

# Research Paper: Attention Program and Math Performance of Students With Intellectual Disability



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## ABSTRACT

**Objectives:** The aim of the present study was to determine the effectiveness of attention training on the math performance of elementary school students with intellectual disability.

**Methods:** The present research was a quasi-experimental study by pre-test, post-test design with the control group. The study population comprised students with intellectual disability aged 10-12 years. Subjects were selected by convenient sampling method. In this study, 30 students with intellectual disability participated. Subjects were divided into two groups (experimental and control group) randomly, and each group consisted of 15 students. The experimental group received attention training program in 18 sessions while the control group did not. In this study, the Raven progressive matrices test and math performance test were used. The obtained data were analyzed using MANCOVA.

**Results:** The findings showed that there was a significant increase in math performance scores (in context, operation, and application domains) of the experimental group in comparison with the control group.

**Discussion:** The results indicated that attention training program has influenced math performance of the primary school students with intellectual disability.

## 1. Introduction

The American Association on Mental Retardation was renamed as the American Association for Intellectual and Developmental Disabilities in 2007. For the first time in the same year, the term “intellectual developmental disability” or in short, intellectual disability was used instead of mental retardation, and intellectual disability was placed in the category of in-

tellectual and developmental disorders [1]. In the field of special education, intellectual disability is a disorder in the development process occurring due to failure in the intellectual function and adaptive behavior in the conceptual, social, and practical areas [2, 3]. The most prominent feature of children with intellectual disability is their limited ability to learn [4].

Nowadays, the goal of teaching students with an intellectual disability is to support them learn the skills re-

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quired for their normal lives. Since mathematics as one of the most complex mental processes, requires visual harmony and perception, mental preservation, recognition, codification, and reproduction of written symbols, learning the math skills and utilizing the thinking skills will be very helpful for these students [5]. Children with intellectual disability have major problems in mathematical concepts such as understanding concepts including small, large, bigger, smaller; and performing operations such as counting, adding up, and subtracting [6]. Poor attention in an individual significantly reduces the ability to receive information and learn through observation and imitation. Students with intellectual disability possess an attention problem due to which they encounter difficulties in processing the information and providing the response [7].

Students with intellectual disability often have difficulties in learning and require special educational programs to acquire basic mathematical skills [5]. Attention is one of the most critical and complex factors affecting the education and learning. In other words, one of the most common problems which reduce children's efficiency in schools is their lack of attention. Attention refers to a series of complex mental acts involving concentration on a goal, keeping one's attention, hypervigilance, stimulus encoding, and changing one's focus from one goal to another [1, 8].

Children with intellectual disability are facing difficulties with their cognitive functioning, especially attention problems. One of the primary goals of educating children with intellectual disability is to take into account their cognitive issues [9, 10]. Various educational interventions have been offered by psychologists and education specialists, and attention training is one of them [11]. They introduced some helpful strategies for the improvement of attention, memory, generalizability, and problem-solving skills of people with intellectual disability. For the educational and therapeutic interventions, teachers can apply strategies such as using interesting and attractive activities, having colorful materials to get students' attention, focusing on the content keywords, giving the learners opportunities to choose the material or activities for their practices and learning [12].

Several studies have investigated the effectiveness of attention training. One of the studies investigated the effect of attention training and reported that attention training is an effective and efficient method for improving children's attention and their performance in daily activities and facilitates their learning in the future [13]. Another study [14] concluded that the attention training technique

improves self-regulated behaviors and can be considered as a predictor of children's behavioral problems.

The critical role of attention and attention training in acquiring math skills is demonstrated in various studies. It is reported that [15] the lack of attention is associated with math disorder, and attention plays an important role in predicting the Math progress in these students. Attention training program is effective in improving the math achievement performance [16-18], and it has a positive impact on the performance of children with intellectual disability [4]. Also, studies [12, 19] have reported the positive effects of attention training in teaching different concepts such as objects, animals, and places to children with autism spectrum disorder and also resulted in reading improvement of children with aphasia.

Studies about the effectiveness of attention training on the math performance of students with special disability in learning math and students with intellectual disability showed that attention training increases the students' math performance and its component including math content, operation, and application [20, 21]. However, cognitive skills training could improve problem-solving and math performance of students with intellectual disability [22].

The available limited literature support that attention training may have an impact on the math performance of students with intellectual disability; however, only a few studies have addressed this critical issue. On the other hand, mathematics, as one of the most important and practical school subject, requires the most complex mental processes. Poor attention of students with intellectual disability can cause problems in their functioning such as information processing, recognition and codification and has a significant impact on their educational performance. In the recently conducted studies, no specific study was found on this subject, and in Iranian society in particular, which suggests that there is a research gap in this area. Therefore, the present study seeks to investigate the effectiveness of attention training on the math performance of elementary school students with intellectual disability.

## 2. Methods

This study was an experimental study with pretest, Post-test, and control group.

### Participants

The population consisted of all students with an intellectual disability who was in the fourth grade of three

special primary schools. The convenience sampling method has been used. The inclusion criteria were having an intellectual disability and an age range of 10 to 12 years). The exclusion criteria were having disorders other than intellectual disability such as autism, deafness, blindness, and not attending more than two sessions of the intervention program. The eligible students were assigned randomly to one of the two experimental and control groups, with 15 students in each group. The following tools were used for data collection.

### The tools and procedure

#### Raven Progressive Matrices Test

This test is one of the most accurate and most reliable general intelligence tests that was designed by Raven in 1938. It has three forms. The form which is the colored progressive matrices test and has 36 colored images was used. It is used to measure the intelligence of children aged 10 to 12. The test's scoring is based on the questionnaire's key and the individual's raw score is compared with the norm table, and then individual's IQ is calculated [23]. The test reliability in a sample of 259 children was 0.73, and it was 0.499 in a retest administered two years later [23]. Also, the reliability of this test was 0.91 in two months interval using the internal consistency method and 0.82 using the internal consistency method of Cronbach's alpha coefficient. The validity was 0.71 [24].

#### Math performance Test

The math performance questions were designed by five special education teachers of fourth grade who had at least ten years of experience with students with intellectual disability and at least two years' experience of teaching in the fourth grade. Each of these teachers designed 60 questions based on the concepts in the math textbook of fourth grade for students with intellectual disability. The concepts include addition, subtraction, multiplication, division, measurement, time, money, problem-solving, counting, even and odd numbers, numerical comparison, Latin numbers, and geometry. The teachers selected 30 questions that were most consistent with the content of the book. The questions were then converted into two similar tests based on their odd and even number, each containing 15 questions. In fact, 15 questions were considered as form A for the pre-test and 15 questions were considered as form B for the post-test.

To measure the math performance of students, two teacher-made parallel forms of A (for pre-test) and B

(for post-test) were used. The coordination of the final formulation of the two forms was carried out by the researcher who was specialized in this field. Each of the A and B forms contained 15 questions to measure students' math performance in content subscale (including counting the rational numbers and geometry), the operational subscale (including addition, subtraction, multiplication, division, mental calculation) and the application subscale (including measurement, time, money, estimation, data analysis and problem solving). Each subscale contained five questions, and each question was scored as Likert's five-point scale (very good=4, good=3, acceptable=2, and needing more effort=1).

The minimum and maximum scores for each subscale were 5 and 20, respectively. Thus, the minimum score of each test form was 15, and its maximum score was 60. The content validity method was used to assess the validity of forms A and B of the test. First, both forms were presented to five teachers of students with a disability in the fourth grade and the content of the questions was confirmed. Meanwhile, the validity of forms A and B were obtained as 0.79 and 0.77, respectively. The reliability coefficient of the tests was calculated using the Cronbach's alpha method for each of the three subscales, and each question was scored using Likert's four-point scale. The validity of forms A and B were obtained as 0.88 and 0.90, respectively.

For the consents, we first received a letter of recommendation from University of Social Welfare and Rehabilitation Sciences to conduct the thesis-related research for the Exceptional Education Organization for selecting special schools. Then, the importance and necessity of this study were explained at a meeting with the school principals and relevant teachers. Also, a briefing session was held for parents to explain the research goals and asked them to complete the written consent for their children's participation in the research.

The experimental group participated in eighteen 45-minute sessions (6 weeks and 3 sessions per week). The control group received no education regarding attention training (the content of the training sessions of the experimental group is presented in Table 1). Moreover, the teacher of the experimental and control groups had passed a specialized 12-hour course of math education under the supervision of a researcher who had the necessary expertise in this field so that the experimental group could receive the same education. At the end of the last session, both the experimental and control groups were re-evaluated using form B of the math performance test as the post-test. The data obtained from these two test ad-

ministrations were analyzed for two groups using multivariate analysis of covariance with the help of SPSS-Version 22. In this study, all of the ethical codes have been considered based on the international rules of ethics and accepted by the University Ethical Committee.

### 3. Results

The mean age of participants for experimental and control groups were 10.90 and 11.10, respectively. The mean IQ was 66.07 and 65.98, respectively. Using the independent t-test, no significant difference was found between the age and intelligence of the sample in both groups. The descriptive indexes of the research variables in the two experimental and control groups in the pre-test and post-test are presented in Table 2.

The results of Table 2 show that the mean scores for math performance and its subscales including content, operation, and application have changed after the intervention. To select an appropriate statistical method, the data distribution normality was confirmed by Kolmogorov-Smirnov test ( $P>0.05$ ). Therefore, parametric tests can be used to analyze the data. The multivariate covariance analysis was used to determine the independent variables (attention training) and the four dependent variables (content, operation, application, and math per-

formance). We also used the multiple analysis of covariance to adjust the pre-test's effect [25]. The results of the M-Box test showed the homogeneity assumption of variance-covariance matrices ( $P>0.05$ ) and Bartlett's test showed a sufficient correlation between the dependent variables ( $P=0.006$ ). The homogeneity assumption of variances in the research variables was also confirmed by the Leven test ( $P>0.05$ ).

Therefore, all the assumptions of the statistical test of Multivariate Analysis of Covariance (MANCOVA) were observed and therefore, this test can be used to analyze the data. For this purpose, the scores related to the content, operation, application, and math performance of students in the experimental and control groups were calculated in the statistical assumptions "Pillai's trace, Wilks Lambda, Hotteling's trace, and the largest square root," the results of which are presented in Table 3. The results of the four tests presented in Table 3 indicate that the experimental group and the control group have a significant difference at least in one of the variables of content, operation, application, and math performance ( $P<0.0001$ ). The MANCOVA test was used to find out this difference, and the results are presented in Table 4. In this analysis, the pre-test variable was controlled due to correlation with the post-test. As presented in Table 4, the post-test scores of the experimental group

**Table 1.** The content of the educational sessions

Sessions	Objective and Content
First and second	Auditory accuracy enhancement; these sessions included listening to various recorded sounds including the sounds of the things being eaten and shaken.
Third and fourth	Visual accuracy enhancement; the activities of these sessions include the "look and say" game, seeing the children's pictures and recognizing them, and then changing the set of responses to the subject.
Fifth and sixth	Drawing accuracy enhancement; the activities of these sessions include, for example, showing a picture to the student over a specified period, and asking him/her to draw up specific details of the picture and asking questions about the picture.
Seventh and eighth	Improving and increasing practical accuracy and concentration; The activities of these sessions included targeting games, such as throwing balls in the ring, darts, and bowling.
Ninth and tenth	Improving their listening comprehension accuracy; In these sessions, stories were read to the subjects, and they were asked to answer the questions at the end of the story.
Eleventh and twelfth	Enhancing visual accuracy and focus; In these sessions, card games, as well as the game of differences and similarities were played.
Thirteenth and fourteenth	Eye-hand coordination; these sessions included games with legos and their classification regarding color.
Fifteenth and sixteenth	Enhancing their stereognosis: These sessions included activities such as closing the student's eyes to guess different objects inside a bag by just touching them.
Seventeenth and eighteenth	During these sessions, the activities and exercises for auditory and visual attention sessions were reviewed and practiced.

**Table 2.** Statistical indices of the research variables

Variables	Pre/Post-Test	Mean	SD	Mean	SD
Content	Pre-test	7.25	0.94	7.30	0.97
	Post-test	15.50	0.86	10.05	0.91
Operation	Pre-test	8.60	0.93	8.65	0.85
	Post-test	16.05	0.84	10.25	0.82
Application	Pre-test	8.80	0.68	8.60	0.70
	Post-test	17.25	0.64	10.40	0.63
Math performance	Pre-test	24.65	1.71	24.55	1.47
	Post-test	49.25	1.80	30.70	1.50

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were increased significantly ( $P < 0.05$ ). Considering the Eta squared measure, it can be suggested that 67% of the changes in content, 66% of the changes in operations, 74% of the changes in application, and 71% of the changes in math performance are due to the effect of the intervention program on the experimental group.

#### 4. Discussion

The purpose of this study was to determine the effect of attention training on the math performance of students with intellectual disability. As for the primary hypothesis of the study, results indicated that attention training had a positive effect on the math performance of the students with intellectual disability. The first finding of this study

was consistent with the results of some other studies in this field [13, 15, 20, 21, 26].

Since there is a high correlation between intelligence and educational achievement, there is no doubt that the educational success of students with intellectual disability in all educational affairs is lower than that of their normal peers. When they entered the school at the age of six, they were not ready to read, write, and calculate. They get these skills later because of lack of concentration, paying attention to a disturbing stimulus while learning, delay in learning and forgetting are among the characteristics of this group of students [21]. Poor attention and concentration are the most apparent and noticeable problems of the students with intellectual disability and

**Table 3.** The total results of the multivariate analysis of covariance

Test	Value	Degree of Freedom of the Hypothesis	Degree of Freedom of Error	F-Statistic	Level of Significance
Pillai's trace	0.834	4	21	3.67	<0.001
Wilks Lambda	0.019	4	21	3.67	<0.001
Ho Hotteling' trace	68.941	4	21	3.67	<0.001
Largest square root	68.941	4	21	3.67	<0.001

Iranian Rehabilitation Journal

**Table 4.** The results of the multivariate analysis of covariance for each variable

Source of Effect	Dependent Variables	Sum of Squares	Degree of Freedom	F-Statistic	Probability	Eta Squared
Group	Content	31.111	1	62.222	<0.0001	0.67
	Operation	39.681	1	91.642	<0.0001	0.66
	Application	29.996	1	83.091	<0.0001	0.74
	Math performance	137.686	1	127.842	<0.0001	0.71

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causes their educational weakness in various subjects including mathematics [4]. Today's goal of education of students with intellectual disability is to help them learn the skills needed for a normal life. Meanwhile, learning the math skills and utilizing the thinking skills will be very helpful for these students [5].

They require special educational programs to acquire the basic mathematical skills. Attention is one of the most critical and complex factors in their learning and working on their attention could help them to progress in their school subjects. Attention development in children with intellectual disability can be perceived by effective teaching design where the emphasis would be placed on strengthening the direction and sustainment of attention by way of specific, creative activities and exercises [4]. Enhancing drawing accuracy, improving and increasing efficiency in concentration, improving the listening comprehension accuracy, enhancing visual accuracy and eye-hand coordination are among the primary components of the attention training program. For example, precision in drawing shapes will increase the focus on practical activities followed by concentration. Additionally, listening and observing carefully will improve focus and concentration in children. Such activities will enhance the eye-hand coordination [18], which indicates close relationships of the main components of the attention training program. In this regard, it is likely that attention training which includes these cases helps enhance the learning of math-related content skills such as counting, rational numbers, and geometry.

The results also indicated that attention training helped students in improving math content, operation, and application performance. This finding is consistent with the results of the studies about the effectiveness of attention training on mathematical mastery and math content performance of students with disability [4, 15, 13, 16-18, 20, 21, 27-30]. Mathematics, as one of the most complex mental processes, requires the visual coordination and perception, psychological preservation, recognition, codification, and reproduction of written symbols. Many children with intellectual disability have significant problems in mathematical activities such as understanding concepts including small, large, bigger, smaller; and performing operations such as counting, adding up and subtracting [6], problem-solving, planning, reasoning, judgment, adaptive behavior and cognitive performance [4].

On the other hand, they suffer from attention problem. Poor attention significantly reduces the ability to receive information and learn through observation and imitation, processing the information and providing the response [7].

Attention as a cognitive factor accounts for unique variance in predicting each aspect of math performance [31, 32]. Attention training can enhance the level of awareness and significantly increases spatial working memory, math fluency, and reading fluency, suggesting that better focus leads to better cognitive performance [27].

## 5. Conclusion

The findings showed that attention training is effective in improving the math performance of students with intellectual disability. Considering the attention-related problems of students with intellectual disability, the type of training could enhance their mathematical performance. The teachers and educators should be aware of different levels of educational goals. Additionally, they should be aware of the critical role of operationalizing the learning with an emphasis on the needs of assessment and specific problems of students with intellectual disability. They should provide practical training to increase the attention capacity of the learners proportional to their intelligence capacities, in which case the learner will be curious to learn the skills necessary for everyday life, including the math skills.

It is commonly challenging to provide favorable conditions for the implementation of research. The researcher has encountered certain limitations in this study. The intervention was investigated during a short period, with no opportunity to conduct a follow-up test and to examine the long-term results of the research. Limited resources, a small number of subjects, not having a specialized tool to assess these students' math performance, were other limitation of this study. Therefore, the results should be generalized cautiously. The future research could consider larger sample size so that the differences are identified more accurately, and the results could be widespread more reliably. It is also recommended that the attention training programs should be more specialized for students with different levels of intellectual disabilities.

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## Conflict of Interest

The authors declared no conflicts of Interest.

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