ETHIOPIAN PUBLIC UNIVERSITIES' MATHEMATICS CURRICULUM: A CHANGE NEEDED TO TECHNOLOGY SUPPORTED LEARNING

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Abstract. The aim of this study is to improve the quality of mathematics curriculum in Ethiopian Public Universities by investigating the required changes in mathematics curricula to satisfy the demands of the STEM vision. The researchers used a case study research design of qualitative research approach to answer the research questions. Moreover, respondents from undergraduate Mechanical Engineering students was a selected through simple random sampling technique. We found that the current mathematics curriculum in Ethiopian Public Universities lacks important ingredients' technology supported learning, to meet STEM vision. Furthermore, it is better to have Mathematics Computer Laboratory as a part of the curriculum. Finally, we end with further research about the implementation.

Keywords: STEM vision, mathematics curriculum, Ethiopian public universities, technology supported learning

Introduction

In higher education across the globe, more attention is given to Science, Technology, Engineering and Mathematics (STEM) since economic growth and industrial notions are highly dependent on such areas of study (Awang &Zakaria, 2013; MoE, 2008; Teshome, 2004). In line to this, Ethiopia gave due attention to science, technology and mathematics education to cop up with upsurge of new worldwide competition in science. Thus, Ethiopia Ministry of Education (MoE) used a 70:30 ratio placement of students into science and technology programs over social sciences and humanities programs (Anduale m, 2014; Kassa & O'Connell, 2014; Mekbib, 2011; Taye, 2011). Out of 70% enrolled to science and technology program, about 40% assigned to Engineering and Technology (Mekbib, 2011; Mulugeta et al., 2015).

In contrary to this, literature indicates that students' mathematical performance is poor. For instances, a study conductive by Tadesse (2014) at Dire Dawa University indicates that students have weak mathematics background, poor conceptual understanding and poor problem solving skill based on assessment done in. Similarly, Kassahun (2014) indicates that student's mathematics performance at Jimma University is very weak.

Statement of the problem

Ethiopia education policy gives a special attention to the proper usage of educational technology to support and strengthen the teaching-learning process (MoE, 1994). Moreover, literature indicates technology supported learning as one way of strategies to enhance student's conceptual understanding and problem solving skill (Al-Ammary, 2013; Mulugeta et al., 2015; NCMT, 2000 and Roblyer, 2006; Solomon & Ashebbir, 2012).

In general, there is a limited amount of research conducted that examines the prerequisite skills, beliefs, knowledge base and experience necessary for

teachers to support instruction with technology in general and in Public Universities in particularly. Thus, this study fulfils the research gap when looking for technology supported learning and its challenge during implementation.

Research questions

This study aims to give answers for these two main questions: (1) How students learn mathematics using MATLAB supported; (2) what are the challenges of technology supported learning in Ethiopian public universities; (3) do the current Mathematics Curriculum for undergraduate students adequately prepare them for the workplace.

Significance of the study

This study is significant in several ways when looking at technology supported learning. So, beneficiaries of this study are students, teachers, instructional designers and mathematics education researchers.

The first beneficiaries are students. They were suffering a lot to understand concepts of functions of two variables in Applied Mathematics II during classroom lecture. To tackle this, today, there are a lot of activities that needs software simulation, so that it enables teachers and students to use it within and outside classroom. Out of such software, MATLAB is one when used for instructional purpose.

The second beneficiaries are teachers. Teachers took much time to elaborate and make the concepts in a function of two variables understandable for students. But, mathematical software enables the teachers to make mathematics classroom active, interact and attractive in all ways like through explaining a concept using symbolic and graph representation, letting the learner to build their own understanding and driving meaning through relating on concepts with others using mathematical software among which MATLAB is one.

The third beneficiary from this study is instructional designers. Different scholars highlighted the importance of different educational software in teaching and learning process. So, wisely application of software encourages students to understand the concepts behind problems and save time to solve the problem particularly, in sketching 2D and 3D graphs of functions of several variables in different disciplines.

Literature review

Teaching and learning mathematics in 21st century

A mathematics classroom is a classroom that provides practical experience in mathematical skills and serves as a bridge to the real world. It is an environment that goes beyond memorization into a world of reasoning and problem-solving. The mathematics classroom is a forum that provides interplay between the mathematics teacher, the learner, the content which hinges on mathematics and the learning experience to help understanding (Gladys & Deme, 2016). In order to ease this interplay of the 21st century in mathematics class, mathematics teachers need have an in-depth knowledge of content, pedagogy and technology. On top of this, teachers need to think on how teach an important ideas embodied in the mathematical concepts using an appropriate integration of pedagogy and technology to foster students understanding and skill (Chai et al., 2013; Handal et al., 2013).

In the 21st century society, true learning requires being able to use new technologies, not simply to enhance the ability to memorize and repeat facts, but to gather, organize and check information to solve problems and innovate practical ideas in real-world settings (Jimoyiannis, 2010). In developed countries (e.g., USA, UK, etc.) technology is one of the fundamental principles forwarded by Principles and Standards for School Mathematics (PSSM) to assure quality education in general and mathematics in particular. Nowadays, educational technology all school levels and across all disciplines, particularly mathematics is highly recommended to enhance mathematical thinking (Ferrini-Mundy,

2000; Van de Walle, 2007). Thus, to bring a concrete and experimental approach to mathematics class, mathematical technology plays a vital role. Especially, use of different software becomes one of important elements of computer-assisted instruction among which MATLAB software is one that is used at higher education level.

MATLAB software supported learning

MATLAB is an abbreviation for matrix laboratory (Charles-Ogan, 2015). It is dynamic mathematical software that integrates computation, visualization and programming that helps as a language for technical computing (Almekhlafi & Almeqdadi, 2010; Katehi, 2005; Lim et al., 2013; Majid, 2014; Ocak, 2006; Preiner, 2008). It is an interactive system that allows the learners to solve different problems using matrix and vector formulation when compared with non-interactive languages like C or FORTRAN. Besides, MATLAB software is a quite popular and used for both teaching and research.

Software helps for creating, exploring, and analyzing a range of mathematics concepts in the field of mathematics such as algebra, geometry, trigonometry, calculus, and other areas (Scher et al., 2005). So, software supported learning is a process of using software aided system in teaching and learning process. It is a matter of using different software in classrooms that suits and make learning simple and understandable. Nowadays, different software is available on the market useful for the educational system, particularly in mathematics (Tarmizi et al., 2010). Moreover, technology supported learning is supported by NCMT (2003).

According to Al-Ammary (2013) technology supported learning is a solution to instructional problems that improve the effectiveness and efficiency of learning within education context. Al-Ammary (2013) sees educational technology as a medium for inquiries like usage of data modelling; communication like utilization of graphic software; construction like utilization of CAD; and expression like software animations; and as a tool for improving lessons, empowering

teachers and learners through, and shifting teaching and learning process for teacher-centered to learner-centered approach.

For Roblyer (2006), educational technology could be a media, instructional system and instructional design, vocational training, and computer system in general. It lets learners motivated, have clear mental pictures about the content, enhance instructional methods, increase productivity, and equip with up-to-date information. That is why the National Council of Mathematics Teachers (NCTM, (2002) included technology as one principle of mathematics education since it influences content taught and enhances students' learning.

Educational technology is now seen as an essential tool in teaching and learning of mathematics because it saves time and gives students an access to explore concepts in depth that has not been possible in the past. The new developed technologies such as computer, smart classroom, internet, and different educational software are affecting educational system. It is "not only a product of a given culture; it also shapes the culture that created it" (Almeqdadi, 2005).

Technology facilitate classroom and make student beneficiary. Ghavifekr & Rosdy (2015) claims that technology supported learning promotes positive attitudes toward learning. It is true that technology, particularly software integrated learning makes the classroom more interactive, and encourage the students to build their own understanding and not passive receivers. Almeqdadi (2005) claims that to get the maximum benefit from technology schools should expect more integration, interaction, and intelligence from future technology. So, it is the duty of the mathematics teachers to upgrade themselves with technology and integrate it into teaching and learning process to enhance learning.

In fact, technology is not only the usage of different software; it also includes materials like TV, Calculators, Laptop, LCD projectors, Computers and so forth. So, the teacher is in a place to use an appropriate educational media that fosters mathematical literacy of students, enhancing students' thinking, giving attention and use mathematics intelligently and not on covering a wide area

of mathematical content or on using advanced mathematical content, integrating the various branches of mathematics and the role of technological tools in enhancing mathematics learning (Tesfaye, 2009). According to Tarmizi et. al (2010) such novel technology is supposed to add value to education and to support instructional approaches particularly mathematical software.

Nowadays, many types of computer software are used in mathematics education. The widely used are Computer Algebra Systems (CAS) and Dynamic Geometry Systems (DGS). While DGS have their focuses on relationships between points, lines, circles, etc, CAS focuses on manipulation of symbolic expressions, and includes graph to visualize mathematics (Mehanovic, 2011).

One of important features of mathematics software is that it allows the learners to get an immediate feedback on his/her work. This implies that, in an interaction with dynamic software, mathematical concepts and /or simulations of real world problems explored in a broader way in comparing with non-software supported learning (Mehanovic, 2011). Moreover, Hohewarter (2004) and Preiner (2008) suggested that software supported learning allows the learner to different representations. An access to different representation registers of a mathematical concept can support students' conceptual understanding (Duval, 2006).

On top of this, Preiner (2008) revealed that interacting with software lets the students to explore a mathematical concept in a broader way when compared with non-dynamic learning environments. Based on these recommendations, the researcher supported collaborative method and traditional lecture method by MATLAB software to investigate its effect on students' conceptual understanding and problem solving.

Role of teachers and students in MATLAB software supported learning

Software technology support learning allows the students active thinkers about information, making choices and executing skills than is typical learning

(Preiner, 2008). Moreover, when software technology is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress (Ghavifekr & Rosdy, W2015).

The students are no longer passive listeners sitting on desks during teaching and learning process. They are in charge of their own learning, taking an active role (Eyasu et al., 2013). They are held responsible for their work and their findings. Teachers take on a facilitating role than an executive role. Leading their students to develop the information on their own is more effective than telling their students vocabulary, facts, recalling of information, and relationships that they need to memorize.

Teachers' willingness embraces the use of new technology. According to Ghavifekr & Rosdy (2015), the process of using technology to learn mathematics leads teachers to think of mathematics as a subject for exploration through which they (the teachers) can make conjectures, confirm and prove conjectures, extend a problem with a change of index or assumption, and excite participants about their own capacity to learn. However, effective use of the software also requires conceptual learning (Tesfaye, 2009). The proper implementation and usage of technology in classroom determines the attitude of the students towards technology supported learning (Nguyen, 2009). So, what is the pedagogical implication of software supported learning in an educational context? This is discussed under the following sub-topic.

Pedagogical implication of software in education context

` Teaching in a systematic approach requires teachers in the process of developing knowledge through the suitable method to induce effective learning in the classroom. The time of pouring one's own understanding into the learners' mind is already gone. Now, we are in the era of constructing our own understanding based on our prior knowledge, interaction with peers, and ideas we gain from teachers. The overlaps of these three lead us to what we call meaning

construction. Learning depends on the way the learners interact with situations, beliefs, attitudes, and experiences (Handal & Herrington, 2003).

A variety of approaches could be used to increase students' mathematical skills and their understanding of mathematical concepts. An alternative approach is the use of software technology supported learning that could help teachers not only in the teaching of mathematical concepts, but also to lighten their workload and allow them to solve student's problem individually. The use of computers in mathematics education was able to make the teaching and learning approach more up-to-date and interesting as compared to the traditional lecture method. Indirectly, this helps to shape a young generation physically, emotionally, spiritually and intellectually capable of solving mathematical problems (Nordin et al., 2010).

Material and methods

Research methods and design

Qualitative is a research approach guided by interpretivist or constructivist (Creswell, 2012; Creswell & Clark, 2007; Yin 2003). It enables the researchers to understand, explore, describe and explain phenomenon under investigation (Tewksbury, 2009). Therefore, to conduct this study the researchers employed a case study research design.

Population and sampling techniques

The target population for this study included all students in the school of engineering and technology enrolled at Wolkite University. Out of Engineering and Technology students, two intact classes: Mechanical Engineering group 1 and 2 were selected using simple random sampling technique. Moreover, purposive sampling method was used to select a sample for interview from each intact class. Totally, about 6 students were selected for interviews.

Instrument

About 32 closed ended questions for classroom observation checklist questions were prepared by the researcher in order to see the way teachers are delivering lessons. Moreover, the researchers observed the way instructional designs prepared was implemented in the computer lab and in classrooms. Classroom observation checklist was classified into three components such as learning environment, students MATLAB software use and lesson implementation. Based on this, the researcher answered question that deals with the challenges of using MATLAB supported learning method for instructional purpose.

Results

Challenges of MATLAB supported learning in the classroom

An observation checklist tool was prepared by the researcher and observation was done three times by a third party, teachers, who have both content and pedagogical knowledge. The result of classroom observation done based on checklist was classified into three categories, i.e. observation related with learning environment, MATLAB supported learning implementation in computer lab room, and students' MATLAB software usage capacity.

Learning environment

Regarding learning environment, the students' willingness to work in groups and use of higher order thinking to cope up with the new environment in the computer lab was very high. In classrooms attractive, interactive and good discussions were observed. Students' willingness to help one another and interesting initiatives to discuss with their peers were high. Lab room was well furnished with 30 working computers, MATLAB Software installed to each computer and have internet. There is one desktop computer for one student. It was well organized and well ventilated room for students.

Majority of the students can able to cope up with MATLAB features as fast as they can when demonstrations were given by MATLAB teacher. Firstly,

they were exposed to practice based on examples given to them through lab room teacher. And then, they were asked to practice individually. Then, their conceptions were probed using different questions in order to do different activities as per their group for MATLAB supported learning in combination with collaborative method and individually for MATLAB supported learning in combination with traditional lecture method. Almost all students were performing high as per classroom observation checklist recorded.

MATLAB supported learning implementation

Under this section the way MATLAB with collaborative learning method and lecture method used to teach selected topics of the course was presented. Moreover, the implementation of MATLAB supported learning in computer lab was discussed and classroom observation result was presented.

a) Computer laboratory sessions

MATLAB based activities were designed in order to foster students conceptual understanding, develop students' problem solving skill and motivate students. The activities contained MATLAB commands and exercise problems for students to be done.

Group discussion creates good opportunities for students to share their ideas for each other. They were highly encouraged to discuss with each other to solve activities given to them. In case if they cannot perform it the lab assistant and MATLAB teacher give them a necessary guidance in order to reaches at right solution by themselves. For MATLAB supported learning with collaborative learning method about 20 minutes were given for teachers to introduce the daily lesson and demonstration, 40 minutes to do activities with MATLAB software on Computer and 30 minutes for group discussion and teacher use. For MATLAB supported learning with lecture method 30 minutes were given for teachers to introduce the daily lesson and demonstration, 40 minutes to do activities with MATLAB software on Computer and the remaining 20 minute was

used for stabilization purpose. Generally, topics chosen for teaching MATLAB software in both groups were listed in the following Table 1.

Table 1. Course topics covered in MATLAB supported learning classes

Labs	Period	Course topics covered
1.	2	Basic MATLAB tutorial, sketching and visualizing graphs of function of several variables
2.	2	Level curves
3.	2	Limit and continuity
4.	2	Partial derivatives
5.	2	Extreme values
6.	2	Double integrals
7.	2	Triple integrals
8.	2	Regions of integration

b) Laboratory one

The objectives are: to introduce MATLAB software to the students - brief introduction of MATLAB and ketching and visualizing graphs of functions of several variables

A tutorial was given to students on how to operate MATLAB software and the way they have to write different commands on the command windows. This includes: (i) brief introduction to MATLAB; (ii) MATLAB command window, command history and workspace; (iii) the way to use mathematical functions (abs(x), sin(x), asin(x), exp(x), pi, etc.); (iv) commands such as close all, clear all, clc, ctrl c, exit, quit.

Saving m file: basic arithmetic commands such as +, *, /, ^, ; defining variables (syms x, y, z).

c) Laboratory two

Objective: To sketch graphs of 3-D and visualize level curves of a function of two variables.

The teacher introduced level curve concept and demonstrate it using MATLAB Software. The teacher showed them using different functions of two variables as example, then the teacher gave them an activity to sketch the level curve of a function $f(x,y) = x^2 + y^2$. Then, students write the following commands on the window of the MATLAB so that they can get the 3D graph and the level curve of the function on the same figure as follows:

```
x=[-2:0.1:2];
y=[-2:0.1:2];
[xx,yy]=meshgrid(x,y);
zz=sqrt(xx.^2+yy.^2);
surfc(xx,yy,zz).
```

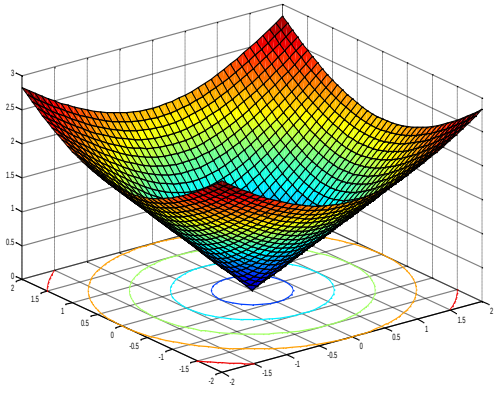

Figure 1. Level curve of a function of two variables

There are also students using the following MATLAB script

```
symsxy
ezmeshc(x^2+y^2,[-2,2,-2,2]).
```

d) Laboratory three

Objective**:** To find limit of a function of two variables.

The teacher introduced limit of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, then the teacher gave them an activity to find $\lim_{(x,y)\to(0,0)} \frac{2xy}{x^2+y^2}$. Then, students write the following commands on MATLAB window so that they can sketch the graph of the given functio and determine limit and continuity of the function at a given point as follows:

```
symsxy
ezsurf((2*x*y)/(x^2+y^2))
```

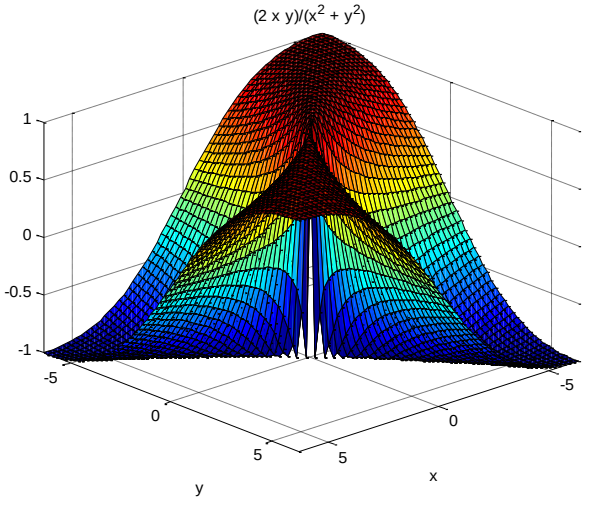

Figure 2. Limit of a function of two variables

e) Laboratory four

Objective: To find partial derivatives of a function of two variables.

The teacher introduced partial derivatives of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, then the teacher gave them an activity to find a

partial derivative of $f(x,y) = sin(xy)$. Then, students write the following commands on MATLAB window so that they can get solution as follows:

```
syms x y;
f=sin(x*y);
diff(f,x)
diff(f,y)
diff(diff(f,x),y)
Answer
ans = y*cos(x*y)
ans =x*cos(x*y)
ans = cos(x*y) - x*y*sin(x*y)
```

f) Laboratory five

Objective: to determine extreme values of a function of two variables.

The teacher introduced how to determine extreme values of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, and then the teacher gave them an activity to determine extreme values of a function $f(x,y) = xe^{-x^2-y^2}$. Then, students write the following commands on MATLAB window so that they can get solution as follows:

```
symsxy
ezmesh(x*exp(-x^2-y^2),[-2,2,-2,2])
```

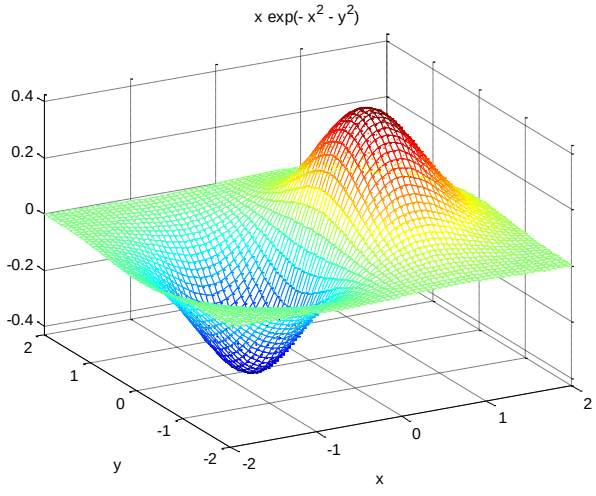

Figure 3. Extreme values of a function of two variables

g) Laboratory six

Objective: to find double integrals (both definite and indefinite) of a function of two variables.

The teacher introduced double integrals of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, and then the teacher gave them an activity to determine double integral $\int_0^3 \int_0^{3-x} xy\,dydx$. Then, students write the following commands on MATLAB window so that they can get solution as follows:

```
syms xy
firstans=int(int(x*y,y,0,3-x),x,0,3)
Answer
firstans  = 27/8
```

h) Laboratory seven

Objective**:**to find triple integrals (both definite and indefinite)of a function of two variables.

The teacher introduced double integrals of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, and then the teacher gave them an activity to determine double integral $\int_0^2 \int_0^{\sqrt{4-x^2}} \int_0^{\sqrt{4-x^2-y^2}} x^2y^2\,dzdydx$. Then, students write the following commands on MATLAB window so that they can get solution as follows:

```
symsxyz
firstans=int(int(int(z*(x^2*y^2),z,0,sqrt(4-x^2-
y^2)),y,0,sqrt(4-x^2)),x,0,2)
Answer
firstans =pi/3
```

i) Laboratory eight

Objective**:** to determine regions of integration for both double and triple integrals using graphical method from MATLAB result.

The teacher introduced how to determine regions of integration for both double and triple integral of a function of two variables using MATLAB Software. The teacher showed them using different functions of several variables as example, and then the teacher gave them an activity to determine regions of integration between a function and a function so, that to determine the volume of the region found between the intersecting surfaces $f(x,y) = 20 - 3x^2 - 2y^2$ and $f(x,y) = 2x^2 + 3y^2$ on the interval $-3 \le y \le 3\ and - 2 \le x \le 2$and determine which of the function is an upper region and which is a lower region using MATLAB. Then, students write the following commands on MATLAB window so that they can get solution as follows:

```
ezmesh(sqrt(20-3*x^2-2*y^2),[-3,3,-2,2]);
holdon
```

```
ezmesh(2*x^2+3*y^2,[-3,3,-2,2])
view([1,2,3])
holdoff;
```

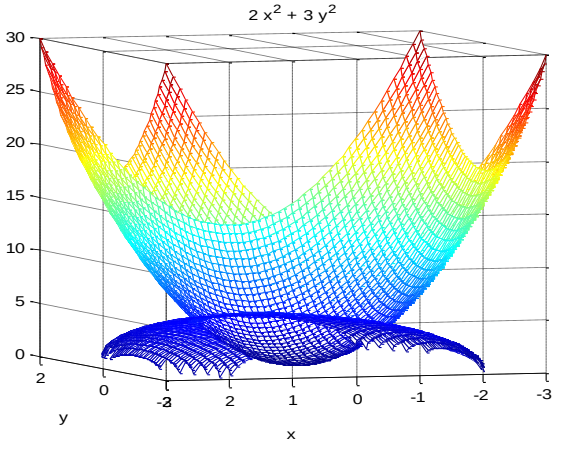

Figure 4. Region of integration

Challenges of implementing MATLAB supported learning

Concerning MATLAB supported learning implementations observation checklist indicates that MATLAB software goes hand-in-hand with objective of the lesson. It lets the classroom teachers to assess process that the students follow during problem solving and spatial skill of students in addition to traditional assessment method which relies only on paper and pencil test to measure the outcome only. Moreover, MATLAB features are simple to understand easily and make classroom active, attractive and interactive especially when it is used with collaborative method.

It was observed that some students were confused to working on MATLAB. They need help of their friends and teachers particularly to write a given function of two variables on MATLAB command window. Students from both groups were observed redundantly that they were looking for help. Unfor-

tunately, those of students assigned under MATLAB supported learning in combination with traditional lecture method have on chance to discuss with their peers, so fail to construct what they were asked. On the other hand, the students assigned under MATLAB supported learning in combination with collaborative method have a chance to discuss and debate with each other on how to construct the given concept. They were encouraged to do activities and shows what they did to the classroom teacher and the assistant in order to get additional feedback in case.

Besides, MATLAB supported learning provides opportunities for students to interact with their colleagues and encourage them to discuss with each other on how to work with MATLAB, how to use different command, how to fix different region of functions of several variables using MATLAB within and outside of classroom. Sometimes the activities given to the students and the time allocated for the given activities mismatch. This forced the students to spent additional time for discussion and practices. For this purpose, classroom observer suggested the researcher to make lab room open for students to use it at any time till the end of the study.

The currentmathematics curriculum for undergraduate students

In 2009 Ministry of Education urged to develop a new harmonized curriculum to ensure quality, standard and relevance in line with the country demand. Besides, it aims to enrich the Ethiopian Higher Education Curriculum incorporate a good practice of European universities to meet the current global trend.

Moreover, the harmonized curriculum document of higher education indicates that instructional approaches like lecture method based on active participation, classroom discussion, presentation in group, reading assignment, practical work (Computer Lab.), project work, modelling of practical problems and class activities to be used in mathematics classrooms. The document lacks on recommending useful mathematical software so that teachers can utilize them

in classroom settings. There is still a gap observed on the current mathematics curriculum for undergraduate students on preparing them for this digital era.

Literature indicates that utilization of technology in classroom for instruction purpose enlivens and revitalizes the learning of mathematics in general and Applied Mathematics in particular (Mulugeta et al., 2012). The result of observation checklist also shows that utilization of MATLAB software in such advanced mathematics course is useful to make lesson simple and understandable.

However, those who designed undergraduate mathematics curriculum did not take any mathematical software in general and MATLAB software in particular into consideration to be used in mathematics classroom. This could be because of many reasons. Some of the major factors could be as follows: lack of trained human power; lack of awareness; lack of motivation from teachers' side; lack of adequate time allocated, etc.

This result aligned with work of Cretchley et al. (2004) that shows there is the challenge of coping with the diversity of background, mathematical skills, interests, needs and aspirations that both teachers and students have on the entry. Software technology supports learning mathematics, especially, MATLAB software is a package that is favored by Engineering and Applied Mathematics field of studies which is considered as a strong potential in supplementing students understanding and problem solving skill (Cretchley, et al., 2004). But, a study conducted by Eyasu et al. (2013) reveal that MATLAB supported learning in combination with the collaborative method supplements students' conceptual understanding than other method of teaching.

On the other hand, there are ample studies shows that teachers are challenged in using software technology in their classroom. According to Jones (2004) there are challenges like lack of confidence to use software technology, lack of access to resources, lack of time in the classroom, the lack of effective training, facing technical problems while using in the classroom and lack of

preparation. Moreover, Snoeyink & Ertmer (2002) barriers like lack of computers, lack of quality software, lack of time, technical problems, teachers' attitude towards computers, poor funding, lack of teacher confidence, resistance to change, poor administrative support, lack of computer skill, poor fit with curriculum, scheduling difficulties, poor training opportunities and lack of how to integrate it into instruction. Similarly, a study conducted by Agyei & Voogt (2011) reveals that specific feature of teacher training scenario matters software integration in mathematics class.

Conclusion

This study reveals that students were novice for technology supported learning in general and particularly, MATLAB software supported learning in Applied Mathematics II. So, it is wise to consider technology supported learning in Ethiopian higher education to make the concept clear, simple and understandable for students and preparing them for the twenty first century workplace since they are in the era of technology born generation in general and MATLAB supported learning in particular for such advanced mathematics classrooms. Thus, Ethiopian public universities need to take into account the use technology supported learning in general and MATLAB supported learning in particular in mathematics classrooms rather than sticking to the traditional instructional approach.

Implications of the study

The study has direct implication for university leaders, educators, policy makers, researchers, mathematics educators, students and the instructional designers. The advanced mathematics courses require the use of educational software like MATLAB can be a good choice for engineering and technology students. MATLAB is one of the mathematical software most widely used for teaching mathematics.

Mathematics educators can adopt the strategies that fit their context so that they can supplement their classroom instruction with MATLAB. This study can be extended to all mathematics courses (such as numerical, optimization, etc) in general and applied courses (such as Applied Mathematics I and Applied Mathematics III) in particular.

Utilization of mathematical software in general and MATLAB software in particular is more appropriate if it is used in small classroom size and combined with collaborative learning method.

Recommendations

MATLAB was considered because of its relevance in mathematics and engineering and technology disciplines. It is recommended to support classroom instruction by MATLAB software to foster students' conceptual understanding and problem solving. However, some factors need to be taken into consideration. Those are: (1) careful activity design, where to apply, when to use and how to use MATLAB; (2) MATLAB supported learning requires a competent enough instructors to use technology for teaching purpose; (3) MATLAB supported learning in combination with collaborative method can be made both in computer laboratories; (4) the researcher recommends that it would be better for students if they learn through MATLAB supported learning in combination with the collaborative method for better conceptual understanding.

NOTES

1. https://projects.worldbank.org/en/projects-operations/project-detail/P106855

2.https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.572.3115&rep=rep1&type=pdf

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