INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) TO TRANSFORM TEACHING-LEARNING PROCESS IN SCIENCE CLASSROOMS

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Abstract

This paper discusses the implementation and impact of ICT in science classrooms. ICT has infiltrated all aspects of our life to the extent that society is unable to function. It is being in availing governmental services, purchase of necessities as well as in education. In many countries, ICT is strongly featured in education, with most students and teachers using it to enhance the teaching learning process. It is a "major tool for building knowledge societies" (UNESCO 2003) and as a mechanism for promoting quality school education.

ICT incorporates technology usage of various electronic devices. At educational level, ICT is believed to bring about pedagogical changes. It can help in reshaping the curriculum and pedagogy of science as it offers easy access to resources that helps extend opportunities for students to learn.

This paper explores how science teachers who have access to ICT incorporate it while teaching. It was designed as a mixed method study, using both quantitative data and qualitative data collected from around 68 students. The data were used in a complementary manner. Quantitative included both formative and summative assessments and qualitative included interview, focused group discussion and opinionnaires.

The data collected and analyzed showed that when science teachers have access to ICT they can add value to their teaching which is further enhanced if they have previous technological knowledge. The results indicate that in "ICT pilot schools" many teachers adopted more student-centered activities which led to increase in student achievement and motivation of students in science classrooms as well as helping them relate science to real world experiences It also helped them understand of how they prefer to learn and which materials can help achieve it. They utilize a pedagogical reasoning process as they utilize knowledge of their learning styles and assessments to make decisions. This highlights the need for further research on how ICT use can be integrated into classroom practices.

Keyword: Information and Communication Technology; Pedagogy; Science; Teaching; Learning

1.INTRODUCTION

"How can learning technologies improve learning? What the answer depends on is, of course, the context of learning. Any educational method depends for its effectiveness on the students, teachers, classroom style, institutional milieu, and so on, as much as on the material or method itself." (Laurillard, 1993, p.46.)

Recent technology innovations have led to many claims about their potential for learning. The rapid growth of computing, networks and infrastructure offers not only an increase in available technologies for learning, but also a change in its potential use in education. In the past two decades, the speed with which the ICT revolution has taken over the world is extraordinary. The changes have been rapid and sweeping across all domains (Haddad & Draxler ,2002). As we have all experienced, ICT allows us to collect, create and store knowledge in various forms. It also helps people from all over the world to connect, to collaborate and to distribute knowledge. (Kearns & Grants ,2002; Loveless & Dore ,2002). The term ICT as we know it, was until recent times known as information technology. But to

include the field of electronic communication, it came to be known as ICT. (Kennewell, Parkinson, & Tanner,2000; Plomp, Anderson, Law; Law & Quale,2003).

This paper is concerned with the integration of ICT in education. It is because due to the fast development, it has effectuated many arcane changes, in a phenomenon we now know as 'information society'. But societies in which ICT is regularly in use or also known as 'Knowledge Society'.

ICT is the means or the tools needed by information or knowledge society. This is the reason, teachers are tasked with the demand of ICT integration. However, ICT integration is a complex process of educational change and in many schools, it is extremely varied and even very limited in some (Loveless & Dore ,2002). One of the reasons could be that teachers are working with "Digital Natives" who take ICT for granted as it is something which they have been in touch since the moment they were born. Researchers are in a dilemma on whether ICT is a new academic subject or a teaching learning tool. For some it is a new subject matter with new skills to be learned by students and for with constructivist views, it is a learning tool that can help build up learning through various means. But ICT integration in educational institution bring with it various challenges. It is because integrating it effectively is much more complex than just providing computers and internet connections. Technology, no matter how expensive are just tools and cannot fix poor practices or undeveloped educational philosophies (Niederhauser & Stoddard,2001). There is no single approach to integration, as it is a dynamic wonder involving interacting approach and factors over time (Brummelhuis,1995).

But Judah Schwartz in his chapter "The right size Byte" has suggested to bring changes in a single leap, instead of a phased approach in adopting technologies, changing pedagogy and curriculum planning. Although technology is useful for enhancing student centered learning (Hoppe et al,2007), few studies have explored the factors that affect the application in the classroom. The integration of wireless technologies can expand technologies as part of the campus environment for teachers and students to adopt and help share and coordinate their work (Gay et al,2006). Even though educational application is rising, but empirical studies on effectiveness are still rare. Some studies have revealed the effectiveness of mobile devices in improving student achievement and instructional activities (Crawford & Vahey ,2002). It has also been found to enhance learning processes, conceptual understanding and increase student motivation (Swan et al; Crawford & Vahey 2002). A Study revealed that most students enjoyed using mobile devices and viewed it as a valuable learning tool.

A few empirical studies have also talked about the negative effect of ICT in class discipline as well. It was discovered that often time learners use their devices for activities unrelated to learning such as accessing social networking sites, playing online games among other things.

2.LITERATURE REVIEW

2.1.Science Education

Various research literatures on science has reported that learning in science is not mere content knowledge of the subject but it is a multifaceted construct (Duschl et.al 2007) This approach is in direct contrast to the traditional science teaching practices. The purpose of science has always been to unravel the secrets of the natural world. It reflects the vision of 'things 'exist and 'are as they are 'in the world (Lopez & Potter,2005). The role of science education is to educate learners on how to interrogate the 'real things'.

The words science and technology are often used interchangeably, but the goals differ. Science is pursuit of knowledge whereas technology can be said to be practical application of science. These two also serve entirely different social purposes. But technology cannot be considered a 'vitamin 'which when fed to the teachers will result in better educational outcomes, nor it is some other subject which can just be learnt, examined and marked by the teachers. But "Information and communications technologies (ICT) are a diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information" (Blurton,1999)

Use of emerging technology as tools can result in improved pedagogies, stronger link between school and real-life issues and can result in the empowerment of learners to better serve society. As is echoed by many teachers, student centered classroom can be conducted without the help of technology. But tech has permeated all aspects of our life and is not going away anytime soon. So, teachers should try to "engage students in

exploring real-world issues and solving authentic problems using digital tools and resources." As well as "develop technology-enriched learning environments that enable all students to become active participants in setting their own educational goals, managing their own learning, and assessing their own progress." (ISTE ,2008). It also helps if curriculum is modeled around 'authentic' issues plaguing humans, thus resulting in students trying to formulate innovative solutions using tools like those in high tech companies. (Linn 1997). One of the major issues plaguing science education is the losing of interest among school students (Murphy, 2003). Studies have suggested that project-based learning can motivate students (Mistler-Jackson and Songer, 2000). if topics which are relevant to everyday life of students are dealt with (Mistler-Jackson and Songer, 2000; Osborne and Collins, 2000) which would allow them to regulate their learning. Using the internet on their devices enables collaboration among classmates and reinforces learning (Murphy, 2003)

The benefits of ICT with teaching and learning can be summarized as :

• Helps students become more socially aware and helps them communicate effectively
• Significantly enhances knowledges, skills and attitudes of the learners
• Learn how to represent information through use of ppt, word files etc.
• Better problem solving and critical skills

3.ICT USED IN SCIENCE CLASSROOMS

ICT usage in the science classroom can be classified into (i) "application of tools" and (ii)" Learning through ICT" (Webb,2002; Lavonen, Juuti, Aksela, Meisalo,2006). Figure 1 indicates the examples of ICT.

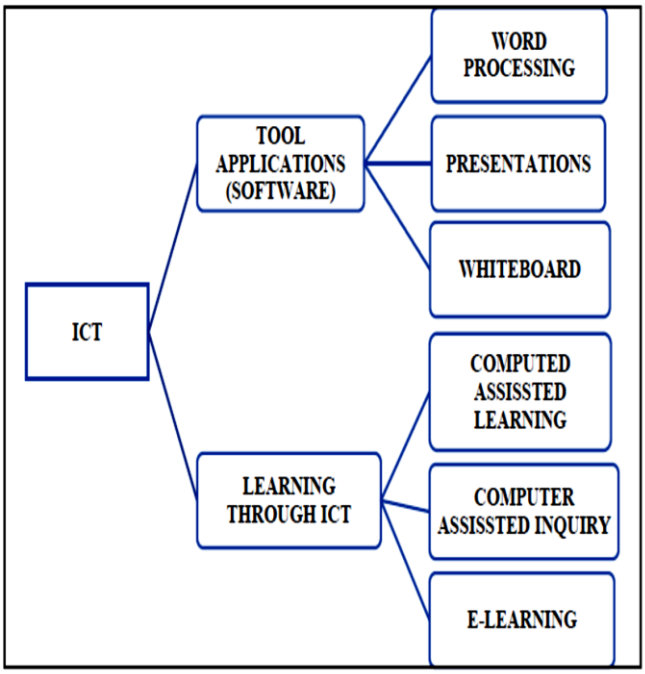
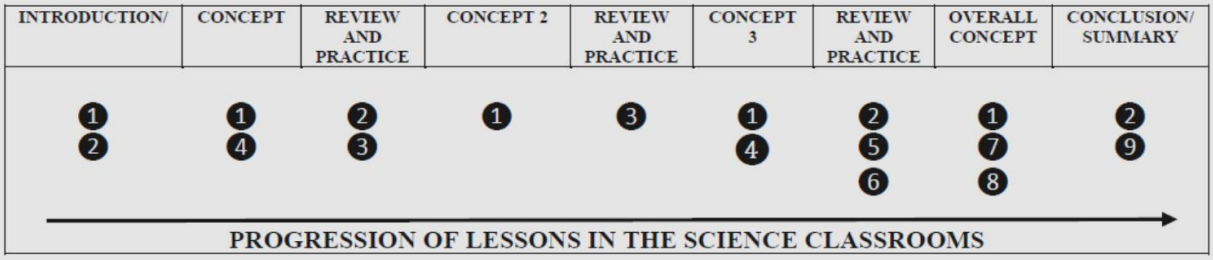


FIGURE 1: ICT IN CLASSROOM

FIGURE 2: PEDAGOGICAL PRACTICES IMPLEMENTED IN THE STUDY



1. Displaying Images/Videos/Presentation
2. KHWLAQ Chart
3. Inspection/Assessment
4. Online Learning
5. Cooperative Learning
6. Integrated response displaying(Kahoot/Edmodo)
7. Broadcasting
8. Inquiry Sessions
9. Individual Learning
10. Students Preparing portfolio

4.PEDAGOGY

Nowadays application of ICT has resulted in the creation of a content driven pedagogy which does not reflect the creativity of the process. As (Koper and Olivier, 2004) pointed out, the content-driven pedagogy is based on the following, quite limited, set of guiding principles "Learning is the process of consumption of content… To learn, a single user needs to go through a sequence of learning objects… Teaching is the art of: (i) selecting and offering content in a structured, sequenced way and (2) tracking the learner's process and assessing the acquired knowledge" (Koper and Olivier, 2004, pg. 97).

Teaching/learning processes are highly creative and is rarely followed as decided beforehand. These practices need to be captured and shared to guide pedagogy in a technological classroom. This has been taken up the proposed theory of "Learning Designs" (Koper,2005).

This theory strongly supports the top-down approach of learning experiences as it believes in applying proven pedagogical models rather than the prevalent ones. Learning designs describe "under which conditions, which activities have to be performed by learners and their teachers to enable learners to attain desired learning objectives" (Koper and Olivier, 2004). In this study the researcher has tried to describe the actual teaching -learning process implemented in the classroom under study.

PRACTICES	USED BY	FUNCTIONS
Displaying	Teacher	Projecting prepared digital materials
KHWLAQ	Students	Chart for group, independent learning or formative assessment.
Assessment	Teachers Students	Assessing and reviewing the concepts taught in the classroom through online/offline quiz or through prezi presentations
Inquiry Sessions	Students	To clear their doubts or to ask questions during group presentations
Broadcasting	Teacher	Transmitting information through the online forum or through the iPads.
Selective and Spot Inspection	Teacher	Gathering students work through their iPads directly onto the teacher's laptop through "Apple notes"
Individual Learning	Students	Reading and taking notes either on their devices or notebooks
Online Learning	Students	Accessing the digital material through the online school forum and discussing it with peer if the need arises
Cooperative Learning	Students	Students working together in real time for a project or assignment
Integrated-response Displaying	Teacher & Students	The Teacher display an online either on the forum or through real time leading to students answering through their devices. It allows in showcasing student responses, time and even the correct answer. The study used two online sites kahoot and Edmodo.

TABLE 2: DESCRIPTION OF SOME FREQUENTLY USED COMPONENTS OF PEDAGOGICAL PRACTICES

The design was derived after reviewing various educational theories, best practices and common patterns observed. The common patterns were used to derives common solutions to recurrent problems. The features are common to many ICT enhanced classrooms and can be easily applied to support student centered teaching through collaborative or project-based activities. The pedagogical practices are listed in the figure 1 and table 1 describes each of the practices.

5.RESEARCH DESIGN

The researcher after reviewing different methods utilized quasi experimental nonequivalent pretest-posttest control group design It was selected as it provided a means to collect and analyze data of intact groups rather than shuffling them based on age, gender, achievement etc. Since this study sought to determine if a significant difference existed between control and experimental group after an ICT intervention was applied.t-Test was utilized to compare the means of the outcome and to determine if the intervention in the experimental yielded higher level of student achievement.

6.RESEARCH ENVIRONMENT

The participants for this the study were 68 students of science classroom. Since this was a quasi-experimental study the sections were not disturbed and They were assigned into two groups, i.e., an experiment class (n=34) and a control group (n=34).

7.DATA COLLECTION

For this study a mixed method approach was utilized. It is quasi experimental as the groups were selected without any random pre- selection process. This was done to cause minimum disruption to the students. The group were divided into a control group and an experimental/treatment group. Intervention was applied to the treatment group with ICT usage. The control group received no intervention with traditional classroom instruction.

A set of Pre-test questions was administered on both the groups to determine their level of understanding in the science topics. The pre-test was administered and were the same questions in pretest. The treatment group underwent classroom intervention for 3 months with ICT integration in every lesson. The student in both the groups were assigned to an online forum. Subject teachers were required to post classroom syllabus, test dates, notes and even encourage discussions.

The forum even allowed students to post their assignments online and take time restricted assessments. The teacher had access to all the tests and could even create online assessment to facilitate easy assessment.

8.INTERVIEW

To further investigate the effects of ICT integration in the science classroom, qualitative process of data collection was conducted. The qualitative process was in the form of students, parents and teachers interview. Online survey was conducted through the online forum as well. This helped us in obtaining anonymous opinions from students.

The following topics were kept in mind for the interview and the opinionnaires.

1.Extent of ICT usage by Students for classroom activities.

2.How technology benefited their learning experiences both in and out of the classroom

3.Students recommendation

9.FOCUSSED GROUP DISCUSSIONS

The focused group discussion is a valid and reliable method for data collection. It is effective for identifying agreements and for eliciting suggestions and recommendations. It is flexible as the researcher could clarify questions or follow-up on vague responses. It provided meaning to the quantitative data.

The following suggestions were noted

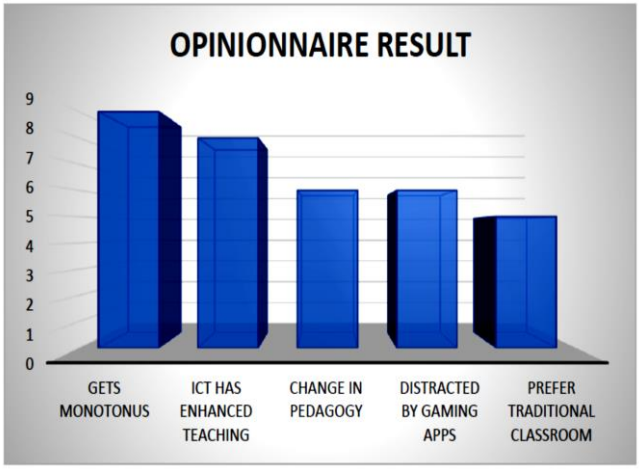
(i) The activities in the classroom would get monotonous after a while as students sometimes craved practical learning such as museum tours and excursions.

(ii) Students sometimes wanted to use iPads freely for independent browsing or for playing games. They believed they deserved the relaxation while in school.

(iii) Students felt that they had fewer opportunities to express their creativity in collaborative activity

10. OPINIONNAIRES

The opinionnaires were posted online and questions pertaining to student's experiences were posted. The results are displayed below.



11.INTERVIEW RESULTS

Semi-structured face-to-face interview guide was used to collect qualitative data as the questions were already set about the different issues.it was done to make sure all relevant topics were covered and to keep the interaction focused. Reviewing the interview transcripts lead to the revelation of the following points

• Students had become much more competent in ICT usage
• It helped them develop social skills and the networking helped them collaborate on assignments
• It helped in dissemination of new information through sharing of notes, discussions and even presentations

12.RESULTS

12.1. Analysis of Pre-test & post test

The results obtained through the pretest post test results were analyzed using excel. The sample consisted of 68 students i.e. an experiment group of 34 students and a control group of 34 students.

TABLE 2. PARTICIPANTS' PRE-TEST SCORE IN EXPERIMENT AND CONTROL GROUP

GROUP	NO OF STUDENTS	MEAN	STANDARD DEVIATION	STANDARD ERROR MEAN	t-test
EXPERIMENTAL	34	71.44	14.75	2.53	0.35
CONTROL	34	70.14	13.74	2.36	

13.METHODS:

A preliminary test for the equality of variances indicates that the variances of the two groups were significantly different **F=.87, p=.34.** Therefore, a two-sample t-test was performed that assumes equal variances.
Results: The results of the both the groups revealed that that t-value of was 0.35, with the significant level less than .05. The t-test indicated no significant differences between the two groups. It indicated that the experiment **group (M=71.44, SD=14.8)** performed significantly higher than the control group **(M=70.14, SD=13.7)**. Overall, the results indicated no different in academic achievement of the group before the start of the study."

TABLE 3. PARTICIANTS' POST-TEST SCORE IN EXPERIMENT AND CONTROL GROUP

GROUP	NO OF STUDENTS	MEAN	STANDARD DEVIATION	STANDARD ERROR MEAN	t-test
EXPERIMENTAL	34	81.79	12.74	2.19	0.01
CONTROL	34	72.94	15.53	2.66	

Results: "The results showed that t-value of post-test was 0.01, with the significant level less than .05. The t-test indicated significant differences between the two groups. It indicated that the experiment group (M=81.79, SD=14.8) performed significantly higher than the control group (M=72.94, SD=15.5). Overall, the results of this study suggest positive and significant relationships between the use of ICT in the classroom and the academic achievement."

As expected, the students from the experimental group scored significantly higher on the posttest compared to the pretest. It is interesting to notice that even after 6 months, students continued to demonstrate high levels of retention. The results also showed that most students who were apprehensive of the test became convinced of its applicability and retained concepts even months after class.

14.DISCUSSION AND CONCLUSION

The various research studies have revealed that simply placing a computer into a classroom will not be enough

to impact student academic achievement but a well thought of application of ICT can influence student knowledge, attitude and skills. Three major issues in terms of impact of ICT in classroom were considered

1.Learning outcomes of students through achievement in assessment or development of new skills
2.Classroom and teacher outcomes such as development of teacher's competency leading to adoption of new pedagogical practices
3.Student Outcomes such as increased innovativeness, creativity and attitudes towards science.
The evidence suggests that ICT can thus contribute significantly to students' academic achievement.

The literature review recommends the importance of ICT inclusion into the science classrooms as various studies has shown that if integrated properly can lead to improvement in academic achievement. It can also facilitate a more positive motivating and challenging learning environment Furthermore broader studies needs to be undertaken to confirm the results. As to the main research question in this study it was found to influence learning and helped transform the science classrooms. Many a times ICT classroom environment are like a double-edged sword as the students access online material but it also distracts them from the lesson. It is important for the school to help teachers by developing a software to monitor student activities on their devices. The school had appointed software engineers who programmed the iPads to regulate the websites that students visit. But the students had learned to hack their way into the commands and use their devices freely. As warned, "While the Internet is a powerful source of information, it can also pollute young minds, so teachers should give guidance on the moral hazards in today's computer age" (Moy, 1998). There were some skills which cannot be learned through ICT such as manual calculation, discussion and writing (Semenov,2005; Zimmerman & Schunk ,2001). The major issue plaguing science teacher is the large amount of information that needs to be digested by the students, this creates an issue with the teacher rushing to complete their curriculum. The syllabus should be revised to remove the unnecessary or complicated topics to make it easier for students to learn.
Learning with technology does not always guarantee positive benefits but is influenced by many factors. Factors that needs to be taken into consideration is the pedagogical approach of teachers, infrastructure, teachers training, classroom practices, classroom management skills among others. Zimmerman (p. 108) declares that "ICT is not . . . a panacea for all educational problems". Students are sometimes overwhelmed when they access the huge amount of internet information (Reid,2002). As pointed out that "some studies reveal a positive correlation between the availability of computer access or computer use and attainment, others reveal a negative correlation, whilst yet others indicate no correlation whatsoever between the two" (Kozma,2008)

We as humans are expert at transforming practices through creation of tool. This creativity includes ICT as well. Knowing how to properly utilize it is not so straightforward as it challenges to well established traditional practices, thus there is a need to further orient the user as well as the facilitators about the positive aspects and the pedagogy associated to enhance its positive influence in the classrooms.

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