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ICT Mediated Multiple Intelligence Based Teaching And Achievement In Mathematics At Secondary Level

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Abstract

Mathematics is well known as the father of all sciences. Each student in their day-to-day life must achieve certain vital goals and objectives. Mathematics is the backbone for prosperity in every field of life. The current state of learning of Mathematics requires urgent attention to determine effective strategies for enhancing students' achievement and saving the nation from plunging into mathematical anarchy which will dim the nation's quest for scientific and technological development. Information Communication Technology (ICT) provides teachers with foundational tools and means to help teachers change teaching methods, support students in independent learning, and actively participate in the discovery of concepts in Mathematics and students gain deeper understanding of Mathematical ideas. Among many approaches for effective teaching learning process, Multiple Intelligence Theory-based teaching is one, which asserts that learning environments should be designed considering individual differences. Therefore, the study determined whether the achievement of students taught through ICT Mediated Multiple Intelligence based teaching will differ from those taught through conventional teaching in the classroom. The study was a quasi-experimental pre-test post-test control group design. The population of the study consist of all secondary CBSE school students from Mysore city of Karnataka state. One CBSE school was purposively selected with 75 sample students of two different sections of the same class were randomly selected as experimental group (37) and control group (38), sample had 31 Girls and 44 Boys. The experiment group was taught Mathematics using ICT Mediated MI Based teaching while the control group with conventional teaching. The instrument for data collection was a researcher made Mathematics Achievement Test with a reliability coefficient of 0.71. The data were analyzed using mean, standard deviation and ANCOVA. The result of the study revealed that ICT Mediated MI Based teaching was effective in enhancing secondary school students' achievement in Mathematics and minimising gender gaps. Recommendations for Mathematics teachers are to apply ICT Mediated MI Based teaching to enhance students' achievement in Mathematics at the secondary school level.

Keywords: Mathematics, Multiple Intelligence, Information Communication Technology, ICT Mediated MI Based teaching, Achievement in Mathematics.

Introduction

Mathematics is well known as the father of all sciences. Each student in their day-to-day life must achieve certain vital goals and objectives. Mathematics works as a base camp to achieve these objectives. It is impossible to think about any scientific study without Mathematics. Mathematics is the knowledge of 3R's i.e. reading, writing and arithmetic. Every stage of education has its importance. Secondary education lays the foundation for all types of higher education. Mathematics is an important subject of the curriculum at every stage of school education due to its numerous applications in all walks of life.

The importance of Mathematics is recognized by every Education Commission and Policy. The National Policy on Education (NPE-1986) states that "Mathematics should be visualized as the vehicle to train a child to think, reason, analyse and to articulate logically". Similarly, the National Education Policy (NEP-2020) recognized the importance of Mathematics and mathematical thinking in upcoming research-oriented fields such as artificial intelligence, machine learning and data science. The NCF 2005's vision of excellent mathematical education is based on the twin premise that all students can learn Mathematics and that all students need to learn Mathematics. Therefore, imperative that Mathematics education of the very highest quality is offered to all children.

Despite the usefulness of Mathematics, students still do not exhibit encouraging performance in the subject area both in internal and external examinations. Maduabum & Odili (2006) indicated a low achievement in Mathematics among students. Many other researchers like Elekwa (2010), Uwadiae (2010), Nufus (2020), Dahliana et al (2019), Nuraina (2018), Mursalin (2019), Usmadi (2020), Niswah (2020), Rind & Mughal (2020) and Olunloye (2010) variously indicated poor achievement in Mathematics by students. This is a clear indication that students' Mathematics problem-solving and learning ability is not satisfactory.

The problem may originate from the fact that most Mathematics teachers still maintain the use of unproductive teaching methods being the conventional method of teaching. The method is teacher-centred as such does not allow activity-based learning which is student-centred. Regarding learning is an active process, instructional activities which enable students to actively learn Mathematics should stand at the forefront. It is widely declared that instructional activities raise students' interest in Mathematics lessons, draw students' attention to the subject on which students working, and allow students to actively learn the subject in a pleasurable way (Moyer, 2001). Therefore, instructional activities which provide students to participate and learn actively should be used in Mathematics education. Otherwise, some difficulties would appear in Mathematics education, especially in primary schools. Most of the contemporary educational philosophies claim that teaching approaches caring the individual differences should be used to overcome the difficulties in the learning environment. (Baki, 2006).

Information Communication Technology (ICT)

Information and Communications Technology (ICT) is considered a powerful tool for educational change and reform (Fu, 2013; Goktas et al., 2009). Several previous studies have shown that the appropriate use of ICT can raise educational quality and connect learning to real-life situations (Lowther et al., 2008; Van Weert & Tatnall, 2005). ICT assists in transforming a teaching environment into a learner-centered one (Sanchez & Education, 2011), learners are actively involved in the learning processes in ICT classrooms, and they are authorized by the teacher to make decisions, plans, and so forth (Lu et al., 2010).

In Mathematics education, ICT also provides teachers with foundational tools and means to help teachers change teaching methods, support students in independent learning, and actively participate in the discovery of concepts and Mathematics topics. As a result, students gain a deeper understanding of mathematical ideas. Therefore, it can be understood that the integration of ICT in Mathematics education is the result of the ability to apply ICT to help students achieve better in Mathematics. These potentials of ICT make classroom integration a promising practice, but its success depends on various factors. Research on the use of ICT in Mathematics education is also one of the ways to increase the effectiveness and feasibility of the applications of ICT in Mathematics education.

The National Council of Supervisors (2005) states that computers are better to develop 10 basic skills in Mathematics, namely (1) problem-solving, (2) applications of Mathematics in everyday life, (3) opportunities, (4) estimation and approximation, (5) numeracy, (6) geometry, (7) measurement, (8) reading, interpreting, and constructing tables, diagrams, and graphs, (9) use of Mathematics for prediction, and (10) computer literacy.

Both National Council of Teachers of Mathematics (NCTM 2000) and British Educational Communications and Technology Agency (BECTA 2003) focused on the technology as enabling, as well as encouraging the learner to focus on reflection, verification, decisions making and problem-solving.

Technology is essential in teaching and learning Mathematics. ICT improves the way Mathematics should be taught and enhances student understanding of basic improves concepts. ICT also supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem-solving strategies which are in line with the recommendations forwarded by the National Council of Teachers of Mathematics (NCTM 2000); students would then use technology to concentrate on problem-solving processes rather than on calculations related to the problems (Ittigson & Zewe, 2003).

Many researchers have carried out studies to evaluate the benefits of using ICT in Mathematics. BECTA (2003) summarised the key benefits – ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation. It also allows them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations.

Multiple Intelligence Theory

Over the past few decades, research in the field of learning has led to the discovery of the Theory of Multiple Intelligences. In short, this theory states that each person has different ways of learning and different intelligences they use in their daily lives. While some can learn very well in a linguistically-based environment (reading and writing), others are better taught through mathematical-logic-based learning. Still, others benefit most from body-kinesthetic intelligence (learning by doing with hands). Each person possesses each intelligence to an extent, but there is always a primary, or more dominant, intelligence. The work on multiple intelligences began in the early 1980s with Howard Gardner, and the research continues.

Howard Gardner's Theory of Multiple Intelligence

Howard Gardner of Harvard University originally identified seven distinct intelligences. According to Gardner, this theory, which emerged from cognitive research, documents the extent to which students possess different kinds of minds and therefore learn, remember, perform, understand in different ways.

The Nine Multiple Intelligences

Gardner claims that all human beings have multiple intelligences. These multiple intelligences can be nurtured and strengthened or ignored and weakened. His research from 1991 identified seven intelligences; in the intervening time, he has come to believe there are a total of nine intelligences:

1. **Verbal-Linguistic Intelligence:** Well-developed verbal skills and sensitivity to the sounds, meanings and rhythms of words.
2. **Mathematical-Logical Intelligence:** The ability to think conceptually and abstractly, and the capacity to discern logical or numerical patterns.
3. **Musical Intelligence:** The ability to produce and appreciate rhythm, pitch and timbre.
4. **Visual-Spatial Intelligence:** The capacity to think in images and pictures, to visualize accurately and abstractly.
5. **Bodily-Kinesthetic Intelligence:** The ability to control one's body movements and to handle objects skilfully.
6. **Interpersonal Intelligence:** The capacity to detect and respond appropriately to the moods, motivations, and desires of others.
7. **Intrapersonal Intelligence:** The capacity to be self-aware and in tune with inner feelings, values, beliefs and thinking processes.
8. **Naturalist Intelligence:** The ability to recognize and categorize plants, animals and other objects in nature.
9. **Existential Intelligence:** The sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why we die and how we got here.

While all people possess some degree of each of the intelligences, most of them will experience one or more dominant intelligences that impact the way they learn and interact with the world around them. One of the teaching approaches is Multiple Intelligence Theory (MIT) which asserts that 'Learning environments should be designed considering individual differences.' MIT provides new insight into intelligence and claims that a person has nine different types of intelligence contrary to classical intelligence which was described as one-piece (Gardner, 1999). To avoid the existence of learning difficulties, teaching methods and strategies which focus on the instructional activities and adopt the idea that each person has different types of intelligence, should be employed in the learning environment (Campbell, Campbell, 1999). This theory, suggests that teaching activities should be planned to allow students to use not only their mathematical and verbal intelligence but also their all types of intelligence. Because MI Theory lets all students learn difficult subjects and encourages them to improve their different types of intelligence, it is also appropriate for Mathematics education. When the activities designed by regarding MIT are used in the instruction, both teachers enable their students to learn Mathematics actively and students perceive the Mathematics lessons as interesting to study and easy to understand.

Rationale for the Study

The persistent poor achievement of students in Mathematics has remained a great concern to researchers, parents, and stakeholders. The situation is attributed to several factors, including instructional techniques teachers adopt (Olulonye, Ihendinihu, 2013). The current state of Mathematics requires urgent attention to determine effective strategies for enhancing students' achievement and saving the nation from plunging into mathematical anarchy which will dim the nation's quest for scientific and technological development. Therefore, this study was carried out to investigate and determine 'the effect of Information Communication Technology Mediated Multiple Intelligence Based Teaching of selected content of Mathematics on students' achievement in Mathematics at class IX.

Purpose of Study

In the present experimental study, the effects of Information Communication Technology Mediated Multiple Intelligence Based Teaching for selected content of Mathematics at the secondary level was investigated. Specifically, the study was conducted to determine whether: Students exposed to ICT Mediated MI Based Teaching will differ in their mean achievement from those exposed to Conventional teaching. And Gender gap in students' achievement in Mathematics will be reduced when exposed to ICT-mediated MI based teaching.

Research Questions: The following research questions were framed for the study:

1. Is there any difference between the mean achievement scores of students taught Mathematics using ICT-mediated MI based teaching and those taught using Conventional teaching?

2. Is there any difference between the mean achievement scores of Boys and Girls students taught Mathematics using ICT mediated MI based teaching?

Hypotheses: The following hypotheses were formulated to guide the study

Ho1: There is no significant difference between the mean achievement scores of students taught Mathematics using ICT-mediated MI based teaching and those taught using Conventional teaching.

Ho2: There is no significant interaction effect of gender and ICT-mediated MI-based teaching.

Research Method

The study was a quasi-experimental type adopting the pre-test post-test experimental control group design to investigate the effect of ICT-mediated MI-based teaching on students' achievement in Mathematics.

Population and sample of the study

The population for the study consists of all secondary CBSE school students from Mysore city of Karnataka state. One coeducational secondary CBSE school was purposively selected as a sample for the study and two sections of the same class were randomly selected and assigned to one for experimental group and the other for control group. This gave a total sample size of seventy-five (75) students comprising 31 Girls and 44 Boys. The experimental group had 37 students comprising 21 boys and 16 Girls while the control group comprised 38 students with 23 Boys and 15 Girls.

Tool used for the study: The instrument for data collection was a teacher-made Mathematics Achievement Test with a reliability coefficient of 0.71, comprising objective and descriptive questions, constructed by the researcher based on the concepts taught to the students as outlined in the CBSE Mathematics syllabus. Students were taught three chapters, namely, Quadrilaterals, Circles and Constructions by the researcher, using a lesson plan drawn based on ICT-mediated MI-based teaching intervention.

Intervention

To administer the treatment, both the experimental and control groups were given a pre-test to determine their prior-achievement level. After that, the experiment group was taught all the three chapters, Quadrilaterals, Circles and Constructions by the researcher, using a lesson plan drawn based on ICT-mediated MI-based teaching. During the learning process, the teacher provided learning experiences through ICT mediums such as Interactive White Board, Presentation slides, Simulations, animation, videos, GeoGebra software, Fotor's NFT Creator - GoArt, AutoDraw-AI Software, Musical background soundcloud software to the students and guided them to apply and solve problems. The control group was taught all the same chapters through conventional teaching methods by their regular Mathematics teacher. The entire process of intervention took for about three months after which a post-test was administered to both groups using rearranged version of achievement test.

Data analysis procedure: The generated data were analyzed using mean and standard deviation, t-test and Analysis of Covariance ANCOVA.

Results and Discussion

Hypothesis H1: There is no significant difference between the mean achievement scores of students taught Mathematics using ICT-mediated MI based teaching and those taught using Conventional teaching

Table 1. Analysis of Mean Achievement scores of both Experimental group and control group

Group	N	Test	Mean	SD	Mean gain	Diff in Ach
Experimental Group	37	Pre-test	20.743	4.045	15.27	
	37	Post-test	36.013	5.995		3.73
Control Group	38	Pre-test	16.407	4.355	11.54	
	38	Post-test	27.947	8.011		

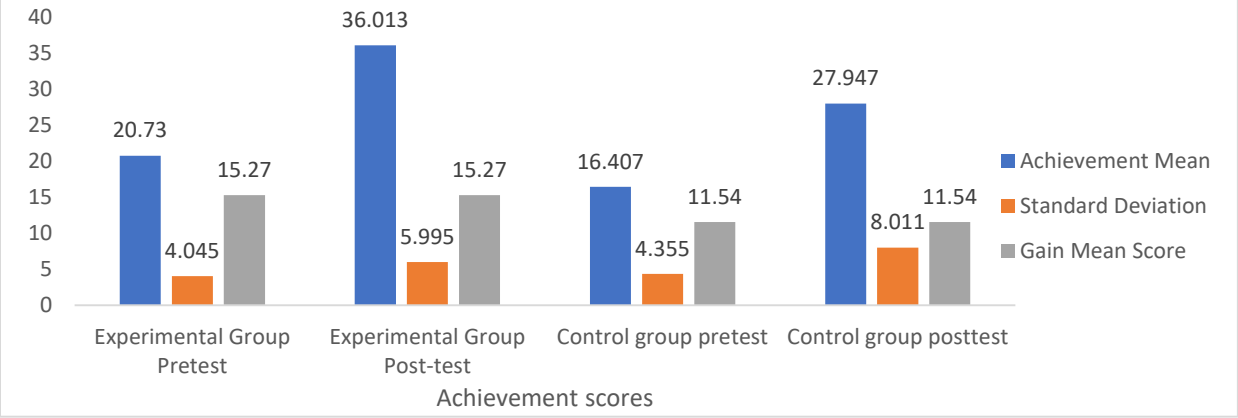
Table 1 shows that the experimental group had a mean of 20.743 and SD of 4.045 in the pre-test with 36.013 and 5.995 in the post-test, this gave a mean gain of 15.27 while the control group had a mean of 16.407 and SD of 4.355 in the pre-test with 27.947 and 8.011 in the post-test, this gave a mean gain of 11.54. These gave a difference in mean achievement score of 3.73 in favour of the experiment group.

Table 2: Analysis of Co-Variance for Tests of between–Subjects Effect

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1463.179	2	731.589	15.379	0.000
Intercept	2038.405	1	2038.405	42.849	0.000
Pre-test	243.470	1	243.470	5.118	0.027
Group	563.147	1	563.147	11.838	0.001
Error	3425.168	72	47.572		
Total	81336.750	75			
Corrected Total	4888.347	74			

From Table 2, it is evident that the F-value (Group Treatment) is 11.838 which is significant with 0.001 as the value is <0.005. It shows that the mean scores of the Achievement test of the experimental group and control group differ significantly. The same is graphically represented in the Fig 1.

Fig 1: Achievement score analysis w.r.t pretest and post-test of both Experimental and Control group



Based on the result, the stated null hypothesis (Ho1) is rejected and the alternate Hypothesis is accepted. This implies that there is a significant difference between the mean achievement scores of students exposed to ICT mediated Multiple Intelligence Based Teaching and those exposed to conventional teaching. The students exposed to ICT mediated MI based teaching performed better than the control group students.

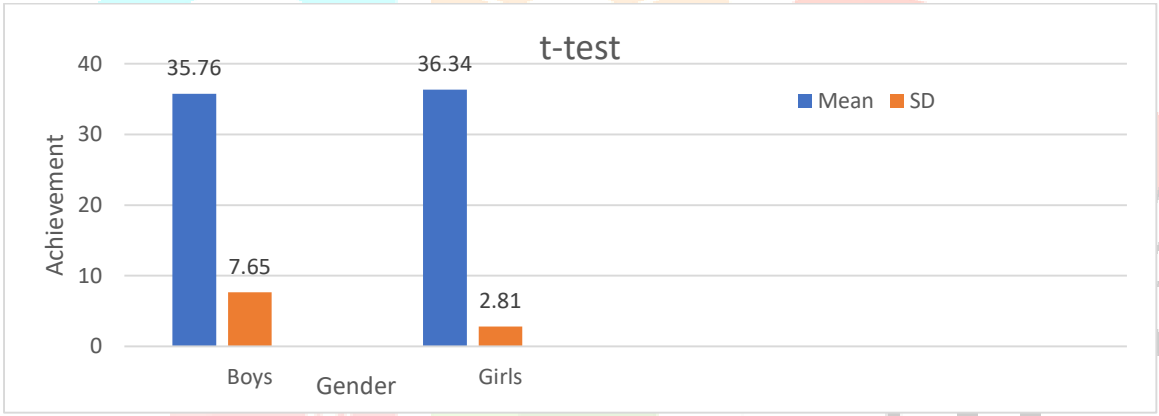
Ho2: There is no significant interaction effect of gender and ICT-mediated MI-based teaching.

Table 3: Analysis of posttest achievement scores of Experimental Group w.r.t Gender

Group	Gender	N	Mean	SD	t	Sig.(2-tailed)
Post test EG	Boys	21	35.76	7.65	-0.289	0.775
	Girls	16	36.34	2.81		

Table 3, t-test for gender-wise analysis of Experimental Group Posttest scores reveal, that there are 21 boys with a Mean of 35.76, a standard deviation of 7.65 and 16 girls with a Posttest Mean of 36.34, a standard deviation of 2.81, t-value -0.289 which is not significant. The same is represented in Fig2.

Fig 2: Bar graph for gender wise analysis of Posttest scores of Experimental Group



Based on the result, the null hypothesis (Ho2) is accepted. This implies that there is no significant interaction effect between boys and girls of the Experimental Group taught Mathematics through ICT-mediated Multiple Intelligence Based Teaching. Therefore, there is no difference of gender in the performance of Achievement test when exposed to ICT mediated MI based intervention.

Discussions

The result of the study revealed that students taught Mathematics using ICT mediated Multiple Intelligence based Teaching had better achievement than their counterparts taught using conventional teaching. Further statistical analysis indicated a significant difference between the mean achievement scores of students exposed to ICT-mediated Multiple Intelligence based teaching and those exposed to Conventional teaching. The result of the study also revealed that mean achievement scores of boys and girls are not significantly differing in Achievement in Mathematics when ICT-mediated MI-based teaching was applied for teaching Mathematics. This is suspected to have resulted from the nature of the approach as it allowed for technology-oriented, student-centred, activity-based learning, ICT-mediated, MI-based teaching.

This study is in accordance with Das Dhiraj Kumar (2015) study, A critical study of some variables of effective dimension in relation to the achievement in Mathematics at the secondary level revealed there is a significant effect of variables such as Mathematical ability, and attitude on achievement in Mathematics. Angel Rathnabai, S (2014) in the study Effectiveness of ICT Infused Instructional Design in Methodology of Teaching Mathematics at the Secondary Level revealed Conventional method of teaching when supported with open-source software helps a better understanding of Mathematical concepts and Conventional method along with ICT is better than the conventional method alone. The result of the study revealed that using ICT-mediated Multiple Intelligence-based teaching is very effective in learning Mathematics at the secondary stage as it enhances students' achievement.

Implications of the study

Based on the results of the study, Mathematics teachers at the secondary school level can apply ICT-mediated MI-based teaching to enhance students' achievement. Curriculum planners should adopt ICT-mediated MI-based teaching as an adequate teaching method for teaching Mathematics. Workshops, seminars, and symposiums should be organized for teachers to enlighten them on the importance and use of ICT-mediated MI-based teaching in Mathematics

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