Impact of adoption of Information and Communication Technologies (ICTs) in Teaching Mathematics to Intellectually Disabled Children

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Abstract: This study examined the effect of information and communication technologies (ICTs) on intellectually disabled children's academic achievement in teaching mathematics. Hundred children with mild to moderate levels of intellectual disability participated in a four-week experiment in two groups. The results showed that (1) the experimental group (taught with the help of ICT based instruction) performed significantly better than the control group (taught with a conventional method); (2) a significant effect of the level of intellectual disability was observed on the academic achievement in mathematics, and (3) while no significant difference was observed on the basis of gender. Results of regression analysis showed that out of three, two variables-treatment and level of intellectual disability added significance to the prediction. The study proposed that the use of ICT-based instruction could prove helpful in teaching mathematical concepts to children with intellectual disability.

Keywords: ICT, mathematics, intellectually disabled children.

INTRODUCTION

Intellectual disability implies the condition of ceased or incomplete development of a person's mind, notably marked by natural intelligence (Persons with Disabilities act, 1995). Individuals with Disabilities Education Act (2004) describes intellectual disability as a considerable decline in average intellectual function that exists simultaneously with adaptive behavior deficits and negatively impacts children's academic performance. Due to societal and political compulsions, the term used to define this condition has changed several times throughout the years. In the late 20th century, the term "mental retardation" has now been replaced in most nations by "Intellectual

Disability (ID)" as mentioned in the "Diagnostic and Statistical Manual 5th Revision (DSM-V)". The International Classification of Diseases (ICD-11) 11th revision has suggested the name of "Intellectual disability" to "Disorders of Intellectual Development" (DID). It has been classified as a health condition rather than a disability in ICD-11 (Girimaji & Pradeep, 2018).

Intellectual disability has various causes, and its prevalence is impacted by social, economic, ethnic, cultural, and other environment-related variables, including age and gender. The prevalence of intellectual disability has consistently been linked to the low socioeconomic status of people in many research studies (Durkin, Hasan & Hasan, 1998). It is more common in underdeveloped nations due to increased birth trauma, oxygen deprivation, and brain infections during early childhood. As per Nicholas (2003), the major causes of intellectual disability among individuals are genetic, biological, and environmental. Often, genetic and biological factors cause a severe Level of Intellectual disability.

Students with intellectual disability should be provided with a different curriculum, unlike other students with special needs, and therefore, extra efforts are required to be put in as per their cognitive ability (Myreddi & Narayan, NIMH, 1998). Children with intellectual disability must learn functional academic skills to become self-sufficient and employable (Manavalan, *Functional Academics for Students with Mild Intellectually disability, NIMH*, 1998). Teaching mathematics to intellectually disabled pupils, on the other hand, entails learning based on concrete experiences and applying the learned skills in real situations. Furthermore, classroom learning should be blended with community exercises in a way that allows the generalization of learned skills (Myreddi & Narayan, NIMH, 1998). The mathematical curriculum provided to pupils should consider their future learning needs that are likely to be used in their real-life contexts (Polloway, Patton, Epstein & Smith, 1989). Numbers play a crucial part in our daily lives, and the subject of negotiating quantities comes up in our daily conversations. Over the last few decades, India has experienced a paradigm shift in teaching-learning. Children with intellectual disability have become engaged learners due to tailor-made individualized programs.

In the last few decades, technological advancement has leaped enormously. It has woven the world together as globalization and constituted further avenues for various sectors and institutions of society; ICT is one of them. DeSimone & Parmar (2006) underlined the benefits of visual technologies in engaging learners in concrete representation and helping them comprehend abstract concepts without difficulty. Instructional technology features like spell-checking, word predictions, touchscreen technology, navigation, etc., can help reduce the cognitive load required in learning (Ciampa, 2017; Kennedy & Deshler, 2010; Hasselbring & William Glaser, 2000). Virtual learning spaces in e-learning (Skillshare, 2018) help children with disabilities to work on concepts at their own pace through course material (Braddock et al., 2004; Fichten et al., 2009).

Over time, the use of technologies in learning boosts the productivity of children (Ciampa, 2017) by enabling them to become more adaptable, self-reliant, more confident, and self-esteemed (Stock et al., 2004). Children with disabilities are usually inhibited in schools due to fear of failing. However, virtual technologies and e-resources provide them with opportunities to learn from errors (Cromby et al., 1996). E-learning platforms help them keep away from social anxieties and provide an individualized form of instructional materials, enhancing learners' confidence (Bühler & Fisseler, 2007; Fichten et al., 2009). Several technologies can be effectively utilized for the development of intellectually disable individuals (Carey et al., 2005; Sowers et al., 1985; Wehmeyer, 1998). UNESCO (2011) stressed how ICTs could be effectively utilized for the disabled population and their education. Many frameworks have focused on the positive effects of various technologies on the development of children with disabilities in diverse classroom contexts (Bowser & Reed, 1995; Parette, 1997; Parette & Wojcik, 2004; Zabala, 1995). Nonetheless, teachers still feel lack of adequate knowledge and skills to adopt appropriate technological devices (Anderson & Petch-Hogan, 2001; Derer et al., 1996; Edyburn, 2004). Also, educators and students face challenges in accessing technological devices for teaching and learning (Wehmeyer, 1998), which may result in causing frustration and unwillingness among teachers, parents, and students in the integration of technologies into the learning process (Lahm et al. 2001; Lesar, 1998). Children with intellectual disability are considered to have significant difficulty in learning basic

mathematical skills (Noffsinger & Dobbs, 1970). Many research studies have shown that multimedia education boosts pupils' academic achievement in science, mathematics, and literacy (Gee, 2003). However, it has been observed that these facilities are not available at ground level to people with disabilities in all parts of the country.

Teaching mathematical concepts and exercises to children with intellectual disability is a great challenge. The use of various technological devices by intellectually disable people helps to increase their level of self-sufficiency, self-determination, and the ability to integrate all acquired skills (Wehmeyer, 1998). Bennett et al. (2013) observed the positive effect of a computer-based memory training program on Down Syndrome-affected children in the United States. Intellectually disabled children are considered to have significant difficulty learning basic mathematical skills (Noffsinger & Dobbs, 1970). Advocates of computer-based instructional programs say that this method of instruction has many benefits for exceptional children (Schmidt, Weinstein, Niemic & Walberg, 1986). Lin et al. (1994) studied the effect of CAI on mathematical abilities among children with and without intellectual disability and found an increased response rate using technologies. The use of a computer-based program for teaching addition to intellectually disabled children was found to be more beneficial than traditional methods (Leung, 1994). Computer-aided software program assists in improving the reading abilities of children with disabilities and shows the positive attitude of children towards the program (Kim et al., 2006). Also, computerized programs help in developing mathematical skills of addition and subtraction among children with mental disabilities, including children with intellectual disability (Al Rassees, 2003; Anitha, 2005; Podell, Tournaki-Rein & Lin, 1992; Kumar, 2012; Leung, 1994; Mary & Premila, 2019; Pang, 2005; Patra & Rath, 2000; Raouf, Alenizi & Attiya, 2016; Sharma, 2004). The efficacy of CAI and behavioral approaches for teaching mathematics to intellectually disabled children have been validated by these findings. Tudela and Ariza (2006) carried out research showing a significant positive effect of using computer-assisted instruction with multimedia-based programs in improving children's mathematical skills with Down syndrome. Campbell et al. (2008) have shown the effectiveness of smartboard technology for children with learning difficulties in letter-sound

training. These children can benefit from computers in learning mathematics (Küçükalkan, Beyazsaçl, and Öz (2019). Haugland (1992) found that computer-assisted instruction is useful in the medicinal program on dialect improvement for those youngsters who have cognitive delayed development or are 'at risk' for school disappointment. Mioduser et al. (2000) investigated the role of computer-based instruction in improving phonological awareness, word and letter recognition among students with learning disabilities, compared to conventional instruction through printed resources and formal reading practices.

Further, Moore & Calvert (2000) reconnoitered the usefulness of computer-based technologies to enhance the language skills and vocabulary abilities of children with autism. Technology usage also helps children with intellectual disability develop self-help skills (Rai, 2008; Turan, Yilma, Sakalar & Ucan (2016) worked on designing a digital-based education model for the development of auditory and visual perception in educable children with intellectual disability. Learning will occur more effectively and permanently when auditory and visual elements are implemented together. Kumar (2012) recommended integrating CAI-based programs for teaching children with special needs. It was also suggested that CAI could prove to be an effective tool for special educators.

Further, Dandashi et al. (2015) proved the positive effect of the edutainment gaming program on the cognitive and motivational levels, specifically when students were more physically active in their classrooms. Technological games tend to simulate the process of learning but are incapable of replacing the natural mode of teaching for children with disabilities (Kwon, 2012). However, serious games can also teach basic job skills to individuals with developmental disabilities (Kwon & Lee, 2016). Agarwal & Yash (2012) supported the usage of computer games in the rehabilitation of students with intellectual disability. Davies & Wehmeyer (2004) conducted a pilot test on\an internet-based multimedia assessment system that uses audio, video, and image assistance to help people with intellectual disability. Stock, Parette, and Wojcik (2004) constructed an assistive technology-based toolkit for students with intellectual disability that would benefit the professionals working in special education. Also, various studies have been conducted to propose

ways of utilizing augmented reality technology for future development (Karamanoli, Tsinakos & Karagiannidis, 2017).

Moreover, some studies are conducted in the area of technology use in special education. However, these studies are either at trial or merely about awareness. Investigators found the dire need for more specific and scientific research to be conducted in using technology in special education to make it work in real-life situations rather than merely on a small scale of research. Studies could be done to acquire and assess the efficiency of using ICT-based instructional packages for various target groups. With a subsequent review of related literature, the researcher felt that very few empirical studies had been conducted on the present theme in India. Therefore, comprehensive research is crucial to studying information and communication technology's effect on children with intellectual disability in teaching basic mathematical functions. After reviewing all the previous research studies done on similar areas, the investigators gained assistance in developing a program based on information and communication technology and recognizing the skills that would be established. The investigators observed that the ICT-based programs utilized in previous research focused on developing mathematical skills and limited arithmetic functions among students with mental or intellectual disabilities, as in the research conducted by Dyab (2001) and Al Kashef (2002). At the same time, the present study attempts to find the effect of information and communication technology on children with intellectual disability in developing mathematical abilities related to concepts of numbers, addition, subtraction, and time and money.

The investigator realized that there is a lack of Indian studies that worked on Children with intellectual disability and mathematical abilities, which is believed to be a novel additive. Also, the sample size taken in previous studies is relatively small, making it difficult to generalize the results. This study has been planned to fill the gap by examining the effect of ICT-based instruction on teaching mathematical concepts to intellectually disable (MR) children. This study has built a link and thrived in augmenting the gaps left by previous research and can shape the way special and mainstream educators teach mathematical concepts to intellectually disabled children. In other programs that serve intellectually disabled children, employing ICTs can be repeated. Recent

advancements in technology have created an ideal atmosphere for creating individual training programs. After reviewing all the previous research done on similar areas, the investigators conceptualized the present study to investigate the effect of ICT on Children with intellectual disability in developing mathematical abilities related to concepts of numbers, addition, subtraction, and the concepts of time and money. The study's primary objectives were to develop an ICT package for teaching Mathematics to intellectually disabled children and compare the effectiveness of ICT-based teaching with that of conventional teaching in terms of academic achievement of intellectually disabled children in Mathematics. The study also aimed to investigate the main effects and interaction effects of treatment, gender, and Level of Intellectual disability on the academic achievement of Children with intellectual disability in mathematics. This study seeks answers to the following research questions: (1) What is the effect of ICT-based instruction on academic achievement in mathematics in the case of MR children? (2) Do MR children differ in their academic achievement in mathematics based on gender? (3) What is the effect of the Level of Intellectual disability on the performance of MR children?

METHOD

However, true experimental research is almost impossible in social sciences, as a result, the current study used a quasi-experimental two-group pre and post-test design. The sample was divided into experimental and control groups (details are given in Table 2). The experimental group was taught mathematics with the help of ICT, while the control group was taught using the conventional method. For the present study, gender, Level of Intellectual disability, and "treatments" (ICT-based teaching and conventional teaching) provided to children with intellectual disability were taken as independent variables, while academic achievement in mathematics was considered as a dependent variable. Academic achievement scores were assessed twice during the process of research. Firstly, before the start of experimental treatment, i.e., at the pretest stage, and then after the end, i.e., at the post-test stage.

Participants

The present study population selected children with intellectual disability from Haryana state. A multistage random sampling technique was applied to select a sample of 100 (72 male, 28 female) children having mild or moderate levels of intellectual disability from special schools in Gurgaon and Rewari district (refer to Table 1 for more details), and subjects were assigned into one of the two groups randomly. The age group of the subject ranges between 10-22 years. Before approaching the participants, consent from the parents and schools included in the study was obtained and students were informed about the purpose of the study, and their willingness to participate in the study was sought. Investigators tried to build rapport with the students before starting the experiment, and it was the most challenging task during the study as these students took time to connect with a new teacher. Moreover, it was not easy to maintain their attention during the experiment as they did not follow instructions easily.

		Frequencies (f)	**Percentage (%)**
Gender	Male	72	72%
	Female	28	28%
Level of Retardation	Mild	29	29%
	Moderate	71	71%
Group	Experimental	50	50%
	Control	50	50%

Table 1: Detail of Sample

Investigators applied some controls in the study to minimize the errors during the experiment viz: (1) only students studying in special schools were considered for the study (Selected schools were Khushboo Welfare Society, Navprerna Shikshan Kendra, and Manav Vikas SewaSamiti); (2) only mild and moderate level of children with intellectual disability were selected; investigator herself taught (3) children of both the group; (4) same Mathematics concepts were taught to both the groups for four weeks; (5) To nullify the effect of non-equivalence of groups, ANCOVA statistical technique was employed as perfect dichotomization and randomization were inconceivable for the present study (Winer, Brown and Michels,1991).

Experimental group (ICT based Teaching)		Control Group (Conventional Teaching)	
Male	Female	Male	Female
35	15	35	15
Level of Intellectual disability			
Mild	Moderate	Mild	Moderate
12	38	17	33

Table 2 Sample in Experimental and Control Group

Tools Used

An academic achievement test was constructed and standardized on a sample of 50 intellectually disabled children. This test was reviewed by three experts working in special education for more than five years. Item analysis of the test was completed by determining each item's difficulty value and discriminating power. Also, the test's reliability was calculated using the split-half method and was found to be 0.73. The investigator prepared an ICT package for teaching mathematics for intellectually disabled children, focusing on concepts of mathematics related to numbers, time, and money. This test was used to obtain pretest and post-test academic achievement scores in mathematics.

Development of an ICT-based instructional package

The researchers followed the following steps to develop an ICT-based instructional package in mathematics for children with intellectual disability.

1. ***Content Selection***: The investigator referred to "Behavioral Assessment Scales for Indian Children with Mental retardation (BASIC-MR)" prepared by R. Peshawariya and S. Venkatesan (first edition, 1992 and reprint 2000). This scale is designed to collect information about all the functional skills of persons with intellectual disability, which can be used for individualized program planning. These functional skills include motor skills, activities of daily living, language, reading-writing, numbers-time, domestic-social, prevocational-money skills. The investigators also visited schools of intellectually disabled children and, after consultation with the teachers,

selected content related to essential mathematical functions of numbers, shapes, addition, and subtraction, and time and money concepts; ICT-based packages were prepared.

2. ***Defining the Entry Behavior of the Target Group*** According to Russell (1974), the entry behavior of learners refers to the precondition set of knowledge, skills, or attitudes that are acquired for the new learning, which also incorporates their previous learning and experiences. The primary objective of preparing such modules is to observe learners' progress from their entry behavior to terminal behavior (mastery over learning/instructional objectives). In the present study, the entry behavior of the children was observed with the help of their special educators. The latter assisted in determining students' current learning level of mathematics concepts, which further helped the investigator select the related concepts of mathematics.
3. ***Task Analysis:*** According to Alberto and Troutman (2003), task analysis can be defined as the process of splitting up a complex task into easier and smaller steps. These many smaller steps or components are further divided into phases that can be used for teaching purposes. Children with intellectual disability may not learn the concepts in the same way as children without disabilities. Therefore, the investigator found it essential to split up the whole content into smaller sections according to the learning needs of the learners. Mathematical numbers, shapes, time, and money-related concepts were further split into smaller sections. Details are given in Table 3.
4. ***Scriptwriting and Storyboard:*** As per the views of Kumar, 2006, the script can be defined as a comprehensive plan of action and events envisioned in a teaching program. It also includes a list of all activities in all visuals and words spoken in a storyboard format. Writing a script is the beginning stage of developing any ICT-based multimedia package. The script was written while keeping in mind the needs of all learners, and all pertinent information related to content was included in the script. The entire content was divided into smaller chunks or sub-topics. Afterward, the opinion of the subject experts was sought for modification or rewording of the script.
5. ***Story Board:*** According to Varvel and Lindeman, 2005, "Storyboards are a means to graphically represent layout, organization, content and linkages of information within a multimedia to create a conceptual idea of the information location, meaning and appearance." Thus, a storyboard, a general outline in the form of a working document, was prepared, highlighting major headings and

captions and showcasing all the critical points of the necessary information. A sample storyboard on the topic' Numbers 1-10' is shown in Table 3.

6. ***Collection and Development of Resources:*** After preparing the storyboard, appropriate resources pertinent to the selected content were placed together before starting the program development. In the present study, the investigator recorded the videos herself using a platform like Screencast-o-Matic, an Active presenter. Open resource videos were also obtained from YouTube and Teacher Tube sites. Images were also downloaded from open resources.
7. ***Sequencing and Integrating:*** Proper sequencing of the content with the integration of various multimedia components like images, text, graphics, audio, video clips, etc., in a storyboard, helps prepare an effective ICT-based program. Thus, the researcher collected various e-resources from the web and self-prepared components, arranged sequentially and integrated after discussion with experts in the related field.
8. ***Editing:*** The process of revising and reorganizing the content to develop modified new work is called editing. Here, the researcher, at this step, attempted to edit the unwanted content or footage of the video, add effects, narration, graphics, music, audio, using user-friendly and readily available software such as MS PowerPoint with updated features, Audacity, Filmora, Active presenter etc. In general, the same concept is required to teach intellectually disabled children several times over and with this instructional program based on ICT, this can certainly be possible. Multiple media such as text, images, audio, video, and animations can make it more interesting.
9. ***Evaluation:*** After completing the ICT-based instructional package editing, the investigator sent it to subject experts to evaluate and provide feedback on its content and technology used. The program was evaluated along with its content accuracy, ease of use, and appeal to learners. Based on the feedback, the required modifications were made. This step helped the investigators to avoid ambiguity, insignificances, and other shortfalls in the program.

Content	Visuals	Effect
Counting package from 1 to 10	Researcher's introductory video	Video

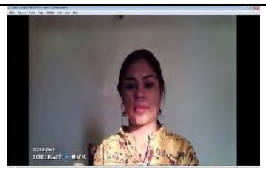
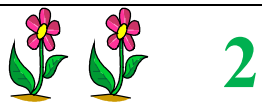
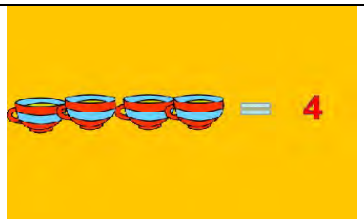
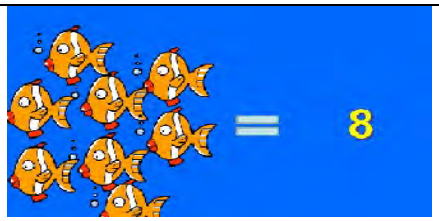
		
Stage 1: Minor stage Concept of a number is introduced	1	Ppt, pictures
Numerals 1 to 10 are introduced this way		Pictures, animations
Stage 2: Major Stage Identification of taught numeral (Straight line) Learner has to match the particular numeral with number of objects in pictures in straight line		Pictures, animations
Cluster Counting Learner has to match the particular numeral with same no. of objects presented in cluster		Pictures, animations
Recapitulations with different objects and pictures		Pictures, Video

Table 3: Sample Storyboard for Teaching Numbers from 1 to 10

Procedure

The experiment was conducted for four weeks in each school. Following the formation of the control and experimental groups, the investigator established a positive rapport with the children

and provided them with information about the study's tools and significance. Before conducting the pretest, necessary instructions related to the test were given to the children of both groups. Then, lastly, the pretest of standardized achievement test in mathematics was administered to both the groups of children with intellectual disability as per the plan. Once the pretest was administered at stage I, treatment was presented to both groups. The experimental group was taught concepts of mathematics through an ICT-based multimedia package prepared by the investigators herself. Simultaneously, the control group was taught the same mathematics concepts using conventional teaching methods like lecture and demonstration. The program was conducted for four weeks. The following concepts of mathematics were covered.

Phases	Experimental Groups	Control Groups
Pretest Stage	Administration of pretest of achievement test in Mathematics prepared for intellectually disabled children.	Administration of achievement test in Mathematics prepared for intellectually disabled children.
Experimental Stage	Teaching mathematical concepts through ICT based instructional package	Teaching mathematical concepts through conventional method of teaching
Posttest Stage	After completion of experimental stage, administration of post -test achievement test in Mathematics prepared for intellectually disabled children.	After completion of experimental stage, administration of post -test achievement test in Mathematics prepared for intellectually disabled children.

Table 4: Stages of Experiment

The program was conducted for four weeks, following concepts of mathematics were covered. ICT-based Instructional program included demonstrations and practice exercises on the related concepts. For example, in 'Single Digit Addition', first students were shown the demonstrations with the help of a small story using images, animations. Then, the concept of addition was

introduced with numerals on the screen. The first addend was displayed first, followed by the '+' sign, and then the second addend. Then, a horizontal line was drawn underneath the '+' and the second addend. Finally, the answer is presented with the addends, blinked for 2 seconds to highlight. The children were asked to read the entire procedure aloud. For example, the sum '3 + 2 = 5' can be interpreted as 'three plus two equals five.' Similarly, other examples were used for their better understanding.

The researcher noticed the children's interactions throughout teaching sessions by observing them in mathematics class. The ICT-based instructional program resulted in positive interactions between experimental group children. Children were more joyful, interactive, and focused during the teaching-learning process.

During the intervention programme, children from both the groups were given worksheets on the related concepts of mathematics which were taught in the classroom, and parents were given instructions on how to assist their wards in completing their homework tasks. Parents of intellectually disabled children were also asked about their opinion on the use of ICTs in the classroom. Most of them supported the idea that ICTs make the instruction process more appealing due to the use of images, audio, ease of use, and multisensory approach of the medium. As one of the responses says *"My nine years old son easily spend 50 minutes daily on completing mathematics worksheets as he says, 'I want to learn mathematics'. That's quite satisfactory for me because he's rapidly expanding his mathematical understanding and interest".* Another excerpt from the parent, "*I believe that children from today's generation are born into a digital world of images and animations. As a result, use of computers and technology piques their interest, and they are able to watch more clearly".* With the use of ICTs, children don't just memorize mathematical facts, instead, they obtain a conceptual comprehension of mathematical abilities with the help of drills and exercises. Hence, the use of technologies has the potential to enhance intellectually disabled children's classroom mathematical experiences, but teachers and parents must carefully plan the integration of technological resources and implement them into learning tasks.

Number-related concepts	**Shapes**	**Time-related**	**Money-related**
Numbers from 1 to 20	Different types of shapes	Concept about days of the week, months in a year	Concept of Money with illustrations

Single-digit addition and subtraction	Concept of Big-Small, Tall-Short, More-Less	Concept of time: Hour hand and minute hand	Familiarity with coins and notes of Indian currency

Table 5 Concepts of mathematics covered during the treatment stage

The instructional program was completed for both groups, i.e., the experimental and control group. Their performances were measured to find the effectiveness of ICT-based teaching treatment and conventional teaching methods on teaching mathematics to intellectually disabled children. Post-test was administered on both groups using achievement test constructed and standardized by the investigators.

Results and Discussion

After measuring the mean and standard deviation of the achievement in Mathematics in the pretest, the experimental group was given the treatment of ICT-based teaching. The mean scores of academic achievements in Mathematics of the experimental and control group after the intervention treatment (Post-test) were 15.78 and 14.58, respectively. The estimated t-value is 2.027, which is significant at 0.05 level of significance. It shows that children taught through the ICT-based approach performed better than children who were taught using the conventional method. This result agrees with the findings of Kumar (2017), who revealed the significant positive effect of computer-assisted instruction programs on the development of motor, academic, and communication level of intellectually disabled children.

Additionally, Singh & Aggarwal (2013) concluded that computer games helped in better gain in Mathematics concepts among intellectually disabled children. Similar results have been shown by Parette, 1997; Silver & Oakes, 2001; Forgen & Weber, 2002; Weber, Forgan, Schoon & Singler, 1999). Mary & Premila (2019) found out the more significant effect of computer-assisted instruction than teacher-centric instruction on developing mathematical skills among primary level students with mild intellectual disabilities.

	N	**Mean**	**SD**	**t-value**	**df**	**p**	**Effect size**
Control Pre-test Score	50	8.44	2.60	0.937	49	0.353	0.133
Experimental Pretest Score	50	8.00	2.52				
Pre-test Score	100	8.22	2.56	30.341	99		

Post-test Score	100	15.20	3.03			< .001	3.034
Experimental Post-test Score	50	15.78	2.78	24.827	49	< .001	3.511
Experimental Pretest Score	50	8.00	2.52				
Control Post-test Score	50	14.62	3.18	20.653	49	< .001	2.921
Control Pre-test Score	50	8.44	2.60				
Experimental Post-test Score	50	15.78	2.78	1.969	49	0.05	0.278
Control Post-test Score	50	14.62	3.18				

Table 6: Effect of ICT on academic achievement of intellectually disabled children in mathematics

As per the objectives, the main effect of treatment on the academic achievement of intellectually disabled children in mathematics was verified. To nullify the effect of non-equivalence of groups, ANCOVA as a statistical technique was employed. The pretest and post-test scores were analyzed for both the groups, and pretest scores were considered co-variate. It can be observed that the main effect of treatment is significant ($F=4.898$, $p<0.05$) at 0.05 level of significance. This means that the group of intellectually disabled children taught using ICT has shown greater improvement in academic achievement in mathematics than those taught using traditional methods. This finding agrees with Zarei & Gharibi (2012), who found that the learning and retention of fourth grade educable intellectually disable girl students were significantly higher in the experimental group (who were given training through multimedia software) compared to the control group students.

Tests of Between-Subjects Effects (Dependent Variable: Post-test Score)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Pre-test Score	25.783	1	25.783	6.054	.016
Gender	7.887	1	7.887	1.852	.177
Treatment	20.859	1	20.859	4.898	.029*
Leve of MR	28.175	1	28.175	6.616	.012*
Gender * Treatment	2.343	1	2.343	.550	.460
Gender * Level of MR	2.755	1	2.755	.647	.423

Treatment * Level of MR	2.811	1	2.811	.660	.419
Gender * Treatment* Level of MR	.990	1	.990	.232	.631
Error	387.537	91	4.259		
Total	24012.000	100			

*Significant at 0.05 level

Table 7: ANCOVA for Academic Achievement in Mathematics

From Table 7, it can be observed that the main effect of gender is found to be insignificant ($F=1.852$, $p > 0.05$). This implied that male and female intellectually disable students' academic achievement in mathematics did not differ significantly. It concludes that male and female intellectually disabled children performed equally well in mathematics. The findings are in congruence with the observations of Singh & Aggarwal (2013), who reported that gender does not affect significantly the acquisition of mathematical concepts of time and number-related skills by intellectually disabled children using computer games. However, males benefitted more than females on one concept of money-related skills.

From Table 7, it can be observed that the main effect of the Level of Intellectual disability is found to be significant ($F= 6.616$, $p<0.05$) at 0.05 level of significance. Also, Table 10 shows the adjusted means of academic achievement of mild and moderately intellectually disabled children in mathematics to elucidate the direction of the difference, which are 18.379 and 13.901, respectively. The result shows that children with mild levels of intellectually disability ($M=18.379$) performed better than moderately intellectually disabled children ($M=13.901$) in terms of academic achievement in mathematics.

One of the research purposes was to study the interaction effect of treatment and gender on the academic achievement of intellectually disabled children in mathematics. It is evident from Table 7 that the F value (0.550, $p > 0.05$) for the interaction effect of treatment and gender on academic achievement in mathematics is found to be insignificant. This result agrees with Aladwan (2013) study, who found no statistically significant interaction effect between the technology-based

program and gender on the mathematical skills of addition and subtraction. Similarly, Singh & Aggarwal (2013) found no interaction between treatment and gender in time-related mathematical skills.

Multiple regression was run to predict children's academic achievement from gender, treatment, and Level of Intellectual disability. From Table 8, the R-value (0.73) predicts the level of prediction, and adjusted R square (0.5236) shows that gender, treatment, and Level of Intellectual disability explain 52.36% of the variability in the academic achievement of children in mathematics. The model statistically significantly predicted academic achievement F (37.27), $p<0.05$, R Square (.538). Out of three variables, only two, treatment (p=.000) and Level of Intellectual disability (p=0.000) contributed significantly to predicting academic achievement scores. However, gender (p=0.1281) is not significant, and therefore no substantial contribution of gender was observed in explaining the academic achievement of intellectually disabled children when the variables treatment and Level of Intellectual disability are present in the model.

Regression Statistics				
Multiple R	0.733534136			
R Square	0.538072329			
Adjusted R Square	0.523637089			
Standard Error	2.090231061			
Observations	100			
ANOVA	df	SS	MS	F
Regression	3	488.5696746	162.8565582	37.27491467
Residual	96	419.4303254	4.369065889	
Total	99	908		
	Coefficients	Standard Error	t Stat	P-value
Intercept	26.46672478	1.213580619	21.80878993	0.0000
Gender	-0.718669445	0.468334634	-1.534521244	0.12819069
Treatment	-1.649161172	0.420843157	-3.918707349	*0.000
Level of MR	-4.604143939	0.465794965	-9.884486276	* 0.000

Table 8: Model Summary, ANOVA and Coefficients

Figure. 1 Graph Showing Contribution of Treatment, Gender, and Level of Intellectual disability on the academic achievement.

Conclusions

Based on the findings of the analysis and interpretation of the obtained data, it can be inferred that the post-test score of the experimental group is significantly different from that of the control group in terms of the academic achievement of intellectually disabled children in mathematics. It follows that children with mild and moderate intellectual disability who were taught using ICTs showed better performance in mathematics than those taught using the conventional method of teaching. The role of gender was found insignificant in terms of the academic achievement of intellectually disabled children, whereas children with mild levels of intellectual disability performed better in mathematics after treatment than moderately intellectually disabled children. Also, after regression analysis, it was found that no substantial contribution of gender is present in explaining the

academic achievement of intellectually disabled children when the variables treatment and Level of Intellectual disability are present in the model. Based on the outcomes of the present study and previous research, it can be stated that the use of information and communication technologies significantly improves the academic achievement of Children with intellectual disability at mild and moderate levels in mathematics. There may be several reasons for the dominance of ICT-based teaching over traditional methods, such as that ICTs provide various platforms for children to rehearse the same content repeatedly without wasting any content with the help of joyful drills and practice exercises. Also, graphics, animation, immediate feedback, and different multimedia lead to better learning of mathematical concepts through ICTs. Another factor contributing to its favorable impact might be the children's enthusiasm and focus during the intervention program. Support provided by the teachers and parents to the students for engaging in the training program may also be crucial in determining the positive and beneficial effects of the ICT-based intervention program. Children with intellectual disability can benefit from information and communication technologies (ICTs) by overcoming the barriers to autonomy and inclusion. Support provided by the teachers and parents to the students for engaging in the training program may also be a crucial element in determining the positive and beneficial effects of the ICT-based intervention program. Usage of technology should be offered to intellectually disabled children as early as possible as it can help compensate for their functional limitations. Technology accessibility, usage, and how the user is instructed to operate the devices should be consistent.

Educational Implications of the Study

This research analysis was intended to determine the effects and advantages of ICT integration into the educational process for students with intellectual disability in mathematics. The present conclusive research analysis would have immense ripple effects on students with intellectual disability welfare. That will be visible through educational facilities for children with disabilities. Research has highlighted the advantages of successful consolidation of ICT into the educational process for children with mental disabilities and emphasized how ICT integration can supplement the overall efficacy of all the stakeholders involved, be it the teachers, students, and their parents, towards the augmentation of the settlement and rehabilitation of intellectually disabled children

and other disabled people in society. This research analysis has reflected how imperative it is to incorporate specialized assistive programs into the daily classroom, especially for students with special needs. It will be a guiding principle for institutions and teachers on implementing technology-assisted programs into the educational process for children with disabilities.

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