Impact of ICT on Critical Thinking in Mathematics: An Empirical Study

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Abstract: This research paper is based on the study made by investigator on the impact of ICT on critical thinking ability of mathematics students. The study was experimental in nature. The data was collected from 120 students of elementary level of private schools in Delhi-NCR with ICT facilities. The objectives of the study were (a)To study the critical thinking abilities of elementary level students of mathematics (b)To study the impact of ICT on critical thinking abilities of elementary level students of mathematics. The results show that the impact of ICT on critical thinking abilities of elementary level mathematics students is found to be significant at 0.01 level of significance.

IndexTerms - ICT, Critical thinking, Elementary level students

1. Introduction

In the present era when we are standing at the crossroads of transition from digital immigrants to natives there are many issues ranging from technology to culture to globalisation and social norms which have widened the gap between the two. In such a situation the teachers have a major role to play to keep the gen next rooted to the ground yet providing them wings to fly. The learning can take place to its fullest only when the learners are taught in the way they want to learn and take interest in the methods through which the teaching and learning is taking place.
The present generation of learners is living in an uncertain world where there are constant threats of terrorism, school violence, globalisation, influential media, and acute climatic conditions. This has led the parents of this generation to become overprotective and shielding in nature. Each parent wants their child to be the best in almost all arenas which has put tremendous pressure on the young minds and more so, on their teachers. Because of their inability at such tender age to handle such parental pressures and expectations they tend to give up and start indulging in anti- social behavior, psychological complications, drug abuse and increased delinquent behavior. So these young buddy minds need to be the decision makers and must acquire the ability to think critically.

1.1. Need Of The Study

We the human beings have been blessed with the ability to think and make judgements. But in due course of time our education system has made way to mechanical learners. According to NCTM (2000) there is need to develop critical thinking skills through the subject of mathematics and pedagogy of mathematics. Also, Jacob (2012) states that problem related to real life can be solved with the young students with ease and on their own if the higher order thinking skills like critical thinking is encouraged amongst the learners. The fundamental of the present Indian education system is its examination, which enforces rote memorisation and ignore the development of higher order thinking skills. The schools only emphasise on learning of the facts and memorization using the outdated lecture method of teaching which does not initiate use of higher order critical thinking skills (Cobb et al., 1992; Duplass and Ziedler, 2002).
The results of research conducted by Chukwuyenum (2013) are evident that the achievement score in mathematics can be improved with the development of critical thinking ability amongst the learners.
Also, the major areas of concerns with the present era of young learners are that they are more into socializing, always reaching out for mobiles or tabs or laptops. Also, they want to reason out things and know its utility, they question. But isn't all this very natural, who would like to go back to the black and white submissive modes of learning when abundance of information is available at the click of a mouse. But all this requires a well prepared program which includes engaging and exciting pedagogical innovations.
There is need of a league of teachers and teacher educators who can extend themselves beyond their comfort zone to unleash their potential to reach out to the young vibrant minds and evolve their innate capabilities.

1.2. Role of ICT in Education

There has been tremendous work in the field of technology. The teachers are expected to have potential to handle the changing classroom scenario in terms of research, effective thinking, communication and creation. In the intermediate level of ICT

competency for teachers as recommended by **National Policy on ICT in school education** the teachers should be the creator of digital content and also should be proficient in managing data with the help of various ICt tools like hardware devices as well as software applications. Also UNESCO has prescribed integration of ICT at pedagogical level in addition to integration at curricular or spatial level. In this regard many initiatives have been taken by Central Institute of Education Technology(CIET), NCERT in terms of National Repository for Open Educational Resources (NROER) in 2013, e-pathshala and e-PG pathshala in 2015 and Massive open online courses (MOOCs)with the name swayam in 2016 are to name a few. But still the majority of teachers are struggling and juggling with the basic interface with technology.

One tool that can be used in most efficient manner for developing higher order thinking skills like reflective thinking, problem solving, critical thinking and creative thinking amongst the learners is Information and Communication Technology. With the help of ICT various information can be collected, disseminated, manipulated, retrieved and stored etc. with utmost accuracy and thus the higher order thinking skills can be developed in an effortless manner by the teachers amongst the learners.

1.3. Critical Thinking And Mathematics

According to Facione (2011) in general critical thinking consists of following variables:

- interpretation
- analysis
- evaluation
- inference
- explanation
- self-regulation

It is evident that these are also the characteristics of mathematics and so while developing general critical thinking skills it can initially be made domain specific in context of mathematics. Critical thinking as defined by **Krulik and Rudnick (1995)** is "Critical thinking is analytical thinking and reflection that involve testing activities, questioning, connecting and evaluating all aspects of a situation or problem". According to **Shakirova(2007)** in order to deal with social, practical and scientific problems in an effective manner, critical thinking skills are essential. The students who can think critically are good problem solvers. And since problem solving is an integral part of mathematics learning and triggers critical thinking ability so critical thinking leads of learning of mathematics more engaging and meaningful. Also, **Cobb et al., (1992)** specifies that through meaningful learning of mathematics the higher order thinking skills may be developed in a systematic manner at the school level.

1.4. Use of ICT For Developing Critical Thinking

The systematic and organized way of developing critical thinking is with the help of appropriate use of technology in the subject of mathematics. Mathematics by nature is unambiguous, logical and hierarchical. Use of technology allows the students to explore the various possible solutions make inferences, synthesis and analyse the problems and arrive at the conclusions in a streamlined manner with ease. Also, use of technology allows the otherwise unexplored areas where concrete examples are very difficult to use in mathematics more practical and interesting.

2. Objectives :

1. To study the critical thinking ability of elementary level students in mathematics.
2. To study the effect of ICT on critical thinking ability of elementary level students.

3. Hypothesis

There is no significant difference between the critical thinking ability of elementary level students taught using ICT or without using ICT

4. Methodology

4.1 Sample

The sample of the study consisted of 120 children (60boys and 60girls) of class VIII from three schools in Delhi NCR. Purposive sampling technique was used for choosing the schools for the study based on the availability of ICT facility.

4.2 Tools Used

In the investigation following tools were used for data collection:

1. Monitoring performa, adopted by the investigator
2. Basic Technology competencies for educators inventory by Flowers C and Algozzine B
3. Self-developed critical thinking questionnaire (covering class VIII NCERT curriculum)

4.3 Statistical Technique

Mean Score and 't' test were used for analysis

5. Findings of the study

The self-constructed Critical Thinking questionnaire was administered on the 60 students each of control and experimental groups. The tool consisted of 25 questions of mathematics specially designed to test interpretation, reasoning, analysis, synthesis

etc. These skills and were assessed using the standardised rubric of **Holistic critical thinking scoring rubric** developed by Peter A.Facione and Noreen C Facione. The results of analysis are discussed below:

Table 5.1: Comparison of Pre-Critical thinking scores between control and experimental respondents

Groups	N	Mean	SD	t-value
Control Group	60	13.717	6.857	1.337(NS)
Experimental Group	60	15.217	7.726	

NS – *Not significant*

It can be observed from the **Table 5.1** that the mean pre-test scores of control and experimental groups on critical thinking variable are13.717 and 15.217 respectively with their SD 6.857 and 7.726 respectively. The t-ratio between the two groups on critical thinking is 1.337 which is found to be insignificant. It signifies that the control and experimental groups are equal and matched with respect to the variable of critical thinking.

Figure 5.1 Comparison of Pre-Critical thinking scores between control and experimental respondents

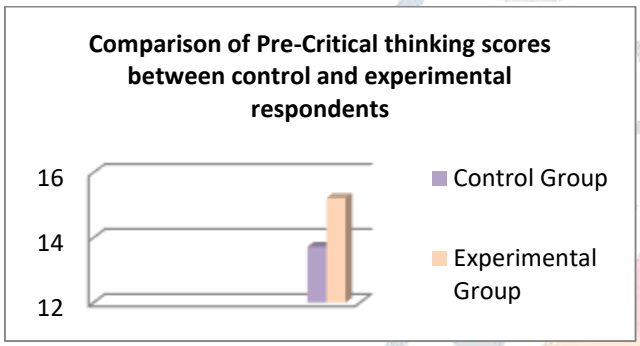


Table5.2: Comparison of Post-Critical thinking scores between control and experimental respondents

Groups	**N**	**Mean**	**SD**	**t-value**
Control Group	60	31.5	8.775	10.045**
Experimental Group	60	49.217	10.220	

***Significant at 0.01 level*

It can be observed from the **Table 5.2** that the mean post-test scores of control and experimental groups on critical thinking variable are 31.5 and 49.217 respectively with their SD 8.775 and 10.220 respectively. The t-ratio between control and experimental group on critical thinking is 10.045 significant at 0.01 level of significance. It indicates that there is significant difference between the post-test scores of critical thinking of control and experimental.

Figure 5.2 Comparison of Post-Critical thinking scores between control and experimental respondents

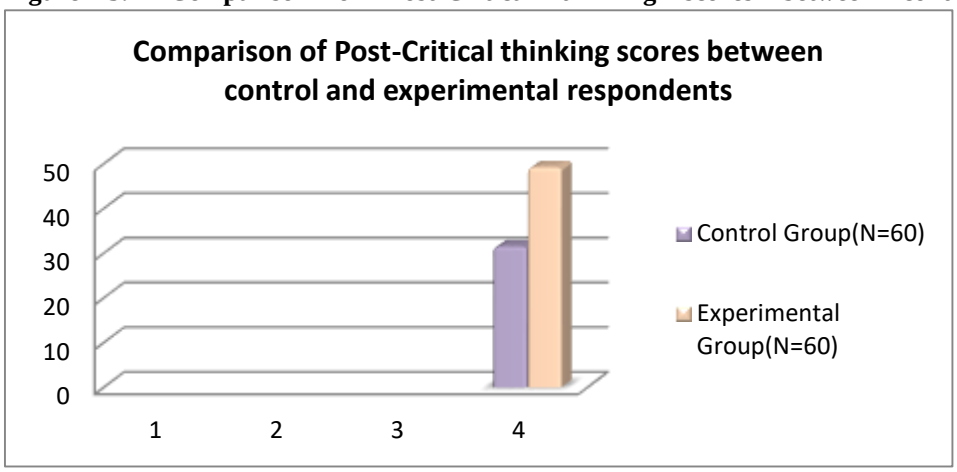


Table5.3: Comparison of difference of Pre and Post Critical Thinking scores of both control and experimental group respondents

Group	N	Mean	SD	t-value
Control Group	60	17.783	7.399	14.301**
Experimental Group	60	34	6.433	

***Significant at 0.01 level*

It can be observed from the **Table 5.3** that the difference of mean pre and post test scores of control and experimental groups on critical thinking variable are 17.783 and 34 respectively with their SD 7.399 and 6.433 respectively. The t-ratio between the two groups on critical thinking is 14.301 which is significant at 0.01 level of significance. It indicates that the students of two different groups differ significantly in critical thinking. The comparison of mean scores further reveals that the mean score of experimental group in post- test is much higher than the pre-test. It shows that the ICT intervention programme has positive effect on the critical thinking of elementary level children.

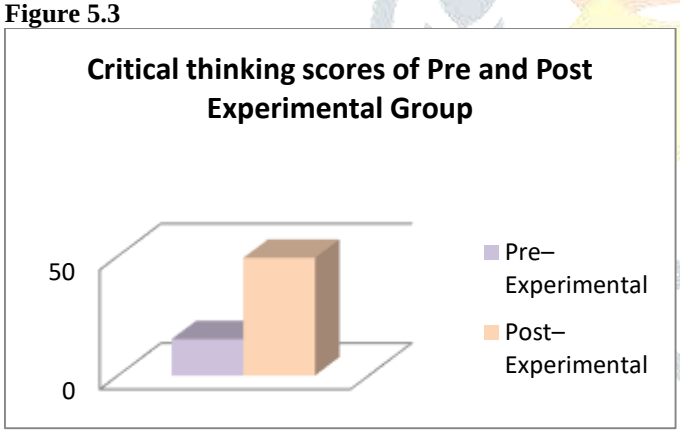
Table 5.4: Comparison of Critical thinking scores between Pre and Post Experimental group respondents Paired t-Test (N=60)

Group	Mean	SD	t-value
Pre –Experimental	15.217	7.726	40.936**
Post –Experimental	49.217	10.220	

***Significant at 0.01 level*

It can be observed from the Table 5.4 that the mean pre-test and post-test scores of experimental group on critical thinking variable are 15.217 and 49.217 respectively with their SD 7.726 and 10.220.The t-ratio between the two groups on critical thinking is 40.936 which is found to be significant at 0.01 level of significance. It signifies that there is significant difference between the pre and post test scores of experimental groups with respect to the variable of critical thinking. The comparison of the mean score further reveals that ICT has positive effect on the critical thinking ability of the elementary level students in mathematics.

Figure 5.3



6. Conclusion

Thus it can be concluded that there is a significant difference between the critical thinking ability of students taught with ICT, although there is increase in the critical ability of both the groups but as evident from the tables that the critical thinking ability has increased more by using ICT for teaching mathematics. ICT can be used as a great tool by the teacher and teacher educators to enhance higher order critical thinking skills in the specific subject of mathematics. Although, it is very important to develop student's critical thinking skills across all specific subjects but more so in mathematics. Learning of subject like mathematics which is unambiguous, scientific and hierarchical should not be only learning of mathematical content. Rather it should lead to enrichment of critical thinking skills necessary which will develop the life skill of problem solving amongst the young learners and help them in facing the obstruction in their social life.

7. References

Chukwuyenum, A.N. (2013). Impact of Critical thinking on Performance in Mathematics among Senior Secondary School Students in Lagos State. *Journal of Research & Method in Education*, 3(5),18-25

Cobb, P; Wood, T; Yackel, E. and McNeal, B. (1992). Characteristics of Classroom mathematics Tradition: An interactional analysis. *American Educational Research Journal*, 29, 573-604

Facione, P.A. (2011). *Critical Thinking: What It Is and Why It Counts*. Millbrae, CA: The California Academic Press

Firdaus, Ismail Kailani, Md. Nor Bin Bakar, Bakry. (2015). *Journal of Education and Learning*. *Vol.9(3) pp. 226-236.*

Jacob, S.M. (2012). Mathematical achievement and critical thinking skills in asynchronous discussion forums. *Procedia - Social and Behavioral Sciences*, 31 (2012), 800 – 804

Krulik, S. and Rudnick, J.A. (1995). *The New Sourcebook for Teaching Reasoning and Problem Solving in Elementary School*. Needham Heights: Allyn dan Bacon.

NCERT.(2013).*National Policy on Information and Communication Technology in School Education,* New Delhi

NCTM. (2000). *Principles and Standards For School Mathematics.* Reston, VA: NCTM.

Semerci, C. (2005). The influence of critical thinking skills on students' achievement. *Pakistan Journal of Social Sciences*, 3(4), 598-602.

Shakirova, D. M. (2007). *Technology for the shaping of college students' and upper-grade students' critical thinking*. Russian Education & Society, 49(9), 42–52.

Silver, E.A. and Kenney, P.A. (1995). Sources of Assessment Information for Instructional Guidance in Mathematics. In T.A. Romberg (Ed.). *Reform in School Mathematics and Authentic Assessment (pp. 38-68)*. Albany: State University of New York Press