ORIGINAL ARTICLE

The Influence of E-Learning on the Academic Performance of Mathematics Students in Fundamental Concepts of Algebra Course: The Case in Jimma University

Kassahun Melesse Tegegne*

Abstract

The expansion and dominance of technology is increasing globally one of which is the influence of e-learning in educational systems. E-learning is any electronic supported learning either with or without infusing the ICT facilities in the current conventional learning methods be it traditional or active learning. The aim of this study is then to evaluate the influence of e-learning on the academic performance of year II mathematics students in Jimma University, in basic algebra course (fundamental concept of algebra). This study was a Quasi-Experimental design whereby students were categorized into three performance levels (slow learners, average learners, and above average learners) through pre-test so that the two groups, i. e, experimental and control groups, were predetermined to help as a baseline during the analysis. The study revolves around constructvism theoretical learning emphasis on self regulated learning whereby blended e-learning is the analytical framework. The experimental result showed no difference between the conventional and ICT supported learning on student performance with all pros and cones occurred during the experimenting time. Further deep study is therefore recommended avoiding all the factors (as much as possible) that affect the successful implementation of e-learning.

INTRODUCTION

The influence of e-learning is increasingly dominating the current educational style as the influence of technology increases dominating our day to day activities worldwide (Bass 2006). As one of the major sectors of technological influence is education it is assumed the vanguard for developmental change of all countries in the contemporary world (Caillds et al, 1996).

**Department of Mathematics College of Natural Sciences, Jimma University, Ethiopia. E-mail: kassahunml@yahoo.com*

Especially governments of developing countries like Ethiopia are convinced that their journey towards civilization is mainly dependent on technological support (MoE, 2005; Serbessa, 2006). For this, science and technology education is the primary target in which case tertiary education will come to the front. Mathematics, the fundamental tool for all sciences and technology is then the basic primary element which needs a very serious support during the teaching-learning process. This shows that the chain of interdependent relationships between development, technology, education, tertiary institutions, science and mathematics, in bringing the issue of the conceptual change in teaching and learning methodologies. This interdependent chain is cyclic such that education support the growth of technology, while in return, technological facilities support educational system, in our case, the learning system, specifically by electronic support (e-learning).

Theoretical framework

The current trend of learning theory is based on constructive learning where by students construct their new knowledge grounded on their previous knowledge and experiences assuming the surrounding environmental conditions around the learning situations in hand. In this line, students actively involve in their learning activities constructing their own new knowledge in a piece meal, i.e. a journey to the new conceptual change, to a new schema of accommodation through assimilation process.

As opposed to objectivism theory of learning which believes that knowledge is an independent, unchanging phenomenon which is passively transmitted from the teacher to the student, constructivists believe that knowledge is constructed within oneself; emphasis is given to self-regulated active learning. From its very nature therefore mathematics is highly attracted towards such self-regulated active learning through continuous exercises passing through a spiral development right from the ground of previous experiences. Constructivists are against the belief of the objectivists who are saying that teachers know what is important to the students (Creswell 2009, Cobern, 1996). William (2004) support the constructivists' idea that knowledge is rather individually constructed and socially negotiated by learners themselves based on prior knowledge.

As Yager (1991) and Cobern (1996) put it, the issue is how learning takes place rather than how it rationally develops. It is the issue of the content of thought rather than merely the formal operations of logic in which the learners themselves are primary actors. The ICT integrated learning is therefore highly recommended for facilitating individually constructed knowledge by supporting the teachers professional development, the students benefit there after promoting organizational learning (Mc Kenney, 2001). Choi (1995) express that knowledge is natural byproduct of an individual within the environment and context, which is supported by Wilson (1995) saying that constructivism tends to be holistic. This is taking sense of the world by taking information from the environment.

Shuell (1986) explain further that what a student does is more important than what the teacher does. Biggs (1999) adds that students should depend on what they perceive, interpret and intend to do. So, the ICT integrated learning creates opportunities to facilitate such interaction of learning. This supports Perking's (1991) idea that constructive learning environment will be enhanced if reinforced to play more task oriented activities like in the electronic supported learning.

Since self regulated learners are purposeful and strategic by generating and directing their own learning experience, rather than being externally controlled (Olaussen & Barten, 1999), the electronic integrated learning is assumed to scale up individual learning activities based on their prior experiences.

This study is therefore in line with the constructivism theoretical framework, assuming that conventional learning might be enhanced by the newly infused agent (e-learning). It is presupposed that it will contribute to construct new knowledge over the existing ones, and initiates and facilitates learning towards independent learning. This is aiming the improvement of students performance at a better level. In return the electronic integration presumed to bring new trend of learning changing the role of the teacher into coaching status while the students are actively involved in self-regulated learning, constructing their own new knowledge internally. The expectation is that new teaching-learning system could be manifested through this new experience of learning using ICT reinforcing the conventional system for modification if not for a radical change which may come later on. Furthermore, individual learning styles differ and individual differences become even more important in the area of education specifically in mathematics. Therefore, the real challenge in e-learning is keeping the people in line of its design for the mind set up (Canavan, 2004; as quoted by Manochehr, n. d). In support of this, Hiltz (1993) indicate that a primary goal in studying a new medium of communication for education system must be the identification of its impact on learning which is the aim of this study. The study is therefore assumed to benefit from the understanding of students' own learning style by taking measures to adjust the way they acquire knowledge (Cwely et, al., 2002). So e-learning may be effective in facilitating those with particular learning style since it is conducive for independent learning (Manochehr, n. d.).

Therefore the following theoretical model is presupposed that the study could be related to contribute to theoretical components beyond the practical contribution in justifying whether or not students achievement is improved.

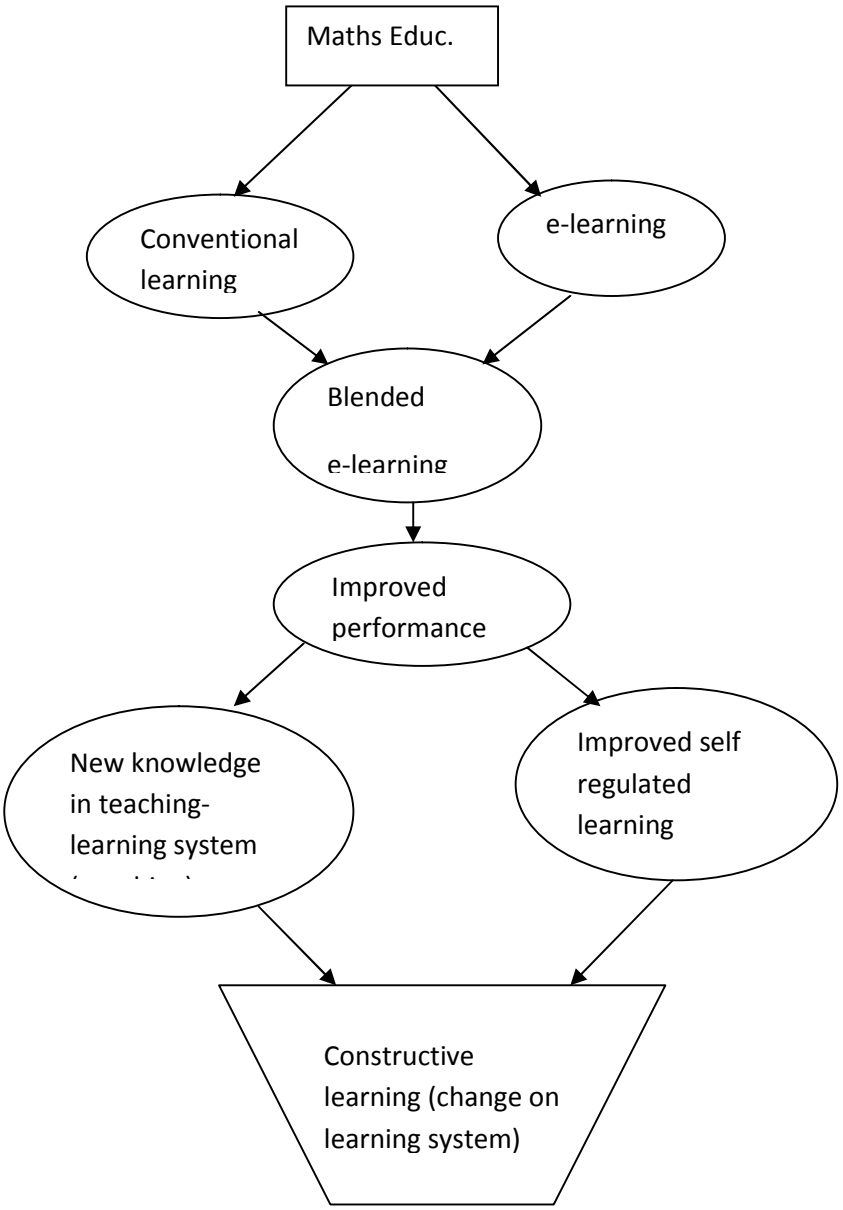

Figure-1: Theoretical model towards a new knowledge in line with constructivism theory of learning

In other words, students' performance will be evaluated at preliminary stage to see their existing basic knowledge and skills at the experiment stage (development stage) and then the final evaluation stage to lead to recommendations in either way. The aim of this study is then to evaluate the influence of e-learning on the academic performance of year II mathematics students in Jimma University, in Basic

Algebra course (fundamental concept of algebra).

Therefore, like any other subjects we have to work for testing the influence of e-learning in mathematics learning areas which is the purpose of this study. That is to say, testing the level of the influence of e-learning in mathematics education looking into the tension between the students and this newly infused facility.

Statement of the problem

In the arena where the influence of electronic learning is pushing to dominate the educational systems, the universities in Ethiopia are working not only for the expansion of programs but also for their quality assurance (Kamer, 2000). This endeavor is initiated by the government to improve teaching-learning methods of teacher Education Institutes (TEI) by redirecting the emphasis given to active learning via the support of HDP (Higher Diploma Program), a one year on job training on active learning implementation and CPD (Continuous Professional Development) a supportive element mainly at high school and elementary school levels (MoE, 2003 & Yizengaw, 2007). Besides this program, recently, Jimma University is trying to reinforce the teaching-learning systems through the newly influential agent introducing online learning blended with the existing conventional system. From experience, it is that observed students and teachers seem very much interested towards ICT utility movement if it is not to be a seasonal fashion. The University is part of this motivated group initiating e-learning program at pilot level training for selected interested academic staff to deliver sampled courses from each college, where by in mathematics, fundamental concept of algebra course is the one selected under this project to exercise the e-learning blended learning activity. If this pilot exercise on e-learning support delivery is to be extended to a larger scale, it will be wise to grasp the opportunity to measure the rate of improvement made by the new agent infused for a better change. The assumption is the achievement of students will increase as we indulge electronic support which will create opportunities for students to learn independently constructing new knowledge through self regulated learning. But, before expanding it beyond the pilot, it will be wise to ask, whether we really can get the intended improvement. If so, is the change of improvement is significant so that if we expand it we will get the return for the expensive cost we are to incur for the expensive technological equipment, online service, technical experts and the like. If so, not only will the quality of education improve but also it will add some new knowledge for theoretical understanding contribution (Mayer, 2003; Descamps, 2006, and Couco & Goldenberg, 1996).

Therefore, the purpose of this study is to answer the main question of whether the e-learning support is significantly improving the academic performance of students in mathematics classes. In other words; the researcher want to answer the research question: **How does e-learning influence the academic performance of mathematics students in JU in Basic Algebra course**? The study is also intended to answer the sub-questions indicated below:

- What is the performance level of mathematics year II students of JU in Basic Algebra course before and after e-learning infusion?
- Is there any influence of e-learning on academic performance of students? And what is the level of the influence?
- What is the contribution of e-learning in the learning process?
- What are the major challenges of e-learning supported learning in mathematics classes?

- Could there be possible solutions to alleviate these problems?
- What is the level of access opportunity on electronic facilities in the campus to the students?

Significance of the study:

This study is assumed to contribute to the following relevant areas.

- It conserve as an initial point for similar impact studies in the same subject or other subjects
- It can give some evidences to convince the University to decide further expansion in e-learning validity.
- It could help to redirect the teaching methods of mathematics to motivate students learning and reduce their fear of learning mathematics.
- Theoretical contributions to methodological aspects in the direction of new conceptual change
- It would suggest for improvement of e-learning delivery system based on the last evaluation after the experiment is done
- E-learning system designers could benefit from challenges faced to improve the design.

METHODOLOGY

Research design and study site:

This study was a Quasi-Experimental design whereby students were categorized into three performance levels (slow average, and above average) when assigned by the department at the beginning and hence the two groups (experimental and control groups) could be predetermined to help us as a base line during the analysis. The experiment was quasi since randomization was not applied. The groups were simply taken as the two sections were assigned by the department not to disturb the regular system.

The study site was Jimma University Mathematics Department, while the subjects were year II mathematics students of 2012/13 academic year who were involved in the class of the Basic Algebra course named, Fundamental Concept of Algebra. The study was conducted in 2005 E. C. (2012/13) academic year and the experiment was processed in semester one while the analysis was done in semester two and summer session.

Data collection instruments and administration: In this quasi-experimental study design, the tools used to collect data were experimental measures followed by consecutive standard performance tests supported by activity observations. Experimentally, e-learning was treated on the conventional system for one of the two groups while the control group was taking the usual methods of teaching. Here, two academic staff members who were teaching the course were involved, one teaching conventionally, and the other, the researcher himself facilitating e-leaning supported learning. This was assumed to help in controlling personal bias if only one teacher was involved in both groups. Besides, one computer expert assistant and one technical lab assistant were involved to train the students on how to use the e-learning software and facilitate the computer utility skills and to make ready the lab environment and its facilities.

Sampling: In this qausi-experimental study, all mathematics year II students of 2012/13 (2005 E. C.) were taken as sources of information, accepting as they are grouped into two sections proportionally. Therefore, the population size of the study was 144 regular students in which 75 were group one (the experimental group) and 69 were group two (the control group).

Experimental design: Since the first two units (Mathematical Logic and Set Theory) of the course were more or less revision contents. In preparatory school they were offered conventionally for both groups uniformly whereby the two pre-tests were conducted one after another. The experiment was planned to focus on the third unit, Group Theory which is totally new for first year students, equally challenging for both groups and hence the treatment e-learning started there.

Experimental procedures: The following procedures were followed during the experiment:

I. Conducting the pre-test to determine the performance levels of the students in the three categories. The pre-test was conducted just before the start of e-learning for both groups.

II. Organizing them into two groups, control and experimental, by using the already formed groups by the department since there were two sections.

III. Implement e-learning supported learning for the treatment group, while the control group went with the conventional methods, separately, until one or two units were completed. The two groups were taught or facilitated by two different teachers to avoid contamination.

IV: The post-test-1 was made at the end of the unit(s) planned for the first e-learning cohort, the same test for both groups. This was followed by final examination uniformly for both groups.

V: In post-test-2 the examination comprising of the whole contents of the course was given, the scores indicated in the result section.

VI: Then finally survey assessment was made to evaluate the learners' reflection on the challenges they encountered during the e-learning sessions. This was done by using a questionnaire to be answered in groups, 13 groups all in all. This part was delivered in a separate article just for the sake of convenience.

VII: The experimental results of the two groups were analyzed, compared and examined to see if there were some influences or effects on students' performance.

Analysis: Data were analyzed through basic methods of both descriptive and inferential statistics using SPSS package. Relevant analytical tests like descriptive, chi-square, ANOVA and t-test were dealt calculated.

Ethical considerations: Official permission from the department was secured. The teachers and students consent were taken into consideration by approaching them.

RESULTS

Experimental results

Pre-tests

As indicated in the methodology section two pre-tests were given to the two groups categorized for the quasi-experimental. It was process just before doing the treatment, infusing the e-learning, the first out of 30 and the second out of 40.

Two units of the course Fundamental Concept of Algebra were given conventionally for both groups in which one pre-test was given at the end of each unit. The first unit was Mathematical Logic while the second was Set Theory, Relation and Function in it was assumed that the students had had reasonable experience of

these topics from their preparatory mathematics and from the preliminary course given at the university level named Fundamental Concept of College Mathematics. The tests at the end of each of these units were given to see students' basic differences through learning conventionally. These pre-tests were followed by other two post tests conducted after the implementation of the experiment on the third unit, Introduction to Group Theory which was totally new to the batch. The first post test was given purely on the experimental unit mentioned above secored out of 40, just at the end of the experiment, the target of the study for comparison. The second post test was given as a final examination out of 40 consisting of all the three contents mixed comprehensively as was deemed reasonable.

According to the two pre-tests, the academic performance of the two groups found to be significantly different at 95% confidence interval with the respective p-values being P=0.000 and P=0.011 whereby the mean score of the first treatment group appeared to be 23.137 (st. dev=4.8593) and that of the control group being 19.479 (st. dev=5.6276) in the first pre-test which was out of 30. Similarly, in the second pre-test which was out of 40, the mean score of the experimental and control groups were 21.61(st. dev=7.731) and 18.63 (st. dev=5.873) respectively.

In general, all the four tests were arranged focusing on three learning categories in which the first part focused on understanding of mathematical concepts, the second on applications and computational skills, while the third focused on logical reasoning through proving theorems. According to these learning categories, still the treatment group significantly surpassed the control group in both pre-tests at P=0.05 except the third category of the second pre-test which was marginal**.**

Post tests

As briefly explained above, after the experiment involving the e-learning modality for the treatment group, two post tests were given, one specific to the experimented unit on group theory; the second post test was actually a final examination whose contents comprehensively consisted of all the experimented and non-experimented units mixed. According to the post test conducted on the experimental unit, which was the main target of this study, the T-test showed no significant difference between the two groups academic mean scores (22.36 and 22.80) respectively at P=0.724. This shows that the performance of the treatment group tended to decrease from their pre-test scores. Specially, the study revealed that the control group scored significantly higher (P=0.000 & P=0.004) than that of the experimental group in understanding the mathematical concepts and logical reasoning respectively. This relatively similar performance of the two groups was also reflected in the aggregate result of the final examination whose p-value was found to be 0.050**.**

Table-1: Performance comparison of the two groups

Group Statistics						t-test for equality of Means		
Yr-Grp		**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sign (2-tailed)**
P11.10	2.1	73	7.082	2.5847	.3025	2.052	140	
	2.2	69	6.290	1.9561	.2355			0.042
P12.10	2.1	73	7.81	1.905	.223	2.287	141	
	2.2	70	6.99	2.379	.284			0.024
P13.10	2.1	73	8.25	1.878	.220	5.245	140	
	2.2	69	6.38	2.339	.282			0.000
T1.30	2.1	73	23.137	4.8593	.5687	4.166	141	
	2.2	70	19.479	5.6276	.6726			0.000
P21.16	2.1	73	9.870	3.5483	.4153	3.608	141	
	2.2	70	7.914	2.8842	.3447			0.000
P22.9	2.1	73	5.90	2.110	.247	2.133	141	
	2.2	70	5.24	1.493	.178			0.035
P23.16	2.1	73	5.842	3.6647	.4289	0.688	141	
	2.2	70	5.471	2.6891	.3214			0.493
T2.40	2.1	73	21.61	7.731	.905	2.588	141	
	2.2	70	18.63	5.873	.702			0.011
P31.15	2.1	73	7.12	2.938	.344	-5.669	141	
	2.2	70	9.83	2.761	.330			0.000
P32.10	2.1	73	6.72	2.635	.308	0.811	141	
	2.2	70	6.39	2.261	.270			0.419
P33.15	2.1	73	8.51	3.779	.442	2.944	140	
	2.2	69	6.65	3.753	.452			0.004
T3.40	2.1	73	22.36	7.484	.876	-0.354	141	0.724
	2.2	70	22.80	7.497	.896			
F18	2.1	73	10.64	3.106	.364	-2.040	141	
	2.2	70	11.63	2.682	.321			0.043
F7	2.1	73	3.66	1.732	.203	0.650	141	
	2.2	70	3.47	1.816	.217			0.516
F15	2.1	73	8.73	2.963	.347	-2.451	141	
	2.2	70	9.93	2.901	.347			0.015
TF40	2.1	73	23.03	6.020	.705	-1.981	141	
	2.2	70	25.03	6.058	.724			0.050

P1: Pre-test one on Mathematical Logic,

P2: Pre-test two on Set Theory,

P3: The post test immediately at the end of the treatment, on group theory

F: Final examination, a comprehensive one on the whole course content

2.1 is for group one, the treatment group

2.2 is for group two, the control group

Competency category

Pi1= understanding mathematical concepts

Pi2=Application or computational skill

Pi3=Reasoning power, critical thinking like proving theorems

Ti.n= Total of the Pi test out of n percent

1. Observation on the experimental process

Like that of the preliminary survey done before the experimental treatment, the process during e-learning implementation was monitored to see some favorable conditions and challenges mainly through close observation and face to face interaction. This was followed by post survey through focus group discussion conducted by the treatment group only aimed to obtain their reflections on the opportunities that new experience conserved and challenges encountered supported by suggestions for possible solutions.

Close observation

At the beginning of the experimental sessions, the e-learning activities, students were introduced to the materials designed and on how to use then application software, Moodle, by both the teacher and site administrator who was the ICT expert by profession. The introduction was more on technical matters on how to utilize Moodle to do the course activities designed for it according to the specific sessions given in a piece meal. This was done technically by the ICT expert and academically by the teacher of the course who knows the actual course module fitted into the e-learning system. According to the plan, the teacher's follow up and guidance permanently continued while the ICT expert help ended just after one or two sessions. Here, the regular classes which were going on conventionally were terminated and replaced by regular e-learning activities going on twice a week for 2 hours per session in two ICT labs; one lab borrowed from information science department to use it by the time it was not occupied by the department schedule. This ICT lab can handle not more than 20 working/connected desks though it has about 40 computer desks. The second ICT lab was the mathematics department small lab used for teaching senior undergraduate specific courses and doing assignments and project works for both undergraduate and post graduate students; about 15 computers are installed there but not more than 10 function properly. These two labs were supposed to serve the experiment group (N=75). Following the two days e-learning sessions, there would be one face to face consolidation session for 2 hours at the end of each week on Saturday morning, going on conventionally.

During the two sessions of the week the teacher regularly monitor, as guided and collected problems encountered for at least 30 minutes at the beginning of every ICT lab work for e-learning. During this interaction it was observed that some students were well ahead of the others in basic skills of using computer facilities even on how to handle accessing the internet which makes the e-learning package easy for them. Here, some other students who are lagging behind due to lack of basic technological skill were observed benefiting by sitting around those who were ahead of them. Of course, on the other hand, one could see frustrated students who cannot access the facility either due to lack of basic skills or lack of space to access the connected computer desks in which the teacher cannot help them at all; except advising them to sit around the connected group of students as much as it can handle. The following are some of the opportunities and challenges observed during e-learning activities in brief.

Observed Opportunities

- Independent learning experience was coached by the teacher which facilitates self regulated constructive learning
- Students basic knowledge and skills in computer and internet usage increased from time to time which develops the technology know how of both students and teacher
- Some experienced and fast students were seen helping in experienced and slow learners on the implementation of the e-learning module as well as the technology utility which promotes cooperative learning
- Students were encouraged to use their spare time for such e-learning activities browsing the internet to learn the course by themselves using any accessible areas planted in the campus.
- Very much active participation of students was observed during the face-to-face sessions when consolidating the weeks e-learning lessons since they were challenged by the new experience during the ICT supported independent learning.

Observed challenges

- As discussed above, there were reasonable numbers of students with very low knowledge and skill on computer application and internet browsing. Of course, there were few students who were highly qualified in the ICT utility. So, such students with very low skills were seen frustrated and lagging behind.
- The ratio of students per the functional computer desk was not proportional, usually more than three students (about 5 students sometimes) per desk in most cases. This increased the frustration, and did not allow individuals to use the technology at individual basis, though the collaborative learning was encouraging.
- Besides this congested working desk, lack of independent e-learning computer lab or secured ICT lab for the e-learning sessions were observed until the program was completed for at most in the ratio of 2 students per desk one heal of a problem observed
- Almost every student tended to copy the reading materials uploaded which needed more time instead of using the time for the exercises which is the imposition of the traditional experience, chalk and talk.
- Some times, the number of working computer desks reduced from 20 down to 10 due to simple technical failure which could be adjusted by an average ICT technician. So, lack of supportive staff to help students in simple technical trouble-shooting right at the spot during e-learning sessions was one of the major problems.
- Since the ICT labs used for this study were scheduled to be used only when they were free, specially the borrowed one, students of this department who felt they owned the lab regularly sabotaged the connection either by disconnecting some elements or closing it by secrete codes and the like. Here, there were very serious arguments

among students when asked to free the lab for the next class which was wasting much time.

- In addition to the above sabotage, regularly, senior students of both departments (both labs) who were found working on their urgent project assignments like senior research projects looked unhappy when asked to get out for the e-learning sessions. This wasted the time for the experiment session.

- During these e-learning activities, some lesson design problems were also observed which are to be corrected from the teacher side. These problems were like wrong answers for some exercises, and some without possible choices to answer correctly where students identified during the activities. Such mistakes happened by the teacher sometimes due to lack of knowledge to design the lessons to fit into the Moodle software or lack of concentration due to large work load.

- Again, another issue on the side of the teacher was some mathematical exercises like proving theorems were very difficult to make them fit into the available Moodle exercise packages mainly objective items like multiple choice, true and false, matching, completion etc. Of course, manipulating mathematical symbols was not as such easy in this software in general. One has to think critically to adjust this software to mathematics courses.

- Usually, it is also very difficult to find the site administrator or ICT expert to consult and adjust the program that needed fast response before the time allotted for the semester is wasted. This of course could be because the expert was busy doing other technical support in other areas, which is his/her regular work.

Possible solutions recommended to migate these challenges

- Provide short training for both students and teachers on handling the course; for the students, on how to make the computer and internet browsing friendly and manage the e-learning software, Moodle, in this case; for the teachers, on how to manipulate the e-learning software in designing the course module and the exercises to fit into the e-learning model.

- Get the proper ICT lab ownership corresponding to the student population, at most 2 students around a connected computer desk, if not, at individual level. Such e-learning laboratories would be suitable if owned independently for this purpose.

- Avail hard copies of the lesson in the library and advise students to take only very brief notes while doing in the e-learning labs to stop the tendency of copying the whole thing. Or, they should take such notes in their spare time if they have to.

- Assign lab assistants with reasonable knowledge and skills who can help students during trouble-shooting permanently. Assign ICT expert who can go round periodically to check if there is any need for technical support beyond the lab assistants. The teacher of the course is also supposed to be able to help students with some technical trouble shooting

by upgrading his/her knowledge and skill on the technology.

- Adjust the schedule of the e-learning to avoid any external distraction like fighting with other group of classes, fixing the 2 hours regular e-learning sessions about 2 to 3 times per week according to the weight of the course and scheduling appropriate summary or consolidation sessions for face to face classes enough to revise the weeks lessons. That means, get everything ready for blended learning as much as possible. Make the lesson topics? to be opened to the students in a piece meal.

- Make regular supervision on daily basis to check the progress and take serious attendance to identify who is working regularly. Provide guidance on how to do the exercises but do not do it for them, it must be self regulated independent learning. This follow up by the teacher must last for at least one hour at the beginning and decrease slowly to is it scientifically proven? minutes when students get friendly with the program.

- Encourage students to do some remaining exercises or readings in their spare time and adjust special privilege for the e-learning students to have more library time to use the digital library based on their list given by the teacher. The teachers, the site admin and the e-learning director have to convince the library authority beforehand using the appropriate top manager in charge of e-learning and the vice president for academic and research in our case.

- Large student population like 75 students per class is very difficult to handle e-learning in one lab since the class will be congested, in more than one lab since the teacher shall ran here and there per session which was the experience in this study. At most, 40 students per lab consisting of 20 computers is advisable in the Ethiopian context. This minimum number of students per class is conducive for the teacher to communicate with them online friendly.

- Things will be easy if the teacher is given some authority of the site administration like opening student accounts (user name and pass word) in addition to uploading the lessons. Otherwise, there will be hectic situations to find the site administrator whenever he/she is needed by the teacher due to assignment to other technical failure.

- The teacher should edit and update the e-learning materials based on the observed short comings and problems identified by the students.

DISCUSSION

The influence of e-learning

Several arguments are going on among scholars on the influence of e-learning upon the current conventional learning system in many places, particularly, in Ethiopia (MoE, 2002, 2005 & Serbessa, 2006). Although some are in favor of it, others have doubts or even are against the possibility of learning improvement by the new technology. Most of them do come to a compromise that it will at least be additional input to facilitate the teaching-learning activities going on under the current scenario. In support of the compromise, Hic & Pokorny (2005) said that the development of technology has at least influenced the method of the teaching style transforming it into techno-pedagogy

(Khirwadkar, 2007). In any way, this experimental study revealed that there is no significant influence on the students' performance when imposing/infusing the e-learning in one of the mathematical concept, group theory in our case, was by the p-value for comparing the post test of the treatment group to that of the control group was 0.724. When we see the pre-test differences of the two groups the treatment group was significantly better than the control in both pre-tests 1&2, P = 0.000 & P=0.011 respectively according to the t-test done. This rather shows us that the performance of the experiment group after the treatment tends to decrease simply because two groups showed no significance differences in the two post tests conducted. As Mrtin Carnoy (2004) stipulated, whether ICT involvement increases the performance or not, at least, the quality of the instruction was not reduced due to the application of ICT; rather, the variety of teaching approach obviously increased.

Nevertheless, using the above results it will be very difficult to generalize that there is no significant influence of the involvement of ICT supported learning. This is because there are several other factors to be considered which are observed challenging the e-learning modality exercised during the experiment sessions like what Adel Ben Youssef (2008) call the indirect effects. The three indirect effects of ICT on students' performance are the students, characteristics, the teachers characteristics and the learning environment which could have impact on the outcome of education, hence influencing the performance. Here the problems identified in both preliminary survey and post evaluation survey could also be some of the bottlenecks to implement the e-learning activities successfully, and was dare to say that there is no as such any change or influence based on the t-tests.

This is because it was observed that lack of basic knowledge and skill on handling the technology facility needed more time independent of the experiment time whereby in our case both are conducted within the same session which leads students to frustration. Shortage of technological facilities to satisfy the need of the students at individual level (at a 1:1 ratio of students to that of a connected computer desk) which needs a lot of money including appropriate lab rooms related as per the connected computers available is another problem to add upon to the frustration. We can imagine how students will think about mathematical concepts and do exercises while so many students are congested around a computer desk, except collaborative work initiation. The above technological problems will therefore be intense when connectivity and power interruption are added which need ICT professionals to assist and generator as optional substitute, still requiring a lot of inputs.

The e-learning lesson design challenge is another problem not only for students but also for teachers facing problems when designing the course syllabus to fit into the system, model in this case (Hiltz, 1993). As requested by the students, the face to face sessions should be well scheduled with sufficient frequency per week. At the start it should be designed in a way that the e-learning be infused in the conventional system without replacing the regular classes unlike? it was done in the experiment of this study. That means, the blended nature should be dominated by the conventional at the start at least till students and instructors are well acquainted with the technology handling, then gradually decreasing the face to face upgrading like it was done in this experiment, and then next to the highest level, the face to face to be communicated through discussion forum purely. In general, it will be wise to repeat such experimental tests through a sort of

longitudinal design for more than one course, and repeated semesters.

Theoretical Framework Connection

When we are thinking of e-learning integrated learning in regular courses, in mathematics in our case, we need to consider the leading actors in the learning process. That is to say, students and teachers beyond the facilities and conducive environment lubricating the interaction to reach the final goal, the success of both actors; the students a better achievement and the teachers a successful coaching / facilitation. This final goal, the achievement of students assumed to come in a spiral development based on previous experience/knowledge, the conventional system of teaching emphasis on active learning integrated with the newly introduced agent, the e-learning infusion supported by individual learners' talent and positive attitude towards this new electronic learning agent in a form of self regulated constructive learning. To encourage this new constructive learning process, we should look forward to see if it produces a better student performance as expected or change the direction of the teaching and learning process. As a consequence, one has to test it empirically based on scientific investigation which was the aim of this study.

As can be seen from the theoretical model **[Figure-1]**, involving e-learning into conventional learning, the learning style was modified by this experimental study into blended e-learning model using the modern technology in support of upgrading quality of education in general and mathematics in particular. The aim of the study was therefore to see if there is any improvement in contribution to the learners' academic performance.

The study did not show any difference in academic performance though there were several contributions gained by this ICT supported learning style.

To begin with, the two major components, the conventional and e-learning were the basis to implement the blended style exercised in this study.

As from the constructivist points of view, pervious knowledge and experiences should be the basis for constructing new knowledge for sure emerging from both the above components. The conventional learning demonstrates the dominant lecture method supported by tutorial sessions which are regular activities for mathematics class activities done both in group and individually supported by assignments and home works and then continuous assessment integrated from the beginning to the ending.

In the new second component, students at least have awareness and some theoretical background about the ICT to support the blended style, or else, sufficient skill to handle it fully.

In this new scenario, students are supposed to read content materials, do a variety of exercises and reflect their ideas in open - ended queries in the discussion forum. They exchange ideas with friends and instructors online, and communicate any information disseminated by the teacher like notices and instructions. So all the above activities are integrated together based on the previous experiences to build new knowledge in a piece meal demonstrating constructive learning. According to the ICT supported learning observed in this study, students demonstrated more of the e-learning participating in group/collaborative learning and self work with no pure conventional face -to -face learning except the weekly consolidation sessions. In this experimental design of learning, students read the learning materials by themselves,

do exercises either in group or individually; the teacher simply provide introduction and guide for few minutes (about 15) whereby the Moodle software package acting as a tutor by giving feedbacks right away. The teacher exercises the conventional face-to-face only for 2 hours summary session per week briefly consolidating all the lessons of the week. In addition, continuous assessments are controlled by the teacher giving assignments through the ICT and quizzes, tests and examinations (formative and summative) conventionally since the control group shall take them too.

Therefore, the analytical framework of this study could possibly be categorized into three compartments: first the prior knowledge of students to be tested by the pre-test, the next, the actual integrated learning process indulging the mix of deliveries (conventional and e-learning) influenced by individual learner's attitude, talent and effort provided is supported by conductive facilitation. And then the third is the expected output in question, the students' performance which could still be affected by the quality of delivery system and other external factors like availability (access) of the electronic materials outside the ICT labs, which was tested after the designed experiment was done successfully, to bring about a change to a new direction.

The following analytical model portrays the intended analytical design to put the investigation into practice so that the result may either be successful as predicted (better performance) or redirect the investigation according to the findings.

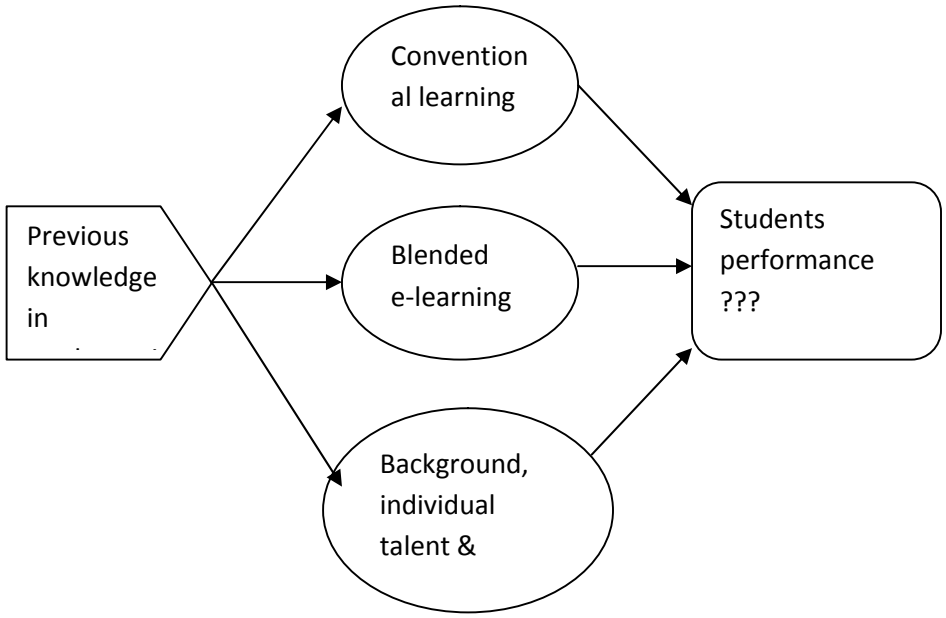

Figure-2: Analytical framework model for e-learning infusion influence

As expected by the theoretical model, two major changes were observed as revealed by the study. These were students involved in self regulated learning throughout the e-learning activities detached from traditional teacher dependent tendency, and the new

knowledge and skill of teaching and learning method exercised by the teacher gained from the experimental practice. That is, the teachers involvement reduced to introduction, guiding, supervising, consolidating and assessing continuously while the reading and understanding the concepts, the computational exercises including logical reasoning by proving theorems though simple constructive exercises, all through the technology support which is the new phenomenon. Here, even the tutorial, the session when students demonstrate what they have tried and get feedbacks are done by the technology itself right away and could be repeated as many time as the learner needs.

So, the study demonstrated a change in the learning system constructively; students who are better off in their previous knowledge and skills of handling the technology benefited a lot and transformed it by helping their friends who have very low experience in using computer and internet. This demonstrates enhanced collaborative learning. Besides, collaborative learning, students also exercised self regulated learning by using the internet facility and working independently during their extra time. In addition to the subject syllabi, Group Theory, students' knowledge and skill about handling internet-connected computers increased a lot in which they did not get it sufficiently during their previously delivered computer courses and it will be a very good basic background to ICT related courses (be it computer or mathematics) later on, making the technology friendly. Obviously, how to take the challenge is one important experience gained by both students and teachers constructively. The change in planning and designing the learning material and lessons to fit into the technology is also very important new experience of the teacher in addition to the change in teaching and learning methods explained above.

Therefore, the blended e-leaning style has contributed a lot to changing the conventional system into a new but assimilated schema of learning based on the previous knowledge and experience of teaching and learning of both parties. For this change, the new technology facilities supply to the conventional one and the individual student talent and attitude towards wanting to learn through the new system are factors/inputs affecting the learning system to change, though we cannot say about the performance yet due to various reasons mentioned above.

This is, as conveyed by the analytical, model expected during the plan of the study. In such a way that the blended model implemented underpinning the background as a foot step and supported by individual talent and attitude of students. Is to say that the modern technology facilities taken into consideration to come up to a new contribution to enhance mathematics learning as an output, a change in the existing learning system.

Conclusions and recommendation

The influence of e-learning: The academic performance of the two groups was significantly different before the experiment in which the treatment group had relatively better performance in the two pre-tests done. But, from the t-test done on the post test, after the treatment, the results showed that there is no any a significant difference among the groups except variety of challenges surrounding the implementation activities which needs to be considered before acting on the experiment. From this result, we can recommend that it will be wise to repeat the experiment through longitudinal design after seriously alleviating the very critical

problems against e-learning implementation.

Benefits of e-learning: As we can see from the finding, e-learning exercise benefited the learners to practice independent work, collaborative learning, making students to be technological friendly, making them use their extra time, etc. So constructive learning was enhanced through this blended learning. This has to be encouraged and we have to refrain from generalizing the new system that it did not surpass the conventional one just using one experiment experience. Hence, the need to test it several consecutive treatments and variety of courses may be the future scope.

Major challenges and suggestions for solutions: From the results, problems like lack of adequate ICT facilities to satisfy the learning needs including independent e-learning implementation labs, reducing the density of student population per computer desk and increase the time given to access internet, availing adequate ICT experts to help students and teachers for trouble-shooting during e-learning exercises, reducing connectivity problems and smoothening the ICT management system.

Acknowledgement

I am very much grateful to Jimma University for granting me the fund to accomplish this study.

REFERENCES

Bass, H. (2006). E-learning Mathematics Panel promoted by the Spanish Conference of Mathematics deans. The Instructional Potential of Digital Technologies. (Presenter). (pp. 6-10),

Biggs, J. B. (1999.). From Theory to Practice: A Cognitive Systems Approach. *Scandinavian Journal of Educational Research*: N(n),

Brown, J. S., Collins, A, & Duguid, P. (1989). Situated cognition and culture of learning. Educational Researcher, 18(1), 32-42.

Caillods, F., Gottelmann-Duret, G. & Lewin, K. (1996). Science education and development: Planning and policy issues at secondary level. Paris: UNESCO international Institute for educational Planning (IIEP), Pergamon Press.

Carnoy, M, (2004). ICT in Education: Possibilities and Challenges. http://www.uoc.edu/inaugural104/dt/eng/carnoy1004.pdf

Choi, J. I. & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. Environmental Technology Research and Development, 43(2), 53-69.

Cobern, W. W. (1996). Constructivism and Non-Western Science Education Research. *International Journal of Science Education*, 4(3): 287-302.

Couco, A. A. & Goldenberg E. P. (1996). A Role of Technology in Mathematics Education. Journal of Education, 178(2), 15-32.

Creswell, J. W., (2009). Research design Qualitative, Quantitative, and Mixed Methods Approach. University of Nebraska-Lincoln, Los Angeles. London. New Delhi. Singapore.

Descamps, S. X. (2006). E-learning Mathematics (pp. 1-5), Panel promoted by the Spanish Conference of Mathematics deans. Introduction to the presentations (Moderator).

Hic P & Pokorny M. (2005). E-learning in Mathematics Teaching. Department of Mathematics and Computer Science,

Faculty of Education, Trnava University, Priemyselna, Trnava, Slovak Republic. phic@truni.sk, mpokorny@truni.sk

Khirwadkar, A. (2007). Integration of ICT in education: Pedagogical Issues. Center of Advanced Study in Education, Faculty of Education. The M.S. University of Baroda. India.

Kramer, B. J. (2000). Forming a federated Virtual University through course broker middleware, in proceedings: Lear Tec 2000, Heidelberg.

Mayer, R. E. (2003). Elements of a Science of E-Learning. J. Educational Computing Research, Vol. 29(3), 297-313.

Mc Kenney, S. E. (2001). Computer based support for science education materials development in Africa: exploring potentials. Thesis University of Twente, Enschde. ISBN 9036516420. (p. 33-37)

Ministry of Education [MoE], (2002). Education Sector Development Program II (ESDP II).The Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.

Ministry of Education [MoE], (2003). Teachers Education System Overhaul (TESO), Handbook, final. Ministry of Education, Addis Ababa, Ethiopia.

Ministry of Education [MoE], (2005). Education Sector Development Program III (ESDP III).The Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia.

Olaussen, B. S., Barten, I. (1999). Students' Use of Strategies for Self-regulated Learning: cross-cultural perspectives. *Scandinavian Journal of Educational Research*: N(n),

Perkins, D. N. (1991). What Constructivism demands of the learner educational technology. 31(1), 19-21.

Shuell, T. J. (1986). Cognitive Conceptions of learning. Review Educational Research, (pp. 411-436).

Serbessa, D. D. (2006). Tension between Traditional and Modern Teaching-Learning Approaches in Ethiopian Primary Schools. CICE Hiroshima University, Journal of International Cooperation in Education, 9(1), 123-140.

Wilson, V. (1997). Focus Group Discussion: a useful qualitative method for educational research?. *British Educational Journal*, 23(2), 209-224.

Yager, R. E. (1991). The Constructivist Learning Model. The Science Teacher, (pp. 52-57).

Yizengaw, T. (2007). A Policy white paper prepared by Ministry of Education and Capacity building on Undergraduate and Graduate degree programs mix and student placement in the expanding of higher education system in Ethiopia.

Youssef A. B. (2008). The Impact of ICT on Student Performance In Higher Education: Direct effects, Indirect Effects and Organizational Change. Revista de Universidad y Siciedad del Conocimiento. 5(1), p45.