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Effect of an Arithmetic Training Programme on Working Memory of Children with Mild Intellectual Disability

[1]Indu Chacko, [2]Sambathrani K.
[1]Research Scholar,
induchacko@gmail.com.
[2]Associate Professor & HOD,
sampathranek@gmail.com
Department of Special Education,
Avinashilingam Institute for Home Science and Higher Education for Women
Coimbatore 641043

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Abstract

Purpose: Mathematics is widely used in our day-to-day lives. Our ability to perform mathematics relies on several basic skills. These include specific knowledge and skill training in maths as well as more general cognitive abilities. Working memory is an important cognitive skill that plays a key role in mathematic performance. In this paper, the researchers evaluated the effect of an arithmetic training programme on working memory skills. The samples encompass 30 children with mild intellectual disability, boys (N=17) and girls (N=13), from rural inclusive schools in Malappuram district, Kerala. The students studying in the 5th and 6th grades (aged between 9-12 years) were selected through a random sampling method. The intervention included training in arithmetic skills using cognitive strategies. The result showed that strategy-based instruction significantly influences the working memory skills of children with mild intellectual disability.

Keywords: Arithmetic Skills, Cognitive Process, Mild Intellectual Disability, Working Memory

Introduction

In our daily lives, mathematics is extensively adopted. All other areas of advanced mathematics are built upon arithmetic. The area of mathematics that most people are familiar with is arithmetic. Actual figures and calculations are involved in it. Our capacity to perform arithmetic skills is based on a variety of underlying elements, including more fundamental cognitive capacities as well as specialised knowledge and skill development. One of the cognitive abilities that significantly influences arithmetic performance is working memory (Cragg, 2014). The 'learning by doing' strategy, popularized by Dewey and Freire in the 20th century, allows students to learn a topic through engagement, a hands-on approach, and contact with their surroundings. Pupils' working memory interacts with this approach. Personal growth is of utmost importance to increase inclusion, equality, and equal opportunities. Yet, due to restrictions in their cognitive functioning, children with intellectual disabilities may struggle with their math abilities.. In order to get an effective result, teachers can assist children with mild intellectual disabilities (who are educable) to cultivate a positive attitude towards arithmetic skills using working memory.

Working Memory

Working memory is a cognitive system designed to store and manipulate information temporarily to coordinate various activities, such as keeping an action goal or holding a conversation. (Baddeley, 2003). Working memory is the most widely used term in psychology that helps to keep information in an individual’s mind to execute cognitive tasks. It is often related to intelligence and information processing skills. One working memory model that educationalists most frequently recognize and employ is Baddeley's (2001) Multicomponent Model. This model consists of four parts. The central executive has little influence and responds to the perceptual management of processes and actions. It coordinates the sub-systems like phonological loop (storage and

[1] Corresponding author
[2] Second author

preservation of language information) and visual sketchbook, (to preserve visual-spatial information). The episodic buffer is a multi-dimensional storage mechanism that was recently added to this paradigm and integrates data from several sources into a single, cohesive whole (Baddeley, 2000).

Children with Mild Intellectual Disability

A neurodevelopmental disorder called intellectual disability impacts a child's cognitive or intellectual abilities. Depending on how well their intellectual abilities are working, children with intellectual disabilities can be categorized as mild, moderate, severe, or profound. Self-help skills, interpersonal skills, and academic skills can be taught to children with mild intellectual disabilities. The "Stanford-Binet Intelligence Scale "can be used as a diagnostic tool to classify children with minor intellectual disabilities who have an IQ score below 70. Of the world's population, 1% of persons have affected mild intellectual disability, and of those, 85% have mild intellectual disability (American Psychiatric Association).

Challenges faced by Children with Mild Intellectual Disability in Acquiring Arithmetic Skills.

Cognitive abilities greatly impact a person's ability to survive in society. A healthy life's foundational elements include learning, solving issues, making decisions, and executing adaptive functioning. Learning includes improving one's understanding of geometric, algebraic, and arithmetic principles. Children were given the opportunity to practise their mathematical abilities in the early stages of their education by identifying numbers, shapes, and measurements. The three kinds of mathematical notions are conceptual knowledge, procedural flexibility, and procedural knowledge (fundamental skills for sequence and stages) (ability to grasp mathematical concepts and ideas and apply them). Children with mild intellectual disability frequently struggle with understanding basic concepts of addition, subtraction, as well as spatial relationships, sequencing, time and money values, and abstract symbols like +, -, ×, ÷,<, >, =,%, etc. They may also have trouble remembering the order of the numbers.

One of the most commonly used languages and an integral element of daily life is arithmetic. A person with strong maths abilities could explore the globe, deal with different currencies, and be financially independent. Children with mild intellectual disabilities have trouble learning these fundamental skills, but they can develop by using tactics that are in line with their pedagogical methods. So, it is crucial to help children with mild intellectual disability get over their fear of maths, understand its significance, and master it. Consequently, having a solid foundation in basic maths would help the students achieve academic success and boost their confidence.

Review of Literature

To assess the development of working memory in children with mild to borderline intellectual disabilities (ages 9 to 16; N=197), Van der Molen *et al*. (2014) used the well-known Working Memory Model created by Baddeley. They examined the connections between academic abilities and working memory. The study's main outcome measures were single-word reading, inhibition, short-term memory, working memory and arithmetics. Based on the findings, the development of inhibition, working memory and short-term memory persisted until the age of 15. Researchers examined the association between working memory and the ability to comprehend numerical magnitudes in eight-year-old children with mild intellectual disability. The study's findings showed that children with mild intellectual disability have substandard performance as compared to typically developed children of the same age. Nonetheless, it was discovered that additional regulated help was helpful in tasks that called for numerical magnitude comparison (Brankaer *et al*. 2013).

A close connection between working memory and mathematical abilities has been shown in studies in this field. Working memory is thought to play a variety of roles in how well humans accomplish mathematical operations (De Stefano and LeFevre, 2004). A study (N=233) examined how well children performed on an arithmetic word problem. The study included a digit span test, an arithmetic word problem test, a Corsi block tapping test, and a response time test. The findings showed that verbal and spatial working memory abilities were connected to arithmetic performance (Formoso, 2018). Exact addition and subtraction computations are directly related to the verbal component of working memory (Lemaire, 1996). It also involves counting and maintaining awareness

of all pertinent facts, particularly when performing continual mental calculations (Furst & Hitch, 2000; Trbovich & LeFevre 2003).

Dunning et al. (2013), provided a training in the domain of working memory, and found out that the participants' functioning on the taught working memory tasks was significantly enhanced. The participants successfully completed the visuospatial working memory tests, which were not part of the training programme. The participants' mathematics performance also significantly improved.

In recent years, a substantial quantity of research has been done on how working memory functions in individuals with intellectual disability. Researchers in this field have found that individuals with intellectual disabilities fall short of their peers who are typically developed in almost all working memory-related domains (Numminen et al., 2001; Schuchardt et al. 2010; Alloway 2010; Van der Molen et al. 2010). Research studies revealed that youngsters with intellectual disabilities can considerably enhance their working memory with strategic training (Roording-Ragetlie et al. 2022; Danielsson, et al. 2015).

According to Dahlin (2013), a working memory training course helped special needs students between 9 and 12 improve their mathematics ability. A working memory training programme significantly improved children's working memory and mathematical performance with dyscalculia (Layes et al., 2018).

Most of the research in this area has touched on the influence of working memory training on students' mathematical performance. The current study aims to find out whether teaching individuals with mild intellectual disability to do maths by incorporating cognitive strategy training which may be significantly helpful in enhancing their working memory.

Research Questions

Based on the existing literature, the authors narrowed down four research questions to measure the impact of an arithmetic training programme on the working memory skills among children with mild intellectual disabilities.

1. Is there any significant improvement in the working memory of children with mild intellectual disability as part of the arithmetic training programme?
2. Is there any significant change in the effect of the arithmetic training programme on working memory of children with mild intellectual disability according to selected socio-demographic variables?

Method

Participants

The sample consisted of 30 students aged 9-13 with mild intellectual disability from various inclusive schools in the rural areas of Malappuram district, Kerala, selected by probability sampling method. The selected students' parents were informed of the study's scope, different evaluation tests and activities that would be carried out during the study period as well as received written consent from them for their children to participate in the study. Children with mild intellectual disability studying in 5^{th} and 6^{th} grade were selected for the study. Children with associated problems like visual impairment, hearing impairment and autism are excluded from the study.

Materials

A checklist to assess working memory (CAWM) was developed by the researchers, established content validity and calculated the reliability coefficient. The obtained reliability coefficient was 0.861. The checklist included items regarding visual and auditory memory. Baddeley's model of working memory was the theoretical basis for the development of the checklist (Baddeley, 2007).

The items included in the checklist were a) Missing item; b) Odd one out; c) Number sequence; d) Sound sequence and e) Spot difference. The number of items in each domain is different. The checklist consisted of a total of 30 items. The number of items in each domain and the range of scores are given in the below table.

Table 1. Domains and Items in the working Memory Checklist

S.No.	Domain	No. of Items	Range of scores
1	Missing item	10	0-2
2	Odd one out	10	0-2
3	Number sequence	6	0-2
4	Sound sequence	8	0-2
5	Spot difference	6	0-2

Procedure

With the assistance of resource instructors, 30 students with mild intellectual disabilities were chosen via lottery method. The chosen pupils attended two testing sessions. Each child received a working memory checklist and underwent an individual test during the first session. The children were evaluated in the second session using an arithmetic assessment checklist that looked at pre-number, number, computation, and geometry. After the assessment, an intervention programme which includes cognitive strategies was introduced and it lasts for 90 days. After the completion of the intervention, the students were assessed using the same checklist used before the intervention.

Result

The collected scores were tabulated and entered in the SPSS. To analyse data, 't'-tests of both independent and dependent samples were applied.The data analysis results are given and discussed here.

Table 2. Demographic Details

Variable		Number	Percentage
Gender	Boys	17	57%
	Girls	13	43%
Class	5^{th}	15	50%
	6^{th}	15	50%
School type	Government	19	63%
	Aided	11	37%

Majority of the students were boys while 43% of them were girls with mild intellectual disabilities. Fifty per cent of them were in 5^{th} grade and 50 % were in 6^{th} grade. Among the students, 63% studied in Government schools while 37% studied in Aided Schools.

Table 3: Overall pre and post-test scores of Children with Mild Intellectual Disability on Working Memory skills

Test	N	Mean	SD	't'	Sig.
Pre-test	30	35.05	12.03	4.40	0.00*
Post-test	30	41.30	9.90		

*=significant at 0.01 level.

The above table depicted Means and SDs of pre-test and post-test scores of children with mild intellectual disability in enhancing working memory. The calculated 't' value is 4.40, which is greater than the table value ($p<0.00$). It shows a significant improvement in the overall working memory skills of the students. The finding is supported by

Table 4: Impact of Arithmatic Skill training on enhancing Visuospatial Working Memory Skills.

Test	N	Mean	SD	T	Sig.
Pre-test	30	19.83	6.14	8.67	0.00*
Post-test	30	23.87	4.45		

*=significant at 0.01 level

It is evident from Table 4, that the 't' value calculated is higher than the table value ($p<0.00$), showing the significant difference in the pre-test and post-test Mean scores of visual working memory skills. Children with mild intellectual disabilities were provided training to increase arithmetic skills through working memory models. The results point out that the model had a notable impact to develop the ability to perform arithmetic skills.

Table 5: Mean values, SDs and 't'- value of pre and post-test scores of Children with Mild Intellectual Disability on Auditory Working Memory Skills.

Test	N	Mean	SD	't'	Sig.
Pre-test	30	15.83	7.23	1.893	NS
Post-test	30	17.18	6.45		

^{NS}=Not Significant

Table 5, depicted that the t value obtained is 1.89, which means that there was no significant improvement in the auditory working memory skills of children with mild intellectual disability. The improvement of performance in auditory working memory skills was found not to be significant.

Table 6: Mean values, SDs and 't'- values of pre and post-test scores of Children with Mild Intellectual Disability on Working Memory Skills with respect to Gender.

Test	Gender	N	Mean	SD	't'	Sig.
Pre-test	Girls	13	40.12	7.87	2.14	0.05*
	Boys	17	31.18	13.39		
Post-test	Girls	13	44.08	7.37	1.44	NS
	Boys	17	39.17	11.23		

*= Significant at 0.05 level , ^{NS}=Not Significant

Table 6. indicates the working memory scores of students with mild intellectual disability with respect to gender. In the pre-test, the working memory scores of boys were significantly higher than that of girls ('t' – 2.14). After the intervention, in the post-test, the performance of both the boys and girls was almost the same. No significant differences were observed.

Table 7: Mean values, SDs and 't'- values of pre and post-test scores of Children with Mild Intellectual Disability on Working Memory Skills with respect to Class and Type of School

Test	Variable		N	Mean	SD	't'	Sig.
Pre-test	Class	5^{th}	15	34.13	12.31	0.41	NS
		6^{th}	15	35.97	12.11		
Post-test		5^{th}	15	39.90	11.04	0.77	NS

		6th	15	42.70	8.79		
Pre-test	Type of	Aided	11	35.09	13.90	0.01	NS
	School	Government	19	35.03	11.22		
Post-test		Aided	11	43.64	10.89	0.94	NS
		Government	19	39.95	9.32		

NS=Not Significant

The mean scores of working memory skills with respect to class and type of school were presented in Table 7. It was found that the class and the type of school had no significant impact in increasing the working memory skills to perform arithmetic. Thus it can be said that students need individual attention to develop certain skills to benefit from their academic activities.

Discussion

The current study's objective was to look into how an arithmetic training programme affected the working memory of individuals with mild intellectual disability. Except for auditory-verbal working memory, the results showed a significant improvement in all other working memory domains. The performance of the students with mild intellectual disability were significantly higher in the post-test proving the effectiveness of the training on working memory skills. This outcome is consistent with the findings of a clinical case study conducted by Orsolini et al. (2015). After a training programme, they discovered that a youngster with a mild intellectual disability could perform well on visuospatial memory tasks, but verbal working memory was unaffected.

Another finding from the analysis was that the girls performed better in working memory skills in the pre-intervention test than the boys. However, there was no significant difference in performance after the training program. Various studies highlighted the gender difference in working memory performance (Duff and Hampson, 2001; Pauls, et al. 2013; Elosúa and Contreras, 2017).

Arithmatic skills are essential for a children for equal participation and inclusion. Children with mild intellectual disability, however, could have difficulty with their maths skills because of limitations in their cognitive functioning. Teachers can help to educate youngsters with mild intellectual disabilities to have a positive outlook on developing their working memory and arithmetic skills in order to achieve effective results.

Conclusion

To conclude, working memory is an important factor which has a significant role in the arithmetic performance of individuals. This article is part of a research programme on the effect of cognitive strategies on arithmetic skills and working memory of children with intellectual disability. The findings of the study highlighted the connection association between working memory and arithmetic. Hence it is imperative that systematic training need to be given to enrich working memory in turn it will reflect on other areas of academic performance.

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