consistency between 0.72 and 0.85, while test-retest validity ranged from 0.83 to 0.89 within two weeks. Iranian researchers found an internal consistency of 0.85. In a specific study, Cronbach's alpha coefficient

was 0.795, composite reliability was 0.859, and the AVE value for convergent validity was 0.551(21).

Colorado Learning Difficulties Questionnaire (CLDQ):

Willcutt et al. (2011) developed a self-report questionnaire to evaluate learning difficulties in individuals (22). The questionnaire consists of 5 subscales focusing on math, spatial skills, social anxiety, social cognition, and reading comprehension. It contains 20 questions rated on a 5-point Likert scale ranging from 1 to 5, with total scores ranging from 20 to 100. Higher scores on the questionnaire indicate more significant learning difficulties. Willcutt reported convergent validity between 0.44 and 0.64, while researchers in Iran found the internal consistency coefficient to be 0.90. In another research, the Cronbach's alpha score was 0.723, while the composite reliability was 0.828. The recorded AVE value for evaluating convergent validity was 0.548(23).

Student Social Cognition Questionnaire (SHAD):

In 2018, Nejati et al. developed a self-report questionnaire to evaluate social cognition among individuals (24). The questionnaire consists of 19 questions and is rated on a 5-point Likert scale ranging from rarely to almost always (1 to 5), with

scores ranging from 19 to 95. The total score of social cognition is determined by summing the individual scores, with higher scores reflecting a superior level of social cognition. Nejati et al. reported the internal consistency of the questionnaire to be between 0.71 and 0.86, while other researchers found it to be between 0.6 and 0.74. In their study, Nejati et al. calculated a Cronbach's alpha coefficient of 0.816 and a composite reliability value of 0.863 for the questionnaire. The AVE value for convergent validity was 0.865.

Statistical analyses

The researchers utilized SPSS version 27 for conducting descriptive statistics and SmartPLS version 4 for analyzing the paths between variables and conducting Multi-Group Analysis (MGA). The normality of the distribution of the variables under study was tested using the Kolmogorov-Smirnov test, which revealed that the variables did not exhibit a normal distribution. Therefore, SmartPLS was deemed appropriate for further analysis. The researchers established a P-value of 0.05 for their study

4. Results

The researcher initially examined the descriptive statistics of the study's variables. Table 1 displays the mean and variability of the research factors.

Table 1. Description of research variables				
Variable	Groups	Mean	SD	Independent Samples T-Test
				P-Value
Problem-solving skills	Man	91.20	12.19	<0.001
	Female	100.6	12.75	
Social cognition	Man	51.17	4.52	<0.001
	Female	53.67	5.39	
Learning Difficulties	Man	55.32	8.27	< 0.001
	Female	48.84	8.07	

SD: Standard Deviation.

According to Table 1, an independent samples t-test showed a significant

difference between girls and boys in Problem-solving skills, Social cognition, and Learning Difficulties ($P < 0.05$). The researcher verified the assumptions of the test. "To evaluate normality, the Shapiro-Wilk test was utilized to analyze the distribution of the study variables. The findings indicated a substantial departure ($P < 0.001$) from normal distribution for the study variables." However, the researcher's random sampling method fulfilled this assumption. The sample size of 134 people is considered sufficient for implementing the structural equation model using the partial least squares method.

In Table 2, the researcher analyzed to explore the potential for conducting a multi-group analysis of the MICOM method using the Permutation test by examining the

similarity of means and variances among groups. The first step was to confirm if the same signs were considered for both groups, as evidenced by the recent study. The second step, Hybrid matching, did not confirm any variables and showed a significant Permutation p-value. Moving on to the third step, the researcher examined the equality of means and variances among groups for the variables. Since some variables had different means and variances, the researcher utilized the WELCH-SATTERHWAITE TEST in the PLS software to analyze the path between variables. Following the model run, the researcher assessed the path coefficients and significance levels between variables in Table 3. The researcher specified a bootstrap value of 5000 for this study.

Table 2. Similarity Results with Permutation Test

Step	Step 1. Sameness	Step 2. Hybrid Matching	Step 3. Equality of Mean		Step 3. Equality of variance	
Variable		Permutation P-value	Permutation MD	Permutation P-value	Permutation MD	Permutation P-value
Learning Difficulties	Yes	0.019	0.740	0.000	0.049	0.569
Problem-Solving Skills	Yes	0.000	-0.714	0.000	-0.090	0.464
Social Cognition	Yes	0.000	-0.488	0.001	-0.353	0.000

Table 3. Standard research coefficients

Path Between Variables	Path (Boy)	P- value (Boy)	Path (Girl)	P- value (Girl)	Difference (Boy - Girl)	P-value (Boy vs Girl)	Result
Problem-solving skills -> Learning Difficulties	-0.631	0.000	-0.323	0.005	-0.308	0.029	confirmation
Problem-solving skills -> Social Cognition	0.673	0.000	0.762	0.000	-0.089	0.204	rejection
Social cognition -> Learning Difficulties	-0.135	0.180	-0.412	0.000	0.277	0.060	rejection
Indirect Effects Between Research Variables							
Problem-solving skills -> Social cognition -> Learning Difficulties	-0.091	0.201	-0.314	0.001	0.223	0.047	confirmation

According to the data presented in Table 3 and Figures 2 and 3, Problem-solving skills had a noticeably negative impact on Learning

Difficulties (p (Boy vs Girl) = 0.029). A significant difference was observed between men and women, with girls being more

affected by this variable. Additionally, Problem-solving skills had a positive influence on Social cognition. There was no significant variation between men and women in this aspect (p (Boy vs Girl) = 0.204). Conversely, Social cognition had a detrimental effect on Learning Difficulties, with no notable difference between genders (p (Boy vs Girl) = 0.060). The analysis revealed that Problem-solving skills negatively affected Learning Difficulties

through the mediating factor of Social cognition, with a significant distinction between boys and girls (Difference = 0.223, P = 0.047). This suggests that Social cognition may act as a mediator only in girls, reducing their Learning Difficulties. The researcher also assessed the coefficient of determination for endogenous variables in Table 4.

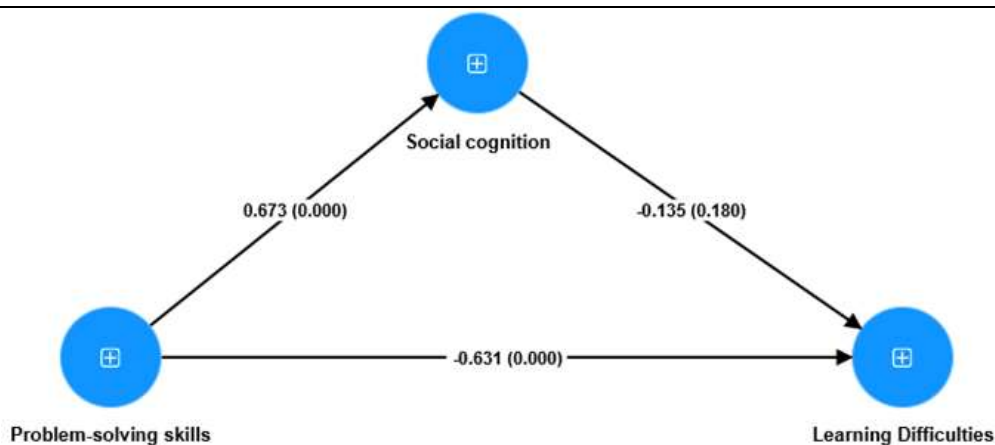


Figure 2: Path coefficients between variables and P-value in the Boy's group

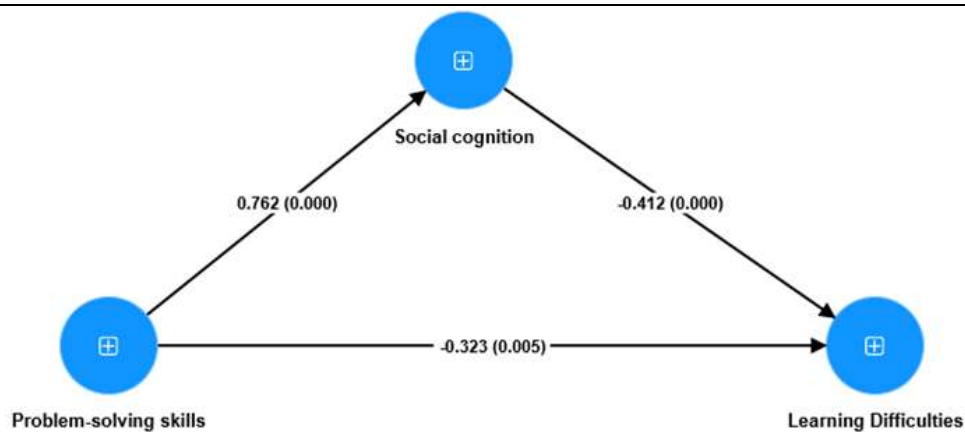


Figure 3: Path coefficients between variables and P-value in the Girl's group

Table 4. Coefficient of Determination of the Model				
	Boy		Girl	
Variables	R ²	Adjusted R ²	R ²	Adjusted R ²
Learning Difficulties	0.531	0.521	0.477	0.467
Social Cognition	0.452	0.446	0.581	0.576

The researcher examined the reliability and validity of the research model presented

in Table 5.

Table 5 presents the verification of the

model's reliability and validity. The variables exhibit a Cronbach's alpha reliability higher than 0.7. Moreover, the combined reliability of these variables also surpasses 0.7. Additionally, the model's validity was assessed using the average variance extracted index, which yielded a value above 0.5 for the research variables, confirming the

model's validity. The researcher also evaluated the model's fit, with all fit indices confirming its adequacy. One such index, the SRMR (Standardized Root Mean Square Residual Index), which measures the difference between the observed correlation and the correlation matrix of the structural model, had a value of 0.107 for the model.

Table 5. Reliability and Validity of the Model

Variables	Cronbach's Alpha	Composite Reliability	AVE
Learning Difficulties	0.723	0.828	0.548
Problem-solving skills	0.795	0.859	0.551
Social cognition	0.816	0.863	0.865

5. Discussion

The main objective of this study was to examine the structural model showing how problem-solving skills impact learning difficulties in boys and girls with ADHD, with social cognition playing a mediating role. Results from this research indicate that problem-solving skills helped decrease learning difficulties and enhance social cognition, particularly in girls compared to boys. Social cognition played a crucial role in addressing learning obstacles, as problem-solving skills hurt learning difficulties through social cognition. " It is indicated that social cognition plays a role in assisting girls by reducing learning difficulties within this specific group (25). "

The results of the current study indicate that problem-solving skills have a positive impact on reducing learning difficulties, especially among girls compared to boys, which is in line with previous research (12-14). Previous research has indicated that girls typically excel over boys in problem-solving and reading skills in various countries (12). Another research has demonstrated that problem-solving skills can enhance students' self-concept, self-esteem, and self-regulation, particularly for students with learning difficulties (13). Moreover, a research study that targeted students with learning difficulties discovered that

enhancing cognitive-social problem-solving skills can increase social adjustment and reduce academic burnout (14). Even though there is no documented study specifically connecting problem-solving skills to social cognition, the results of the current study are consistent with previous research (26, 27). One study highlighted the connection between social cognition, self-efficacy, and problem-solving skills (26). Another research emphasized the significant impact of problem-solving skills and critical thinking on learning approaches based on research and reflective thinking (27).

Gender differences in problem-solving among boys and girls may be attributed to variations in skills, interests, and influences related to problem-solving performance. On average, girls tend to prioritize relationships more than boys. Those who place value on relationships tend to excel in problem-solving. Research indicates that females are more prone to perceive themselves as understanding, friendly, and collaborative, whereas males frequently see themselves as confident individuals (12). Problem-solving skills enable students to effectively convey their emotions, explore their interests, and feel a sense of mastery over their surroundings. These skills contribute to the growth and enhancement of motor, cognitive, and language skills, which enable students with learning difficulties to engage

with their environment and enhance their social skills. Problem-solving skills can help reduce learning difficulties and increase social cognition in students by encouraging cooperation, empathy, and self-esteem (28).

Generally speaking, students who excel in problem-solving demonstrate more effective behavioral strategies when confronted with challenges, as they are more proactive in addressing issues and managing complex life situations. This proactive approach enhances their belief that they can overcome obstacles by working towards specific goals. Students can effectively decrease their learning difficulties by utilizing problem-solving skills to boost self-efficacy and confront challenges (29).

The current study also revealed that social cognition can act as a mediator specifically for girls, helping to decrease learning difficulties in girls. Previous findings on this topic have been contradictory (17, 18). According to a study, children with learning disorders and ADHD exhibit lower levels of social cognition compared to those without these conditions (17). Another study focused on social cognition disorders in young individuals with specific learning disorders found that these patients have difficulty recognizing angry faces and show impairments in emotion recognition and executive functions (18).

Variations in sample size and the geographical locations of participants are the reasons for the disparity between this research and earlier studies. This study was conducted in Iran, whereas Ciray et al. (2022) conducted their study outside of Iran. Cultural differences may contribute to the inconsistencies in results (18). Additionally, social cognition, which involves cognitive skills and accurate processing of social information, plays a crucial role in students' problem-solving skills (26). It can also help students with learning difficulties develop social skills, emotional regulation, and the ability to improve relationships. When these students engage in friendly behavior and

receive positive feedback from others, they experience a decrease in negative emotions and an increase in desired social goals. Developing social relationships can provide support and companionship, potentially reducing learning disorders in these students (30).

While the present research carries significant consequences, it is essential to recognize certain restrictions." The research concentrated on individuals diagnosed with attention deficit hyperactivity disorder. One must exercise caution when applying the findings to various populations. Upcoming studies should involve a broader range of students to improve the applicability of the conclusions. The small sample size of students diagnosed with learning difficulties by mental health professionals limited the scope of the study. Therefore, researching a larger sample of students with learning difficulties would allow for broader applicability of the results.

Additionally, assessing problem-solving skills in real-world scenarios could yield findings that better reflect actual situations. The research faced limitations in controlling unrelated and confounding variables such as interest, motivation, variety, strategies taught to students, fatigue, and external influencing factors outside the educational setting. Another limitation was the restriction of the research findings to a specific academic period and the reliance on a questionnaire as the measurement tool without utilizing other methods. Furthermore, the study did not account for different types of disabilities or learning disorders, which also presented a limitation. Therefore, the importance of exercising caution when generalizing the results of this study is emphasized, and it is recommended to conduct similar research in different educational settings and age groups while controlling for variables and types of learning disorders to enhance result accuracy and generalization of findings.

6. Conclusion

The research suggests that there should be a focus on improving problem-solving skills to help students with hyperactivity disorder overcome learning difficulties and improve their social cognition. Providing educational workshops and lecture sessions is advised to help improve this skill among students. Teachers and educators should quickly address any learning difficulties in students with hyperactivity disorder by consulting with specialists or organizations with expertise in managing these issues. Implementing problem-solving skills may be beneficial in reducing the learning difficulties associated with this disorder. The outcomes of this study can be valuable for future research on learning difficulties in individuals with attention deficit hyperactivity disorder.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Availability of data and materials: The entire dataset is available as in a spreadsheet format in plutoF data repository.

Conflict of interest: There are no conflicts of interest.

Consent for publication: "We are providing our permission for the release of identifiable information, such as photographs, videos,

case histories, and details within the text ("Material"), to be included in the mentioned Journal and Article."

Ethics approval and consent to participate:

The research was conducted by first obtaining the necessary approvals from the researcher's university (I.R.IAU.CTB.REC.1402.121). The study was conducted in accordance with the principles of the Helsinki Declaration.

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