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Fusion of Ict In Mathematics Learning To Improve Secondary School Students' Academic Achievement

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ABSTRACT:

The purpose of this study is to investigate the effect of fusion of Information & Communication Technology into mathematics instruction on mathematics achievement of secondary school students. The present research was based on three elements, effective mathematics instruction, 7E learning cycle and Information and Communication Technology fusion. Design Based Research (DBR) was adopted as a research model in the study. 55 mathematics teachers working in 40 secondary schools participated in the study. Data was collected from participants through a research instrument prepared by the researchers. The collected data was analyzed by specific statistical tools using SPSS (V22). The results of the study revealed that the fusion of ICT with mathematics instructions created a positive environment among secondary school students in learning mathematics. It was also found that fusion of ICT with instruction was positively correlated to students' mathematics achievement.

KEY WORDS: ICT, Mathematics Instruction, 7E Learning Cycle, Mathematics Achievement, Secondary School.

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1.0 INTRODUCTION:

Dissemination of ICT amongst teenagers and elders around the world is yet a developing event. It is not amazing that Information and Communication Technologies, including computer applications, mobile technology have become essential and highly germane items in teaching and learning in secondary schools. In the 21st century, efficacious denizens and workers are required to have functional and critical cerebrating skills such as information literacy, media literacy and ICT literacy. In this regard, edifiers are expected to enable denizens, workers to acquire those functional and critical cerebrating skills. This denotes that edifiers have to be competent in the utilization of information and communications technology (ICT). They require being yare to provide their students with technology supported learning opportunities to fortify student learning.

The dynamic nature of technology coerced educators to re-evaluate the mathematics that students need to determine the best methods for procuring higher calibers of mathematics achievement. Many students are struggling to learn mathematics today. Some students might state that they execrate mathematics and feel that they will never utilize it in the future. According to Campoy[1] technology provides a better way of educating mathematics. Technology is the great equalizer; it brings everyone to the same level. It does not matter whether the student is a high achiever or a low achiever, teaching and learning through the utilization of technology takes the low and high caliber students to heights unknown.

In the area of inculcation, a growing body of evidence demonstrates that ICT is an efficacious designates for addressing inculcation goals and requisites[2, 3, 4]. Consequently, the effects of integrating ICT into teaching and learning on students' development have gained more and more attention from edification policy makers and researchers[5, 6, 7, 8, 9, 10, 11]. However, given that students have more access to computers and the Internet at both home and school, the question of whether students' personal ICT use is propitious for outcomes, especially academic achievement in mathematics has withal been explored[12, 13, 14, 15, 16, 17, 18].

The National Council of Teachers of Mathematics[19] accentuates the paramountcy and desideratum of technology in gaining mathematical erudition and skills from prekindergarten through grade 12. The utilization of technology in mathematics teaching enriches the edification environment by offering multiple representations, quandary solving adeptness, modeling skills and visualization of mathematical concepts[19, 20, 21, 22, 23].

1.1 Effective Mathematics Instruction(EMI):

According to Protheroe[24] in an efficacious mathematics classroom, an educator should find that students are actively engaged in doing mathematics, solving challenging problems, making interdisciplinary connections, sharing mathematical ideas, Using multiple representations to communicate mathematical ideas and using manipulative and other tools. It is paramount that a pedagogia commences a lecture with questions at the Recall and Understand levels of Bloom's Taxonomy. However, in order to solve paramount quandaries, students must be challenged with higher level questions that follow the lower-level questions. Students will find arduousness applying their mathematical conceptions or analyzing a mathematical situation if they are not asked higher-level questions in classroom activities and discussions.

The Education Alliances[25] visually examined a varied numbers of research studies, and recognized a list of instructional strategies in mathematics teaching. These are focusing lecture on concrete concept/skills that are standards-predicated, distinguishing tutelage through pliable grouping, specifying lessons, compacting, using layered assignments, and varying query levels, ascertaining that instructional activities are student-centered and accentuate quandary-solving, utilizing experience and prior cognizance as a substructure for building incipient cognizance, utilizing cooperative learning approaches and make authentic-life connections, utilizing platform to make association to concepts, procedures, and understanding and accentuating the development of rudimental computational skills.

There are two potent approaches to mathematics instruction, skills-based instruction and concepts-based instruction. Skills-based instruction is a more traditional approach to teaching mathematics. In this method, teachers concentrate exclusively on developing computational skills and quick recall of facts. On the other hand, in concepts-based instruction, instructors inspire learners to solve a problem in a way that is meaningful to them and to explain how they solved the problem, resulting in an increased awareness that there is more than one way to solve most problems. Most researchers[26, 27] accede that both approaches are consequential.

Students learn mathematics through the experiences that educators provide. Thus, students' understanding of mathematics, their talent to utilize it to solve questions, and their self-confidence in mathematics, and proclivity toward mathematics are all molded by the teaching they experience in educational institutions. The amendment of mathematics teaching for all students needs effective mathematics instruction in all classrooms[28].

Anthony & Walshaw[29] developed a set of ten principles for effective mathematics instruction. These principles are, an ethic of care, arranging for learning, building on students' thinking, mathematical communication, mathematical language, assessment for learning, worthwhile mathematical task, making connections, tools and representation and teacher knowledge and learning. Considering class room as a 'community of practice', the researchers claimed that effective mathematics instruction approves that all students can generate confident mathematical congruity and become robust mathematical learners; it is based on social respect and awareness and is flexible to the heterogeneity of ethnic heritages, reasoning processes, and facts found in usual schoolrooms; it is spotlighted on maximizing a range of expectable academic result including logical understanding, methodical eloquence, diplomatic proficiency, and adaptive reasoning; it is committed to enhancing a range of social outcomes within the mathematics classroom that will contribute to the holistic development of students for productive citizenship.

1.2. 7E Learning Circle (7ELC):

The 7E Learning Cycle proposed by Eisenkraft[30] is an investigation based teaching instruction which is based on the theory of constructivism. Educators and researches elongated the phases of model to increment the accentuation on some issues and variants of the model were emerged as 3E, 4E, 5E and 7E. Among them, 7E learning cycle instruction model is the comprehensive one encircling seven phases each starting with the letter E, which are Elicit, Engagement, Exploration, Explanation, Elaboration, Evaluation, and Extension[31]. The elicit phase invigorates learners' existing knowledge and new knowledge is built on existing knowledge and also assists in transferring knowledge. The next phase is engagement which creates learners' interest in the subject matters, enchants learners' concentrations and contributes conversation opportunities for all students. In the exploration phase, students assimilate the new concept, prepare plan and conduct investigations. Moreover, learners analyze and interpret new phenomena. The fourth phase is ***explanation*** in which pupils generate explanations and design answers, involve in arguments from proof gathered, evaluate and communicate information with others. In the ***elaboration*** phase, students swap ideas with each other in order to elaborate their understanding of the topic, made inferences on similar situations, revealed similarities of new definitions, explanations and skills. ***Evaluation*** is the sixth phase of the circle. In this stage, learners attempt to solve the problems by using observational outcomes, ask to have a better comprehension of the subject, convey their views on the topic, find out their own drawbacks by asking questions and reengage themselves in research again. 7th phase is ***extension*** in which stage learner can extend their idea and knowledge from one subject to other, can design real-life solutions on the basis of new knowledge.

The utilization of 7E learning cycle in science courses increases students' academic and conceptual achievement more efficiently since the model give students the chance to explore, pellucid efficacious learning takes place[32, 33, 34, 35, 36, 37, 38, 39, 40, 41].

1.3. Fusion of ICT in Learning Mathematics (FILM).

There is a general notion that ICT can empower educators and learners by changing the focal point of teaching and learning processes from teacher community to learner community. This transformation due to fusion of ICT will result in incremented learning gains for students. Fusion of ICT and education will generate and permit opportunities for learners to develop their ingeniousness, problem-solving faculties, informational reasoning skills, communication skills, and other higher-order cerebrating skills[42]. The benefits of such an incipient approach have been glorified by Buabeng-Andoh[43] who affirms the great capabilities of ICT in the spreading of erudition, making inculcation more authentic and the development of more efficient scholastic accommodation.

Two things are involved when we verbalize about utilization of ICTs in efficacious instructional distribution in other to prepare the teachers to utilize technology in teaching[44]. The first is general computer literacy on operating system, word processing, spreadsheet, database and telecommunication. The second is professional literacy- a rudimentary understanding of how computer and cognate technology can be utilized in edification, as well as concrete abecedarian skills for integrating technology into the curriculum at the grade level and in subject edifiers plans to edify[45]. A coalescence of computer literacy and professional literacy in a efficacious learning environment will invariably enhance the performance of the learner. Procurement of enhanced learning is highly dependent on the will and competencies of the teachers in performing his obligations. For this a fusion of effective mathematics instruction and techniques of ICT implementation is required.

2.0 MATERIALS AND METHODS:

The objective of the study is to examine the effects of fusion of ICT and EMI on students' scholastic achievement in mathematics.

2.1 Hypotheses:

The following hypotheses are formulated for the present study.

H_1: There is no significant difference between fusion of ICT with 7ELC and students' achievement in mathematics.

H_2: There is no significant difference between the types of schools (Government and Private) and students' academic achievement in mathematics regarding fusion of ICT with 7ELC.

2.2 Methodology:

To examine the formulated hypotheses, an instructional design was arranged on the basis of Design Based Research (DBR). **Design-based research** (DBR) is a type of research methodology used by researchers in the learning sciences. The elementary process of DBR entangles building interventions to problems. The interventions are gathered and applied on the problem to solve it. Adopting iterations technique the problem may be re-tested to gather more data. In this paper, the researchers tried to make a fusion of EMI and ICT through DBR. Amiel & Reeves[46] stated that design-based research may handle some of the deficits of other research methods in examining the functions of technological tools and techniques in the classroom. DBR has recently received considerable attention by researchers in education as an emerging framework that can guide better educational research[47, 48, 49, 50, 51, 62, 53].

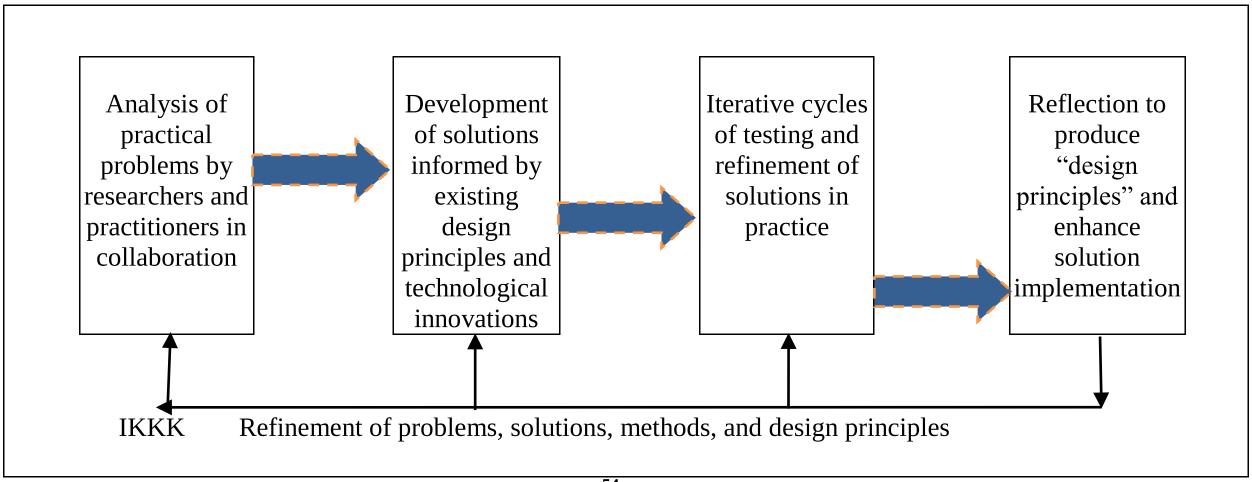

Fig.1: Reeves[54] Design-Based Research Model

The ultimate goal of DBR is to build a more vigorous connection between educational research and authentic world quandaries. An accentuation is placed on an iterative research process that does not just evaluate an innovative product or intervention, but systematically endeavors to refine the innovation while withal engendering design principles that can guide homogeneous research and development endeavors. This results in a cycle of research that is exceptionally different from what is currently pursued by many researchers in the field. In traditional empirical predictive research, an incipient technique or contrivance is put to the test in a controlled environment. The time of engagement with the "stimulus" is customarily constrained because of time constraints. In DBR, iterations are emboldened in order to refine hypotheses[55].

2.2.1 Selection of Sample:

For this study 40 different secondary schools situated in both urban and rural areas of Assam were selected as the sample. 55 teachers teaching in these secondary schools participated in the study. Students' achievement was measured with the help of a geometry test among 900 secondary school students studying in these schools taught by the participated teachers. There were 460 male students and 440 female students in the survey. Out of 900 student participants, 400 studied in rural area schools and 500 in urban area schools. 443 students were from government / govt. aided schools and 457 were from private schools.

2.2.2 Research Instruments:

Four research instruments were designed by the researchers to carry out the study.

a) **Accessing and Using ICT (AUI) questioner** was prepared on the basis of ***Survey in schools: ICT and education*** funded by the European Commission and organized in Europe. The researchers accepted only seven questions which are suitable for Indian environment.

b) **7E Learning Cycle Checklist (LCC)** was constructed on the basis of a number of researchers[56, 57, 58].

c) **Fusion of ICT Questionnaire (FIQ)** was prepared and distributed among participated teachers. This research instrument has 35 questions and prepared by studying different literatures (DETWA) . FIQ scale was scored on a 1-7 Likert-type scale. '1' for 'very strongly disagree' (VSD) and '7' for very strongly agree (VSA).

d) **Mathematics Achievement Scale (MAS)** was constructed by the researchers. This scale consisted of 10 MCQ and 10 descriptive type questions from Geometry Chapters of class nine NCERT text book.

2.2.3 Reliability Test:

The instruments were pilot tested on a sample of 10 teachers and for reliability test Cronbach's Alfa were evaluated with the help of SPSS. The reliability index for AUI instrument was found as 0.792. The reliability index for FIQ was 0.804 and MAS was 0.788. According to Nunnally[59] all the four instruments have acceptable level of reliability.

2.2.4 Factor Analysis:

For validity of research instruments, factor analysis test were done. Kaiser-Meyer-Olkin (KMO) value for AMU, FIQ and MAS were 0.754, 0.777 and 0.796 respectively.

2.3 RESULTS:

The table 01 reflects the demographic pattern of the respondents of the present study.

TABLE: 01 Sample Demographic Data. N=900

Parameter	n	%
Gender (Students)		
Male	460	51.1
Female	440	48.9
Domicile		
Rural	450	44.4
Urban	550	55.6
School Authority		
Government	443	49.2
Private	457	50.8

The one-way analysis of variance (**ANOVA**) was used to determine whether there were any statistically significant differences exist between the means of two or more variables. SPSS (Version 22) is applied on the collected data.

2.3.1 Hypothesis H_1:

Fusion of ICT Questionnaire (FIQ) was divided into 7 factors on the basis of seven stages of 7ELC. F_1: fusion of ICT in Elicit stage, F_2: fusion of ICT in Engagement stage, F_3: fusion of ICT in

Exploration stage, F_4: fusion of ICT in Explanation stage, F_5: fusion of ICT in Elaboration stage, F_6: fusion of ICT in Evaluation stage, F_7: fusion of ICT in Extension stage. To examine the relation between F_1 and Mathematics Achievements of teenagers, ANOVA analysis was applied using SPSS (version 22). The results are shown in the table 02 below.

TABLE: 02

ONEWAY Achievement BY F_1 /MISSING ANALYSIS. Oneway Achievement				**ANOVA**	
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	161.797	11	14.709	1.370	.195
Within Groups	9535.732	888	10.738		
Total	9698.429	899			

In the above analysis table we observe that the significance value is 0.195 (i.e. p=0.195) which is greater than 0.05, and therefore, the relation between F_1 and Mathematics Achievement is not statically significant.

The relationship between fusion of ICT in Engagement stage (F_2) and students Mathematics Achievement is reflected in the table No: 03

TABLE: 03

ONEWAY Achievement BY F_2 /MISSING ANALYSIS. Oneway Achievement					**ANOVA**
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	281.176	15	18.066	1.685	.022
Within Groups	9144.232	884	10.631		
Total	9698.429	899			

The above analysis table shows the significance value as 0.022 (i.e. p=0.022) which is smaller than 0.05, and therefore, the relation between F_2 and Mathematics Achievement is statically significant.

The relationship between fusion of ICT in Exploration stage (F_3) and students Mathematics Achievement is reflected in the table No: 04

TABLE: 04

ONEWAY Achievement BY F_3 /MISSING ANALYSIS. **Oneway** Achievement				**ANOVA**	
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	431.875	14	32.666	3.055	.000
Within Groups	9132.447	885	10.877		
Total	9698.429	899			

The above analysis table: 04 reflect that the significance value is 0.000 (i.e. p=0.000) which is below 0.05, and therefore, the relation between F_3 (fusion of ICT in Exploration stage) and Mathematics Achievement is highly significant.

The relationship between fusion of ICT in Explanation stage (F_4) and students Mathematics Achievement is reflected in the table No: 05

TABLE: 05

ONEWAY Achievement BY F_4 /MISSING ANALYSIS. Oneway Achievement					ANOVA
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	232.441	10	20.597	2.098	.022
Within Groups	9557.320	889	9.677		
Total	9698.429	899			

Table 05 shows that the significance value is 0.022 (i.e. p=0.022) which is much smaller than 0.05. Therefore, there exists statistically significant relationship between fusion of ICT in Explanation stage (F_4) and teen's achievement in mathematics.

The relationship between fusion of ICT in Elaboration stage (F_5) and students Mathematics Achievement is reflected in the table No: 06

TABLE: 06

ONEWAY Achievement BY F_5 /MISSING ANALYSIS. Oneway Achievement					ANOVA
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3644.005	5	898.376	134.008	.000
Within Groups	6122.883	884	5.999		
Total	9698.429	899			

Table 06 reflects the significance value as 0.000 (i.e. p=0.000) which is less than the 0.05 level. Hence, there exist a significant correlation between F_5 (fusion of ICT in Elaboration) and the mathematics achievement of students.

The relationship between fusion of ICT in Evaluation stage (F_6) and students Mathematics Achievement is reflected in the table No: 07.

TABLE: 07

ONEWAY Achievement BY F_6 /MISSING ANALYSIS. Oneway Achievement					ANOVA
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	120.008	1	121.009	11.354	.001
Within Groups	9532.776	898	10.998		
Total	9698.429	899			

As the value of p is 0.001 < 0.05, there exists a significant correlation between fusion of ICT in Evaluation stage (F_6) and school learners' mathematics achievement.

The relationship between fusion of ICT in Extension stage (F_7) and students Mathematics Achievement is reflected in the table No: 08

TABLE: 08

ONEWAY Achievement BY F_7 /MISSING ANALYSIS. Oneway Achievement					ANOVA
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	60.887	1	60.443	5.223	.015
Within Groups	9609.003	898	10.889		
Total	9698.429	899			

The value of p is 0.015 < 0.05, there exists a significant correlation between fusion of ICT in Extension stage (F_7) and school learners' mathematics achievement.

Combined effect of F_1, F_2, F_3, F_4, F_5, F_6 and F_7 on achievement in mathematics is shown in the following table 09.

TABLE: 09

ONEWAY Achievement BY ICT FUSION /MISSING ANALYSIS. Oneway ANOVA Achievement					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	888.987	59	15.334	1.307	.009
Within Groups	8698.145	840	10.113		
Total	9698.429	899			

Table 09 depicts the relation between Fusion of ICT (Combined effect of F_1, F_2, F_3, F_4, F_5, F_6 and F_7) and school going teenagers' scholastic achievement in mathematics. The significance value p is obtained as 0.009 which is much smaller than 0.05significance level. Therefore, there exists statistically significant relationship between the fusion of ICT and achievement in mathematics of teenagers and we may reject the null hypothesis H_1.

2.3.2 Hypothesis H_2:

A one-way ANOVA analysis was conducted utilizing the means of Mathematics achievement of students and the authority (Government/ Government Aided schools and private Schools) to evaluate the relationship between in regards of fusion of ICT with 7ELC effects. Table 10 reflects the analyzing result.

TABLE:10

ONEWAY Achievement BY School_Authority /MISSING ANALYSIS. Oneway ANOVA Achievement					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	61.322	1	61.322	5.770	.019
Within Groups	9603.154	898	10.225		
Total	9698.429	899			

Significance value is 0.019 (i.e. p= 0.019) which is less than the 0.05 level. Therefore, there exist a significant relationship between the authority of school and the mathematics achievement of students and therefore we may reject the null hypothesis H_2.

2.4 DISCUSSION AND CONCLUSION:

In this study, the researchers investigate the relationship between scholastic achievements of students in mathematics and fusion of ICT with 7E learning circle (7ELC). Results from the study reveal that there exists no significant relationship between fusion of ICT in Elicit stage (F_1) regarding students' learning and mathematics achievement of students (i.e. $p = 0.195 > 0.05$). Mathematics achievement of teenagers and fusion of ICT in Engagement stage (F2) of 7ELC are significantly related (i.e. $p = 0..022) < 0.05$). Fusion of ICT in Exploration stage (F_3) is strongly correlated with mathematics achievement as the analysis shows that $p = 0.000 < 0.05$. Fusion of ICT in Explanation stage (F_4) is a remarkable variable connected to mathematics achievement of school going teens as the analysis reflects ($p = 0.022 < 0.05$). F_5, fusion of ICT in Elaboration stage bears very effective correlation with learners' mathematics achievement ($p=0.000<0.05$). Table 07 reflects the positive effect of fusion of ICT in Evaluation stage (F_6) on academic attainment of teenagers in mathematics ($p=0.001<0.05$). . F_7, fusion of ICT in Extension stage is significantly correlated to students' scholastic attainment as the analysis reflects ($p=0.015<0.05$). The table 09 depicts the overall effect of fusion of ICT with 7ELC on scholastic achievement of secondary school students' in mathematics. The one way ANOVA analysis reveals significant value as ($p=0.009<0.05$) and therefore, the researchers may come to the conclusion that fusion of ICT with 7ELC is positively correlated to the achievement of secondary school students' in mathematics. Consequently, the null hypothesis H_1 is rejected.

The correlation of type of proprietorship or authority with mathematics achievement of school students is analyzed in the table 10. The one way ANOVA analysis clearly shows that there exists an effective relationship between mathematics achievement of school going teenagers and type of proprietorship (Government/ Non Government) with relation to ICT fusion with 7ELC as $p=0.019$ which is smaller than 0.05 significant levels. Hence, the researchers reject the null hypothesis H_2.

2.5 RECOMMENDATION FOR FURTHER STUDY:

Information and communication technology (ICT) is among the most recent developments that has reformed different tasks on the world. It is especially imperative in the area of educational instruction since it has recently made such platforms and openings that have encouraged to obtaining of knowledge and information. The researchers have observed that fusion of ICT in mathematics learning has manifold positive effects. Some of the benefits of use of ICT in mathematics learning are: influences the learners to learn more, upgrades learning, energizes learners self-learning, clearly exhibits the scientific ideas to pupils and helpful for students for developing new ideas.

The present investigation focused just on secondary level of education; similar angles can be explored at the elementary and higher level. Following are a portion of the zones identified with the present research where investigations may be done in future by researchers.

(i) Factors influencing fusion of ICT in mathematics learning at elementary level.

(ii) Factors influencing fusion of ICT in mathematics learning of higher secondary science students

(iii) Fusion of ICT in teaching & learning mathematics in U G level.

(iv) Parents' attitude towards fusion of ICT in mathematics learning and its effects on students achievement in mathematics. (elementary, secondary and higher secondary level)

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