# LearningAlgebrathroughBlended Approach: A Mixed Method Methodology

**Aweke Shishigu**

**A Dissertation Submitted to**

**The Department of Science and MathematicsEducation**

**In Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Mathematics Education**

**Addis Ababa University**

**College of Education and Behavioral Studies**

**Addis Ababa, Ethiopia**

**July, 2019**

# Learning Algebra through Blended Approach: A Mixed Method Methodology

**Aweke Shishigu**

**A Dissertation Submitted to**

**The Department of Science and Mathematics Education**

**In Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Mathematics Education**

**Dissertation Supervisors:**

**Dr. Mulugeta Atnafu**

**Dr. Kassa Michael**

**Addis Ababa University**

**College of Education and Behavioral Studies**

**Addis Ababa, Ethiopia**

**July, 2019**

**Declaration**

I, Aweke Shishigu, declare that this dissertation entitled, “Learning Algebra through Blended Approach: A Mixed Method Methodology” and the work presented in it are my own. I confirm that this work was done wholly while enrolled for a PhD degree at this University. Neither the thesis nor the original work contained therein has been submitted to this or any other institution for a degree. Where I have consulted the published work of others, I always clearly acknowledged. I have also acknowledged all main sources of help.So, this thesis is entirely my own work.

Sign: 

Date: July, 2019

# ADDIS ABABA UNIVERSITY

## College of Education and Behavioral Studies

## Department of Science and Mathematics Education

## Dissertation Approval Sheet

This is to certify that the thesis prepared by Aweke Shishigu, entitled: *Learning Algebra through Blended Approach: A Mixed Method Methodology* submitted in fulfillment of the requirement for the degree of Doctor of Philosophy in Mathematics education complies with the regulations of Addis Ababa University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Board Committee:

| | | |
|---|---|---|
| _____ | _____ | _____ |
| Supervisor | Date | Sig |
| _____ | _____ | _____ |
| Internal Examiner | Date | Sig |
| _____ | _____ | _____ |
| External Examiner | Date | Sig |
| _____ | _____ | _____ |
| Chair of Department or Graduate program Coordinator | Date | Sig |

# Learning Algebra through Blended Approach: A Mixed Method Methodology

**Aweke Shishigu**

**PhD in Mathematics Education**

**Addis Ababa University, 2019**

**Abstract**

With the current technological advancement, traditional ways of teaching and learning are considered as an oldest approach that does not suit for an active learning required of this generation. Because of this, adapting different ways of learning and teachings are being developed, one of which is the one used in this study (blended learning approach). This study was aimed to investigate the effect of blended learning approach in enhancing students' algebra learning with respect totheir achievement and affection. It also explored the perspectives of instructors and students as they experienced the blended approach. In order to improve the learning process that will address the above purpose, an interactive web-based learning platform was developed to supplement the face-to-face instruction in a university algebra course. To achieve the goal of the study, a mixed research methodology was employed. For the quantitative cause-effect relationship, a quasi-experiment with a pretest-posttest design was employed. For the qualitative part, a case study has been used. The study comprised three universities found at Southern Nations and Nationalities regions of Ethiopia. The data were collected over one full semester of the year 2017. The analysis followed an embedded analysis of quantitative and qualitative data. The quantitative data was analyzed

using both inferential and descriptive statistics, whereas for the qualitative part, thematic analysis was employed. Results indicated that as a result of the blended learning approach, students tend to advance their achievement and interest. However, the study highlighted that the affective aspect of students depend not only on the way of the teaching and learning process, but largely on other external factors. The study further found out a 95.74% satisfaction of students in the blended course. Blended learning is also effective in lessening the gender gap in mathematics learning. While blended learning approach has the potential to reasonably infuse the future, it remains critically important that it should be designed curiously and purposefully, which requires a thorough need assessment, and aimed to fill specific gap. Based on the results, additional imperative implications for practice and future research are forwarded.

**Acknowledgements**

This dissertation is the essence of a challenging journey that started as an idea which seems impossible for many peoples I met. Along the journey, I experienced many blind lanes and dead ends which finally let me to build a momentum. A number of individuals have provided guidance, support and motivation along this journey:

I am particularly thankful for my supervisors Dr. Mulgeta Atnafu and Dr. Kassa Michaelwho were the key guide in providing frequent, constructive and detailed feedback. I also forward my appreciation for my fellow colleagues: Eyasu Gemechu, Fikadu Eshetu, Habtamu Wodaj, Wolde Belachew and Yenealem Ayalew for their continuous support and beautiful commentary which helped me during this tiresome process.

I thankfully acknowledge the support of University of Vienna, Austria, for offering me a fellowship as an ERASMUS+ International mobility exchange student, which helped me to use all resources of the University and got in touch with prominent professors of the University. I am grateful to Dr. Michelle Proyer who was my supervisor during my stay in the University of Vienna. I thank you for your keen guidance and support. I also appreciate the salient contribution of Professor Renate Motschnig, Professor Daniel Tröhlerand Professor Judith Schoonenboom all of whom have read my dissertation. Their valuable advice and constructive criticisms helped me to improve the quality of my dissertation.

I greatly appreciate and acknowledge U1 for offering me a leave throughout the study years. I am also thankful to Addis Ababa University for giving me the admission for the PhD and support for my study.

I also forward my respect and appreciation to my beloved wife and my daughter whose prayers and love guided and supported me throughout the course of this study. To all of my family, friends, and loved ones who supported me during the last four years of study, I thank you for your love and support.

I would also like to extend my great appreciation to algebra course instructors, lab assistants and students of the study area, where the study was carried out. This study would not have been possible without their cooperation.

# Table of contents

**Contents** **page**

# List of Figures

## List of Tables

# List of Abbreviations

| Abbreviation | Definition |
|---|---|
| AHS | Academic Hardiness Scale |
| ANCOVA | Analysis of Covariance |
| ANOVA | Analysis of Variance |
| BL | Blended Learning |
| CTE | Colleges of Teacher Education |
| EIU | Economist Intelligence Unit |
| ERIC | Educational Resources Information Center |
| EBSCO | Elton B**. S**tephens**Co**mpany |
| HSD | Honest Significance Difference |
| ICT | Information Communication Technology |
| IT | Information Technology |
| ILIAS | Integrated Learning, Information and work cooperation System |
| KR-20 | Kuder-Richardson reliability index |
| LMS | Learning Management System |
| MARS | Mathematics Anxiety Rating Scale |
| MOE | Ministry of Education |
| Moodle | Modular Object Oriented Dynamic Learning Environment |
| MSLQ | Motivated Strategies for Learning Questionnaire |
| NEAEA | National Educational Assessment and Examinations Agency |
| OSLQ | Online SRL Questionnaire |
| OED | Oxford English Dictionary |
| Pdf | Portable document format |
| SRL | Self-Regulated learning |

| | |
|---|---|
| SR | Self-Regulation |
| SPSS | Statistical Package for Social Sciences |
| TPACK | Technological Pedagogical Content Knowledge |
| TV | Television |
| UK | United Kingdom |

# Chapter 1:Introduction

## 1.1. Background of the Study

Mathematics is studied at every level of formal education because of its immense role in the development of individual and society(Suratno, 2016). Compared with other subjects and fields of study, mathematics is fundament of all science and technology as its applications spear in different areas(Simamora, Simamora, Sinaga, & Calderon, 2017). Having knowledge of mathematics is therefore indispensable; it equips an individual with critical abilities such as reasoning, abstraction, relationshipand patternrecognition. Those skills are the foundations of higher-order thinking that are linked to other subjects. These aspects of mathematics are bases for a fast growing world.

Any educational program aims to change the human behavior in order to adapt to the changing environment. Study shows that quality of education has a strong influence on economic growth(Hanushek & Wößmann, 2007).So, maintaining quality education will bring about changes in the development of society and nation at large. Despite this fact, these days, quality of education, especially students skill in mathematics,have deteriorated in western countries(Pohjolainen, Nykänen, Venho, & Kangas, 2018); in Australia (Plenty & Heubeck, 2013), Uganda(Kiwanuka, Damme, Noortgate, Anumendem, & Namusisi, 2015), in South Africa (Preez, 2018); as well as in Indonesia (Simamora et al., 2017); and America (Tokpah, 2008). This is also true in Ethiopia. For instance, the national learning assessment conductedby the National Educational Assessment and Examinations Agency in 2014 confirms this phenomena, depicting the decline inthe achievement of students in mathematics(NEAEA, 2014). Though this assessment is conducted on grades 10 and 12,

those results can be inferred here because of the foundational contribution of secondary school education for higher education.Particularly, grades 11 and 12 are organized as preparatory for higher education in the Ethiopian context. Research also shows that university entrance examination has strong predictive power of university performance(Tesfa, 2014).

Learning outcomes in mathematics are not dependent merely on good teaching and sufficient resources, but also on what a student does such as attitudes, orientations, intentions and motivations(Pohjolainen et al., 2018).There are many variables, such as teacher-beliefs, instructional approach, gender, environment, lack of parental support, lack of self-confidence, learning styles, mathematics anxiety, and helplessness appearing to affect students mathematics learning(Iossi, 2007). Generally, the factors can be seen from two different perspectives namely behavioral and psychological. Factors external to students' personality are considered as behavioral or environmental factors, which include learning facility, family support, teacher factor, peer support etc. On the other hand, mathematics anxiety, motivation, attitude, confidence, self-efficacy, satisfaction and academic hardinesscan be taken as psychological factors that affect academic achievement(Mushtaq & Khan, 2012).

The maximum impact of educational research is obtained only when affective issues become a central position in the minds of researchers(Mcleod, 1992). To this end there is a need for more research focusing on students' engagement, motivation and satisfaction as part of students' academic performance(Drysdale, Graham, Spring, & Halverson, 2013). Students learning can also be affected by factors other than affect. Such factors include the pedagogy being used and social factors.

Currently, our world is experiencing scientific and technological changes.But, the traditional methods are relatively unable to cope with these changes(Alotaibi, 2013). This movement may force schools to adapt technological innovations to achieve their goals. But, if not managed effectively, it may lead to failure rather than success. Scholars rose the negative sides of technological adoption mainly due to resistance and failures(Asseffa, 2017a, 2017b). Not only this, technology has also other observed shortcomings such as dependency among students and the killing of time on social media. For instance, a meta-analysis conducted by Huang (2018) found a negative relationship of social media and academic achievement. But, in the course of action and effective use, educational technology may improve the quality of education (Asseffa, 2017b).

In the 21st century, the increasing popularity of computers and online learning environments are rapidly becoming more pervasive(Viz & Kaur, 2017). However, online learning environments lack many notable advantages that face-to-face environments have.This leads to the notion of blended learning approach, which can compensate weaknesses and pack the strengths of both traditional and online environments. Blended learning is the integration of classroom face-to-face learning experiences with online learning experiences. Blended Learning (BL) combines some characteristics of both traditionallearning and technology based learning which can overcome the limitations of both kinds of learning. It combines the traditional face-to-face learning environments with the information technology and telecommunications(Graham, 2009; Kitchenham, 2011).

Blended learning is further described by Thorne (2003) as a way of meeting the challenges of tailoring learning and development to the needs of individuals by integrating the innovative

and technological advances offered by online learning with the interaction and participation offered in the best of traditional learning.The online learning environment ensures the flexibility and effectiveness which cannot be found in a classroom environment, whereas face-to-face learning environment provides the social interaction which is required for learning(Akyuz & Samsa, 2009). Hence, blended learning involves activities such as contact with students through interactive sessions, e-mail, forums, promotion of interaction and communication between students, publishing electronic handouts, enriching information and links related to the content of the lectures, giving an electronic lecture, publishing samples of previous exams and providing students with an electronic environment of cooperative learning (Alotaibi, 2013). Furthermore, the teacher can use the web discussion area to address students' questions.

Blended learning is a formal and informal education program in which a student learns at least in part through online learning with some element of student control over the time or the pace. Employing only educational technologies is not blended learning rather it is taken as e-learning. More importantly, the method guarantees the ease of communication with students as well as providing them with all useful materials of the course (Alotaibi, 2013).Since definitions vary in the literature, blended learning is defined in this dissertation as a combination of face-to-face and web based environment which is similar to(Akyuz & Samsa, 2009; Graham, 2009), where blended learning is taken as the combinationof face-to-face instruction with technologymediated instruction.

Previous researches on BL show contrasting results in terms of students' achievement and critical thinking. For instance a study conducted bySiew-Eng, Ariffin, Rahman, and Kim-

Leong (2010) revealed that students feel satisfied when they use blended learning in relation to achievement, flexibility, social learning, motivation, participation, reaction and self-learning. Similarly, a study conducted byBurgess (2009) and Cameron (2003)also confirmed the effectiveness of BL in boosting students' motivation to learn and in ensuring immediate feedback.

Though as a professional in the field of learning,Massie (2006)argued that the greatest learning is blended, some studies found it worthless. For instance, a study conducted byAlotaibi (2013) and Akyuz and Samsa (2009)found no statistically significant difference between experimental group and control group on the critical thinking measure. Their result may be ascribed to many factors such as the nature of the materials in fostering critical thinking and their experimental design lacking homogeneity, the length of the experiment for being short and lack of statistical control for cofounding variables. They themselves admitted this limitation of their research by claiming that the existence of serious weaknesses in their design and the duration of the study to be too short to foster critical thinking. Another potential reason for this may be the nature of the blend, as Masie (2006) strongly argued that effective blended learning depends on the mix, and prioritizing context for the learning to take place. However, a study conducted by Korkmaz and Karakus (2009)on the effectiveness of blended learning in fostering critical thinking dispositions and skills found a positive results. Because of such contrasting findings, (Arbaugh, 2014; Dang, Zhang, Ravindran, & Osmonbekov, 2016; Means, Toyama, Murphy, & Baki, 2013; Zhao & Breslow, 2013) argue that the field is still new and the overall pattern that would indicate effective methods of blended learning is still not visible. Thus,experimental research testing design principles for

blending online and face-to-face instruction for different kinds of learners is needed (Means, et al., 2013).

According to Garrison and Vaughan (2008), grouping (they call it community of inquiry) provides the condition for free and opens dialogue, critical debate, negotiation and agreement, which is the characteristic of higher education. They also underlined the effectiveness of blended learning in facilitating these components by magnifying the presence of cognitive, social and teaching in a community of inquiry. However, it should be noted that the notion of group work (one-to-five that is currently practiced in Ethiopia might lead to failure if not continuously assisted by the teacher or engagement is missing from students; because, the task may be left for one talented individual and the others become observers and consumers of the product instead of learning. In this case there is no inquiry.Though students rarely achieved the benefits of discourse in isolation, at the same time, to be a critical thinker there should be control of one's thought processes and gain a meta-cognitive understanding of learning to learn(Garrison & Kanuka, 2004).Similarly, Shea (2007) argued that learning is both a social activity as well as cognitive activity which is shaped by affect. So, learning can be taken as the accumulation of individual's experience. The experience might be seen from different perspectives such as personal, social, cultural and so on. Specially, in mathematics there is a need for plenty of learning experiences to understand mathematical concepts.

According to Abramovitz, Berezina, Berman, and Shvartsman (2012), students face difficulty in learning mathematics due to the abstractness of mathematical concepts, and as a result, they are afraid of it. Thus, theusual approach in which courses are presented and the specific level of the language used matter a lot. Students always relay on instructors lecture note and

show poor motivation to study and read foreign textbooks available in a university library and because of that, instructors are also forced to roughly handle contents without undergoing the required depth, which resulted in surface learning.Hence there is a need for a different approach that supplements the face-to-face lectures and tutorials. Among the many such approaches, blended learning is considered in this study.

### 1.2. Statement of the Problem

It is true that technology, if it is used effectively can save time in achieving the desired purpose.That is why the need for blending also arises.It is therefore, the goal of this study to explore the effectiveness of blended learning in terms of improving academic achievement and components of affection including academic hardiness, satisfaction, motivation, and math anxiety.

One of the crucial challenges in Ethiopia is the low achievement of students in general and mathematics in particular(MOE, 2017; NEAEA, 2014). A large-scale national surveys continue to show poor academic achievement of students in mathematics.Atnafu (2012), conducted a study on grade ten students to assess their motivation, social support and alienation from the school, and their contributions on mathematics achievement. His study revealed that motivation, social support and alienation from school in mathematics significantly affected mathematics achievement and their achievement in mathematics is below average.

The low achievement of students in mathematics is also observed in a needs assessment conducted by (Gebremeskel et al., 2017). The aim of their study was to understandthe status

of science and mathematics teaching particularly in Amhara Regional State of Ethiopia. The intention of the study was to identify the challenges in the preparation of primary school science and mathematics teachers and teacher educators for Colleges of Teacher Education (CTE). The result of this intensive needs assessment shows that prospective teachers have avery low performance in mathematics and science disciplines(Gebremeskel et al., 2017).

A study conducted in Dire-Dawa University also shows the low level of students' mathematical competency (Tadesse, 2014). This study further shows that students' average score on Ethiopian university entrance examination falls from 41.11 in 2008 to 38.55 in 2011, showingpoor mathematicsability of students in Dire-Dawa university. From the aforementioned studies it can be seen that students' achievement is low and the main areas of mathematics in which students fail to achieve includematrix operations and solving system of linear equation, which are the gist of algebra. One of the main reason found for this unpleasant achievement was the negative attitude of students towards mathematics, low motivation to learn, less practice and avoidance of mathematics courses(Tadesse, 2014). It is also agreed that for many years, mathematics education community has realizedstudents difficulty in algebra (Warren, Trigueros, & Ursini, 2016). Algebra is also taken as a base for other branch of mathematics such as calculus and applied mathematics. It therefore demands further research as to how the current technological innovations influence algebra learning (Warren et al., 2016).Though research conducted in western countries confirmed that blended learning produces higher levels of student achievement better than the traditional classroom learning, it is not clear and should not be assumed that it will produce the same levels of achievement in the developing world like Ethiopia. This is because, the context is markedly different.

Blended learning and e-learning are recent developments in Ethiopia. For instance,Melesse (2014) conducted a research by taking the e-learning as an experimental intervention. The purpose of his study was to examine the influence of e-learning on the academic performance of mathematics students. However, he came up with unsuccessful ending, that is the experimental and comparison group students tended to be similar at the end of the intervention. Articles on blended learning are also on the rise. For instance,Geta and Olango (2016) conducted a research by using blended learning as their experimental intervention to improve students English writing performance at an undergraduate level in Hawassa University. Their research shows a significant improvement of students writing skill which is also better than the comparison group that are thought with the usual face-to-face instructional approach. However, the concept of blended learning for mathematics courses has not yet come into the spot.

The use of radio and TV in the teaching-learning is also a well-known practice in Ethiopia. The notion of television supported learning was introduced in 2004 for the purpose of providing equal coverage of contents throughout the country. It also aimed toattract students' attention for learning and to ease abstract concepts with visual demonstration.After facing challenges in terms of speed, electricity blackout and language issue, it has been confronted(Kim, 2015b).It is also criticized of being techno-centric (Asseffa, 2017a). Currently, the government of Ethiopia is designing an e-learning project with the support obtained from the World Bank.The forefront issue of this project is to enhance the existing video learning service, launch acomputer laboratory-based learning experience, and expand the reach of online-based out-of-class learning using mobiledevices.This is an initiative aimed at fostering personalized and interactive learning.

Research shows that interactive learning plays a prominent role in students understanding of concepts. For instance, Aslam and Kingdon (2008) posits that teachers' classroom practices and the teaching process such as students participation matters a lot in students learning. This argument leads to examinebetter practices that engage students in the learning process. In line to this,Eshetu, Dilamo, Ayele, and Zinabu (2009)emphasized the need for the development of new pedagogical approaches to improve science and mathematics instruction in Ethiopia. The pedagogical approach should also be endowed with the current students' expectation and technological advancement.

The rapid emergence of technological innovations has a huge impact on the possibilities for web learning and inclination towards technological innovations to solve problems.Blended learning as a pedagogical approach is not well-designed and researched in Ethiopian context, and the method is still new in the world being in its infancy stage(Nazarenko, 2014; Spring, Graham, & Ikahihifo, 2018; Zhao & Breslow, 2013)as a result, intensive research is neededtoprovide evidence about the maximum use of the approach.Especially, more research is needed on how technology can be used within a blended environment(Drysdale et al., 2013) and also on the types of blends that produce deep and meaningful learning(Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Derntl & Motschnig-Pitri, 2005), which is also stressed by Xiaoqing (2017)adding a clue for the need of further study to determine how to innovatively design an appropriate blended learning model for different content areas and different instructional levels.There is also a need for a clear design, development, and implementation of blended learning solutions in African context (Boitshwarelo, 2009).

Upon my experience and observation,the current teaching and learning practice in Ethiopia at all stages of schooling is transmissive rather than interactive, though the education policy calls for interactivity (TGE, 1994). A research conducted byTeshome (2012)similarly shows the poor practices of active learning in Haramaya University. The way courses or school subjects are taughtand learned depend on the particular technological developments of that generation. One of the pedagogical practices that are interactive and comply with the current technological advancementis blended learning,which buildsthe foundation for effective pedagogical practice in 21st century(Graham, 2009).

Thus, motivation for this research arises as a response to one of the central issues recognized nationally, that is the current trend is not on the way of achieving its goal(Eshetu et al., 2009; NEAEA, 2014). The decline in achievement, the need for developing new pedagogical approaches to improve science and mathematics instruction (Eshetu et al., 2009; MOE, 2017), and also the contemporary movement towards technology gives a clue for the need to do something.

Determining an effective system to meet the demands of improved learning in a growing technology age also takes a priority. This is because; the emergences of technology have expanded the possibilities for distributed communication and interaction which urges schools to do so; because, students get technological tools at their early age and they trust it as a knowledge base and believe on its ease of communication. Students today expect schools to be as technology rich as the world around them. They also tend to prefer teachers who have digital competences(Motschnig-Pitrik & Standl, 2012).Thus, it is decisive to relate the latest thinking to the way mathematics is taught and learned.

### 1.3. Objectives of the Study

The purpose of this study wasto investigate the effect of blended learning approach in enhancing students' algebra learning with respect totheir achievement and affection (academic hardiness, motivation, math anxiety, satisfaction and affective aspect of self-regulated learning). Particularly, the following specific objectives were addressed:

1. To evaluate the impact of blended learning on students' algebraachievement and affection.
    - To investigate the effect of blended learning on algebra achievement.
    - To investigate the effect of blended learning on students' affection.
2. To investigate gender difference on the variables treated in the study within and between groups.
3. To examine students' and instructors' perception towards blended learning.
4. To examine the challenges of applying blended learning method.
5. To examine the effectiveness of blended learning approach with respect to algebra achievement and affection.

### 1.4. Research Question

In order to provide a structure and focus for the research, the following research questions wereposed.

1. Are there a statistically significant differences in the students' algebra achievement and affection between the experimental and comparison groups?

1.1. Is there a statistically significant difference on the pretest of students' algebra achievement between the experimental and comparison groups?

1.2. Is there a statistically significant difference between the experimental groups and comparison group on algebra achievement during and after the intervention?

1.3. Is there a statistically significant difference on the pretest of students' affective components between the experimental and comparison groups?

1.4. Is there a statistically significant difference on the posttest of students' affective components between the experimental and comparison groups?

2. Are there differences in gender on the variables treated in the study within and between groups?
3. How do students and instructors perceive blended learning environment?
4. What are the challenges of applying the blended learning method?
5. How effective blended learning is in improving students' algebra achievement and affection?

## 1.5. Significance of the Study

The purpose of this study wasto investigate the effect of blended learning approach in improving students' algebra learning with respect totheir achievement and affection (academic hardiness, motivation, math anxiety, satisfaction and affective aspect of self-regulated learning). Thus, the findings might be beneficial in many ways.The first and foremost benefit is that it produces a shift in pedagogy for effective and personalized learning. This is because, learning requires some sort of ownership. Blended learning represent an opportunity to create variety of learning experiences at the right time and place

for each and every individual. At the same time students get themselves engaged and motivated as a result success will be achieved; which is the aim of any educational program. It can also develop students' ability to pose questions,learn to express themselves in written forms and work together to achieve a common goal.

Therefore, the findings of this study might encourage universities, educational leaders and policy makers to reconsider blended learningto create effective learning environments. Which place the teaching and learning process in line with the current instructional practice. Hence, the result of this study might become a basis to initiate policy reform. Itmight also serve as a foundation for future researchers to conduct research on BL in different contexts.

### 1.6. Scope of the Study

This study was conducted at course level (Linear algebra II) which is a compulsory course designed for mathematics major students. It comprises concepts like characteristic equation of a matrix, orthognality,bilinear forms, quadratic forms, canonical forms, direct sum and decomposition of vector spaces (Harmonized Modular Curriculum for B. Sc Degree Program in mathematics, 2013). According to the harmonized curriculum the course is offered at year II, semester II.

The study contains intervention, as a result only threeuniversities were involved.For ethical issues, the names the universities are not mentioned throughout the dissertation. Thus, pseudonyms are used instead. Accordingly, U1 is for experimental group 1, U2 is for experimental group 2, U3 is for comparison group, and U4 is for the pilot group. The study is further delimited on the following variables; academic achievement, academic hardiness,

satisfaction, motivation, self-regulation, and math anxiety. So, other variables which might affect achievement of students are beyond the scope of the study.

### 1.7. Operational Definition of Terms

**Affection:** affection in the context of mathematics education used in this studyrefers to the beliefs and feelings of students. In this study, affective aspect or simply affection is conceptualized using the five affective variables namely: math anxiety, academic hardiness, satisfaction, affective aspect of self-regulation and motivation.

**Blended learning:** Refers to the combination of face-to-face and web-based learning environment. It is conceptualized as learning from the blended environment.

**Web-based learning environment**: It is a learning platform in which instruction is delivered over the internet.

**Mathematics anxiety**: It is a feeling of nervousness that ruinsstudents' ability to solve mathematics problems.

**Algebra achievement**: It is taken to be the score of students in the algebra achievement tests developed by the researcher at each stage (before, during and after the intervention).

**Linear Algebra II:** A compulsory university course designed for mathematics major students.

**Academic hardiness**: Refers to the tendency of students to managetheir academic failure.Thus, hardy students are characterized by a willingness to engage in challenging academic work, with no fear of failure.

**Motivation**: In this study, it is taken as the trend of being energized or activated toward an end.

**Technology**: It is a tool that assists the learning process with mechanical manipulations of contents. It is effective in terms of saving time, clarity of contents, simulations and speedy communication.

**Mathematics e-learning**: refers to the use of mathematical software and the internet to deliver and facilitate instruction of mathematics related courses.

**Self-regulation**: it is the tendency of students to become self-aware, well-informed and decisive in their approach to learning. It is the learner's ability to understand one's own affective actions and reactions, recognize and control one's own environmental conditions.

**Satisfaction**: in this study, it is defined as the notion of enjoyment and accomplishment in the learning environment.

**Face-to-face**: it is taken as the traditional classroom environment (the usual chalk and talk).

# Chapter 2: Review of Related Literature

## 2.1. Introduction

The purpose of this study wasto investigate the effect of blended learning approach in enhancing students' algebra learning with respect totheir achievement and affection (academic hardiness, motivation, math anxiety, satisfaction and affective aspect of self-regulated learning).A review of previous research relevant to this study can provide a foundation for understanding how the blended learning environment is organized and learner's outcomes of a blended learning environment from different dimensions. All of the sources used in this literature review were collected from credible and reliable academic journals and abstract databases available in print media and electronics including Google scholar, Academic Search, EBSCO host, CrossRef, ERIC, JSTOR, etc.

The use of BL is on the rise in higher education (Bliuc, Goodyear, & Ellis, 2007; Garrison & Vaughan, 2008; Graham, 2006; Mestan, 2019). Similarly, Halverson, Graham, Spring, Drysdale, and Henrie (2014), found that higher education is the most top-cited publications on blended learning, comprising of 66.1% of the top-cited publications. Whereas, 20% focused on all settings, 12.5% focused on corporate/organizational training, and only two

publications (1.8%) focused on the K–12 education. The review begins with the description and conceptualization of e-learning in mathematics education and issues associated with BL that include confusions, practices in general education and that of higher education. In addition, the review also addresses affective variables. Way ahead the review tried to explore empirical researches related to BL and find out research gaps. Finally, informed theoretical framework is developed that guided the development of the conceptual framework with which this research was guided.

## 2.2. Learning Environment

Learning environment stands for the different physical locations, contexts, the pedagogy being used, and cultures in which students learn.It has a notable effect on student learning, such as their engagement in the content, their motivation to learn, and their personal safety. The majority of schooling took place in a traditional classroom (face-to-face) manner. However, as technology expands to impact education, more types of learning environments have emerged these days. Such environment include online and blended environment. It is also evident that many schools throughout the world are using more educational technology(Freihofner, Campbell, & Smala, 2018).

Face-to-face or traditional learning occurs in a physical presence of both students and a teacher. This means that assignments, discussions, and activities occur in the classroom under the direction of the teacher. According to Harrison (2014)withintraditional approach, learning is more teacher directed than student directed. It is more appropriate for younger students who need guidance. In challenging courses likealgebra, students oftenbecome frustrated and hopeless(Lin, Tseng, & Chiang, 2017). The traditional method force students to learn at the

same pace. On the other hand, the classroomteacher often run to cover course contents and hence has little time to assist individual students.

All courses are not suitable for blended learning or online learning. For example, Harrison (2014) found that science labs are more effective for a face-to-face classroom where students can take part in hands on learning. It can also be noted that some practicum classes cannot take place online, as there are concepts that cannot be learned in a virtual environment. Thus, a systemic understanding of the nature of the course and context enables designers to create meaningful learning environments(Singh, 2003).

For the online learning that occurs through internet-based platform, the teacher sets up lessons and assignments beforehand, and students learn and interact through the platform.According to Harrison (2014)online learning tends to be more student centered than tradition classrooms. There is an opportunity for students to direct their learning and interact with course materials. Blended learning on the other hand utilizes both face-to-face and online learning. Students are scheduled for class room instruction, but also to complete tasks and further exploration through the online platform.

In today's educational concept, the insight of learner-centered education enhances the efficient learning environments with the help of the developed technology(Özerem & Akkoyunlu, 2015). As context is at the heart of learning to take place, learning environments on the other hand should encompass the needs of students so as to improve their motivation and engagement. When thevarious factors including technology, space, time, and culture, are integrated into a unified whole, it helps students to develop knowledge, attitudes, and behaviors in order to meet the 21$^{st}$ century competencies(Harrison, 2014; Özerem &

Akkoyunlu, 2015; Vinales, 2015). Thus, modern learning environments can have a potential to effectively promote and support a range of instructional practices such as delivering, applying, designing, and communicating. It is also true that such pedagogical approaches require learners to regulate their own learning. Being an emerging learning environment and a pedagogical approach, blended learning has a promise of building effective instructional practice.Because, it contains both the physical spaces and technological systems to learning.

### 2.3. e-learning in Mathematics Education

e-learning in mathematics, refers to learning by means of systems built on computer and communication technologies (Bass, Evia, & Seiler, 2006; Borba et al., 2016). It covers all learning that takes place using electronic means, such as the computer, and that uses the Internet or storage devices such as CD-ROMS, DVDs, or multimedia. So, e-learning is an innovative approach that uses electronic technology which is learner centered and interactive learning environment to anyone, anyplace, anytime by utilizing the internet and digital technologies(Hedge & Hayward, 2004). Specifically, mathematics e-learning refers to the use of mathematical software and the internet to deliver and facilitate instruction of mathematics related courses (Juan, Huertas, Cuypers, & Loch, 2012). It is clear that these technologies can support collaborative learning and active reflection as students interact with the technology.

These Web-based strategies are being used in Europe and other developed countries. Its use varies from fully e-learning model to partial replacement (blended) or supplements course offerings (Juan et al., 2012). Research indicates the urgent need to undertake more research to inform best practices specific to the discipline of mathematics e-learning (Bass et al., 2006; Borba et al., 2016; Juan et al., 2012).

Not only mathematics but also e-learning practices in other disciplines can also be given an emphasis to produce a positive shift in quality education. It is also important to consider local conditions in which the e-learning is being implanted. As fully e-learning course may be difficult especially in Ethiopia where there is poor infrastructure, learners' background and capability, blended learning can be taken as better option. On the other hand, research also shows that fully e-learning course receives low acceptance among students(Gamal & Aziz, 2011). This shows that the future movement may shift towards blended learning and gradually to fully e-learning system. The next section discusses about basic concepts associated with blended learning.

### 2.4. Confusion Surrounding the Blended Learning Concept

It is widely recognized that the term blended learning is subject to multiple definitions(Oliver & Trigwell, 2005).The definitions seem general and fail to account the variety within BL environments.Graham (2006), observed that blended learning is often mistakenly considered synonymous with distributed learning, mixed-mode learning, open learning, and flexible learning, all of which are taken as a broad definition. This is due to the nature of the term "blended" which requires two or more different kinds of things that can be mixed.

Garrison and Kanuka (2004), discussed the potential of blended learning in higher education by considering on problems in higher education. They stated that "blended learning is the thoughtful integration of classroom face-to-face learning experiences with online learning experiences." In addition, they explored benefits of blended learning in higher education with respect to administration and development characteristics that those benefits are policy, planning, resources, scheduling and support. Their results indicated that blended learning can

lead the process to redefine higher education institutions as being learner centered and facilitating higher order learning experience.

The current trend is the mix of online and face-to-face learning environment. But, the question: how much online and how much face-to-facehas to be taken as blended learning is still debatable and unsolved. As Garrison and Kanuka (2004) argued, it is not clear as to how much, or how little, online learning is associated with blended learning. It is dependent on the nature of the course content and instructional goals, onlineresources, availability of technology, student characteristics and learning preferences, instructor experience and teaching style, and institutional goals(Owston & York, 2018).

On the other hand, the term ‘blended learning’ itself is subject to criticism.Oliver and Trigwell (2005) on their article, ‘can blended learning be redeemed’, argued that the term ‘learning’ should be replaced. They prefer to use blended learning design, blended pedagogies or learning with blended pedagogies instead.

In all cases, the issue is not the terminology, but the ingredients in the mix. So, the possible nature of those things, and of their mixing, will be explored in this section and finally, appropriate contextual definition will be identified and formulated for use in this dissertation.

In their review of undergraduate blended e-learning in UK, Sharpe, Benfield, Roberts, and Francis (2006), recognizedthe difficulty of defining blended learning and they refrain to have their own definition throughout their review. From the institutional visits and evaluations, they observed three ways in which the term ‘blended learning’ was being used. The **first** and widely used type of blended learning is the provision of supplementaryresources for courses that are conducted along predominantly traditional linesthrough an institutionally supported

virtual learning environment. The **second** is an impressive example of transformative course level practicesunderpinned by radical course designs. These often make use of technology tofacilitate interaction and communication and replace other modes of teaching andlearning. The **third** type of blended learning is the blend that students make themselves.

By pointing the diverse meaning of blended learning, Driscoll (2002) identified the most common themes associated with each definition:

- To combine or mix modes of web-based technology (e.g., live virtual classroom, self-paced instruction, collaborative learning, streaming video, audio, and text).
- To combine various pedagogical approaches (e.g., constructivism, behaviorism, cognitivism) to produce an optimal learning outcome with or without instructional technology.
- To combine any form of instructional technology (e.g., videotape, CD-ROM, web-based learning, film) with face-to-face instruction.
- To mix or combine instructional technology with actual job tasks in order to create a harmonious effect of learning and working.

The first two positions suffer from the problem that they define BL so broadly that they encompass almost all learning systems. It is impossible to find any learning system that did not involve multiple instructional methods and multiple delivery media, at least there is a field trip or home activities. So, such definition of blended learning is not a foundation for the current growing tendency of the issue. Rather, the third and fourth positions seems better and are foundations for the emergence of blended learning systems (Graham, 2006). So, it is evident that the idea of BL is the combination of instruction from two historically separate

models of learning: traditional face-to-face learning systems and computer mediated learning systems.

This definition is valuable because of its specificity; however, it does not adequately address the details and complications of blended learning. One approach that attempt to describe the complexity of blended learning is the view of Garrison and Kanuka (2004); they described blended learning as a simple and complex concept. At the simple level, they describe it as "the thoughtful integration of classroom face-to-face learning experiences with online learning experiences" (2004, p.96). Complexity arises when this idea is put into action and the need to respond to different settings which results in an immense variation in learning design possibilities.

From this conceptualization of the term blended learning, it can be noted that in Ethiopian higher education there is little or no indication of blended learning. Some universities such as Addis Ababa university, University of Gondar, Jimma university,Debrebirhan university, Dredawa University, Arbaminch University, Addigrat university, Mekele university, Bahir Dar university and others combine instructional technology (the web) with actual job tasks, usually issues related to student dormitory placement, academic status, and post academic calendar which can be assessed anywhere at any time. But, blending of such technology in academic course is the missing practice.

In the history of modern education in Ethiopia, the use radio in primary schools and plasma television transmission in secondary schools can be taken as blended learning. However, asthe current movement is towards online and personalized learning, those practices are no more valid blended learning.

The former radio transmission is used once a week, to revise every concept covered by classroom teacher. Whereas, the plasma television which has been implementedstarting from 2004 in Ethiopian secondary and preparatory schools, encompasses 75% of the whole lesson. The remaining 25% was left for classroom teachers to summarize the lesson. It is sometimes felt to be an effort to replace the teacher.

I have had an experience to learn through plasma TV for two years (2004&2005). The experience was different to a real classroom experience. As a student, it was very tough to go with the speed of the TV program and to understand the language of the televised teacher which is usually foreigner. Many students at that timewere disappointed with the technology for being too rigid and disregard the condition of many students.Nor does the ongoing effort enhance interaction in the classroom. The situation gives less emphasis for students, the speed and pace is determined by the televised teacher, which can be taken as one size-fits-all. The greatest criticism is made by (Kedir, 2006), who recognized that plasma TV-teaching method doesn't consider learning and literacy as creative activities through which learners' analyze and interpret lived experiences, make connections between these experiences and those of others so as to extend both conscious and understanding actions with reflection. Because of this and other pitfalls this program was discontinued for many years.

However, currently the government is trying to launch it again by revising its content. The revised Plasma TV broadcast is in use in most secondary schools in Addis Ababa. Some contents are selected and the speed is controlled by the classroom teacher. He can pause and reverse back if needed. The new transmission takes half of the period and the other half is left for the classroom teacher. Students can also view the video on computer lab connected with

school net technology. This type of learning can be taken as a blended learning since it gives flexibility for students. Accordingly, the Ethiopian ministry of education has planned to reach 100% coverage of secondary schools with access to television-assisted instruction and 50% of schools to access digital education resources through internet within the coming five years (MOE, 2015).

To be consistent and focused, it is important to have operational definition of the term blended learning. For that reason, blended learning is defined in this dissertation as a combination of face-to-face and web-based environment which is similar to the definition used by (Akkoyunlu & Soylu, 2008; Garrison & Kanuka, 2004; Garrison & Vaughan, 2008; Graham, 2009). Defining blended learning in this manner, emphasizes the central role of computer-based technologies in blended learning (Graham, 2009). The basic principle is that face-to-face oral communication and online communications are optimally integrated such that the strengths of each are blended into a unique learning experience which is congruent with the context and intended educational purpose.

It is also important to lay foundation for the current and future debate on the term ‘blended learning’ itself. The dictionary definition of the term ‘blend’ is a combination of something in an attractive or effective way (OED, 2017). The debate is now on the term ‘learning’. If blended imply the mixing of two or more things, then is it the learning that is going to be mixed or the learning environment? It is clear that the mix is on the environment: namely the face-to-face and the online environment. So, as Oliver and Trigwell (2005) argued, does the term learning be abandoned? In either cases (whether it is abandoned or not), learning has to be perceived from the learners’ perspectiveto reflect recent pedagogic developments, which

place learners at the center of control of their own learning. What is more important in this pedagogy is the mix, as Massie (2006) put it:

> The magic is in the mix, when blended learning became popular as a term in the 1990s. The magic is the power of adding two or more learning elements. Learners have always known this. They have been blending learning for thousands of years. They add what is missing, they mix it with what they need, and they subtract what is not valuable. They socialize it. They find context, and they transform training and instruction into learning (p.23).

Thus, the terminology issue on the term blended learning should be shifted to the mixing elements which bring maximum learning. Therefore, blended learning can be conceived as learning from the blended environment. Though there are many elements that can be blended, in this dissertation blended learning refers to the combination of traditional face-to-face and the computer mediated web based learning.

## 2.5. The Practice of Blended Learning

The movement towards blended learning places technology at the forefront, hence, emphasis is to be found on the electronically facilitated learning. This situation arises due to the increasing influence of e-learning on the current education system (Bass et al., 2006). Its influence is also profound on the development of any country. Especially, developing countries like Ethiopia are convinced that their journey towards civilization is mainly dependent on technological support (Derebssa, 2006; MOE, 2015).

The delivery mode facilitated through the World Wide Web (internet) is relatively 'young' when compared to other technologies that have made an impact on education (Hofmann, 2006).The following table summarizes some of the main technological developments in education adapted from (Bersin, 2004; Hofmann, 2006; Kurland & Kurland, 1987).

Table 2.1. Technological tools for educational use

| Year | Technological development |
|---|---|
| **1450** | Johannes Gutenberg introduces the first western printing press |
| **1840** | First correspondence study (a secretarial program focused on teaching shorthand) |
| **1900s** | Audio recordings |
| **1920s** | Radio station |
| **1960s** | Computer use as administrative office tools |
| **1980s** | Satellite of grounded based video, distance learning, Fiber optics, audio visual/CD-ROM |
| **1998s** | First generation World Wide Web (e-learning) |
| **2002** | Integrated Blended Learning: Web based learning and face-to-face |

The latest technological advancement enhances two way communications by providing tools such as emails, online discussion boards etc. European universities are popular in effectively using the web. This is confirmed by the study conducted in 113 universities (Paulsen, 2003). The study shows that majority of the universities provide sufficient capabilities for successful delivery of online education. This situation lays a foundation for the emergence of blended learning.

The benefit of online learning is profound. For instance, Garrison & Kanuka (2004) forwarded that learning with internet communication technology has a significant educational implication resulting from the emphasis on written communication; because, under certain circumstances, writing can be a highly effective form of communication that encourages

reflection and precision of expression. Next, different scenarios reflecting successful blended learning designs associated with types of courses common in higher education are presented.

### 2.6. Blended Learning in Higher Education

In recent years, traditional face-to-face learningenvironments and computer mediated learningenvironments have begun to converge, creating new learning paradigm called blended learning (Graham, 2006).As the learners are adults, higher education demands individualized engagement and self-regulated learning. To this end, the support BL has in realizing this intention is of paramount importance. Research has found that effective combination of face-to-face class time and self-study with an online workbook is a helpful and inexpensive way to enhance learning (Graham, 2006; Zapata & Sagarra, 2007). As a result, blended learning is becoming an increasingly possible option in many universities (Kobayashi & Little, 2011).So, it can be noted that almost all courses nowadays have some online component, often using web-based technology to facilitate delivery of course documents, which is not true for developing counties like Ethiopia.

The primary goal of blended learning is to reduce lecturing while increasing inquiry and discourse(Garrison & Vaughan, 2008). For effective course or program design, it is important to examine different scenarios that reflect successful blended learning designs in higher education.According to Garrison and Vaughan (2008) and Garrison & Kanuka (2004) the key assumptions of blended learning design are: considerately integrating face-to-face and online learning, deeply rethinking the course design to optimize student engagement, reorganizing and replacing traditional class contact hours.

The idea of blended learning recognizes the strengths of integrating verbal and text-based communication and creates a unique fusion of synchronous (face-to-face) and asynchronous (text-based internet)Garrison and Kanuka (2004), direct and mediated modes of communication in that the proportion of face-to-face and online learning activities may vary considerably(Garrison & Vaughan, 2008).Blended learning is an approach thatmerges the best of traditional and Web-based learning experiences to create and sustain vital communities of inquiry andcritical thinking. Thus, many western higher education institutions are quietly positioning themselvesto connect its transformational potential (Garrison & Vaughan, 2008).

Educational technologies have to support the common goals of higher education, specifically in blended learning contexts(Kitchenham, 2011). Due to the growth of technology, students expect flexible, innovative and engaging learning experiences withtechnology that they commonly use in today's social environments. Therefore, it is not about a choice but, it is a must scenario to catch students' interest and engagement.

### 2.7. Trends of Blended Learning in the World

Though developing countries are still in the conventional instructional approach, blended learning is on the rise across the world. Research shows that the most frequently citedarticles discussing blended learning (BL), are from North American(Halverson, Graham, Spring, & Drysdale, 2012). However, BL is growing worldwide and each region is an important part of the community. The discussion and its implementation of blended learning is at the infant stage in developing countries, whereas some of them are not still aware of the approach and

have no capability to accommodate it.The goal of this section is to discuss the trends of blended learning and to see where the hot discussions on blended learning occur worldwide.

Higher educational institutes in Asia have adapted blended learning as an alternative for interactive learning.The review made by Tham and Tham (2011), shows that blended learning has met varying degrees of success in Asia,including different perceptions of instructors and students towards blended learning approaches. For instance, in China, blended learning is well-received, but educational institutes and staffs lacked the appropriate knowledge for developing courses that would hinder the full potential of blended learning. According to the report of Economist Intelligence Unit (EIU) in 2010, the Asian countries China, Korea, Japan, and Singapore were surveyed for their digital development, previously known as the “e-readiness rankings(EIU, 2010). According to this report all countries being surveyed show a state of e-readiness. Accordingly, Singapore ranked 8$^{th}$, South Korea ranked 13$^{th}$, Japan ranked 16$^{th}$, while China ranked 56$^{th}$.

However, these countries encountered challenges such as culture, pedagogy and design. Cultural issues included teacher dependency in China,objective strategies in Korea, and non-Western learning and teaching styles in Japan. Pedagogical and design issues included competition in China, lack of interaction in Korea, and limited Internet use in Japan and Singapore (Tham & Tham, 2011). Thus, there are key issues and challenges which prevent Asian countries from getting the full potential of blended learning.

According to recent analysis, North America is a leading region both in total citations and average citations per year(Spring & Graham, 2017). The study conducted by Spring and Graham also shows Europe to emerge concurrently with the most cited articles from North

America (2004-2006). Thus, clearly the most cited articles from North America and Europe have been used by hundreds of researchers including me in blended learning field to establish context for their study.

According to Economist Intelligence Unit (EIU) in 2010, some African countries have shown considerable level of e-readiness. On its report of rank of 70 countries, South Africa ranked 40th, Egypt 57, Nigeria 61st and Algeria ranked 68th. However, Ethiopia is not ranked in this report of e-readiness or digital development. However, in the latest report made by EIU in 2017, Ethiopia is ranked 69th out of the 75 surveyed countries. The report shows that poor connectivity, access and high pricesare barriers for developing countries including Ethiopia(EIU, 2017). According to this report, internet access remains unaffordable for many peoples in the developing world. The summary of the report is presented in the following table.

Table 2.2. E-readiness ranks of African countries

| Countries | Rank (Africa) | Rank (world) |
|---|---|---|
| **South Africa** | 1 | 27 |
| **Morocco** | 2 | 34 |
| **Egypt** | 3 | 37 |
| **Nigeria** | 4 | 45 |
| **Seychelles** | 5 | 48 |
| **Ghana** | 6 | 49 |
| **Kenya** | 7 | 51 |
| **Algeria** | 8 | 52 |
| **Tanzania** | 9 | 57 |
| **Senegal** | 10 | 58 |
| **Angola** | 11 | 59 |
| **Cote D'Ivoire** | 12 | 60 |
| **Cameroon** | 13 | 61 |
| **Sudan** | 14 | 62 |
| **Rwanda** | 15 | 63 |
| **Uganda** | 16 | 64 |
| **Mozambique** | 17 | 65 |
| **Burkina Faso** | 18 | 67 |
| **Zambia** | 19 | 68 |
| **Ethiopia** | 20 | 69 |
| **Malawi** | 21 | 70 |
| **Madagascar** | 22 | 71 |
| **Mali** | 23 | 72 |
| **Liberia** | 24 | 73 |
| **Niger** | 25 | 74 |
| **Congo (DRC)** | 26 | 75 |

Source (EIU, 2017)

The inception of blended learning in Africa is very late as compared to North America, Europe and Middle East. Because, conversation on blended learning flared early in Europe and North America which can be placed in 2004. However, in Middle East it can be

accounted as of 2007, in Asia 2008, whereas in Africa and Latin America it is as of 2012. African countries that have started discussing about blended learning approach includes: South Africa, Tanzania, Egypt, Sudan and Botswana(Spring & Graham, 2017), there is also a reasonable debate in Nigeria (Abidoye, 2015).

South Africa is among the leading African countries to adapt blended learning approach. There are numerous articles in the field of blended learning in South Africa. The implementation of blended learning in South Africa however faced many challenges such as uncoordinated efforts to implement blended learning, inadequate infrastructure, humble computer skills of students and lecturers(Tshabalala, Ndeya-Ndereya, & Merwe, 2014). There is also a reasonable articles from Botswana. But, theuse of blended learning into teaching and learning is not adequate, subject for rethinking of pedagogical reform(Kebualemang & Mogwe, 2017).

Therefore, theexecution of blendedin African countries is still very low, regardless of their intention to impose educational technologies. For instance, the government of Tanzania hasremoved all taxes related to computers and similar equipment for the purpose of infusing the technological requirements throughout the country(Lwoga & Sanga, 2007). According to lwoga and Sang, developing countries are still under challenge of lack of systemic approach to ICT implementation, awareness and attitude towards ICT, lack of administrative support, lack of technical support, lack of sufficient preparation of staffs to implement the intended ICT integration, and inadequate funds.

In Ethiopian context, the first article on e-learning is published in 2014 by Kassahun Melesse of Jimma University. As far as the knowledge of the researcher is concerned, he is the

pioneer for adapting an e-learning mechanism to Ethiopian higher education institutions. The purpose of his study was to examine the influence of e-learning on the academic performance of mathematics students.His result shows negligible difference between the conventional and ICT supported learning on student performance. Articles on blended learning are slowly on the rise. For instance, Geta and Olango (2016) conducted a research by using blended learning as their experimental intervention to improve students English writing performance at an undergraduate level in Hawassa University. Their study shows a significant improvement of students writing skill which is also significantly better than the control group that are thought with the usual face-to-face instructional model. However, the concept of blended learning for mathematics courses is not yet come into the spot. Hence, it is evident that interest in BL worldwide is currently increasing and to emerge in Ethiopia.

At the early stage of blended learning in any part of the world, the insertion of blended learning is after havingmuch experience of producing and using e-content(Derntl & Motschnig-Pitri, 2005). That is the emphasis on integrating technology to improve thelearning process in terms of depth and scopeis not observed. This is also to happen in Ethiopia, as the government in its strategic plan of (2015-2020) dictates to produce more e-contents and ICT infrastructures used for accessing the e-content (MOE, 2015). The major intent is to introduce the ‘SchoolNet Cloud-Computing’ technological infrastructure, which is the portal through which students and teachers have access to a range of centrally stored digital contents. Though providing e-contents is a good start for the movement towards digitalized learning, it should not be taken as the only element to be added to the educational context. There should be a learning management system for interactive learning. This will then ensure the increased access to and quality of education at all levels of education. Thus, it

is important to bounce off immediately towards adapting learning management system so as to produce interactive learning environment based on sound pedagogical ground.

### 2.8. Designing Blended Learning Environment

According to Garrison and Vaughan (2008) designing a blended learning environment is a horrifying challenge. They believe that educational designers must accept and adjust to the strengths and weaknesses of the medium. The program should also be designed in such a way that it provides an opportunity for trust and open communication that will support interaction. On the other hand Wilson and Smilanich (2005) strongly suggest not to start extensively. This is because, if the former program relies only on face-to-face environment, students need time to be familiar with the technology and e-learning. So, at the first instant allowing students to learn how to learn in the new learning environment helps to benefit from the blend.

On the other hand, describing a blend in terms of percentage, for instance 30% online and 70% face-to-face, is not informative without knowing the nature of the activities occurring in the distinct learning environments and how the course effectively uses the affordances of the two environments (Cross, 2006). According toRovai and Jordan (2004), a blended course can lie anywhere between the continuum fixed at opposite ends by fully face-to-face and fully online learning environments. Thus, the degree of online and face-to-face learning is dependent on the students' background, infrastructural issue and cultural context. For instance,Dziuban and Moskal (2001) reported that blended courses at the University of Central Florida takes place by replacing a three-hour course by one hour of actual face-to-face classroom time. Which placesefficient use of existing university infrastructure. Such

replacement might not be effective for other contexts, where technological infrastructure is not well organized.

Thus, for blended learning to reach its full transformational potential, the primary goal should be rethinking and redesigning the teaching and learning relationship (i.e., improved pedagogy) with efficiency and convenience (Garrison & Kanuka, 2004). Specifically, Pappas (2014) outlined seven elements that help in creating informative, interactive and immersive blended learning environment:

- Clearly identify the blended learning course's objectives
- Create a blended learning course outline and syllabus to keep your learners motivated and on-track
- Determine the blended learning course's level of interactivity
- Integrate group collaboration activities
- Develop communication and feedback guidelines
- Compile a list of resources and references
- Create an effective assessment plan

Objectives will become a road map since they give the opportunity to see where the blended learning course is directed. Objectives requiring memorization and knowledge acquisition might be good if delivered online (Hofmann, 2006). However, if the concept is abstract, more clarification might be required to avoid rote memorization. Creating a blended environment is highly context dependent and no specific guideline exists for mixing up the ingredients of the blend (Hofmann, 2006), hence there is an infinite number of possible ways to create effective blended learning environment. Due to this scenario, Shea (2007) suggested

researchers to articulate conceptual frameworks that will serve blended contexts. Shea also suggested to examine learner characteristics and available resources while designing a blended learning environment.

In developing countries like Ethiopia, students might not get high bandwidth connectivity, as a result they might be challenged of accessing the course content. Thus, for effective design and implementation of blended learning, care must be taken in all aspects.

According tocorporate and vendor consulting services (Bersin and Associates), blended learning goes through some process. The four processes mentioned by Associates (2003), are (1) define learning challenges, (2) develop learning plan and develop measurement strategy, (3) develop contents, (4) implement and track progress and measure results. Similarly, Alammary, Sheard, and Carbone (2014) have identified three distinct design approaches of blended learning:

1. Low-impact blend: adding extra activities to an existing course
2. Medium-impact blend: replacing activities in an existing course
3. High-impact blend: building the blended course from scratch.

The low-impact approach is associated with providing extra online activities to a traditional face-to-face course. This is done without reducing any of the existing activities. Adding such extra online activities onto an already established course happens when inexperienced teachers build their first blended learning course. According to Alammary et al. (2014) a low impact approach is a swift approach to producing a blended learning course.

In the medium-impact approach, an existing course is redesigned by replacing some of the face-to-faceactivities by online components. The assumption behind this approach is that

some parts of the course would be more effective as online activities(Alammary et al., 2014). In some cases, the remaining face-to-face sessions are keptthe same, while in other cases some changes are made to the inclass activities(Twigg, 2003b). This type of approach allows to start simply and then implement incrementally(Alammary et al., 2014).

In the high-impact approach, the blended learning course is built from scratch. A common way to apply this approach has been described by(Hofmann, 2006). Shecontends that instead of looking at an entire course, the instructor needs to look at each single course learning outcome, which allows a better integration of online and face-to-face components.

## 2.9. Affective Variables and Mathematics Learning

Achievement in mathematics is influenced by a range of factors including mathematics self-concept(Scarpello, 2005; Wang, 2007; Williams & Williams, 2010); mathematicsanxiety (Ashcraft & Kirk, 2001; Hembree, 1990; Iossi, 2007; Shishigu, 2018); mathematics self-efficacy(Iossi, 2007; Williams & Williams, 2010); attitude towards mathematics(Hannula, 2002; Pohjolainen et al., 2018); gender and prior mathematics achievement(Iossi, 2007; Kiwanuka et al., 2015; Shishigu, 2018); socio-economic status, parental support, peer influence and teachers(Kiwanuka et al., 2015).

These factors can be seen from two different perspectives namely behavioral and psychological. Factors external to students' personality are considered as behavioral or environmental factors, which include learning facility, family support, teacher factor, peer support etc. On the other hand, mathematics anxiety, motivation, attitude, confidence, self-efficacy, satisfaction and academic hardiness can be taken as psychological factors that affect academic achievement(Mushtaq & Khan, 2012). Though all factors contribute towards better

mathematical achievement, studies shows that school-level factors have little effect compared to student-level factors(Kiwanuka et al., 2015). Student-level factors include attitudes, orientations, intentions and motivations(Pohjolainen et al., 2018).Because of this and the fact that students' affection drives their cognition, this study focused on affective components.

The affective domain in the context of mathematics education refers to beliefs, feelings and moods such as anxiety, confidence, frustration, motivation and satisfaction that describe mathematics tasks (Scarpello, 2005). Similarly, Černá (2017), describes affective characteristic as a complex ofinterests, attitude, stances and self-assessment.Vermunt (1996) also posited affective factors as attributing learning results to causal factors, motivating one self, concentrating, judging oneself, appraising, exerting effort and generating emotions.

These factors are found to have a strong relationship with successful learning both in traditional classrooms as well as in ICT based learning (Katz & Yablon, 2011). Research reported that learner motivation, learner autonomy, learner control of the learning process, learning flexibility and ICT user friendliness (Katz & Yablon, 2011), learner self-esteem, learner attribution and learner technological efficacy(Katz, 2014) are some of the major affective factors contributing to enhanced learning.

Research also shows that emotional and motivational aspects have played an important part on learning (Caviola, Primi, Chiesi, & Mammarella, 2017; Ignacio, Nieto, & Barona, 2006). It is also argued that the role of affect is indispensable forlearning in general and mathematics learning in particular (Ignacio et al., 2006; Wei, 2010). Some students enjoy learning mathematics, but many dislike it. According to Wei, the affective aspect in learning mathematics has always been a concern in mathematics education. Not only the learning of

mathematics, affection has also an influence on how pupils perceive and value mathematics(Ignacio et al., 2006). Given the extensiveness of the field of study embodied by the affective dimension in mathematics education, the present study focuseson some affective component that are believed to have a prominent role in mathematics learning. These are mathematics anxiety, academic hardiness, self-regulation, satisfaction, and motivation.

### 2.9.1. Mathematics Anxiety

Mathematics anxiety, as one of the affective reactions to learning mathematics, has received a large amount of attention from educators during 1980s and 1990s. Research on mathematics anxiety consistently demonstrates that the low-anxious students outperform their highly-anxious peers in mathematics(Caviola et al., 2017; Hembree, 1990; Hill et al., 2015; Shishigu, 2013; Wei, 2010; Zakaria, Zain, Ahmad, & Erlina, 2012).This indicates that math anxiety is a barrier for students learning of mathematics. As evidenced in the above research findings, it is recognized that anxiety states and feelings of helplessness experienced during mathematics classes or related activitiesare factors with a negative influence on mathematics learning.

Mathematicsanxiety refers to unhealthy mood responses which occur when students come upon mathematicsproblems and manifest themselves as being panicky and losing one's head, depressed and helpless, nervous, fearful and so on (Adams, 2001). According to Adams, learners who are anxious when confronting mathematicsproblems are known to experience rapid pulse, nervous stomach, heart palpitations, upset feelings, and sweaty palms.

The negative effects of mathematicsanxiety include disturbance during the process of learning algebra, department and career selection in higher education. The construct of mathematicsanxiety are the emotional and mental distress that occurs in some students while attempting to understand mathematics. So, mathematicsanxiety can be defined as the negative emotions that interfere with the solving of mathematicsproblems. It leads students to avoid taking math classes and avoid situations in which math become necessary (Ashcraft & Kirk, 2001; Ashkraft & Krause, 2007; Hellum-Alexander, 2010; Sparks, 2011). Tobias, who is a pioneer in the study of math anxiety, described it as "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematicsproblem" (Tobias & Weissbrod, 1980).

Physical symptoms of math anxiety include increased heart rate, sweaty hands, and upset stomach. On the other hand, psychological symptoms include inability to concentrate and feelings of helplessness, worry and disgrace. Behavioral symptoms include avoidance of math classes, putting off math homework until the last minute and not studying regularly (Jackson, 2008). Therefore, it can be said that math anxiety is a phenomenon that is often considered when examining students' problems in mathematics. Studies also show the direct effect of math anxiety on achievement of students. For instance, a study conducted by Sheffield and Hunt (2007), Khatoon and Mahmood (2010), Luo, Wang, and Luo (2009),Caviola et al. (2017)Shishigu (2013),and Shishigu (2018)shows the negative effect of math anxiety on students mathematicsachievement. Thus, reducing math anxiety is essential in preparing the future workforce, who has high literacy and competency in mathematics.

Research also shows that avoidance of mathematicsespecially applies to females(Hembree, 1990; Hill et al., 2015; Shishigu, 2013; Tobias & Weissbrod, 1980). In response to why female students are underrepresented, Witt (2012) identified cultural belief as a factor that many girls are exposed. At this instant, students are entangled with math myth (cultural belief) at their early stage. Similarly,Zaslavsky (1994)contested that the belief that females have an inborn, unalterable inferiority when it comes to doing math is among the myths that induce them to avoid mathematics.In line to this, Zakaria et al. (2012), argues that female students are often characterized as shy, which can affect their ability to learn. A study conducted in India also shows that malestudents are more active in a wider range of social activities than female students(Khatoon & Mahmood, 2010). This situation may lead women not to be competent in mathematicsas men.

However, several studies do not support this theory. Because, there is an evidence that shows the success of women in mathematics, notwithstanding the challenges they are continuously exposed to. For instance, Crisp, Bache, and Maitner (2009) found that female students are unaffected by the typical stereotype threats, and exhibit enhanced performance on a mathematics test. Similarly, a meta-analysis conducted by Lindberg, Hyde, and Petersen (2010) showed that gender difference in mathematicsperformance were very small and, depending on the sample and outcome measure, sometimes favored boys and sometimes favored girls. So, the difference lies on their engagement and hardiness. Thus, females may be as competent as male or may be better than male.

Though there are many studies conducted on gender comparison, contrasting finding exists and also effect size was missing. On the other hand, different studies have used different

measures of both mathematics performance and of math anxiety, making their results hard to compare given that some measures used may have been less reliable than others. Hence in this study, gender difference is investigated in terms of all affective variables and achievement.

Math anxiety is a measurable construct. It can be measured in two different ways. The first and widely used technique is by a self-examination and evaluation when presented with various types of mathematical situations, possibly with the help of a pre-prepared anxiety scale. A degree of anxiety is determined and usually falls under categories such as “very anxious”, “moderately anxious”, and “low anxious”. The second method of measuring anxiety is by a second party, who is usually someone who is trained to see physiological signs of anxiety and the actions associated with them. Psychiatrists and psychologists are an ideal individuals to diagnose such a problem(Tobias & Weissbrod, 1980).

The most widely used instrument in the literature is Mathematics anxiety Rating Scale (MARS)developed by Richardson & Suinn in 1972. The original MARS is a longer instrument having 98 items, 5-point, likert-type instrument that assesses the levels of anxiety in situations involvingnumbers. This scale is very long and might become boring for students. For that reason, researchers tried to minimize the number of items to an optimal level. For instance,Mahmood and Khatoon (2011)conducted a research to develop a theoretically and methodologically sound bi-dimensional instrument of math anxiety with high psychometric qualities, specifically item total correlation, internal consistency, reliability and validity. They collected 50 statements positive and negative affect expressive of anxiety toward math, on a

5-point likert scale after undergoing a careful study of related literature and discussion with several experienced math teachers, expert and parents' opinions. Based on experts' comments, 25 items were left for possible tryout study. The tryout study in tern reduced the scale to 14 items. Thus, the final form of the test has 14 statements which is designed to measure the math anxiety of students. MARS is a bi-dimensional and shorter instrument in which 7items are worded positively and 7 items worded negatively. It is a 5-point likert type instrument that assess positive and negative dimensions of math anxiety(Mahmood & Khatoon, 2011), which had an internal consistency reliability of 0.87 using Cronbach's alpha.

Similarly, Suinn and Winston (2003)also conducted a research which was aimed to create a shorter version of the MARS and provided reliability and validity information for the new version. They have compared the original 98 item scale with the shortened 30 item scale found in the literature. Using Cronbach alpha, they have found that the internal consistency reliability of the 30- item MARS to be 0.96 which is consistent with previous findings of .97 for the longer MARS 98-item scale (Richardson & Suinn, 1972). The test-retest reliability for the MARS 30-item was .90, which is again equivalent to the test-retest reliability of MARS 98-item(.91). Their final data confirms that the MARS 30-item scale has acceptable reliabilities and validity which is comparable to the original MARS. Hence, the shorter scale is preferable.

However, the above review of the existing math anxiety instruments is unidirectional, except the one developed byMahmood and khatoon. This tool produced two factors, the first representing concerns about doing well in mathematics and the second represent strong negative affectivereactions to mathematics. This scale hasa split-half reliabilityof .89 and

Cronbac's alpha of .87, which is still in the acceptable range. Hence, in this study, the two dimensional instrument developed by Mahmood and Khatoon (2011) was used to measure students level of math anxiety.

Studies shows that technology supported learning is a mediating approach for reducing math anxiety. For instance, a study conducted by(Barry, 2017; Reissman, 2017; Sun & Pyzdrowski, 2009)posited that anxious students find learning math by computer as a great solution.As there are varied causes of math anxiety,it can be noted that there are various ways of overcoming it. If the cause is the teacher's and parents'anxiety, it is necessary to reduce the teachers and parentsanxiety(Sun & Pyzdrowski, 2009). On the other hand, if the anxiety is caused by the failure of cognition, then improving the students' cognition is a solution. When technology is used as a tool to enhance students learning, it can overcome the math anxiety caused by the cognitive failure on its way(Sun & Pyzdrowski, 2009). They further explored the idea of websites and software, confirming that websites and software technologies can have a potential to provide virtual manipulative and hands on activities that are easily accessible by both students and teachers.Such technologies allow students to engage in different activities that help them for a quick retrieval of information, which is associated with a deep understanding of a particular concept. In doing this, students became engaged in the learning process and strengthen their cognition. Thus, blended learning as an emerging pedagogical approach has a promise of overcoming some difficulties in mathematics learning.

### 2.9.2. Academic Hardiness

The other affective factor that affects academic achievement of students is academic hardiness. This factor was not thoroughly studied by researches across the world(Ahmadi, Zainalipour, & Rahmani, 2013). It is also impossible to find a research conducted on this construct in Ethiopia. Academic hardiness refers to the essence of students to academic failure, where hardy students are characterized by a willingness to engage in challenging academic work, commit to academic activities and pursuits, and perceive they have control over their academic performance and outcomes (Benishek & Lopez, 2001).Thus, academic hardinessisasetofbeliefsoneholds regarding the self, and emphasizing the importanceof involvement andcontrol rather than isolation and powerlessness(Kamtsios & Karagiannopoulou, 2013).

A hardy individual is the one who believes that he can control the events and can influence them, he believes that psychological stressors can be changed, he is able to feel deep tribute and commitment to activities that heshould do. In other words, he is deeply involved with his daily activities (Ahmadi et al., 2013). Thus, high levels of hardiness promote personal growth, spirit and well-being; whereas, low levels result in self-handicapping and unhappiness (Creed, Conlon, & Dhaliwal, 2013). Kobasa defined hardiness in terms of three components (3Cs) (Ahmadi et al., 2013). **Commitment** refers to the individual's tendency to be involved, and to find meaning in one's activities and environment; it also includes willingness to expend extra time and effort to meet goals. **Challenge**is to appraise potentially stressful situations as exciting and stimulating; acceptance of difficulties associated with task; facilitates positive process of growth through learning; it is an expected part of life, and is a necessary ingredient for personal development. **Control**is the perception that the individual

can manage important life events through the use of imagination, knowledge, skills and associated withgood time management, prioritizing most important activities, taking responsibility for own learning (Sheard & Golby, 2007). Thus, hardiness helps to the development of broad coping responses and actions, which enables the individual to act purposefully, rather than being passive or feeling powerless in the face of stressful and changing situations (Bartone, Roland, Picano, & Williams, 2008). Furthermore, it facilitates turning stresses to advantage, growing in such enhanced performance criteria as creativity, wisdom, and fulfillment, and maintaining or enhancing physical and mental health(Maddi, Harvey, Khoshaba, Fazel, & Resurreccion, 2009).

Studies typically find small positive associations between academic achievement when total academic hardiness scores are used (Ahmadi et al., 2013; Lifton, Seay, & Bushko, 2000). Although the findings are less consistent when component scores are used, some studies have found significant relationships for commitment, but not for challenge or control (Sheard, 2009; Sheard & Golby, 2007), while others have found the main associations to be with challenge and commitment (Ahmadi et al., 2013). On the other hand, some studies have found academic hardiness to be associated with gender (Benishek & Lopez, 2001); but not all (Maddi et al., 2009). The result of gender comparison shows higher commitment scores of female students than male (Benishek & Lopez, 2001). This is consistent with Vogt, Rizvi, Shipherd, and Resick (2008), which have shown that men and women use the appraisal processes of commitment, challenge, and control in different ways.

Regarding the measurement of the construct, Creed et al. (2013) recommended to usethe revised 17-item Academic Hardiness scale, after showing it to be psychometrically stronger

than the original 18-item version, which they claimed to have content and factorial validity weaknesses. They also forwarded that the three components to be interpreted at the subscale rather than at the total score level, by claiming the problematic practice of summing the sub-domain scores to form composite hardiness score. Similarly, Sinclair and Tetrick (2000) showed the possibility of losing information concerning the effect of different components on any outcome variable when the components are summed. They also suggested the importance of increasing the number of positively worded items in hardiness scales, as it either produces response bias problems such as cognitive processing effects, demand characteristics and respondent carelessness or inadequately represents the hardiness content domain.

In this study, the revised Academic Hardiness scale by Creed et al. (2013) was used as it is validatedto have content and factorial validity. However, during the pilot analysis, one item from commitment subscale, one item from challenge subscale and the four items of control were deleted because of their low inter item correlation with the overall subscale. Hence, academic hardiness was measured and defined using the commitment and challenge aspects only.

### 2.9.3. Self-regulated Learning

Self-regulation of learning (SRL) means having the ability to develop knowledge, skills and attitudes which enhance and facilitate future learning which in turn can be transferred to other learning situations. SRL can be described as a goal-oriented process of active and constructive knowledge acquisition, involving the guided interaction of an individual's cognitive and motivational/emotional resources (Boekaerts & Corno, 2005). Self-regulated learning (SRL) is an academically effective form of learning, through which learners

transform their mental abilities into academic skills (Zimmerman, 2002). That is learning is viewed as an activity that students do for themselves in an active way rather than as a hidden event that happens to them in reaction to teaching. And these learners are active in their efforts to learn, because they are aware of their strengths and weaknesses. Zimmerman also contends that if self-regulated learners encounter obstacles such as poor study conditions, confusing teachers or complex text, they find a way to succeed and in terms of meta-cognitive process, self- regulated learners plan, set goals, organize, self-monitor and self-evaluate at various points during the process of acquisition (Zimmerman, 1990). Now in doing this they become self-aware, well-informed and decisive in their approach to learning.

There are different models of Self-Regulation (SR) in education. According to Pintrich (2003), these models are: volitional aspects, cognitive aspects, and socio-cultural aspects. However, all of the models share some basicassumptions. All theorists assume that students who self-regulate their learning are engaged actively and constructively in a process of meaninggeneration and that they adapt their thoughts, feelings and actions asneeded to affect their learning and motivation. Another common element to all models is an integration of both affective and cognitive issues. They alone cannot fully describe the variousaspects of student academic learning (Pintrich, 2003).

Self-regulation requires reflection in the sense of being aware of one's own beliefs and strategies. Reflection can develop through discussion, debates and essays, where students are encouraged to express their opinions. Another important aspect of reflection is being able to distinguish appearance from reality, common beliefs from scientific knowledge (Vosniadou,

2001). Generally, teachers can help students to become self-regulated and reflective by providing opportunities (Vosniadou, 2001):

- To plan how to solve problems, design experiments and read books.
- To evaluate the statements, arguments, solutions to problems of others, as well as of one's self.
- To check their thinking and ask themselves questions about their understanding (Why am I doing? what I am doing? How well am I doing? What remains to be done?).
- To develop realistic knowledge of themselves as learners (I am good in reading, but need to work on my mathematics).
- To set their own learning goals.
- To know what are the most effective strategies to use andwhen to use them.

To be successful and regulate oneself, there is a need to show willingness to learn and to practice.Self-regulated learning includes: setting goals for learning, concentrating on instruction, using effective strategies to organize ideas, using resources effectively, monitoring performance, managing time effectively and holding positive beliefs about one's capabilities(Schunk, 1982). Many of the self-regulated learning strategies are useful in many ways. Specifically, self-regulated learning consists of three components: cognition, meta-cognition and motivation. The cognition component includes the skills and habits that are necessary to encode, memorize and recall information as well as think critically. The meta-cognition component enablesstudents to understand and monitor their cognitive processes. The motivation component enhances the beliefs and attitudes that affect the use and development of both the cognitive and meta-cognitive skills.

Research shows thatself-regulatory processes are learnable and can lead to an increasedstudent motivation and achievement(Schunk, 1982).It also helpsto create better learning habits and strengthen study skills (Wolters, 2011). Schunk recognized an important part of self-regulation to be goal setting that regulates an individual's actions. In the classroom, goals may be as simple as earning a good grade on an exam or as detailed as gaining a broad understanding of a topic. Short-term attainable goals often are used to reach long-term aspirations. In this regard, research suggests that encouraging students to set short-term goals for their learning can be an effective way to help students track their progress (Zimmerman, 1990). In achieving such short-term goals, students then achieve their desired goal at the end.

Self-regulated learners do not try to accomplish every task on their own, but rather frequently they seek help from others when necessary. Thus, teachers can promote positive help seekingbehaviors by providing students with on-going feedback that they can easily understand and allow opportunities to resubmit assignments after making appropriate changes(Butler, 1998).Social support from teachers and peers can also play an important role as students are learning to be more self-regulative (Zumbrunn, Tadlock, & Roberts, 2011).

There is a considerable agreement about the importance of self-regulation in learning and human survival in general(Saks & Leijen, 2014). It reduces the need for teacher directed management at all time and it develops students' skills like problem solving, reasoning, and decision making (Zimmerman, 1990). So, self-monitoring interventions equip students to recognize and keep path of their own behavior (Hoff & DuPaul, 1998). It also improves

students' self-esteem and overall classroom management on the part of the teacher (Boekaerts & Corno, 2005).

The major concern of practitioners is the measurement issue. So far, measuring students' SRL has been made through self-report questionnaires (Pintrich, Smith, Garcia, & Mckeachie, 1993). The most popular instrumentused in studies is the Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ is developed by McKeachie and Pintrich in 1986 (Pintrich et al., 1993). Questions in this scale are designed to assess various facets of the student's self-regulated learning strategies. However, due to less trustworthiness of self-report data, some researchers use SRL think-aloud protocols in their studies(Saks & Leijen, 2014).MSLQ originally consists of 81-item divided into 15 sub-scales, six within the motivation section and nine withinthe learning strategies section (Pintrich, et al., 1993).

Based on the needs of the researcher, the scales can be used together or individually, because the instrument is completely modular (Duncan & McKeachie, 2005). The overall score for a given scale represents the positive wording of all items within that scale and so higher scores indicate greater levels of the construct being measured (Duncan & McKeachie, 2005). On the other hand there is a 24-item Online SRL Questionnaire (OSLQ) developed by(Barnard-Brak, Lan, & Paton, 2010) and used to evaluate students' SRL skills in a web-intensive learning environment.The OSLQ consists of six subscales: goal setting, environment structuring, task strategies, time management, help seeking and self-evaluation.

Regarding its reliability, Duncan and McKeachie (2005)found that the MSLQ had good internal reliability &predictive validity. The fact that it has been used by hundreds of researchers in numerous countries around the world is a proof to its good reliability and

validity. However, as a result of statistical advancements, some researchers are motivated to revisit the MSLQ(Dunn, Lo, Mulvenon, & Sutcliffe, 2012)to create a more valid and reliable instrument.

Particularly, this study examined self-regulated learning in view of the online and face-to-face learning environment. The instrument used to measure SRL was adapted from (Barnard, Lan, To, Paton, & Lai, 2009). The original 24-item scale was revised by the panel of experts and reduced to19-item scale. This is based on the goal and context of the study.Additionally, the pilot analysis found one item with poor inter-item correlation with the overall item. Hence, self- regulated learning was measured using 18-item scale.

Regulating ones own learning is a meaningful process that is needed in everyday life. It is also a necessary phenomenon for adult learners because, learning takes place inside a person and cannot be forced, ordered or fulfilled by someone else (Bauer, Derntl, Motschnig-Pitrik, & Tausch, 2006). Because of this, recently the concepts of learner autonomy, independence, and self-regulated learning have attracted a lot of attention (Rajabi, 2012). The rapid development of e-learning on the hand has led an opportunity for self-learning.Blended learning environments are suited to practice SRL or even foster its development. Because of the great emphasis given to collaborative activities in blended learning, meta-cognitive skills are at the front of the learning process(Lynch & Dembo, 2004). Research findings also show that self-regulation in online and blended learningisan essential factor to guide students' learning(Cho & Shen, 2013; Tseng, Liang, & Tsai, 2014). Because of this, it is agreed that when students fail in online and blended coursesdue to lack of self-regulatory learning ability, they exhibit insufficiency in goal commitment, coping strategies, or academic

hardiness required to complete tasks(Cho & Shen, 2013). Though self-regulation isa crucial force affecting learning(Anam & Stracke, 2016),the interplay between self-regulated learning and blended learning has not been fully explored.Hence, this study tried to shade light on the influence of blended learning on self-regulated learning and vice-versa.

### 2.9.4. Motivation

The word ‘motivation’ comes from Latin, “movere” that means move(Syarif & Sofyan, 2012). It is a necessary construct and a means to enhance understanding of a given concept.Thus, motivation can be taken as the student's willingness, need and desire to participate, and be successful in the learning process(Bomia et al., 1997).A person who feels no encouragement to act is characterized as unmotivated, whereas someone who is energized or activated towards an end is considered to be motivated(Ryan & Deci, 2000). Similarly, Hannula (2006), also perceives motivation as a perspective that illuminates some aspects of affect by considering it as a potential to direct behavior which controls emotion.It drives leaners to engage in academic activities.

Previous research on students’ motivation to learn suggests that it is an important construct for student outcomes(Lynch & Dembo, 2004; Pintrich & Groot, 1990; Richardson, Bond, & Abraham, 2012; Vanslambrouck, Zhu, Lombaerts, Brent Philipsen, & Tondeur, 2018). This is because, it improves and mediates learning and is a consequenceof learning aswell. According to Wlodkowski (2008) motivation and learning are inseparable and so understanding why people behaveas they do is important to help them learn. Thus, when learners are motivated during the learning process, things go more efficiently. However, motivation as an affective component of an individual is not an observable construct, and so

not possible to preciselymeasure it. What we need to do is infer fromwhat people say and do(Wlodkowski, 2008).

Motivation exists in two forms: intrinsic and extrinsic motivation. Intrinsic motivation is a force inside the individual (Atnafu, 2012; Bomia et al., 1997; Guay, Vallerand, & Blanchard, 2000; Wlodkowski, 2008), which enable doing of an activity for its inherent satisfactions rather than for some separable consequence.Extrinsic motivation on the other hand is performed in order to receive something from others. Thus, extrinsic motivator is outside of an individual. Intrinsic and extrinsic motivation can occur simultaneously and in that case the learning process becomes very smooth.

When intrinsic and extrinsic motivation occur at the same time, we call it “total motivation”, which is a combination of both intrinsic and extrinsic motivation. For instance, Almeida (2008) posits this condition as follows: A student wants to become better at the concepts and procedures and has enjoyed learning throughout his schoolcareer, which is an example of his/her intrinsic motivation. He/she also works hard to get good grades and impress his parents,which is an example of his extrinsic motivation. Some scholars also tried to make a categorization within the extrinsic motivation itself.

According to Guay et al. (2000) different types of extrinsic motivations have been proposed by self-determination theory: these are external regulation and identified regulations. External regulation occurs when behavior is regulated by external rewards. In contrast, identified regulation occurs when a behavior is valued and perceived as being chosen by oneself.

Regarding measurement of motivation, Pintrich and Groot (1990) developed a 55-item scale. The overall item is linked to students’ cognitive engagement and academic performance.It is

also developed by considering self-regulated learning components, test anxiety and self-efficacy beliefs. They used this instrument to measure students' motivational beliefs and self-regulated learning and they call the instrument as motivated strategies for learning questionnaire.

On the other hand,Guay et al. (2000) conducted five studies to develop and validate the scale used to measure motivation in situational context.Situational motivation refers to the motivation of students when they are engaged in a specific activity.The situational motivation scale (SMS) has adequate level of reliability and construct validity comprising 16-item.

In order to assessstudents' immediate reactions toward blended learning approach, the current study adapted the SMS. Clearly, the scale was modified to create context. After the expert review and pilot analysis, the original 16-item scale was reduced to comprise 10 items to measures students' intrinsic and extrinsic motivation.

Thoughteaching strategies can impact motivation of students, it is not the only way(Bomia et al., 1997). A study conducted bySyarif and Sofyan (2012) and Akgündüz and Akınoğlu (2017) found out that teaching learning model(blended learning) implementation has significantly improved students motivation. But they also realized that motivation asa complex psychological factor, which is also agreed by (Bomia et al., 1997). The strongest motivation is intrinsic motivation than extrinsic one, depicting the importance of creating students'intrinsicmotivation. Generally, the result of both research shows an increased motivation for learning through blended learning approach.

### 2.9.5 Satisfaction

The word satisfaction has been defined by some scholars in different contexts. For instance, Sinclaire (2011) defined satisfaction as the perception of enjoyment and accomplishment in the learning environment. Similarly, Korkmaz and Karakus (2009) defined satisfaction as the sum of a student'sbehavioral beliefs and attitudes that result from aggregating all the benefits that a student receives as a result of the learning environment. Whereas, O'Leary and Quinlan (2007) differently defines satisfaction in terms of marketing. This is because of the nature of their research. In their research they considered it as an emotional response that can be induced by actual product, service, or process quality or some combination of product and service quality. In educational context, the definitions revolve around similar concepts namely accomplishment and success. Thus, it is a subjective perspective on the way in which the educational environment supports academic success.For the purpose of this study, satisfaction is defined as the notion of enjoyment and accomplishment in blended learning, which is similar to that of (Korkmaz & Karakus, 2009; Sinclaire, 2011), both of which took satisfaction as perception of enjoyment and accomplishment students have in the learning environment.

By providing improved access and opportunity for various learning experiences, blended learning and online learningcreates significant modifications in the learning environment. Students might have different views regarding this type of environment. For instance, Dziuban, Moskal, Kramer, and Thompson (2013) classified students views of online learning into three different parts: large proportion of students be satisfied with their experience, a much smaller proportion is genuinely dissatisfied and a third cohort that isundecided,

expressing simultaneous positive and negative feelings toward their online experiences.With the concerns and dissatisfaction with e-learning, educators are searching for alternative instructional delivery solutions to relieve of ambivalence.In this regard, blended learning has been presented as a promising alternative Graham (2006) and students' satisfaction is an important factor in measuring the quality of blended learning(Rahmana, Hussein, & Aluwi, 2015). However,there areinsufficient researches on learning satisfaction of students in blended learning(So & Brush, 2008).This can be taken as one of the obstacles to the success ofblended learning.

Hermans, Haytko, and Mott-Stenerson (2009), argued that students satisfaction plays an important in the learning process.These authors tested the relationships among the attitudinal variables that contribute tostudent satisfaction in web-enhanced courses. The structural model that was used by theresearchers indicated strong relationships among satisfaction with the teacher, perceived ease of use of the course technology, and satisfaction with the course. Based on this result, Hermans et al. (2009) suggested that satisfaction of students is the most important considerations on Internet-enhanced courses.

As one of the affective components, satisfaction of students in the learning process is a determining factor for knowledge construction. So, when several components in a learningenvironment are not well integrated, it can increase ineffective cognitive load in the learningprocesses(So & Brush, 2008). That is,simply turning classroom courses into blended formats do not necessarily provide students with more interactive and flexible learning experiences. Hence, more careful analysis of learners,contexts, and technologies are needed.

Satisfaction is one of the determinants of success in a given course. So, how satisfied are students with the blended environment experience? Do they receive the academic and expected social benefits? These questions need to be addressed explicitly for successful learning. There is also an evidence that students who are troubled in traditional classroom environments like to ask question through email or chat(So & Brush, 2008). Which portrayed the need for flexible learning environment.

Students' satisfaction can be measured from their level of pleasure and the effectiveness of the student's education experience(Rahmana et al., 2015). Different measures of satisfaction exists in the literature. For instance, Wu, Tennyson, and Hsia (2010) used social-cognitive theory of bandura in their research dealing with student satisfaction of a blended learning environment.They claimed that it is relevant to understand andpredict human behavior and allows to identify methods by which behavior may be changed. On the other hand (Strachota, 2006) developed a survey instrument used to measure satisfaction of students.

In this study, satisfaction of students was measured with a scale developed by (Strachota, 2006). Based on the purpose and context of the study, the original 22-item scale was reduced to comprise only 10-items. Additionally, two items were deleted from the scale due to their low inter item correlation which affect the reliability of the overall scale.These items werenot related to each other and hence were not suitable for measuring the construct (satisfaction).

## 2.10.Empirical Research on Blended Learning

Within this digital age, students accept new technology rapidly and learn easily to handle it. As a result, blended learning is developing rapidly in education(Owen & Dunham, 2015). Research shows that blended learning is favored by students (Güzer & Caner, 2014; Hubackova & Semradova, 2016; Owen & Dunham, 2015). By reviewing available publications across all fields, it is possible to learn how and to what extent BL impacted learning. Consequently, significant numbers of studies were dwelled on effectiveness of BL.

Researchers evaluated effectiveness in general (Al-Ghassani, Shamsi, Islam, Al-Salti, & Al-Hasni, 2015; Cobanoglu & Yurdakul, 2014; Delialioglu & Yildirim, 2008; EL-Deghaidy & Nouby, 2007; Kazu & Demirkol, 2014; Lin et al., 2017; Obiedat et al., 2014; Vernadakis, Giannousi, Derri, & Michalopoulos, 2012) and in terms of some independent variables such as satisfaction, achievement, behavior, critical thinking skills, learner support, participation, interaction, affect, and retention (Akyuz & Samsa, 2009; Hughes, 2007; Korkmaz & Karakus, 2009; Melton, Bland, & Chopak-Foss, 2009; Woltering, Herrler, & Spitzer, 2009).

The study conducted by Hughes (2007), is directed towards testing the effectiveness of blended learning in terms of learner support and retention. The study was an action research conducted on third year undergraduate students. In this blended course, Hughes decreased face-to-face contact time and increased tutor support especially for ‘at-risk’ students. The result of this study indicated that mixture of well-prepared blended learning with proactive help and encouragement for ‘at-risk’ learners’ improves coursework submission and module retention without extra effort (Hughes, 2007).

Melton et al. (2009),have conducted research on effectiveness of blended learning on undergraduate health science course in terms of student satisfaction and achievement. They applied quasi-experimental research design and measured students' course grades, satisfaction and teacher evaluation. Results of this study showed higher learning achievement and satisfaction by students in the blended learning environment. Based on this finding, they recommended to repeat research on achievement and satisfaction among different courses in order to convince educators to grasp the new approach as an effective pedagogy.

Akyuz and Samsa (2009), were also interested in the effectiveness of blended learning on critical thinking skills of students. Their study was carried out on 44 students studying in the department of computer and instructional technology education of Ankara University. It was a one group pre-test and post-test design. They measured students' critical thinking skills with a 100 item Critical Thinking Appraisal Test developed by Watson-Glaser. This study can be considered as problematic in its design as well as the blend itself. They themselves admitted this limitation of their research by claiming that the existence of serious weaknesses in their design and the duration of the study to be too short to foster critical thinking within five weeks. Unfortunately, their results indicated non-significant differences between pre-test and post-test scores. However, a study conducted by Korkmaz and Karakus (2009) found a positive results in critical thinking dispositions. They used Attitude Scale and the California Critical Thinking Disposition Inventory as a data collection tool. By designing a pre-test and post-test approach for four weeks, they have found that blended learning model contributed more to student attitudes toward geography course when compared to the traditional learning model and also the experimental groups possess to have better critical dispositions and levels when compared to the traditional learning groups.

A study by Delialioglu and Yildirim (2008)was aimed to compare the effectiveness of blended learning. They used MOLTA model to design the course and conducted further evaluations on students' achievement, knowledge retention, attitudes as well as course satisfaction on both traditional and blended learning environments. Their study showed that both treatment and comparison groups had similar achievement levels and knowledge retention.Furthermore, high level of positive attitudes and course satisfaction were reported by both groups with no statistical difference. Though their study is thorough, the study is associated with severe limitation. One major limitation is possiblythe nature of the course itself. Students initially might have high levels of willingness to learn the course ''Computer Networks and Communications''. Also from its nature, the course needs a considerable amount of blended learning. For that reason, it might not be ethical to teach students in an environment with no technology (traditional classroom) for a course that requires intensive technology. So, it is impossible to draw implication from such study.On the other hand the study conducted by Eryilmaz (2015) contradicts this finding. The study was applied on introduction to computers course in Atilim University, Turkey. The author designed blended learning environment in the form of online material sharing, forum, exam, text, picture and video supported lesson summaries. The aim of the study was to investigate the effectiveness of blended learning environment as compared to traditional and online learning. According to the data obtained from the likert scale, students prefer the blended learning environment.

EL-Deghaidy and Nouby (2007),also applied blended learning cooperative approach on pre-service teachers' achievement, attitudes and cooperativeness. They conducted randomized pre-test and post-test quasi-experimental study on twenty-six science pre-service teachers in an Egyptian university. Their findings indicated that achievement of students in the

experimental group is significantly higher than students in control group. Besides, students' attitudes towards blended learning are significantly higher in experimental group. However, in students' attitudes towards cooperativeness, non-significant difference was found between the two groups. El-Deghaidy and Nouby regarded blended learning as effective with respect to attitudes and achievement. However, measuring students' attitude towards the new method without experiencing it for control group might not be reliable. This is because, the difference obtained might be due to their lack of experience. It would be better if the pre-test and post-test scores are compared within the experimental group.

Giannousi, Vernadakis, Derri, Michalopoulos, and Kioumourtzoglou (2009), investigated the effectiveness of blended learning in terms of student satisfaction by surveying a sample of 61 undergraduate students and suggested that students' satisfaction is an important factor in order to estimate the effectiveness of a blended course. Further, they found that "perceived e-learner satisfaction was higher than the average, indicating the high satisfaction with the overall learning experience.

Woltering et al. (2009),also conducted a quasi-experimental study aimed to find out whether blended problem-based learning in medical education increases students' motivation and support learning process with respect to student cooperation. It was found that blended problem-based learning increased the student motivation, student satisfaction and subjective learning outcomes.

Specifically, in mathematics Abramovitz et al. (2012) constructed a blended learning environment to help students better understand the meaning ofa theorem in calculus course. The main aim of their study was to allow students study by additional materials by

themselves, in order to supplement face-to-face lectures and tutorials. The report of their study shows that blended learning approach has improved students' self-study habit and they become active learners compared to when studying in the traditional way.

Kazu and Demirkol (2014), assessed the level of success of students in blended learning environment in biology course. The study aimed to compare two learning environments on the basis of the academic achievement grades of the students in blended learning environment and traditional face-to-face learning environment. They designed a non-equivalent pre-test and post-test quasi-experimental design to achieve their goal.According to their result, the experimental group has been found to perform significantly higher than that of the control group on the post-test. The academic achievement of students who have studied in blended leaning environment has been found better than the academic achievement of the students who have studied in traditional learning environment.Obiedat et al. (2014), Gecer and Dag (2012), Cobanoglu and Yurdakul (2014) also found a significant and positive impact of blended learning on academic achievement of students. Similarly, a study conducted by Al-Ghassani et al. (2015) indicated that blended learning improved students understanding of the course concepts (calculus I).

Lin et al. (2017), conducted a quasi-experimental study on junior high school students to investigate the effect of blended learning pedagogy. The result of this study, showed that the blended learning experience benefitted students in the experimental group in terms of learning outcomes and their attitudes toward studying mathematicsin a blended environment.

Generally, studies analyzed effectiveness of blended learning on different variables such as satisfaction, motivation, achievement, attitude, cooperativeness, knowledge retention and

critical thinking skills. The general findings showdiscrepancy. No studies are found indicating higher result in the traditional environment than the blended one, showing that the blended learning environment is at least as effective as the traditional one. But, still there is a need for a better blended learning environment. Especially, the context of developing countries like Ethiopia is of high concern.

### 2.11. Research Gap

The instructional strategies employed so far (conventional methods)in Ethiopian context have not improved students'achievement and motivation in the subject to a considerable extent(Eshetu et al., 2009). The current national assessment confirms that achievement of students in mathematicsis below the expected standard. Also it is agreed that there is a need for new pedagogical approaches to improve science and mathematicsinstruction in Ethiopia.

The maximum impact of educational research is obtained only when affective issues became a central position in the minds of researchers (Mcleod, 1992). Because of this, Drysdale et al. (2013) suggested future researchers to give attention to students' engagement, satisfaction, motivation and generally affective issues as part of students' academic performance to be investigated. There is also a need to undertake more research to inform better practices specific to the discipline of mathematics e-learning (Bass et al., 2006; Borba et al., 2016; Juan et al., 2012).

Studies that are reviewed in this chapter show that blended learning have been under exploration and still needs further research. Accordingto Garrison and Vaughan (2008) there is a challenge to gain a deep understanding of the need, potential, andstrategies of blended

learning. The current literature on BL shows contrasting result in terms of students' achievement and critical thinking; but there is no research that shows the superiority of traditional face-to-face instruction in enhancing the learning process than the blended learning environment. Many researchers such as (Eryilmaz, 2015; Garrison & Kanuka, 2004; Graham, 2006; Hughes, 2007; Lin et al., 2017; Massie, 2006), believe on the effectiveness of the blended learning approach. Because of such contrasting findings, Zhao and Breslow (2013) and Means et al. (2013) claimed that the field is still new and the overall pattern that would indicate effective methods of blended learning is still not visible.It also remains unclear whether these environments are successful, and ifthey are, which attributes make them successful(Oliver & Trigwell, 2005).

Regarding the need for future research, developing effective blended learning designs for different mathematicscourse takes priority (Bass et al., 2006). Based on the debate in the current literature, Drysdale et al. (2013) similarly contends lack of rigorous research on how technology can be used within a blended environment. They also stressed lack of theoretical contribution or foundation of previous research on blended learning.

Although much has been said in the field of blended learning, very few studies examine the different types of blends behind their implementation(Medina, 2018). To address this gap in the literature, this study describes the type of blend, which has been validated by a case study of algebra course in higher education in Ethiopia.It is also argued that till now, there is no common approved model of blended learning(Zhang & Zhu, 2017).

On the other hand, there is a continuous debate on the term 'blended learning' itself. Some researchers such as Oliver and Trigwell (2005) argued that the term learning be abandoned.

Based on rigorous analysis of the current debate, this study tried to uncover the debate by formulating a good look at the term. Research also shows that, both students and teachers fail to have an understanding ofblended learning(Mestan, 2019).

It is the recent movement that Ethiopian scholars are looking for new pedagogy to enhance learning. Mathematicseducators' are among the leading professionals in conducting technology based research. For instance, Gemechu, Michael, and Atnafu (2013), conducted a research using the Geometer's Sketchpad. Even though their research design is exposed to internal validity threats, it produced a positive effect on students' attitudes, confidence and engagement in geometry. Recently, Melesse (2014) conducted a research to investigate the effectiveness of e-learning on the academic performance of mathematicsstudents in fundamental concepts of mathematicscourse. The study was conducted with many challenges such as shortage of working computers in the lab, students' weak knowledge and skill on handling the technology facility, severe power interruption etc. After all this pitfalls his study produced no statistical difference between the conventional and ICT supported learning on student performance. After facing many challenges Melesse recognized that fully e-learning is a challenging method for students. So, to minimize the challenges, applying the blended nature is an option.

Despite these Michael (2015) contends on the necessity of integrating technology, pedagogy and content in order to enhance quality of education. So, on one hand to minimize the challenges of applying (employing) fully e-learning as reported byMelesse (2014) and to enhance the integration of technology in instructional utilization, applying the blended nature

is an option. This study tried to unpack these form of blending and saw the effect on students' achievement and affection.

## 2.12. Theoretical Framework

The emergence of blended learning is based on pragmatic mixing of different method of teaching and learning. It can be seen as the application of two or more methods or solutions to a learning need (Wilson & Smilanich, 2005). But, the mixing in this study was face-to-face and web-based learning environments. Its sole purpose is to support the learning process. Hence, learning can be taken as a process of actively constructing knowledge and instruction is a supportive process which assists in the construction of knowledge rather than communication of knowledge. Online communication tools allow for the establishment of a unique collaborative learning environment.

It is of vital importance to note that the process of learning can be best achieved if there is good environment which is interactive for both the teacher and students. More importantly, the learning process should go in line with the technological advancements of that particular time. Blended learning is one of the strategies that aim to create conducive environment by combining the latest technology and face-to-face class room instruction. Although there is a wide discrepancy in blended learning practices that are occurring (Graham, 2006), the models can be categorized as activity level, course level, program level, or institutional level. Each of the four models are very clear because, their names indicate about the nature of the blend. For instance, activity level blending is when a learning activity contains both face-to-face and online elements. Course level blending on the other hand is used as part of a course, whereas program level is designed in a program such as diploma, degree, or faculty based such as

social science, engineering, natural science and so on. The forth and the broadest blending occurs at an institution level, in which the full program in the institution is delivered through the blended approach. This type of blending requires organizational commitment and this is the highest stage in the development of BL.

The nature of the blend can also be categorized as enabler, enhancement or transformational (Graham, 2009). The enable blends focus on addressing issues of access and convenience. For example, blends that are intended to provide additional flexibility to the learners or an attempt to provide the same opportunities or learning experience but through a different modality usually using technology. Enhancement on the other hand allows incremental changes to the pedagogy, but do not radically change the way teaching and learning occur. For example, in a traditional face-to-face learning environment, additional resources and some supplementary materials may be included online. The teacher may also use for communicating with students, and posting announcements.

But, transformational blending allows a radical transformation of the pedagogy. An example for this is a change from a model where learners are just receivers of information to a model where learners actively construct knowledge through dynamic interactions (Graham, 2009). Graham argued that these types of blend enable intellectual activity that was not practically possible without the technology. At this level, there is a discussion forum, online assessment and interactive learning materials.

There are five models of blended learning to redesign existing course, these are supplemental, replacement, emporium, fully online, and buffet model(Twigg, 2003a).The supplemental model does not change the basic structure of the usual approach, particularly the number of

class meetings. However, technology is used to supplement the face-to-face approach in terms of out-of-class activity.

On the other hand, the replacement model reduces class meeting time, replacing. It provides interactive learning activities for students. The basic assumption is that certain activities can be better accomplished online than in a class(Twigg, 2003b). The emporium model allows students to choose when to access coursematerials, what types of learning materials to use depending on their needs by eliminating class meetings with on demand on-site assistance(Graham, 2009). Thus, it requires commitment from all bodies and sufficient infrastructure in order to fully benefit and improve learning. Aiming to change the notion of using web-based materials as a supplemental resources towards the notion of substituting the face-to-face meetings, the fully online model is used in some developed countries (Graham, Henrie, Gibbons, & Gibbons, 2014; Twigg, 2003b). in this type of model, the instructor should be committed to answer every inquiry or discussion raised by students in a timely basis. Based on the types of students involved, a course might also be redesigned using the buffet model of blended learning. This type of model treat students as an individual by giving plenty of learning options including the face-to-face, online, projects etc. (Graham, 2009)

For the purpose of this study, a unique model that applies blended learning in three stages was used. The stages were used step by step to explore the effect on algebra achievement and affection at course level. The ingredients in the blend are categorized as supplemental: which includes resourcing the online environment with supplemental materials, online discussion, online quizzes, responding to students question at any time, flexibility of online activities for computer lab or home. According to Graham et al. (2014) this type of model is called design

based supplemental model. The following figure shows the BL model that was used in the study which brings together a number of related concepts of the study to explain algebra achievement of students. It also gives a broader understanding of the research problem:

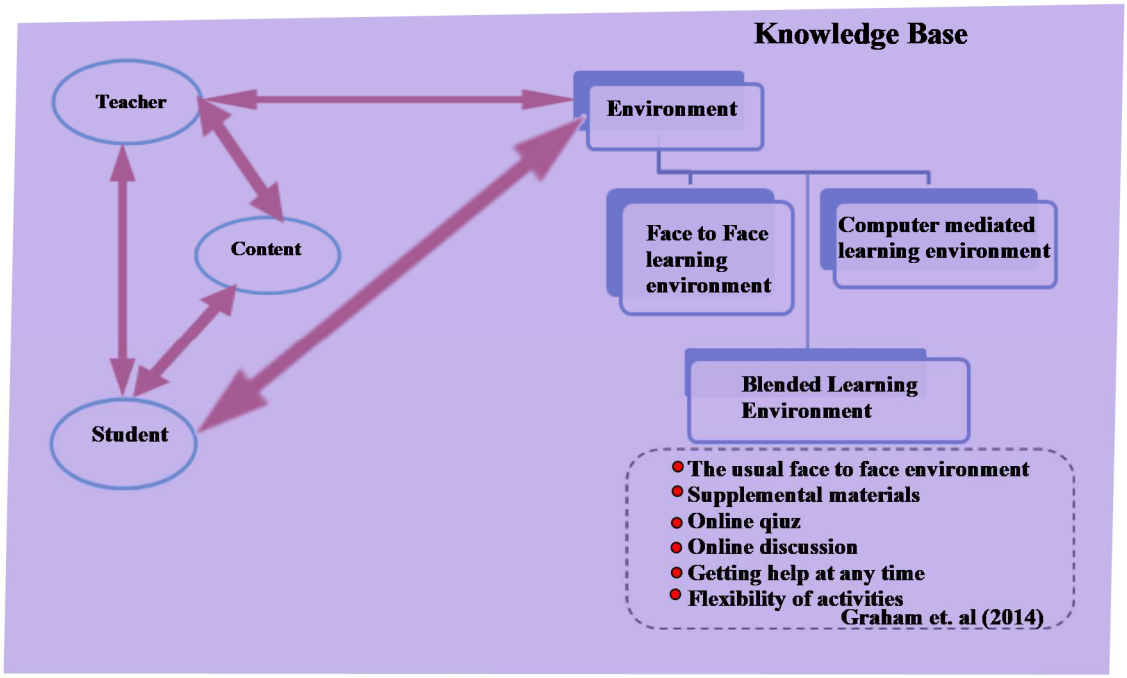


Figure 2.1. Supplemental blended learning model

In the field of inquiry, there should be a common language and focus for the activities that take place. An essential element that helps the inquirer to be focused is theory. Thus, it is argued that developing theory is essential to understand a phenomena (Graham et al., 2014). This is because, it allows for a clear focus on important issues and provides guidance for the design of improved solutions to problems (Burkhardt & Schoenfeld, 2003; Garrison & Vaughan, 2008). So far limited efforts have been made to understand the development and use of theory in the domain of blended learning research (Graham et al., 2014; Halverson et al., 2012). But, Zumbach, Schwartz, Seufert, and Kester (2008)highlighted the importance of

building a research on theory and previous research from more than one discipline and use of methods for data collection and analysis from more than one research tradition.

Though the term blended learning refers to the use of two different methods designed to benefit from the strength of both methods, through the emergence of technology its emphasis is shifted to the integration of educational technology mainly the Web. Hence, it is evident to say, challenges of contemporary education necessitate for the new forms of partnership and communication. It may include; networking, get access to every aspect of information (up to date) and share knowledge and information.

A variety of factors are required to be addressed tocreate a meaningful learning environment. Asystemicunderstanding of these factors can enable designers tocreate meaningful distributed learning environments (Singh, 2003). Thesefactors comprise Khan's Octagonal Framework. This framework serves as a guide to plan, develop, deliver, manage and evaluate blended learning program as a result, this study was shaped by the theoretical influence of Khan's octagonal framework. Theframework has eight dimensions: institutional,pedagogical, technological, interface design, evaluation,management, resource support, and ethical. These issues helporganize thinking, and ensure that the resulting learningprogram creates a meaningful learning experience.

The **Institutional** dimension is concerned with issues relating to organizational, administrative affairs, academic affairs and student services with reference to matters of education. Staff involved in designing and implementing blended learning programs should consider the preparedness of the organization, availability and structure of content and infrastructure as well as the students' needs (Sigh, 2003).

The **Pedagogical** dimension is concerned with the combination of content that has to be delivered (content analysis), the learner needs (audience analysis), and learning objectives (goal analysis). The pedagogical dimension also encompasses the design and strategy aspect of blended learning environment. The learning goals or learning outcomes need to be listed and the most appropriate delivery method is chosen (Amalou, 2006; Singh, 2003).

The **technological** dimension examines issues of technology infrastructure used in blended learning environments, particularly the online aspects. Technical requirements, such as the server that supports the learning program, access to the server, bandwidth and accessibility, security, other hardware and software (Singh 2003). This dimension also addresses the need for finding the most suitable learning management system that could manage multiple delivery types and a content management system that catalogues the learning content for the learning program (Amalou, 2006).

The **interface design** refers to the overall appearance of the blended learning program. It is important to ensure that the user interface supports all the elements of the blend. It has to integrate the different elements of the blend, which will enable students to use different delivery types as well as switch from one delivery type to another. Issues relating to content structure, navigation, graphics and 'help' features are also addressed in this dimension (Akpan, 2015; Singh, 2003).

The **evaluation** dimension includes both assessment of learners and evaluation of the instruction and learning environment. Singh (2003) portrays this dimension as being concerned with the usability of blended learning program. The program should have the capability to evaluate the effectiveness of a learning program as well as evaluating the

performance of students. In a blended learning program, appropriate evaluation method should be used.

**Management** refers to the issues related to the management of blended learning program, such as infrastructure and logistics required to manage multiple delivery types. This dimension also addresses maintenance of learning environment and distribution of information, registration, notification and scheduling the different elements of the blend (Akpan, 2015).

The **resource support** dimension examines the online and offline support and resources required to foster meaningful learning environments. Resource support could also include the teacher that is available in person or via e-mail (Akpan, 2015; Singh 2003). The **Ethical** dimension on the other hand identifies the ethical issues that need to be addressed when developing a blended learning program. Issues such as equal opportunity, cultural diversity and ethnicity should be addressed.

Figure 2.2. Khan's Octagonal Framework, adapted from (Singh 2003)

Students' willingness to work on a variety of mathematical tasks and their diligence in dealing with these tasks plays a key role in achievement (Khine, Al-Mutawah, & Afari, 2015; Reyes, 1984). This refers affective domain which includes wide range of beliefs, feelings and disposition that are beyond the domain of cognition (Mcleod, 1992). After reviewing a plenty of factors that affect achievement of students, affective factors are found to play a prominent role than behavioral factors (see sec 2.9) and hence, this research tried to uncover the effect of blended learning on students' affection. The affective dimension considered in this study include mathematics anxiety, academic hardiness, self-regulation, satisfaction, and motivation.

To produce a learning environment that encompass both student-level factor (audience analysis) and the current technological advancement, it requires to examine Khan's octagonal framework. This leads to comprehend the overall structure of this study.

## 2.13. Conceptual Framework

Conceptual framework is a visual or written presentation of the main things to be studied. It is a map towards realizing the intent of the research. The following figure illustrates the conceptual framework that was used in this study:

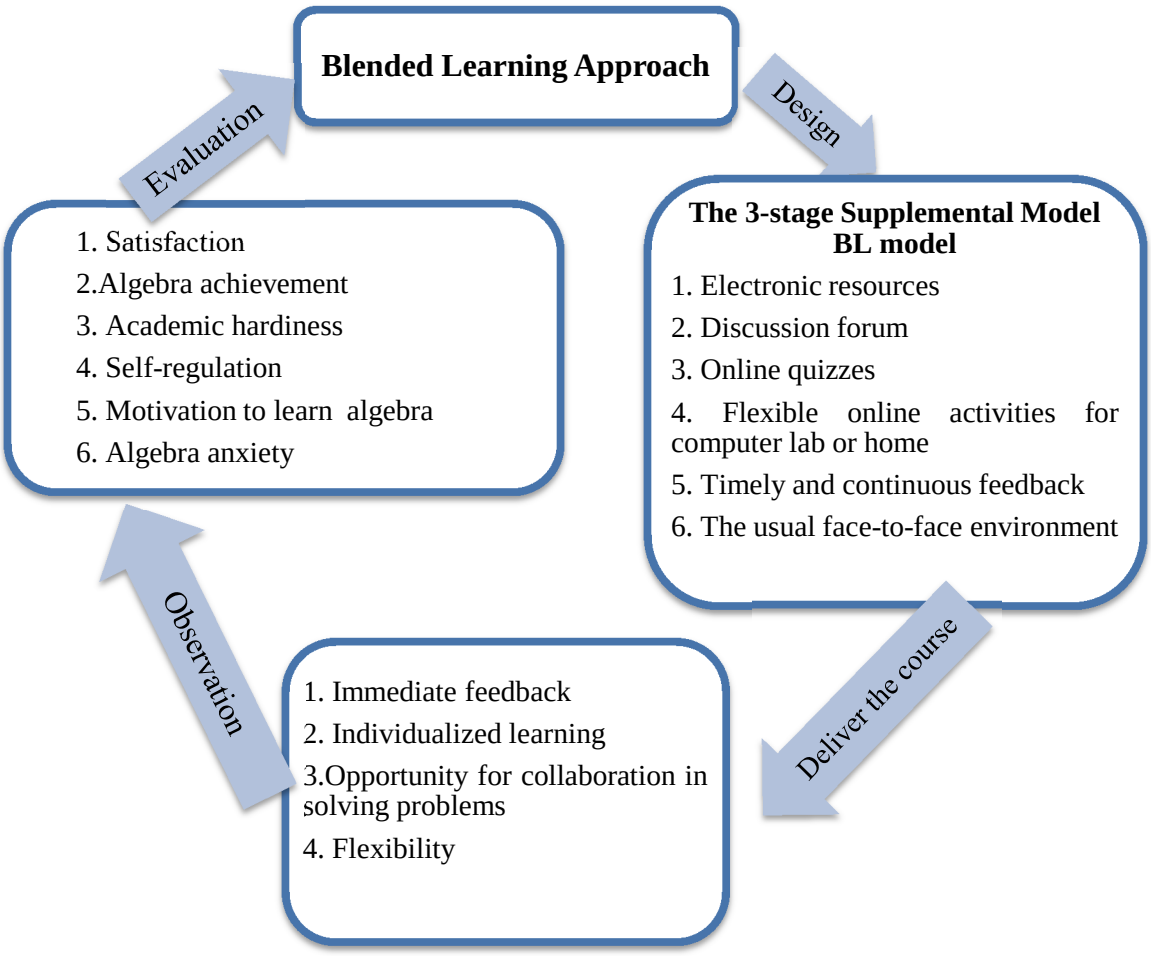


Figure 2.3.Conceptual frame work of the study

As this study is design based, the conceptual framework grounds on the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model of instructional design. It comprises four basic interrelated entities. First and foremost the analyses of learning needs provided by blended learning which confers benchmarks to define educational goals, organizes the needed preconditions and define roles in learning contexts, and observing results regarding stated learning strategies. Second, the design and development of course materials which are based on the information obtained in the first phase. Thirdly, the course

delivery process focuses effectiveness entangled with the attainment of the goal of the study. Then the observation aimed to gather information about the experimental procedures and components. The final one is evaluation. The intent of which is for possible improvements of the design components during the intervention. The data collected during the intervention is also an essential component for the attainment of the goal of the study; because it tells about what to improve throughout the experimentation period. This ensures flexibility within the learning scenario.

# Chapter 3: Research Methodology

The purpose of this study was to investigate the effect of blended learning approach on students' algebra learning with respect to their achievement and affection (academic hardiness, motivation, math anxiety, satisfaction and affective aspect of self-regulated learning). So, this study might contribute to the emerging shift towards distributed learning environment. This chapter presents the procedures followed throughout the study. It introduces a description of the research method used, the participants, the research design, the sampling procedure, variables of the study, the pilot study, ethical considerations, data collection instruments and the data collection procedure. It also presents the data analysis technique employed in this study.

## 3.1. Research Method

On his most influential book entitled "the structure of scientific revolution",Kuhn (1996)stresses to base a research on aset of beliefs about knowledge (theory) which is called a paradigm. The selection of the research paradigm for this study was based on my answers to the three philosophical dimensions: ontological, epistemological and methodological, which helped me to understand the most significant differences between paradigms. Byanswering these questions based on the purpose of this study, which are dependent on one another, it becomes clear to choose the pragmatic research paradigm.

The ontological question is, "what is the form and nature of reality and what is known about it?" (Guba & Lincoln, 1994). The objective of this study is to explore theeffect of blended

learning approachon learning mathematicscourse, which is expected to produce reality between positivist and constructivist ways of knowing in order to look at what is meaningful from both. This is the realm of pragmatism (Shannon-Baker, 2016). The epistemological question is, “what is the nature of the relationship betweenthe researcher and data?” (Guba & Lincoln, 1994). Epistemologically,the researcher’s task was to develop and deliver a blended learning course, evaluate learning outcomes as well as gain access to the participants, and make sense of their constructed meanings about their new experience. The methodological question is, “how can the researcher find out what she/he believes to be known?” (Guba & Lincoln, 1994). The nature of theresearch questions addressed in this studydemandedtheutilizationof both exploratory and explanatory methodology, which appears to be most appropriate to see the cause and effect relationship as well as to present a detailed view of the experience of the students and instructors.

This philosophical assumptions reveal the approach in the current research to be a mixed one. On the other hand, Zawojewski, Chamber, Hjalmarson, and Lewis (2008) contend that to create effective learning environment, design science research is a good option. Thus, this research was framed with design science research framework and mixed methods approach to base knowledge claims on pragmatic grounds. It is also argued that application of only one research method is insufficient to obtain practical results in design science research (Hevner, March, Park, & Ram, 2004; Offermann, Levina, Schönherr, & Bub, 2009).

According to pragmatism, truth is what works at the time, rather than relying on a duality between reality independent of the mind or within the mind (Lesh & Doerr, 2003). The intent for this philosophical position is the need for multiple perspectives, to validate the

quantitative measures with qualitative experiences, to explain quantitative results, to better contextualize the intervention (BL) for the purpose of exploring its effectiveness in enhancing algebra achievement and affection. This is done because, statistical results did not provide the human motivation behind a situation and behavior. Prior to the administration of instruments, mixed method research helps to explore and explain the statistical results by talking to peoples, also to see if the quantitative and qualitative results match, to enhance the experiments(Creswell, 2013).

Additionally, mixed research employs strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problems (Creswell, 2014). It also opens the door for multiple methods of data collection, different worldviews, and different assumptions, as well as different forms of data analysis, which help to expand and strengthen the conclusion than can be drown from the study (Schoonenboom & Johnson, 2017). It is based on these foundations that mixed method was chosen and also the combinations of quantitative and qualitative approaches provide a more complete understanding of the problem at hand than either method alone(Cohen, Manion, & Morrison, 2007; Creswell, 2014).

### 3.2. Research Design

A research design is a plan that guides the investigator in the process of collecting, analyzing and interpreting observations(Yin, 2009).As this study anticipated mixed research it employed the quasi-experimental research design at one hand. This design fits to the cause-effect relationship(Bogdan & Biklen, 2003; Cohen et al., 2007).It is a pedagogicalexperiment associated with some limitation when compared with the true experiment. This limitation

arises as the study is conducted on human element. Thus, intact classes were used instead of randomly composed samples. This is because, school classes exist as intact groups and it is not ethical to take apart and rearrange classes for research purposes as it is a kind of disturbance. Using intact classes ensure the smooth running of the school programs.

The most spread quasi-experimental design in educational research is the nonequivalent control group design (Campbell & Stanley, 1963). Still, contemporary studies such as (Idris, 2006; Mulugeta, 2015; Selçuk, 2010; Selcuk, Caliskan, & Sahin, 2013; Sungur & Tekkaya, 2006) employed this design in their quasi-experimental research. However, this design is subject to the internal validity threat of selection; because any prior differences between the groups may affect the outcome of the study. According to Dennis and Boruch (1989), this type of design is a weak design; because, it can lead the researcher to conclude that the program didn't make a difference when in fact it did, or that it did make a difference when in fact it didn't. So, to resolve this limitation, this study employed a covariate analysis. This ensures the result to be real, as it statistically handles the initialgroup difference.

To achieve the goal of this study, priority was given for quantitative data; because cause and effect relationship can best be described using quantitative method. The purpose of qualitative data on the other handwas to better understand and explain the quantitative results. Furthermore, qualitative data has been used to determine students and instructors perceptions towards blended learning; for this part, a qualitative case study was used. Thus, the approach is a mixed research that embodies quasi-experimental research and case study that appear sequentially, which can be given as:

**Quan ⟶ qual**

According to Creswell (2013)such a design was intervention mixed methods design as shown in figure 3.1 below:

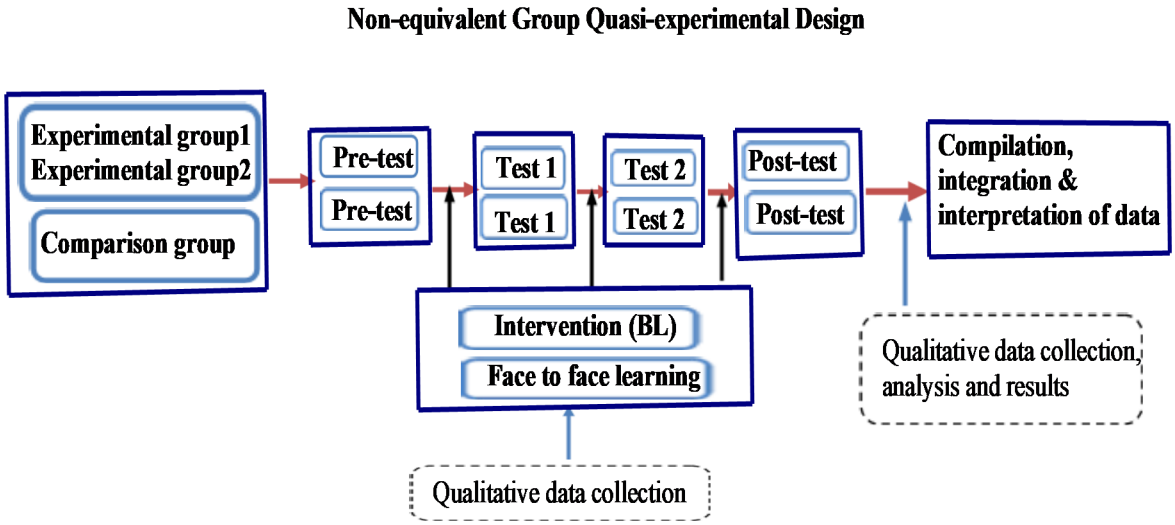


Figure 3.1. Design of the study

As can be seen from figure 3.1, there were two experimental groups subject to the same intervention, which help to examine replicability of results. Furthermore, two tests were administered together with qualitative data collections using interviews to examine the progress of students learning throughout the study period. All of which are accounted for the consolidation of the results by concealing the limitations of non-equivalent group design.

### 3.2.1. Moodle as a Learning Platform

Moodle is an educational web application designed based on social constructionist approach, which emphasizes that learners can contribute to the educational experience in many ways

(Lin et al., 2017; Shachar & Neumann, 2010; Wu, 2008).This web application is first created in 2002 by Martin Dougiamas (a computer scientist and educator) to create online courses with a focus on interaction and collaborative construction of content(Cole & Foster, 2008).His interest of developing alternative learning environment using technology continue to influence his mind. That is why he positioned his postgraduate degrees in Education and Computer Science, which helped him to meet his dream.

Moodle stands for modular object oriented dynamic learning environment. It provides a set of tools that support an inquiry and discovery-based approach to online learning and it is employed to create an online course that is used to enhance and supplement face-to-face classroom instruction (Lin et al., 2017). It is also used to create an environment that allows for collaborative interaction among students as a separate or in addition to conventional classroom instruction and allows students to be active learners, actively participating in the online learning process(Zakaria & Daud, 2013).

There are many open-source, free LMS (Learning Management System), such as Moodle, Coursework, Eliademy, ILIAS, Atutor and Interact (Zakaria & Daud, 2013). However, due to its convenience and matching with the purpose of the study, as well as its nature, Moodle was used in this study to create the online version of blended learning. It is also argued that most course management systems are tool-centered,whereas Moodle is learning-centered(Cole & Foster, 2008).

Based on such suitability and philosophical background, Moodle was used to create an easy and interactive learning platform for students learning. Enrolment to the course was made to be self-enrolment, however most of the students had no email account and faced a difficulty.

Thus, to save time, the enrolment was made manually by course administrator (researcher). Students then sign in and access the site using their name as a username and their student identification number as a password. The front page that students first see when entering into the page is displayed in figure 3.2 below:

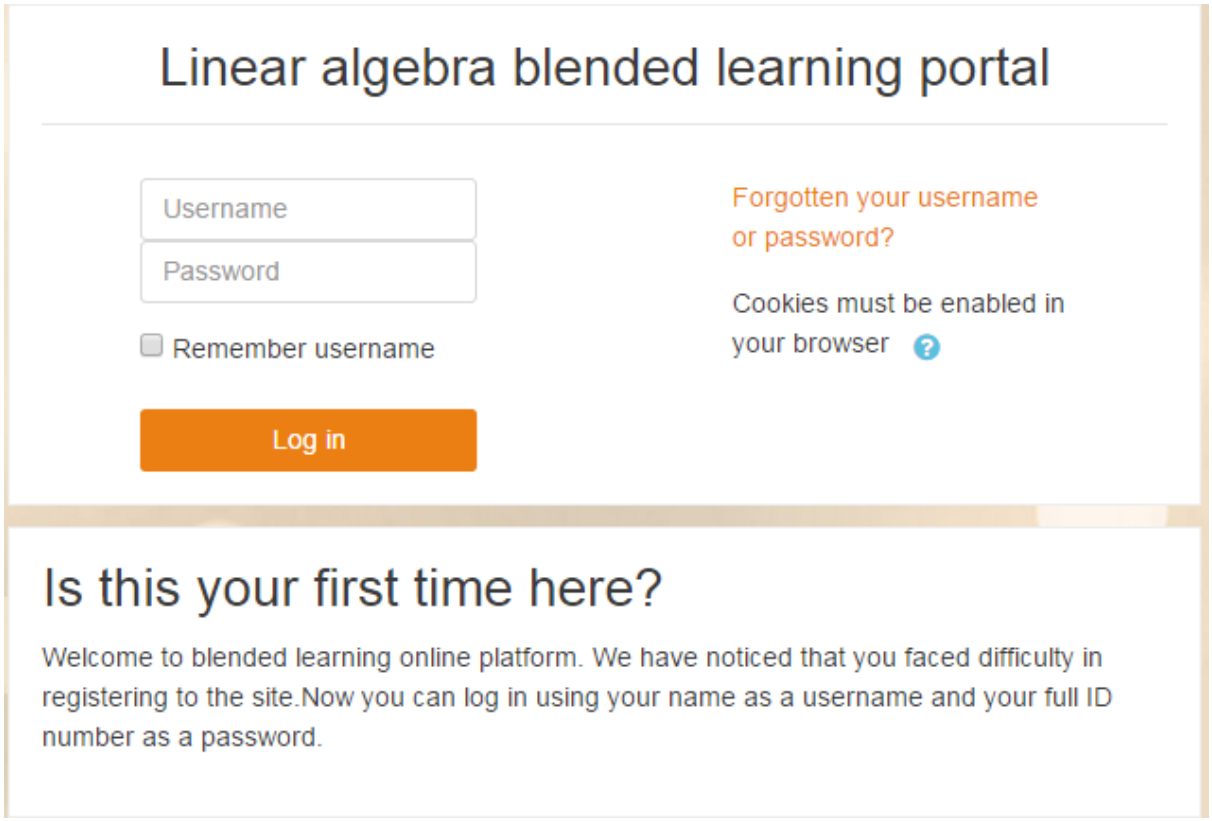


Figure 3.2. The e-learning platform used in the study

### 3.3. Validating the Blended Learning Model Used

To be certain of the appropriateness of the intervention, it was tested on a pilot group of statistics students taking the same course so as to identify difficulties of implementation, determining the time schedule for the actual study and modifying what is necessary in the initial draft before implementing it on the actual study.

The feedback obtained from students show that the intended strategy (BL) was attractive, interesting presentation of contents, motivating and resourceful as compared to the usual course delivery method.As students found the time given for the lab session to be minimum, the schedule was changed from one hour to two hours per each lab session. This is equivalent with the tutorial hours of the comparison group.

The computer lab assistant instructor also liked the learning management system for its suitabilityfor being a low bandwidth platformthat means it can be executed even in low internet connection. He further pointed that the system is easy and user friendly. This is also one of the assumptions that pushed the selection of Moodle from the available open e-learning platforms.

The course instructor also found the easeof the teaching and learning process in such a blended learning format.As a tryout study, the basic components of the blended learning approach being used were examined for their effectiveness. Accordingly, it was found that the interactive online notes and resources were easily accessible for all students at any time, and the self-checking quiz was effective in engaging students. However, to further maintain the smooth execution of the blended learning approach throughout the study, continuous maintenance of the learning management (Moodle) was made. This was done in collaboration with lab assistant instructorsand ICT directors of the universities.There was also a continuous update of the contents throughout the study period.

### 3.4. Site and Participant Selection

The participants of this study were students taking the course linear algebra II in the comparison and experimental universities, at the department of mathematics. It is clear that the study requires at least two groups taking the same course, as a result two universities were selected. Before the beginning of the research, one university (U1) was found to be suitable for the intervention. However, at the beginning of the study, U2 was identified as another more suitable site for implementing blended learning intervention. Hence, it was also included to see the replicability of the results in order to increase the comparability and reliability. The selection of these Universities was based the theoretical framework (institutional dimension). Thus, the universities were selected due to the institutional readiness, infrastructural facilities (computer lab with internet access) and willingness to support the implementation process throughout the semester.

Thus, the intervention was made on these two universities namely: U1 and U2. These two universities were found to be suitable for the intervention and also showed their willingness to support the researcher in all aspects for the successful accomplishment of the study. On the other hand, the comparison group was taken from U3, while the pilot University was taken to be U4.

A total of 71 students participated, which were taken from the three selected universities (see sec 4.1). This number is obtained after rejecting 5 students (two fromU1, one from U2 and two from U3), because of the incompleteness of the data they have provided.

The study was conducted at course level (Linear algebra II). This course is given for year II mathematics students. Students' difficulties with algebra are common, not only when

students are first introduced to the subject, but also when they are assumed to have mastered the subject and are beginning to study calculus (Burton, 1988). Computations, obeying specific rules, working with variables and logical thinking are all components that students need to know in mathematics. Thus algebra can be taken as a gateway to higher mathematics(Stacey & MacGregor, 1999). A study conducted in one of the Ethiopian universities shows that the main areas of algebra in which students encounter difficulty is matrix operations and solving system of linear equation (Tadesse, 2014) which are the gist of algebra. Thus, it was based on this impression that algebra course was selected.

According to the harmonized curriculum, students took three computer courses in semester I, II and III namely; introduction to computer, fundamentals of programming I, fundamentals of database system. This was a good opportunity for the study, as it resolves problems in basic computer use.

For the qualitative data collection, a systematic sampling method is used to select student participants. The recordings of their thoughts were made based on their willingness. In this regard, some students preferred not to be recorded. As a result, a detailed note is taken during the interview and then I gave them to read the note at the end of the interview for possible corrections of omission.

### 3.5.Variables of the Study

Independent variables represented in the teaching program were blended learning and traditional method. While independent variable represented by gender (sex) were male and female. On the other hand, the dependent variables include students' algebra achievement and

affection. Affection was considered to be the affective aspect of students which includes math anxiety, affective aspect of self-regulated learning, academic hardiness, motivation to learn and satisfaction. Each variable except gender and blended learning consists of different numbers of constructs and number of items (see table 3.1 below).

Table 3.1. Variables, instruments and number of items

| Variables | Dimensions (no of items) | Total No of items | Remark |
|---|---|---|---|
| **Satisfaction** | Learner-content (3)<br>Learner-instructor(3)<br>Learner-learner(1)<br>General satisfaction(1) | 8 | |
| **Mathematics anxiety** | Positive item (5)<br>Negative item (6) | 11 | |
| **Academic hardiness** | Commitment(8)<br>Challenge(3) | 11 | |
| **Self-regulated learning** | Goal setting(1)<br>Environment structuring(4)<br>Task value(3)<br>Time management(3)<br>Help seeking(3)<br>Self-evaluation(4) | 18 | |
| **Motivation to learn** | Intrinsic(3)<br>Extrinsic(7) | 10 | |
| **Algebra achievement** | Pre-test(10)<br>Test 1(10)<br>Test 2(10)<br>Post-test(10) | 40 | Each test was examined separately not aggregated as others |
| **Total number of items** | | 98 | |

### 3.6. Data Collection Instruments

Based on the nature of the variables used in the study, multiple data collection instruments were used. Particularly, mathematics anxiety rating scale (MARS), Online SRL Questionnaire, satisfaction survey questionnaire, motivation scale, hardiness scale, interview, observation and achievement test were used in this study.

#### 3.6.1. Mathematics Anxiety Rating Scale (MARS)

To obtain students levels of mathematics anxiety, a 14-item MARS developed and validated by (Mahmood & Khatoon, 2011) was adapted. However, after pilot analysis, three items were rejected because of their low inter item correlation with the overall item. Hence, for this study mathematics anxiety was measured using a likert scale with 11 item scale.

This scale is a bi-dimensional and shorter instrument in which 5 items are worded positively and 6 items worded negatively. It is a 5-point likert scale that assesses positive and negative dimensions of math anxiety. Students choose among the five alternatives namely: strongly agree, agree, neutral, disagree and strongly disagree. The wording of the adapted item has been changed to fit issues of this study. For instance the item “I would prefer mathematics as one of my subjects in higher studies” was changed to “I would prefer algebraas one of my specialization in further study”. The positive effect items were reversed for scoring so that a high score indicates high anxiety. The range of scores was from 11-55 and high scores will indicate high math anxiety.

### 3.6. 2. Achievement Tests

The achievement tests (pretest, test1, test2 and posttest) that were used in this study comprises 10 items each developed by the researcher to measures students' algebra achievement before, during and after the treatment. This is based on the design of the study which requires additional two achievement tests, to be administered at the middle of the study. Different achievement tests were used at each stages, as it is possible that taking the same test several times has some disadvantages such as remembering the test items and memorizing the right answers during the process), which affects the validity of the results. Based on the goal of the course, all tests focused on three learning categories namely: understanding of algebra concepts,computations and logical reasoning. All tests were piloted and validated for their equivalence before use in the actual study.

In this study, students' score on pre-test served as the basis to investigate students' initial difference. All items of pretest, test1, test2 and posttest were multiple choices with 4 options A-D. To identify the achievement domains being measured and to ensure that a fair and representative questions appear on each test, the researcher has developed a table of specification (see appendix H). The table of specification is developed based on the idea of test preparation by (Gronlund, 1977). He suggested that before preparing tests, it is important to prepare a table of specification based on the learning outcome and topics in accordance with their relative importance. In this study, all tests were scored manually by the researcher. Each correct answer holds one mark while a wrong answer was scored zero and for the purpose of simplicity, the results of students on each tests were converted to 100%. The assumption behind the table of specification is that each learning outcome should be achieved by each students after the teaching-learning process is conducted.

### 3.6.3. Self-regulated Learning Questionnaire

Self-regulated learning centers on the self as an agent who acts upon his or her environment to achieve learning goal. Within self-regulated learning, goal settings, time management, task strategies, environment structuring and help-seeking are the core components (Barnard-Brak et al., 2010). After reviewing various tools used to assess self-regulation and goal orientation, as well as considering the goal of the study, a contextualized instrument to the online and distributed learning environments called Online SRL Questionnaire (OSLQ) was adapted. With reference to the theory of self-regulation in educational psychology(Barnard et al., 2009), the instrument was developed to measure students' abilities to self-regulate and monitor their learning in online and blended setting.

Thus, the current study examines self-regulated learning skills and strategies in view of the online and face-to-face learning environment. The instrument was adapted from (Barnard et al., 2009), which comprises 24-items using five ratings. The original 24-items scale were revised and reduced to 19-items. The pilot study further found one item with low inter item correlation, hence a scale consisting a total of 18-items was used to measure self-regulating learning. It consists of six subscales: goal setting, environment structuring, task strategies, time management, help seeking and self- evaluation. Based upon (Zimmerman, 1998) SRL model, the first two subscales (i.e., goal setting and environment structuring) are part of forethought strategies, the next three subscales (i.e., task strategies, time management, and help seeking) are part of performance control strategies, and the self-evaluation subscale belongs to self-reflection. Students choose among the five alternatives namely: strongly agree, agree, neutral, disagree and strongly disagree.

Though research has indicated that self-reported measures of self-regulation have been unreliable as over-estimates of self-regulated learning (Winne & Jamieson-Noel, 2002), the OSLQ has revealed satisfactory psychometric properties being validated across two samples of learners in the online and blended learning environments (Barnard et al., 2009).

### 3.6.4. The Situational Motivation Scale (SIMS)

A person who feels no encouragement to act is characterized as unmotivated, whereas someone who is energized or activated towards an end is considered motivated(Ryan & Deci, 2000). Motivation exists in two forms: intrinsic and extrinsic motivation. Intrinsic motivation is a force inside the individual (Atnafu, 2012), which enable doing of an activity for its inherent satisfactions rather than for some separable consequence.Extrinsic motivation on the other hand is performed in order to receive something from others. Thus, extrinsic motivator is outside of an individual.

According to Guay et al. (2000) different types of extrinsic motivations have been proposed by self-determination theory: these are external and identified regulations. External regulation occurs when behavior is regulated by external rewards. In contrast, identified regulation occurs when a behavior is valued and perceived as being chosen by oneself.

To measure students' motivation, the Situational Motivation Scale (SMS) developed by Guay et al. (2000) was adapted. The scale assesses students' contextual motivation toward educational activities. The scale was also modified to create context. It is a 5-point liker scale. So, students choose among the five alternatives namely: strongly agree, agree, neutral,

disagree and strongly disagree. The overall scale comprises 10 items which measures students' intrinsic and extrinsic motivation.

### 3.6.5. Students' Satisfaction Survey

How satisfied are students with the blended environment experience? Do they receive the academic and expected social benefits? These questions need to be addressed truthfully for successful learning. One of the measures of student satisfaction is through the administration ofstudent satisfaction scale. After expert review the original 22-item scale developed by (Strachota, 2006)was reduced to comprise only 10-items (see sec 3.8). Students choose among the five alternatives namely: strongly agree, agree, neutral, disagree and strongly disagree.

### 3.6.6. Academic Hardiness Scale

To measure students' academic hardiness, the revised academic hardiness scale by (Creed et al., 2013) was adapted. Initially the scale was developed by (Benishek & Lopez, 2001). After rigorous revision, Creed et al. (2013) reduces the original 19 item scale to 17, which is psychometrically strong. The scale measures students' tendency of commitment, challenge and control.

A person strong in commitment believes that he/she can find something in whatever is going on that seems interesting or important. Persons strong in control believe they can beneficially influence outcomes through effort and they are unlikely to feel powerless. Those strong in challenge believe that life is best when they continue to grow in wisdom through learning

from experiences, whether positive or negative. They are unlikely to expect uninterrupted comfort and security (Maddi, 2005).

### 3.6.7. Interview and Observation

To examine perceptions of students towards the blended learning, to understand students' experiences with BL intervention and to hear students' voices about the impact of the intervention, to identify students' personal factors affecting technology and the challenges that emerged as a result of implementing BL approach, a semi structured interview was used. The interview was conducted three times: the preliminary interview, during the intervention and after the intervention. Interview is useful for getting the story behind a participant's experiences and pursue in-depth information around the topic being studied and the researcher has the opportunity to examine or ask follow up questions (Berg, 2001). It is also the most commonly used data collection methods in qualitative research(Yin, 2003).

Additionally, observation was also employed throughout the study to examine the challenges of using the blended learning approach.This helped to understand the nonverbal expressionsof both students and instructors, grasp how participants are learning within the two environments, and to check thetime spent on various activities. The nature of the observation was both structured and unstructured. Pictures and videos were also used to have more understanding of the experimentation scenario. Audio recording was also used during the interviews and focus group discussions. For the purpose of confidentiality, the names of respondents were not mentioned in the report.

### 3.7. Data Collection Procedure

Following the protocol for conducting dissertation research, a letter of permission describing the purpose and the research activities was sent to each target Universities. Upon approval, the same process was followed to seek permission from each Universities. With the support of the ICT director and the department of mathematics, the researcher met with the targeted students and course instructors to describe the purpose of the research, the activities and their rights as participants. Prior to the beginning of the actual study, an orientation of how to proceed and work in the blended learning environment was briefly described by the researcher to students. Instructors and lab assistants were also given a brief description of their role separately. The instructors, lab assistants and students were given time to ask questions about the research or any of the activities described. At the end consensus was reached and appropriate schedule of the lab session was made.

Regarding instructor effect, all instructors were master's degree holders who specialized in algebra. Apart from personality differences which cannot be handled, this creates homogeneity across the three groups. Not only this, students were using the same harmonized curriculum,which comprises the same course description, course objective, credit hour, and course outline.

### 3.8. Validity and Reliability

Pilot study was conducted to check the validity and reliability of instruments. Validity refers to the degree in which the instrument is measuring the intended outcome. The validity of each instrumentwas determined using face validity, construct validity and content validity. It was checked by supervisors and colleagues to ensureface and content validity. Using the

theoretical background and literature review, construct validity wasaddressed.Moreover, Cronbach alphawasused to measure the internal consistencyreliability of the quantitative instruments which ensures the consistency of results across items. Item analysis was also conducted to determine the difficulty level of the achievement tests (pretest, test1, test2 and posttest).

To assess whether the fourteen items that were summed to create the mathematics anxiety score formed a reliable scale, Cronbach's alpha was computed. And also inter item correlation was computed to examine deficit items. The pilot study revealed that the internal consistency reliability using Chronbach's apha for MARS was .70 after deleting 3 items. These 3 items were found to have low inter item correlation with the whole scale, hence affecting the reliability of the whole scale. Therefore, for the actual study mathematics anxiety was measured using 11 item scale.

Validity refers to the ability of a test to measure what it purports to measure, and test validation is the process of gathering evidence to support the inferences made by test scores(Thompson, 2013). The study used the referees' validity, and the internal consistency reliability. To ensure content validity, the test was introduced to a panel of experts in algebra from U1, U2, U4 and PhD Supervisors. Moreover, the table of specification ensures content validity. All tests were piloted on 28 students before use for the main study. The item analysis of each test was summarized in the following table 3.2 below.

Table 3. 2. Item analysis of achievement tests

| Tests | Item analysis | | Remark |
|---|---|---|---|
| | Difficulty index (P) | Reliability coefficient (KR-20) | |

| | | | |
|---|---|---|---|
| **Pre-test** | .41 | .58 | 3 items were revised, because they have low difficulty index; also 2 items were rejected and replaced, as they have negative discrimination index |
| **Test 1** | .57 | .67 | All items have acceptable level of discrimination and difficulty index. Some distractors were changed |
| **Test 2** | .75 | .69 | All items have acceptable level of discrimination and difficulty index. Some distractors were changed |
| **Post-test** | .76 | .75 | All items have acceptable level of discrimination and difficulty index. Some distractors were changed. |

It is agreed that a reliability coefficient KR-20 of .5 and above are acceptable for research. For instance, Salvucci, Walter, Conley, Fink, and Saba (1997) and Andale (2017) all agreed that a test must have a reliability coefficient KR-20 of .5 and above to be acceptable and reasonably reliable.

KR-20 is used if the test items have varied difficulty, whereas KR-21 is used when a test items possess the same or nearly the same difficulty(Andale, 2017). In the current study, all test items were prepared due considering a diverse nature of students and content difficulty. Hence, each items have different level of difficulty.

The item analysis for pretest shows that the test was neither too difficult nor too simple. Moreover, three items with difficulty index of less than .4 were revised and modified for the actual study. Distractors that are not plausible were also changed. But items with difficulty index of greater than .4 and with discrimination index greater than .2 were retained for the actual study. For test 1, it was found that all items have good difficulty and discrimination index, thus the test was neither too difficult nor too simple.

Test 2 and the posttest also comprised 10 multiple choice items taken from chapter 2 which deals with orthogonality and chapter 3 canonical forms respectively. The pilot analysis shows that all items of both tests were valid and reliable, but some distractors were not plausible, that is not chosen by students. For both tests, those distracts were revised and changed for the actual study.

The pilot study further revealed the internal consistency reliability using Cronbach's alpha for self-regulated learning scale to be .83 after deleting 1 item. This item was found to have low inter item correlation, hence affecting the reliability of the whole scale. Therefore, for the actual study, self-regulated learning was measured using 18-item scale.Whereas, the internal consistency reliability of motivation scale was found to be .78. All the revised items were found to have good inter-item correlation. Hence all items were used for the actual study.

The internal consistency reliability using Cronbach's alpha for satisfaction scale was .79 after deleting 2 items. Because, the 2 items were found to have low inter item correlation, hence affecting the reliability of the whole scale. Therefore, for the actual study, satisfaction of students was measured using 8 item scale.

Furthermore, the pilot study revealed the internal consistency reliability of academic hardiness scale to be.72, after deleting 6 items. These 6 items were found to have low inter item correlation. Accordingly, one item from commitment subscale, one item from challenge subscale and the four items of control were deleted. Hence, for the actual study, academic hardiness was measured and defined using the commitment and challenge aspect only. Students' tendency to control their learning can be addressed through self-regulated learning questionnaire.

## 3.9. Method of Data Analysis

The analysis of data in this study followed embedded analysis of quantitative and qualitative data. All statistical tests were computed using IBM SPSS statistics for Windows, Version 20.0.The analyses were carried out using parametric tests such as: t-test, Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA). For the post-hoc analysis, Tukey HSD and Benforoni test were used. Because of the violation of the assumption of using parametric testsfor the variablespost-academic hardiness of the two experimental groups, pre-satisfaction of experimental group2 and post-motivation of experimental group2, non-parametric tests such as Mann-Whitney U,Wilcoxon signed rank test and Kruskal-Wallis test were used.Additionally, Analysis of Covariance (ANCOVA) using pre-test scores and previous experience in using computers as covariates for algebra achievement and the pretest score for all other variableswas used to increase the statistical power. The benefit of ANCOVA is to statistically control for a third variable known as a confounding variable. A p-value of less than .05 was considered to be statistically significant.

For the qualitative data, this study used thematic analysis to identify themes within the data.The objectives of this research allowed the data to speak for itself in parallel with the quantitative data or play a role in further explaining the quantitative results which may diverge or converge. But, the given phenomenon was justified to deeply give meaning about the convergence or divergence, which further gives a clear understanding of why things happened in that direction. On the other hand, themes were not predetermined, but rather emerged from the data. Hence, they were data-driven themes.

## 3.10. Ethical Consideration

In any research, the researcher needs to consider the ethical and political issues in asking a particular research question (Darlington & Scott, 2002). Therefore, in this dissertation, informed consent and confidentiality was considered as an ethical issue to protect participants' identity. Permission to conduct the study wasensured from the academic vice president of U1, U2, U3 and U4. All participants were fully informed, about the purpose of the research, the activities that were to be undertaken prior to data collection, and their rights. They were told that all information, including bio data collected, test results, and audio recorded during interviews will be used only for research purposes, their identities will not be included in any part of the research report, and that they can withdraw their participation any time without any consequences. Participants were also informed that there was no harm whether they agree to participate in the research or not. Moreover, audio recording and video recording during the interview as well as during the experimentation was made with the consent of participants.

# Chapter 4:Data Analysis and Interpretation

The purpose of this study was to determine the effect of blended learning intervention in improving students' affection and algebra achievement.To achieve this purpose, the blended learning program was designed, the study instruments, which included content analysis, likert scales and achievement tests were implemented. The study included one exogenous variable: blended learning. On the other hand, the dependent variable was algebra achievement which was measured using pre-test, test 1, test 2 and posttest. While motivation to learn, satisfaction, self-regulated learning, gender, and academic hardiness were intervening causal variables. To achieve the goal of the study, mixed methods research was applied.

The research questions that were addressed in this study were: (1) Are there a statistically significant differences in the students' algebra achievement and affection between the experimental and comparison groups? (2) Is there a statistically significant difference on the pretest of students' algebra achievement between the experimental and comparison groups? (3) Are there a statistically significant differences between the experimental groups and comparison group on algebra achievement during and after the intervention? (4) Are there a statistically significant differences on the pretest of students' affective components between the experimental and comparison groups? (5) Are there a statistically significant differences on the posttest of students' affective components between the experimental and comparison groups? (6) Are there differences in gender on the variables treated in the study within and between groups? (7) How do students and instructors perceive blended learning environment? (8) What are the challenges of applying the blended learning method? (9) How effective blended learning is in improving students' algebra achievement and affection?

## 4.1. Demographic Information of Participants

The first portion of the questionnaire seeks to obtain demographic information concerning the participants in the study.Table 4.1 provides information on gender, and access to internet, for both experimental and comparison groups.

Table 4.1. Demographic information of the participants

| Groups | Gender | | Age | | Internet use | | Total |
|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Min** | **Max** | **Yes** | **No** | |
| **Experimental 1** | 11 | 11 | 18 | 23 | 10 | 12 | 71 |
| **Experimental 2** | 10 | 15 | 20 | 23 | 7 | 18 | |
| **Comparison** | 7 | 17 | 18 | 25 | 6 | 18 | |

As indicated in table 4.1, majority of students in the experimental group (63.8%) have no experience in using internet for educational or other purpose. The rest 36.2% have an experience in using internet for educational purpose and social media.Campbell and Stanley (1963) stated that experiments need replication and cross-validation at various times and conditions before the results can be hypothetically interpreted with confidence. Accordingly, the experimental group comprises two groups taken from U1 (*N=22*) and U2 (*N=25*). In order to understand the real effect of the treatment, the two universities were given similar treatment (BL) and examined separately.

## 4.2. Study Context and Need Assessment

For the purpose of understanding the context and readiness of the universities where the actual study was conducted, a need assessment was conducted beforehand. This includes assessing students' current need, students'difficulty in learning algebra, availability of infrastructures for blended learning and willingness of the institution to allow and support the

study. Accordingly, four universities including (U1, U2, U3, and U4) were surveyed for their willingness and availability of infrastructure for blended learning. This was done one month before the actual study. At this instance, only U1 had the willingness to support the study. As a result, students of U1 participated in the need assessment phase. The other universities were not ready to provide appropriate schedule and computer lab with internet access. However, at the beginning of the actual study, Wolkite University showed willingness and enthusiasm to support and provide all the necessary things for the study. For this reason, it was included as the second experimental group.The inclusion of the second experimental group adds a good increment to the strength of the study design in order to examine the benefits of blended learning.

Questionnaire, semi-structured interview and non-participatory observation were used as a primary source of data for the need assessment. The goal of the observation was to examinethe existing local context and availability of infrastructure for the blended learning, in line with the purpose of the study. Non-participant observation involves observing without actively participating. This option was used to understand a phenomenon by entering the community or social system involved, while staying separate from the activities being observed (Flick, 2006). Interviews on the other hand are particularly useful for getting the story behind a participant's experiences and pursue in-depth information around the topic being studied and the researcher has the opportunity to examine or ask follow up questions(Berg, 2001).

For the need assessment, twenty seven (27) studentscompleted the need assessment questionnaire and six students were purposely selected for interview. Based on the data

obtained from the department of mathematics these interviewees comprise different achiever levels and gender. This is to obtain the views of the diverse nature of students.

### 4.2.1. Students Current Need in the Learning Process

Before designing and implementing blended learning, there is a need to build consensus with teachers and students as to why a blended learning approach is beneficial to them. A blended learning initiative could require institutional change, and reallocation of funding, so it is important to have transparency and understanding to avoid deviation and promote benefits(Delialioglu & Yildirim, 2008; Shea, 2007). To assess students' current need, different questions were raised by the researcher to obtain a comprehensive data about the issue. These include: the current learning challenge, students' computer skill and things to be included if computer is to be used as a learning tool.

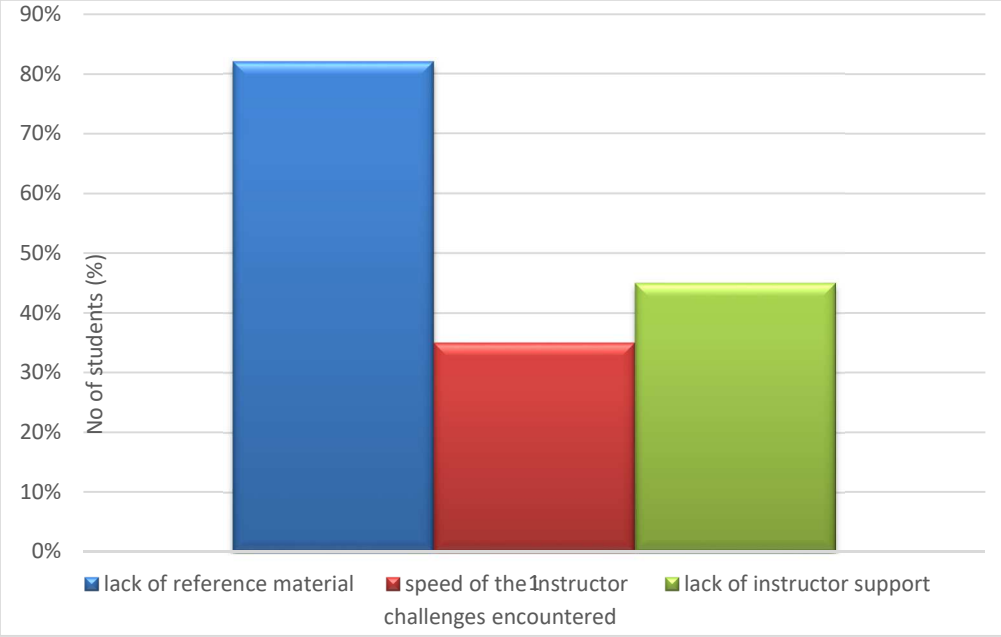


Figure 4.1. Most common current challenges of students

Students reported lack of reference materials, inability to go with the speed of the instructor, and lack of continuous support of instructorsas the contemporary challenge which they demanded for possible alternatives:. Additionally, participants also mentioned the mismatch between the listed references and the course content and librarians' inability to provide the requested material. To endorse these results, the same question was raised during the interview. Regarding the current constraint and future needs one participant responded as follows:

> The reference books listed in the reference list of the course outline do not comply with the course content and sometimes if it exists, it is in a limited number and unavailable when asking the librarians. Because of this, we are striving to take all notes in the classroom and unable to go with the speed of the instructor.

All participants expressed this situation as a problem in their learning and call for availing all important reference materials and also building librarians' skills to support them. Furthermore, students were also asked to list all aspects that help to strengthen their learning of algebra course. Accordingly, students mentionedit important to look for collection of previous exams and worksheets, instructor lecture note, solved problems, collection of learning resources, as well as good assistance from the instructor.

As part of the need assessment, students were asked if they prefer the absence of classroom instruction in a computer mediated class. To this end, they disagreed with the total absence of the instructor in a computer mediated algebra course. One participant replied as "if a computer mediated instruction is to be introduced using computers or internet, it should be with the help and close supervision of the instructor both in the classroom and computer lab".

Lined up with this, another participant replied“the presence of the instructor is crucial since algebra needs deep explanation to understand. Another thing what I want to add is the smartness and preciseness of the online content which is also important for us”. The quality of the content is important not only in the online environment but also in the offline (the usual face-to-face)classrooms. It is therefore important to focus on the quality of the contents delivered such that it could be easily understood. Some students may disregard e-learning due to resistance to change or afraid of technology(Asseffa, 2017a; Ramakrisnan, Yahya, Hasrol, & Aziz, 2011). So, the blended learning model can encompass this entire flaw.

### 4.2.2. Students Skill in Computer Use

Blended learning can be successfully implemented and students make use of it, if students havesufficient knowledge, and are ready to use the newly introduced technology(Poon, 2013). So, before initiating the program, students’ knowledge of computer and their competency need to be identified and assured. Regarding these issue participants of this study responded as follows: “we have a motivation to learn using computers and our knowledge of computer will be improved through the computer courses that we are taking and through time when having an opportunity to practice”.

In a technologically naive society, like Ethiopia, students’ skill in computer usage might be one of the challenges for the resistance to change. Some students came from a rural school where there is no or limited computers and internet access. These students need time to cope-up with the technology usage; this situation may affect their learning simply since they are new to computer.In this study, the target population is second year mathematics students. At this level, students took three computer courses namely: introduction to computer,

fundamentals of programming I, and fundamentals of data base system. So, it is evident to say that starting from the second semester of year I, students can be assumed to have basic computer skills. Additionally, participants both in the questionnaire and interview addressed that they have acquired basic computer skills such as opening and shutting down computers, retrieving documents from the hard drive and writing some notes on Microsoft office word and excel.

Participants also reported that they have an experience in accessing the internet through their smart phones and in the internet cafe, for the purpose of communicating with friends via the social media and sometimes to retrieve educational concepts. Among the participants, 66% reported that they have an experience in accessing the internet for educational purpose to supplement their learning. But, there are limitations in email communications; all participants reported that they have limitations in communicating through email. This is due to the novice nature of students. As the technology expands, this situation will be reverted. Especially, the notion of using technology for educational communication is a main concern in Ethiopia.

There is a promising trend in the future technology integration in the learning process. It is also evident that Ethiopian government recognizes the benefits of educational technology and aimed to fulfill all infrastructures even in lower grades in the ongoingfiftheducation sector development program (2015-2020)(MOE, 2015). Hence, designing good and tested blended learning program and/or course takes priority to benefit from technology integration.

### 4.2.3. Analysis of Local Conditions Suitable for Blended Learning

The worth of blended learning depends on its specific design, implementation and the particular problem for which it is designed to solve. An important component for a blended learning to be effective is therefore the current infrastructures which determine a foundation for blended learning. According to Poon (2013) infrastructure includes technological requirements that must be met for blended learning.

Having difficulty with technologies such as slow internet connections and shortage of computers is found to inhibit students' ability to engage in online discussion(King, 2002; Smyth, Houghton, Cooney, & Casey, 2012; Tadesse, 2014). This issue should be a concern for a nation like Ethiopia where there is limited internet speed. This issue can be reduced by alternatively using the local server, designing a site that can run in a low bandwidth connection and more generally upgrading the speed of internet institutionally and nationally.

In U1, the speed of the internet was good during the implementation of this study. According to the ICT director of the university “It has been upgraded to 150 GBper second and so the speed of the internet was excellent”. In searching suitable computer laboratory in the university, the digital library was preferable in many ways. This library is available for all students of the university. For the purpose of this study, working computers were identified and given a research identification numbers. This is done to document course materials consistently. This laboratory was reserved at the night sessions and Saturday morning. So, by dealing with library directorate, permission was obtained to use the library for research purpose only. The installation of network cables at this laboratory was better as compared to other laboratories found at the department of computer science and information technology.

The computer laboratory for other departments were not connected to the internet. For instance, the computer lab arranged for the department of mathematics and statistics were not connected to the internet and hence not suitable for the intervention. That is why the researcher arranged the digital library as an optionfor conducting the intervention.


Figure 4.2. Students working on the online platform

At Wolkite University, which was taken as the second experimental group, the computer laboratory used for the study was found at the department of mathematics. This computer laboratory was quickly maintained and became available for the intervention. The department and the course instructor showa great keenness to make everything available so as to benefit from the intervention. Apart from their interest, adding another experimental group makes the results of the study more valid and sound.

The development of blended learning requiressufficient resources, including financial resources, time, effort, and expertise. The issue of effort and expertise may not be handled by IT (Information Technology) personnel alone, since designing blended learning course requires subject matter knowledge as well. So, for effective, continuing development and

evaluation of blended learning, teachers must be endowed with both technology and subject matter knowledge. It is also true that high level contentknowledge contributes little when the teacher lacks the generalpedagogical skills required and technological skills which enable the teacher to create a conducive environment where learning can take place. Thus for the current dynamic world, teachers need to have the amalgam of all knowledge (technology, pedagogy, and content).

The Technological Pedagogical Content Knowledge (TPACK) framework describes the type of teacher knowledge required to teach effectively with technology(Koehler & Mishra, 2009). The use of technology for learning introduces a new set of variables which are challenging for teachers. According to Koehler and Mishra (2009), the TPACK framework identifies a fusing structure that guide for appropriate technology integration. Thus, teachers should be endowed and understand how technology, pedagogy and content correlate, and create a form of knowledge that goes beyond the three separate knowledge bases. This is the knowledge structure of teachers required for the 21st century. This knowledge is also required for blended learning to reach its premises. This is because, the online session of blended learning requires a systematic arrangement and restructuring of course contents which will be linked with the face-to-face instruction.

### 4.3. The Implementation process of Blended Learning Approach

The blended learning environment serves as a content delivery platform, as well as promoting communication and construction of knowledge that made it suitable for learners. As a follow-up to the suitability of the design, students were interviewed at the middle of the study. This helped to get valuable information to modify the approach for students' success. The

interview took the form of informal conversational interviews where students were randomly selected and interviewed using open-ended questions to evaluate effectiveness of the intervention in addressing their learning needs.Students of the two experimental groups, reported that the introduction of the blended learning environment had improved their course engagement and interactionwith the instructor. However, due to thepower interruption, students experienced some difficulty in terms of wasting time. Due to the limitation that they do not have their own computer to access the online course materials and contents at any time, students werealso limited in fully benefitting from the blended learning. However, by dealing with concerned bodies, students were allowed to enter the laboratory at any time they want and the lab attendant gives appropriate support for students in need.

Additionally, students were also given a moodle mobile application, which can be accessed anywhere at any time using mobile data or Wi-Fi. This application could also allow students to create forum posts andattempt the self-checking quizzes offline.

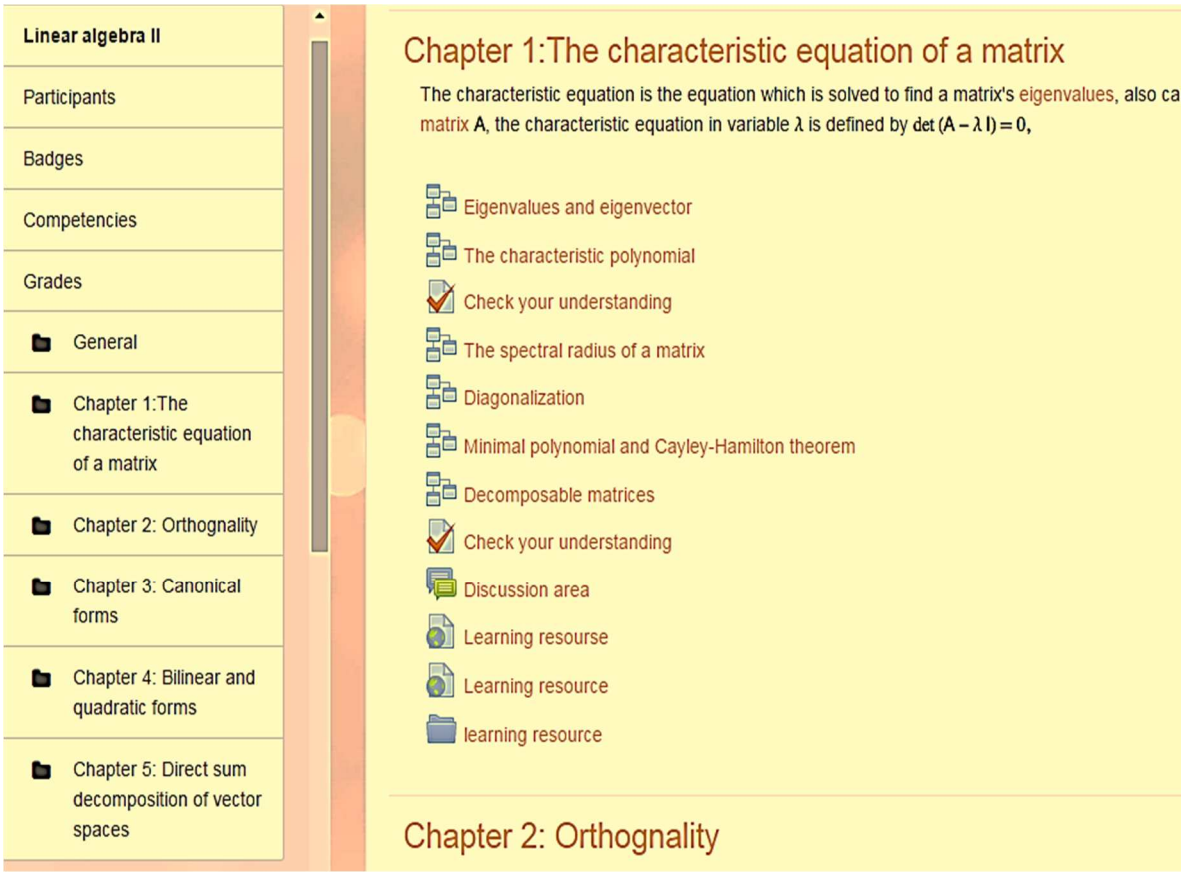


Figure 4.3. Structure of algebra lesson on the online learning platform

Students have also a good opportunity to check their understanding. This is the self-evaluation phase of self-regulated learning. Students liked the self-checking quizzes for the evaluative and challenging nature. The feedback for all questions was provided after submission, which helped students to track their difficulties and get immediate feedback by the system. Students can then read the notes again and understand the content. If still their difficulty persists, they can post to the forum and get help from their peers and the instructor. They can also ask the question in the face-to-face classroom session if needed.

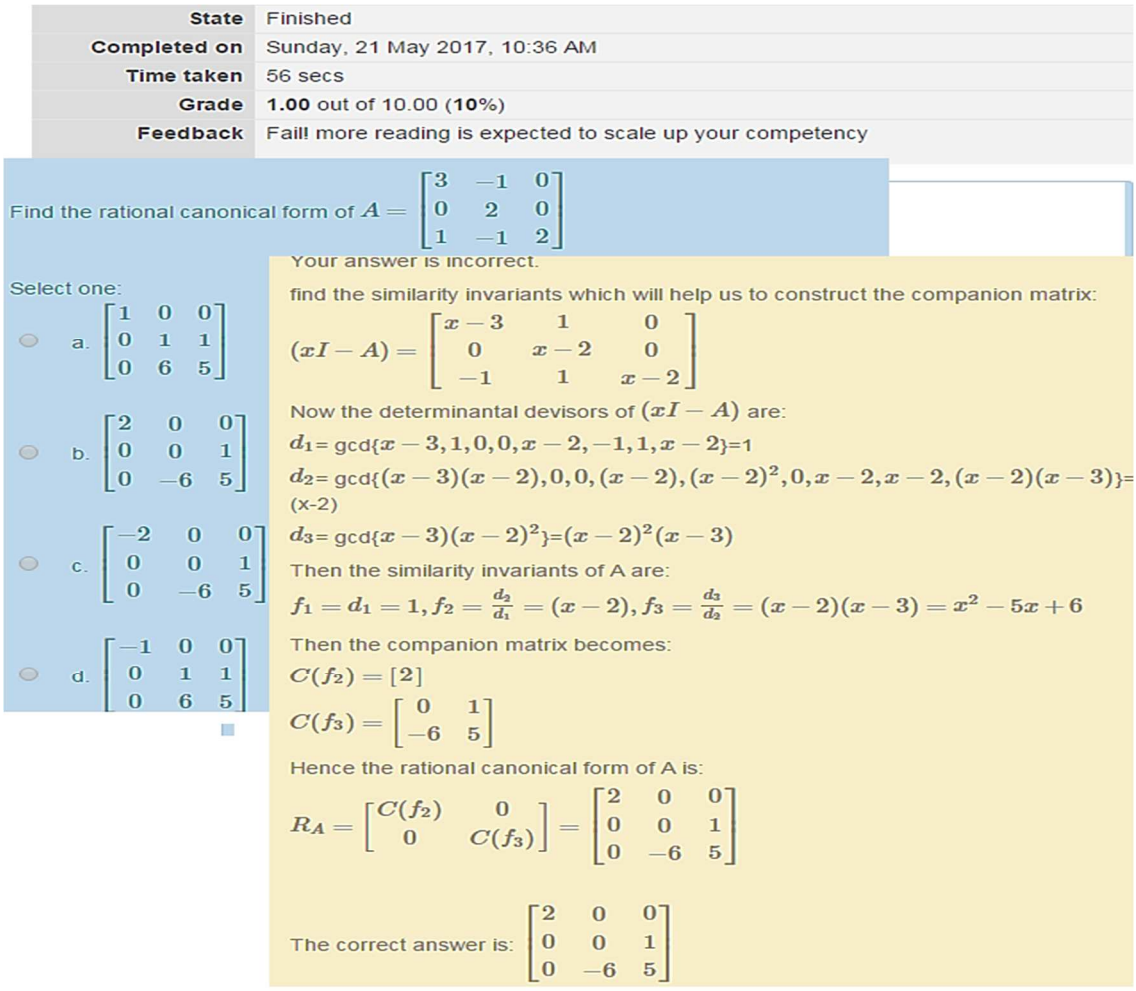


Figure 4.4. Students' Online learning environment self-checking quiz and feedback

In respect to the online learning session, students have gotan opportunity to study anytime from textual digital materials provided in pdf throughout the semester. The lab assistants were informed to assist experimental group students in getting into the reference materials. However, very few students were observed studying the reference materials in the lab. This will be attributed to the lack of time management and resistance to change.

## 4.4. Descriptive Statistics of the Variables Treated in the Study

Table 4.2 shows the descriptive statistics of the variables for the comparison group. The descriptive statistics is computed separately because, the distribution of data is different in the experimental group1, experimental group2 and comparison groups.

Table 4.2. Descriptive statistics of the variables of the study for the comparison group

| Variables | N | Min | Max | Mean | Std. Deviation | Skewness | |
|---|---|---|---|---|---|---|---|
| | | | | | | Statistics | Std. Error |
| **Algebra achievement Pre-test** | 24 | 30 | 90 | 62.92 | 13.667 | -.022* | .472 |
| **Algebra achievement Test 1** | 24 | 10 | 90 | 60.00 | 21.059 | -.884* | .472 |
| **Algebra achievement Test 2** | 24 | 40 | 100 | 72.92 | 21.964 | -.379* | .472 |
| **Algebra achievement Post-test** | 24 | 0 | 80 | 55.42 | 19.332 | -935* | .472 |
| **Pre-MARS** | 24 | 20 | 50 | 40.29 | 7.527 | -1.070 | .472 |
| **Pre-SRL** | 24 | 51 | 76 | 65.29 | 7.871 | -.282 | .472 |
| **Pre-satisfaction** | 24 | 21 | 37 | 30.42 | 3.161 | -.671 | .472 |
| **Pre-AHS** | 24 | 30 | 52 | 42.08 | 5.183 | -.498 | .472 |
| **Pre-motivation** | 24 | 29 | 47 | 37.13 | 5.076 | .408 | .472 |
| **Post-MARS** | 24 | 23 | 51 | 41.50 | 6.972 | -.629 | .472 |
| **Post-SRL** | 24 | 49 | 80 | 67.79 | 7.918 | -.503 | .472 |
| **Post-satisfaction** | 24 | 25 | 39 | 29.25 | 6.668 | -.430 | .472 |
| **Post-AHS** | 24 | 32 | 51 | 40.79 | 4.718 | .313 | .472 |
| **Post-motivation** | 24 | 33 | 46 | 37.83 | 2.823 | .931 | .472 |

MARS-Mathematics Anxiety Rating ScaleAHS- Academic Hardiness Scale
SRL- Self-Regulated Learning*those variables are clearly scale variables

As could be seen in table 4.2, the skewness of the scales; was computed. This is to determine the distribution of the data. According to Cohen (1988) if the skewness is less than plus or minus one (< +/-1.0), the variable is at least approximately normal, which is one of the assumptions for using parametric tests. Using this rule of thumb, all scale variables were approximately normal. Thus, parametric tests could be used to analyze the data during the

within group comparison. Similarly the descriptive statistics of the variables for the experimental groups were given in table 4.3 below.

Table 4.3. Descriptive statistics of the variables of the study for the experimental group1

| Variables | N | Min | Max | Mean | Std. Deviation | Skewness | |
|---|---|---|---|---|---|---|---|
| | | | | | | Statistics | Std. Error |
| **Algebra achievement Pre-test** | 22 | 50 | 90 | 64.09 | 10.075 | .580* | .491 |
| **Algebra achievement Test 1** | 22 | 10 | 100 | 60.91 | 24.671 | -.177* | .491 |
| **Algebra achievement Test 2** | 22 | 30 | 100 | 80.00 | 17.457 | -1.241* | .491 |
| **Algebra achievement Post-test** | 22 | 30 | 100 | 80.91 | 19.978 | -1.320* | .491 |
| **Pre-MARS** | 22 | 27 | 52 | 41.32 | 7.606 | -.454 | .491 |
| **Pre-SRL** | 22 | 52 | 83 | 70.36 | 7.907 | -.660 | .491 |
| **Pre-satisfaction** | 22 | 23 | 40 | 31.91 | 4.471 | -.219 | .491 |
| **Pre-AHS** | 22 | 36 | 51 | 42.64 | 4.293 | .235 | .491 |
| **Pre-motivation** | 22 | 30 | 49 | 38.59 | 5.049 | .328 | .491 |
| **Post-MARS** | 22 | 29 | 55 | 44.09 | 8.164 | -.523 | .491 |
| **Post-SRL** | 22 | 56 | 89 | 74.95 | 8.352 | -.538 | .491 |
| **Post-satisfaction** | 22 | 24 | 40 | 35.77 | 4.830 | -1.077 | .491 |
| **Post-AHS** | 22 | 32 | 52 | 44.86 | 4.774 | -1.233 | .491 |
| **Post-motivation** | 22 | 33 | 50 | 43.68 | 4.961 | -.316 | .491 |

MARS-Mathematics Anxiety Rating ScaleAHS- Academic Hardiness Scale
SRL- Self-Regulated learning*those variables are clearly scale variables

The descriptive statistics for experimental group1 given in table 4.3 above shows that the variable Academic Hardiness Scale (AHS) was not normally distributed during the post-test. The data wasskewed to the left. So, when this variable is considered as a dependent variable later on, non-parametric tests is used. Similarly, descriptive statistics of experimental group2 is presented in table 4.4 below.

Table 4.4. Descriptive statistics of the variables of the study for the experimental group2

| Variables | N | Min | Max | Mean | Std. | Skewness | |
|---|---|---|---|---|---|---|---|
| | | | | | | Statistic | Std. |

| | | | | | Deviation | s | Error |
|---|---|---|---|---|---|---|---|
| **Algebra achievement Pre-test** | 25 | 40 | 100 | 65.60 | 18.046 | .152* | .464 |
| **Algebra achievement Test 1** | 25 | 70 | 90 | 83.60 | 5.686 | -.115* | .464 |
| **Algebra achievement Test 2** | 25 | 20 | 100 | 63.60 | 23.402 | -.039* | .464 |
| **Algebra achievement Post-test** | 25 | 30 | 90 | 76.40 | 15.513 | -1.449* | .464 |
| **Pre-MARS** | 25 | 19 | 49 | 37.68 | 6.719 | -.709 | .464 |
| **Pre-SRL** | 25 | 41 | 78 | 60.96 | 8.502 | -.191 | .464 |
| **Pre-satisfaction** | 25 | 15 | 35 | 29.28 | 4.430 | -1.556 | .464 |
| **Pre-AHS** | 25 | 32 | 45 | 39.48 | 3.959 | -.209 | .464 |
| **Pre-motivation** | 25 | 23 | 44 | 36.76 | 4.746 | -.796 | .464 |
| **Post-MARS** | 25 | 36 | 49 | 42.28 | 2.777 | .078 | .464 |
| **Post-SRL** | 25 | 30 | 83 | 64.80 | 11.402 | -.827 | .464 |
| **Post-satisfaction** | 25 | 25 | 39 | 32.28 | 3.646 | -.115 | .464 |
| **Post-AHS** | 25 | 15 | 51 | 38.84 | 7.209 | -1.232 | .464 |
| **Post-motivation** | 25 | 15 | 46 | 35.72 | 6.542 | -1.259 | .464 |

MARS-Mathematics Anxiety Rating ScaleAHS- Academic Hardiness Scale
SRL- Self-Regulated learning*those variables are clearly scale variables

The descriptive statistics for experimental group2 given in table 4.4 shows that the variables Academic Hardiness Scale (AHS) and motivation were not normally distributed during the post-test. Whereas, satisfaction was not normally distributed during the pretest. All data were skewed to the left. So, when these variables are considered as a dependent variable later on, non-parametric tests is used. The analysis starts with the investigation of group difference on algebra achievement followed by affective components.

## 4.5. Analysis of Group Difference on Algebra Achievement

The first research question seeks to answer whether there is a difference between groups on the pre-algebra achievement test and affection. It says “Is there a statistically significant difference on the pretest of students’ algebra achievement and affection between the experimental and comparison groups?

For the purpose of identifying the difference between the three groups (experimental group1, experimental group2 and comparison group), one-way ANOVA was computed.

### 4.5.1. Analysis of Group Difference on Pretest

Algebra is an important part of mathematics, because,it serves as the gateway to advanced coursework in mathematics and engineering. In this section, algebra achievement of students that was obtained using the ten item test developed by the researcher and administered at the beginning of the study was used. This test is used to examine the initial difference (if any) between the three groups. It is therefore, the intent of the first sub-research question to determine whether there is a difference between the three groups on algebra achievement before the commencement of study. Thus, scores obtained from the pre-algebra achievement testwas analyzed by applying One-Way ANOVA, which compares the means of the three groups as shown in tables 4.5 below.

Table 4.5. Descriptive statistics of the three groups in algebra achievement before the treatment

| Group | Algebra achievement | | |
|---|---|---|---|
| | **N** | **M** | **SD** |
| **Experimental group -1** | 22 | 64.09 | 10.075 |
| **Experimental group-2** | 25 | 65.60 | 18.046 |
| **Comparison group** | 24 | 62.92 | 13.667 |
| **Total** | 71 | 64.23 | 14.309 |

The result of the study shows the mean score of the experimental group 1 (*M=64.09*), experimental group 2 (*M=65.60*) on the algebra achievement test when tested before the

treatment and that of the comparison group (*M=62.92*) was nearly the same. The difference is also not significant at .05 level(see table 4.6). Therefore, at the beginning of the study, the three groups were considered nearly similar in algebra achievement.

This result can be taken as a good starting point to infer the effect of the treatment (BL) after the intervention. Hence, if the experimental groups score higher than the comparison group on the post- algebra achievement test, it will hopefully be due to the treatment, provided that other confounding variables are controlled. On this regard, the researcher tried to control all the possible confounding variables such as time difference, the effect of the teacher and topics covered. The, one-way ANOVA summarized in table 4.6 below.

Table 4.6. One-Way Analysis of Variance Summary table comparing groups on algebra achievement before the treatment

| **Source** | | **df** | **Sum of square** | **Mean square** | **F** | **p** |
|---|---|---|---|---|---|---|
| **Algebra achievement** | Between groups | 2 | 88.743 | 44.371 | .212 | .810 |
| | Within groups | 68 | 14243.652 | 209.465 | | |
| | Total | 70 | 14332.394 | | | |

The result of the study shows that there was statistically non-significant difference on pre-algebra achievement(*F(2, 68)=.212, p>.05*). The basic dependent variable in this study was algebra achievement which is influenced by all other variables. This resultshows that the

three groups possess nearly the same in algebra achievement before the treatment. It is therefore, a good starting point to deduce the effect of the treatment (BL) after the intervention. That is, if the experimental groups score higher than the comparison group on the post-algebra achievement test, it is hopefully be due to the treatment.

### 4.5.2. Comparison within Groups on Algebra Achievement

The first goal of this study was to investigate the effect of blended learning on algebra achievement. During the intervention, algebra achievement test1 and test2 were administered to examine the progress of students. Besides comparing the achievement of experimental and comparison groups, in this section, the progression of each group from pretest to posttest have been examined to observe the effect of the intervention. In this part of analysis, the results of all groups on algebra achievement measured before, during and after the treatment was used. For this type of analysis, a repeated-measures ANOVA was used. This is because, observations aretaken from the same or related subjects over time (Elliott & Woodward, 2007).

As with one-way ANOVA, the repeated-measure ANOVA requires the assumptions of normality and equality of variances. The commonly used assumption for equality of variance is sphericity, which assumes the variances of the differences between all combinations of the related conditions are equal(Leech, Barrett, & Morgan, 2005). To test this assumption, Mauchly's test for sphericity is commonly used within SPSS(Elliott & Woodward, 2007). If $p<.05$, additional correction steps should be taken. The correction is to adjust degrees of freedom of numerator and denominator by multiplying the adjustment factor (epsilon). There are three kinds of epsilon used to test the within-subject effect in SPSS, the Greenhouse-

Geisser Huynh-Feldt epsilonand the lower bound estimate (Kim, 2015a). If the epsilon is close to one or p<.05, the sphericity assumption is met, then there is no need of adjustment(Elliott & Woodward, 2007; Kim, 2015a).Otherwise, the guideline of epsilon is used which is determined by the Greenhouse-Geisser epsilon. That is, if it is larger than 0.75 then the Huynh-Feldt epsilon is used, otherwise, the Greenhouse-Geisser epsilon is used(Kim, 2015a; Leech et al., 2005).To start the repeated-measures ANOVA comparison, the descriptive statistics of students score on algebra achievement pretest, algebra achievement test1, algebra achievement test2 and algebra achievement posttest is given in table 4.7 below, which shows the patterns of students' algebra achievement before, during and after the intervention.

Table 4.7. Descriptive statistics of all groups in algebra achievement

| **Group** | | **Mean** | | | | **Std. deviation** |
|---|---|---|---|---|---|---|
| | **N** | **Pretest** | **Test1** | **Test2** | **posttest** | |
| **Experimental-1** | 22 | 64.09 | 60.91 | 80.00 | 80.91 | 10.075 |
| **Experimental-2** | 25 | 65.60 | 83.60 | 63.20 | 76.40 | 15.513 |
| **Comparison** | 24 | 62.92 | 60.00 | 72.92 | 55.42 | 19.332 |

From table4.7,it can be seen that on average the highest algebra achievement was detected on the posttest (*M=80.91, SD=10.075*) for experimental group1 and during the intervention for experimental group2 (*M=83.60, SD= 15.513*). On the other hand, the highest achievement in algebra for the comparison group was detected on algebra achievement test2 (*M=72.92,SD=19.332*). The data showfluctuations in algebra achievement of all groups from pretest to posttest. But, to find out whether these observed variationswere significantly different from each other, the repeated measures ANOVA was used.To assure that the

assumption of equality of variance is met, Mauchly's test of sphericity is computed and presented in table 4.8 below.

Table 4.8. Mauchly's test of sphericity for testing equality of variance

| Within subjects effect | Approx.Chi-Square | df | p | Epsilon | | |
|---|---|---|---|---|---|---|
| | | | | Greenhouse-Geisser | Huynh-Feldt | Lower-bound |
| **Experimental 1** | 7.586 | 5 | .181 | .808 | .921 | .333 |
| **Experimental2** | 14.058 | 5 | .015 | .727 | .803 | .333 |
| **Comparison** | 3.923 | 5 | .561 | .899 | 1.000 | .333 |

In table 4.8the Mauchly's test indicated that the assumption of sphericity had been met for experimental group 1($\chi^2(5) = 7.586$, $P > .05$) and comparison group($\chi^2(5) = 3.923$, $P > .05$). However, the assumption of sphericity was not met for experimental group2 ($\chi^2(5) = 14.058$, $P < .05$). In this case, the "epsilon" values on the right-hand side of table 4.8is used to calculate an appropriate adjustment to the degrees of freedom of the F-test(Leech et al., 2005). Table 4.9 shows the revised results using Geenhouse-Geisser correction together with the results of both experimental group1 and comparison group.

Table 4.9. Repeated measures ANOVA for testing within-subjects effects on algebra achievement

| Source | | df | Sumof square | Mean square | F | p | Partial Eta squared |
|---|---|---|---|---|---|---|---|
| Experimental 1 | Sphericity assumed | 3 | 7212.50 | 2404.167 | 9.579 | .000 | .313 |
| | Error | 63 | 15812.50 | 250.992 | | | |
| Experimental2 | Geenhouse-Geisser | 2.182 | 6804.00 | 3118.821 | 8.354 | .001 | .258 |
| | Error | 52.358 | 19542.00 | 273.313 | | | |
| Comparison | Espericity assumed | 3 | 3953.125 | 1317 | 4.844 | .004 | .174 |

| | | | | |
|---|---|---|---|---|
| | Error | 69 | 18771.875 | 272.056 |

As shown in table 4.9 above, the repeated measures ANOVA, show the mean scores ofalgebra achievement measured before, during and after the interventionweresignificantly different for experimental group1 ($F(3, 63) = 9.579, p<.05, \eta^2 = .313$), experimental group2 ($F(2.182, 52.352) = 8.354$, $p<.05, \eta^2 = .258$), and also for comparison group ($F(3, 69) = 4.844$, $p<.05, \eta^2 = .174$). Thus, there is a significant difference for all groups between pretest and test1, or test1 and test2 or test2and posttest, or pretest and posttest. To determine the pairs of tests in which the difference has occurred, a further post hoc Bonferroni test have beencomputed and summarized in table 4.10 below.

Table 4.10. Post hoc Bonferroni test for pairwise comparisons, comparing the progress of each group on algebra achievement

| **Group** | **(I)algebra achievement** | **(J)algebra achievement** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Experimental 1** | pretest | Test1 | 3.182 | 1.000 |
| | | Test2 | -15.909* | .002 |
| | | Posttest | -16.818* | .010 |
| | Test1 | Test2 | -19.091* | .012 |
| | | Posttest | -20.000* | .014 |
| | Test2 | Posttest | -.909 | 1.000 |
| **Experimental 2** | pretest | Test1 | -18.000* | .001 |
| | | Test2 | 2.400 | 1.000 |
| | | Posttest | -10.800 | .095 |
| | Test1 | Test2 | 20.400* | .001 |
| | | Posttest | 7.200 | .200 |

| | | | | |
|---|---|---|---|---|
| | Test2 | Posttest | -13.200 | .164 |
| **Comparison** | pretest | Test1 | 2.917 | 1.000 |
| | | Test2 | -10.000 | .529 |
| | | Posttest | 7.500 | .733 |
| | Test1 | Test2 | -12.917 | .051 |
| | | Posttest | 4.583 | 1.000 |
| | Test2 | Posttest | 17.500* | .002 |

*the difference is significant at .05 level.

The multiple comparison presented in table 4.10 shows a significant difference between algebra achievement test1 and algebra achievement test2, and also between pretest and posttest for experimental group1 ($p<.05$). The result further shows that experimental group1 students have gained 19.091 points on average from test1 to test2 and 16.81 point from pretest to posttest. Though the mean gain from test2 to posttest (.909) was not statistically significant, the mean gain they have acquiredfrom pretest to posttest (16.81) was very high and statistically significant, which can be attributed to the blended learning intervention being used.

For experimental group2, the multiple comparison further shows a significant difference between algebra achievement pretest and algebra achievement test1, and between algebra achievement test1 and algebra achievement test2($p<.05$). It can also be inferred that experimental group2 have gained 18.00 point on average from pretest to test1 and 20.40 point from algebra achievement test1 to algebra achievement test2. Their achievement on the final test(posttest) wasimproved by 10.80 points on average compared with the pretest result, though it is not statistically significant ($p=.095$). This can be taken as a marginally significant gain. Because, the difference isnot quite significant, but very close to be significant (Pritschet, Powell, & Horne, 2016). As a threshold for such condition,researchers posited that

a p-value of .10 or less is marked as marginally significant(Guadagno, 2010). Hence, it is evident that there was a positive effect of the intervention (BL) on their algebra achievement.

For the comparison group, the multiple comparison presented in table 4.10 shows a marginally significant difference between algebra achievement test1 and algebra achievement test2($p=.051$). However, there is statistically significant difference betweenalgebra achievement test2 and algebra achievement posttest ($p<.05$). In this case, the difference is not an increase but it is a decrease of students' algebra achievement by 17.50 point on average. As the posttest is administered at the end of the intervention and which is also at the end of the semester, this might be due to the pressure and lack of focus created by the tight schedules and assignments. Thus, the two experimental groups showed better advancement than the comparison group. That is, students in the experimental groups benefited a lot in improving their algebra achievement throughout the course of the study.

### 4.5.3. Analysis of Group Difference on Posttest

This section addresses the sub-research question raised in the study: "Is there a statistically significant difference between the experimental groups and comparison group on algebra achievement during and after the intervention?" Scores obtained from the posttest results of algebra achievement tests were analyzed by applying a one-way Analysis of Variance (ANOVA), which compares the means of the three groups as shown in tables 4.11 below.

Table 4.11. Descriptive statistics of the three groups during and after the treatment by algebra achievement

| Group | Test1 | Test2 | Posttest |
|---|---|---|---|

| | N | M | SD | M | SD | M | SD |
|---|---|---|---|---|---|---|---|
| **Experimental group- 1** | 22 | 60.9 | 23.50 | 80.0 | 17.4 | 80.9 | 19.9 |
| **Experimental group- 2** | 25 | 83.6 | 5.68 | 63.2 | 23.4 | 76.4 | 15.5 |
| **Comparison group** | 24 | 60.0 | 21.05 | 72.9 | 21.9 | 55.4 | 19.3 |
| **Total** | 71 | 68.6 | 21.53 | 71.7 | 22.0 | 70.7 | 21.2 |

Students of experimental group1 scored 60.9, 80, 80.9 respectively on algebra achievement test1, algebra achievement test2 and algebra achievement posttest. While students of experimental group2 scored on average 83.6, 63.2, 76.4 respectively on the above achievement tests respectively. In these similar achievement tests comparison group students scored on average 60, 72.9, and 55.4 respectively. The mean score of experimental group1 and comparison group were nearly similar on algebra achievement test1.But, the mean score of experimental group2 was larger than the score of the two groups. This difference is also significant at .05 level (see table 4.12).

Generally, after successful implementation of blended learning strategy for one full semester, the two experimental groups achieved better than the comparison group in a significant extent. Though there was a fluctuation on the mean scores, the experimental groups benefited a lot from the intervention in improving their algebra achievement. To further examine the statistical differences if any between the three groups regarding algebra achievement, one-way ANOVA was used and summarized in table 4.12 below.

Table 4.12. One-Way ANOVA Summary table comparing groups during and after the treatment on algebra achievement

| **Source** | | **df** | **Sumof square** | **Mean square** | **F** | **p** |
|---|---|---|---|---|---|---|
| Algebra achievement- | Between groups | 2 | 8701.337 | 4350.668 | 12.453 | .000 |
| | Within groups | 68 | 23757.818 | 349.380 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Test1 | Total | 70 | 32459.155 | | | |
| Algebra achievement-Test2 | Between groups | 2 | 3357.350 | 1678.675 | 3.726 | .029 |
| | Within groups | 68 | 30639.833 | 450.586 | | |
| | Total | 70 | 33997.183 | | | |
| Algebra achievement-posttest | Between groups | 2 | 8711.137 | 4355.569 | 13.017 | .000 |
| | Within groups | 68 | 22753.652 | 334.613 | | |
| | Total | 70 | 31464.789 | | | |

The result of the study shows that the three groups were different from each other in a statistically significant extent on algebra achievement test1(*F (2, 68)= 12.453, p<.05*), algebra achievement test2 (*F (2, 68)= 3.726, p<.05*) and algebra achievement posttest (*F(2,68)= 12.017, p<.05*). But there is no evidence about which pair of groups differ statistically on the above variables of the study. Hence, the Post hoc Tukey HSD test was used for algebra achievement test2 and algebra achievement posttest as the Levene test was not significant and so the assumption of homogeneity of variance is not violated. On the other hand, Games Howell test was used for algebra achievement test1, since Levene test was significant and the assumption of homogeneity of variance is violated.

Table 4.13. Post hoc Tukey HSD test multiple comparisons, comparing groups on two variables

| **Variables to be compared** | **(I)group** | **(J)group** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Algebra achievement test 2** | Experimental group1 | Experimental group2 | 16.8* | .023 |
| | | Comparison group | 7.083 | .499 |
| | Experimental group2 | Comparison group | -9.717 | .252 |
| **Algebra achievement-Posttest** | Experimental group1 | Experimental group2 | 4.509 | .678 |
| | | Comparison group | 25.492* | .000 |
| | Experimental group2 | Comparison group | 20.983* | .000 |

*The mean difference is significant at .05 level

Post hoc Tukey HSD test indicated that in algebra achievement test2, the two experimental groups differ significantly in their grades (*p <.05, d=.813*) and for all other pairs, the difference was non-significant *(p>.05)*. On the posttest measure, students of experimental group1 and experimental group2 shows non-significant difference in algebra achievement (*p>.05*). Which shows the convergence of their achievement. This confirms that the treatment made a significant positive effect on their algebra achievement. On the other hand, experimental group1 and the comparison group differ significantly in their grades on the posttest algebra achievement (*p<.05, d=1.296*) and also experimental group2 and comparison group differ significantly on their posttest algebra achievement (*p <.05, d=1.197*). According to Cohen (1988) the effect size for both differences was much larger than typical. For the difference between groups on algebra achievement test1, Games Howell test was used and summarized in table 4.14 below.

Table 4.14. Post hoc Games-Howell test multiple comparisons, comparing groups on algebra achievement test1

| **Variables to be compared** | **(I)group** | **(J)group** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Algebra achievement test- 1** | Experimental group1 | Experimental group2 | -22.691* | .001 |
| | | Comparison group | .909 | .990 |
| | Experimental group2 | Comparison group | 23.6* | .000 |

*The mean difference is significant at .05 level

Post hoc Games-Howell test indicated that for algebra achievement test1, the two experimental groups differ significantly in their grades (*p <.05, d=1.267*) favoring experimental group 2 with effect size much larger than typical. On this similar achievement test, experimental group2 and the comparison group also differ in a statistically significant

extent ($p<.05$, $d=1.53$). This result shows that experimental group2 ($M=83.60$) scored better that experimental group1 ($M=60.91$) and comparison group ($M=60.00$). But, experimental group1 and the comparison group scored nearly similar on algebra achievement test1, which was not significant at .05 level.

### 4.5.4. Blended Learning Approach and Algebra Achievement

In this section, the overall effect of the treatment on algebra achievement is discussed in detail. The initial step is to determine whether the baseline differences have any effect on the final posttest result. Though initially the three groups are nearly the same in algebra achievement and also the pretest and posttest items are different, it gives confidence if initial slight difference is controlled statistically. Additionally, students' previous exposure to computers was also controlled as a covariate variable. In this part of analysis, Analysis of Covariance (ANCOVA) was used to statistically control the effect of the pretest and prior experience of using internet or computer.

ANCOVA provides the influence of an independent variable on a dependent variable by removing the effect of the covariate factor and reducing error variance(Morgan, Leech, Gloeckne, & Barret, 2004). This helps to accurately assess the effect of experimental intervention (BL). Covariates are variables that may cause to draw incorrect inferences about the dependent variable. Thus ANCOVA tests whether the independent variable still influences the dependent variable after the removal of the influences of the covariates.The Levene's test and normality checks were carried out and the assumptions were met to use ANCOVA.

Table 4.15. Adjusted and unadjusted means and variability for post-algebra achievement using pretest and prior computer use as a covariate

| Variables | Groups | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| | | N | M | SD | M | SE |
| **Algebra achievement** | Experimental group1 | 22 | 80.91 | 19.978 | 81.045 | 3.976 |
| | Experimental group2 | 25 | 76.40 | 15.513 | 76.141 | 3.697 |
| | Comparison | 24 | 55.42 | 19.332 | 55.561 | 3.780 |

Results indicated that after statistically controlling the effect of the covariates (pretest and prior computer use), the mean score of experimental group1 (*81.045*) was higher than both experimental group2 (*76.141*) and comparison group (*55.561*) on the algebra achievement posttest.

The analysis of covariance presented in the table 4.16 below further shows the significant difference between the experimental and comparison groups inalgebra achievement posttest (*F (2, 66) = 12.401, p <.05, $\eta^2$=.273*). The effect size eta-squared, is interpreted as small, medium and large effects if it possesses the values .01, .06 and .14, respectively(Stevens, 2009). Since $\eta^2$=.273 for this study, the effect size is large. It can further be noticed that the independent variable (BL) made a 27.3% contribution to the variability of algebra achievement devoid of the covariates.

Table 4.16. ANCOVA result for algebra achievement

| Variable | Source | df | Mean square | F | p | $\eta^2$ |
|---|---|---|---|---|---|---|
| **Algebra achievement** | Comp. use | 1 | 11.483 | .034 | .855 | .001 |
| | Pretest | 1 | 361.977 | 1.067 | .305 | .016 |
| | Group | 2 | 4206.692 | 12.401 | .000 | .273 |
| | Error | 66 | 339.227 | | | |
| | Total | 71 | | | | |

The overall result shows, a significant difference between experimental and comparison groups in algebra achievement after the intervention (*F(2, 66)= 12.401, p <.05*).As a result, it can be said thatBL could be more effective on enhancing algebra achievement than the usual lecture method. It has the potential to improve learning in theclassroom. This result also suggests the effectiveness of the supplemental step by step (enabler-enhancement-transformational) model of blended learning in significantly increasing students' algebra achievement. To further examine each pair of group difference on algebra achievement, the post hoc Bonferonni was carried out and summarized in table 4.17 below.

Table 4.17. Post hoc Bonferonni test multiple comparisons, comparing groups on algebra achievement after controlling the effect of the covariates.

| **Variables to be compared** | **(I)group** | **(J)group** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Algebra achievement** | Experimental group1 | Experimental group2 | 4.904 | 1.000 |
| | | Comparison group | 25.484 | .000 |
| | Experimental group2 | Comparison group | 20.580 | .001 |

Post hoc Benferonni test presented in table 4.17 shows a significant difference between experimental group1 and comparison group and also between experimental group2 and comparison group (*P<.05*). However, the post hoc test does not detect a significance

difference between the two experimental groups on algebra achievement. The overall effect of the treatment (BL) on students' algebra achievement is presented in figure 4.5 below.

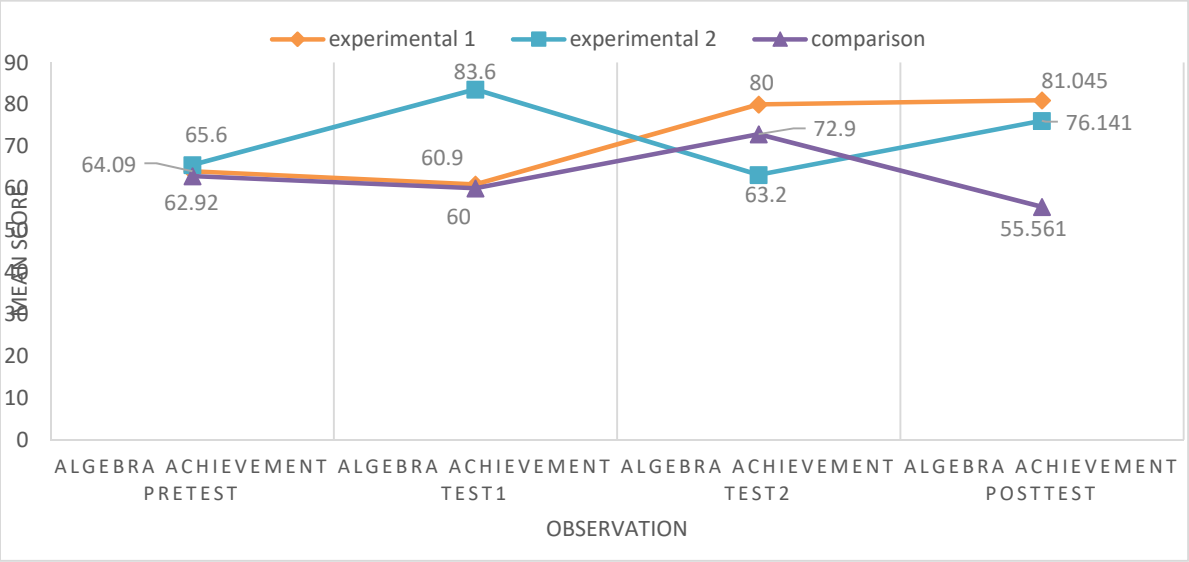


Figure 4.5. The effect of blended learning on students' algebra achievement

Figure 4.5 shows the algebra achievement pretest, algebra achievement test1, algebra achievement test2 and algebra achievement posttest adjusted mean scores of students in both experimental and comparison groups. As it can be seen, the increase made by the experimental groupsbecome related at the end of the experimentation period and higher than the comparison group. The difference between the two experimental groups and that of the comparison group was significant at $\alpha$ = .05 level.

This study investigated the effect of blended learning approach on students' achievement as compared to purely face-to-face (the usual traditional approaches) in learning algebra course. The study revealed that using blended learning approach improves students' achievement scores in algebra as compared to the traditional (face-to-face approach). This could be as a result of the ingredients in the blend. The supplemental blended learning model used in this

study allows students to control their interaction with additional materials, sufficient explanation, more interaction, prompt feedback and self-assessment. Participants of this study found the blended approach as more engaging and resourceful, as a result their achievement has been significantly improved.

It is also clear that when each students have their own computer with access to learning resources, they can control their learning progress. Students can browse learning materials as much as they need and repeat exercises to understand the content. Hence, blended learning approach makes learning accessible, interactive, exciting, stimulating and enjoyable. This was reflected by student participants during the interview. One of the participants forwarded his opinion as:

> …to be honest, I gave it too much emphasis, as its nature also forced to give more emphasis. But, this does not affect other courses as they have their own study time. This approach is more engaging not destructive. Here, we have a good exposure and inclination to algebra course, since we have many resources and interesting features. I can say that we have fully grasped the required knowledge better than any other courses so far. I am feeling that I do not fully understand other courses when I see my understanding of my blended algebra course.

In line with the findings of this study,previous researchers envisioned that new technology such as computer-assisted instruction should be used in the teaching of abstract concept in mathematics(Ahmad, Shafie, & Janier, 2008; Awodeyi, Akpan, & Udo, 2014; Bhatti, 2013). The findings of this study is in agreement with many previous studies such as (Al-Ghassani et al., 2015; Al-Madani, 2015; Awodeyi et al., 2014; Ceylan & Kesici, 2017; Delaney,

McManus, & Ng, 2010; Fakhir, 2015; Lin et al., 2017; Siew-Eng et al., 2010; Syarif & Sofyan, 2012; Viz & Kaur, 2017; Yilmaz & Oghan, 2010) all of which reported blended learning as a good approach with a potential of improving students achievement and instructional delivery in mathematics courses as well as understanding of concepts in the subject matter(Akgündüz & Akınoğlu, 2017; Awodeyi et al., 2014; Balasubramaniam et al., 2018; Lin et al., 2017; Rozeboom, 2017). It is also in line with the findings of Almasaeid (2014) who found improved science achievement and with the findings of Olelewe and Agomuo (2016), who found an improved achievement in programing language.

However, the finding of this study is against with (Akyuz & Samsa, 2009; Alotaibi, 2013; Cracraft, 2015), who reported non-significant difference between the experimental (blended learning approach) and comparison group (conventional approach) in terms of students achievement. The study conducted by Alotaibi (2013) and Akyuz and Samsa (2009) aimed to determine the effectiveness of blended learning approach on critical thinking disposition. Both of which finally found non-significant differences between the experimental and comparison groups.

Despite this variation, in this study it is evident that blended learning approach has a potential to improve students'course understanding and achievement on mathematics in a considerable extent. The finding of this study adds to the existing knowledge that blended learning contribute positively in academic achievement of students.

### 4.5.5. Gender Difference in Algebra Achievement

Gender is a set of characteristics distinguishing male and female. Gender differences in mathematics achievement and ability has remained a source of concern as scientists seek to address the under-representation of women at the highest levels of mathematics and the physical sciences (Ajai & Imoko, 2015). Studies shows that boys performed better than girls in mathematics (Mutemeri & Mugweni, 2005; Shishigu, 2018). There are also studies reporting that female students perform better than male students(Hydea & Mertz, 2009). The difference between male and female students might be due to the way they perceive things or their exposure. One major factor for the gender disparity is the influence of culture and tradition, which places hard sciences and mathematics as a male domain. However, the differences can be handled by applying different strategies. Thus, this section addressed the research question, “Is there a significant difference between male and female students in their algebra achievement?” which seeks to examine the role of the intervention (BL) in catering gender difference.

The mean score of algebra achievement was used to investigate gender difference by carrying out an independent sample t-test. This is done to determine whether the treatment was gender sensitive or gender friendly. Do the intervention (BL) separate students with respect to gender? The independent sample t-test was computed for comparing male and female students before and after the treatment in algebra achievement and is summarized in table 4.18 below.

In the case of algebra achievement test2 for comparison group, the Levene’s test shows that the assumption of equality of variances for the two groups (male and female) were violated

(*F=14.061, P<.05*). Hence, the Levene's test adjusts the variation. In this case the degree of freedom becomes 21.896 instead of *n-2* and the result shows significant difference.

Table 4.18. Comparison of male and female students on algebra achievement within groups before, during and after the treatment

| **Variable** | **Group** | **Sex** | **N** | **Group statistics** | | **t** | **df** | **p** |
|---|---|---|---|---|---|---|---|---|
| | | | | M | SD | | | |
| **Algebra achievement pretest** | Experimental 1 | Male | 11 | 68.18 | 10.787 | -2.043 | 20 | .054 |
| | | Female | 11 | 60.00 | 7.746 | | | |
| | Experimental 2 | Male | 10 | 71.00 | 17.920 | 1.235 | 23 | .229 |
| | | Female | 15 | 62.00 | 17.809 | | | |
| | Comparison | Male | 7 | 64.29 | 7.868 | .309 | 22 | .760 |
| | | Female | 17 | 62.35 | 15.624 | | | |
| **Algebra achievement** | Experimental 1 | Male | 11 | 65.45 | 26.216 | .859 | 20 | .401 |
| | | Female | 11 | 56.36 | 23.355 | | | |
| | Experimental 2 | Male | 10 | 84.00 | 5.164 | .282 | 23 | .781 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **test1** | | Female | 15 | 83.00 | 6.172 | | | |
| | Comparison | Male | 7 | 68.57 | 12.150 | 1.298 | 22 | .208 |
| | | Female | 17 | 56.47 | 23.168 | | | |
| **Algebra achievement test2** | Experimental 1 | Male | 11 | 83.64 | 16.293 | .976 | 22 | .341 |
| | | Female | 11 | 76.36 | 18.586 | | | |
| | Experimental2 | Male | 10 | 69.00 | 20.248 | 1.012 | 23 | .322 |
| | | Female | 15 | 59.00 | 25.204 | | | |
| | Comparison | Male | 7 | 80.95 | 15.461 | 4.233 | 21.896 | .000 |
| | | Female | 17 | 76.54 | 19.379 | | | |
| **Algebra achievement posttest** | Experimental 1 | Male | 11 | 80.95 | 15.461 | 1.071 | 20 | .297 |
| | | Female | 11 | 76.54 | 19.379 | | | |
| | Experimental2 | Male | 10 | 76.00 | 17.764 | -.103 | 23 | .919 |
| | | Female | 15 | 76.67 | 14.475 | | | |
| | Comparison | Male | 7 | 72.86 | 4.880 | 3.440 | 22 | .002 |
| | | Female | 17 | 48.24 | 18.451 | | | |

The result of independent samples t-test indicated in table 4.18, shows that male and female students did not show any significant difference in algebra achievement pretest for all groups(experimental group1, experimental grou2 and comparison group)*(p>.05).* This shows that there was no significant difference in algebra achievement of students within both experimental and comparison groups. To examine whether this difference persists throughout the experiment period, a similar independent sample t-test was computed for the algebra achievement test1, algebra achievement test 2 and algebra achievement posttest.

Unfortunately, the result of independent samples t-test detected gender difference in algebra achievement test2 (*df=21.896, t = 4.233, p <.05, d=1.602*), and algebra achievement posttest (*df =22, t = 3.44, p <.05, d=1.824*) for the comparison group, favoring male students with effect size of much larger than typical. The result of the study further shows non-significant gender difference within both experimental group1 and experimental group2 (*p>.05*). This shows that within the comparison group, male students were superior in algebra achievement test2 (*M=80.95*)and algebra achievement posttest (*M=72.86*), when compared to that of

female students algebra achievement in test2 (*M=76.54*) and posttest (*M=48.24*). This shows that the intervention (BL) has the potential to cater the gender gap for the experimental groups.

The implication is that there was much difference between the achievement scores of male and female students for comparison group. However, within the experimental group, gender gap is narrow at the end of the experimentation period. Thus,Gender factor is not significant in blended learning instruction, which is in agreement with the findings of (Awodeyi et al., 2014; Lin et al., 2017), who found non-significant effect of gender on students' achievement scores in a blended approach.

The finding of this study is also consistent with the finding of (Hydea & Mertz, 2009) which shows parity of gender in mathematics. The result of this study is also in line with the findings of (Ajai & Imoko, 2015; Arhin & Offoe, 2015; Kwame, McCarthy, McCarthy, & Gyan, 2015), all of which has reported non-significant gender difference in mathematics. However, itis against with many of the previous findings in gender(Asante, 2010; Brunner, Krauss, &Kunter, 2008; Mutai, 2016; Osei, 2013; Shishigu, 2018), all of which has found a gender difference favoring male, though the instructional approach of each differs.

The result of the current study is in agreement with studies employing noble instructional strategies of problem based learning (Ajai & Imoko, 2015), which found out a negligible gender difference and PA-driven instruction ofArhin and Offoe (2015), which showed no bias among gender.Thus, the results of this study showed that achievement in mathematics is dependent on the method and orientation.Both sexes are capable of competing and collaborating in blended learning approach.Blended learning could help students to get more

information and examples, which intern help them to understand mathematical concepts and maintain gender parity.

## 4.6. Analysis of Group Difference on Affection

In order to make the learning process smooth, there should be a balanced situation of cognition and affection.Research shows that unbalanced or cognitive oriented teaching-learning process would result in poor educational outcomes(Zhang & Lu, 2011). Therefore,it is important to pay attentions to affective factors in learning. For the purpose of this study, five affective variablesinferring the affection of students has been identified and considered as a dependent variable (see sec 2.9). The five affective factors include: math anxiety, motivation, satisfaction, academic hardiness, and affective aspect of self-regulated learning. So, the second sub-research question seeks to examine the difference (if any) of students affection before the commencement of the study. It says that “Is there a statistically significant difference on the pretest of students’ affective components between the experimental and comparison groups? The result is presented one by one in the following sub-section.

### 4.6.1. Analysis of Group Difference on Pretest

Scores obtained from the pre-test using the five different instruments namely: mathematics anxiety rating scale, academic hardiness rating scale, motivation scale, satisfaction scale, and self-regulated learning questionnaire were analyzed by applying One-Way ANOVA, which compares the means of the three groups as shown in table 4.19 below.However, to determine

group difference in satisfaction, the non-parametric test called Mann-Whitney U test was used since the data is not normally distributed for experimental group2.

Table 4.19.Descriptive statistics of the three groups in affection before the treatment

| Group | | **MA** | | **SRL** | | **AH** | | **Motivation** | |
|---|---|---|---|---|---|---|---|---|---|
| | N | M | SD | M | SD | M | SD | M | SD |
| Experimental -1 | 22 | 41.32 | 7.606 | 70.36 | 7.907 | 42.64 | 4.293 | 38.59 | 5.049 |
| Experimental-2 | 25 | 37.68 | 6.719 | 60.96 | 8.502 | 39.48 | 3.959 | 36.76 | 4.746 |
| Comparison | 24 | 40.29 | 7.527 | 65.29 | 7.871 | 42.08 | 5.183 | 37.13 | 5.076 |
| Total | 71 | 39.69 | 7.338 | 65.34 | 8.870 | 41.34 | 4.657 | 37.45 | 4.945 |

MA: Math Anxiety AH: Academic Hardiness

SRL: Self-regulated Learning

The result of the study shows the mean scores of experimental group1 (*M=41.32*), experimental group2 (*M=37.68*) on mathematics anxiety when tested before the treatment and that of the comparison group (*M=40.29*) were nearly the same. The difference is also not significant at .05 level (see table 4.20). However, the mean score ofexperimental group1 (*M=70.36*) on self-regulated learning seems bigger than both experimental group2 (*M=60.96*) and comparison group (*M=65.29*). The mean and standard deviation of the other affective variables of the study can also be inferred from table 4.19. To determine the statistical difference if any between the three groups regarding affective variables except satisfaction, one-way ANOVA was used and summarized in table 4.20 below.

Table 4.20. One-Way Analysis of Variance summary table comparing groups on affective variables before the treatment

| **Source** | | **df** | **Sum of square** | **Mean square** | **F** | **p** |
|---|---|---|---|---|---|---|
| **Math anxiety** | Between groups | 2 | 168.012 | 84.006 | 1.586 | .212 |
| | Within groups | 68 | 3601.171 | 52.958 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Total | 70 | 3769.183 | | | |
| **Self-regulated learning** | Between groups | 2 | 1034.878 | 517.439 | 7.866 | .001 |
| | Within groups | 68 | 4473.009 | 65.780 | | |
| | Total | 70 | 5507.887 | | | |
| **Academic hardiness** | Between groups | 2 | 136.723 | 68.368 | 3.366 | .040 |
| | Within groups | 68 | 1381.164 | 20.311 | | |
| | Total | 70 | 1517.887 | | | |
| **Motivation to learn** | Between groups | 2 | 43.074 | 21.537 | .878 | .420 |
| | Within groups | 68 | 1668.503 | 24.537 | | |
| | Total | 70 | 1711.577 | | | |

The result of the study shows that there was statistically significant difference on self-regulated learning (*F(2, 68)=7.866, p<.05*) and academic hardiness (*F(2, 68) =3.366, p<.05*), among the three groups. To determine which group differ statistically in self-regulated learning and academic hardiness, Post hoc Tukey HSD test was used and summarized in table 4.21 below. The post hoc Tukey HSD test was chosen because the Levene test is not significant for the two variables, which assures the assumption of homogeneity of variance.

Table 4.21. Post hoc Tukey HSD test multiple comparisons, comparing groups on self-regulated learning and academic hardiness

| **Variables to be compared** | **(I)group** | **(J)group** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Self-regulated learning** | Experimental group1 | Experimental group2 | 9.404 | .001 |
| | | Comparison group | 5.072 | .094 |

| | | | | |
|---|---|---|---|---|
| | Experimental group2 | Comparison group | -4.332 | .156 |
| **Academic hardiness** | Experimental group1 | Experimental group2 | 3.156 | .050 |
| | | Comparison group | .553 | .909 |
| | Experimental group2 | Comparison group | -2.603 | .115 |

From the Tukey table, only the two experimental groups made a significant difference in self-regulated learning, showing that experimental group1 was better in regulating their own learning before the treatment than students of experimental group2.

Though the ANOVA test detected a significant difference, the post hoc Tukey HSD test shows no statistical difference on academic hardiness in any pair of groups. In a one-way ANOVA, the F-statistic tests whether there are differences among the means of the groups. A significant F-value indicates that there are differences in the means. However, the result may not be consistent as Tukey HSD test is conservative because, it attempts to control the overall alpha level. This is because it controls the experiment wise error rate for the collection of all pairwise comparisons(Toothaker, 1993).

Further examining the mean differences, the difference between the two experimental groups were slightly bigger, though it is not enough to be statistically significant. Another thing for this uncommon result is that Tukey's test is based on the studentized range which worksin a different way than the F-test(Bretz, Hothorn, & Westfall, 2011). Thus, students' level of academic hardiness between the two experimental groups can be taken as marginally different at the beginning of the study. On all other variables except self-regulated learning, the difference between the three groups was not statistically significant. Thus, before the execution of the treatment, all assumptions were met. As the data is not normally distributed,

to compare the three groups on satisfaction, a non-parametric test called Kruskal-Wallis was used and summarized in table 4.22 below.

Table 4.22. Kruskal-Wallis test for satisfaction in terms of the three groups

| Variable | Group | N | Mean rank | df | Chi-square | p |
|---|---|---|---|---|---|---|
| **Satisfaction** | Experimental-1 | 22 | 43.57 | 2 | 4.599 | .100 |
| | Experimental-2 | 25 | 31.14 | | | |
| | Comparison | 24 | 34.13 | | | |
| | Total | 71 | | | | |

The result presented in table 4.22 above shows that the means ofthe three groups (experimental group1, experimental group 2 and the comparison group) are the same except the random difference due to chance in their satisfaction at the beginning of the study ($p>.05$).Thus, before the execution of the treatment, the three groups markedly possess nearly the same.

### 4.6.2. Comparison within Groups on Affective Variables

The results of all groups on affective variables measured before and after the treatment were used to examine the progression from pretest to posttest. In this case, each subject is measured twice (before and after the intervention),providing a pair of observations.Therefore, the advancement of each group from pretest to posttest on affective variables was examined using the paired sample t-test as shows in table 4.23 below. For experimental group1 and comparison group, all assumptions were met for all variables except the variable academic hardiness. On the other hand, only math anxiety and self-regulated satisfies the assumption of normality. Thus, a non-parametric test was used to examine the within group effect in satisfaction, academic hardiness and motivation experimental group2.

Table 4.23. Pretest and posttest comparison within groups on affective variables

| Observations | Group | Paired differences | | | | | |
|---|---|---|---|---|---|---|---|
| | | N | Mean difference | Std. Deviation | t | df | p |
| **PreMA-postMA** | Experimental 1 | 22 | -2.773 | 8.997 | -1.446 | 21 | .163 |
| | Experimental 2 | 25 | -4.600 | 7.948 | -2.894 | 24 | .008 |
| | Comparison | 24 | -1.208 | 6.440 | -.919 | 23 | .368 |
| **PreSRL-postSRL** | Experimental 1 | 22 | -4.591 | 9.689 | -2.222 | 21 | .037 |
| | Experimental 2 | 25 | -3.840 | 12.579 | -1.526 | 24 | .140 |
| | Comparison | 24 | -2.500 | 7.896 | -1.551 | 23 | .135 |
| **PreS-postS** | Experimental 1 | 22 | -3.864 | 4.998 | -3.626 | 21 | .002 |
| | Comparison | 24 | 1.167 | 7.522 | .760 | 23 | .135 |
| **PreAH-postAH** | Comparison | 24 | 1.292 | 5.465 | 1.158 | 23 | .259 |
| **PreM-post M** | Experimental 1 | 22 | -5.091 | 5.690 | -4.197 | 21 | .000 |
| | Comparison | 24 | -.708 | 5.409 | -.642 | 23 | .528 |

MA: Math Anxiety SRL: Self-Regulated Learning
AH: Academic Hardiness M: Motivation
S: Satisfaction

A paired samples t-test presented in table 4.23 above depicted that students' tendency to regulate their own learning (*t (21) = -2.222, p <.05, d =.474*) and satisfaction (*t (21) = -3.626, p <.05, d=.773*)have significantly improved for experimental group 1 and not for the comparison group. Experimental group2 also made a significant improvement in math anxiety (*t (24)= -2.894, p <.05, d =.899*).

Regarding motivation to learn, the result of paired sample t-test confirmed that motivation of students in experimental group1 (*t(21)= -4.197, p<.05, d=.947*) was improved in a statistically significant extent with typical effect size. However, students in the comparison group did not show significant improvement in motivation (*t(23)=-.642, p>.05*).On the other hand, experimental group1 and the comparison group did not improve their math anxiety

levels in a significant extent and their level of math anxiety is above average, showing that they were less anxious about mathematics both before and after the intervention.

Regarding the variable academic hardiness, a paired sample t-test shows non-significant improvement by comparison group students (*t (23)=1.158, p>.05*). However, the data for experimental groups violates the assumption of using paired sample t-test. As a result, a non-parametric test called Wilcoxon test was used to investigate the paired difference for the two experimental groups. The Wilcoxon signed ranks test is a non-parametric statistical test used when comparing two related samples or repeated measurements of which the normality of data is markedly violated(Morgan et al., 2004). The results of Wilcoxon test is given in table 4.24 below.

Table 4.24. Wilcoxon signed rank test comparing progress of experimental groups on academic hardiness, satisfaction and motivation

| **Observation** | **Groups** | | **N** | **Ranks** | | **Median** | | **Z** | **p** |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Mean rank** | **Sum of ranks** | **Pre median** | **Post median** | | |
| | Experimental 1 | Negative ranks | 7 | 8.50 | 59.50 | 42.00 | 46.50 | -2.180 | .029 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Pre AH-post AH** | | Positive ranks | 15 | 12.90 | 193.50 | | | | |
| | | Ties | 0 | | | | | | |
| | | Total | 22 | | | | | | |
| | Experimental 2 | Negative ranks | 13 | 13.00 | 169 | 39.00 | 39.00 | -.175 | .861 |
| | | Positive ranks | 12 | 13.00 | 156 | | | | |
| | | Ties | 0 | | | | | | |
| | | Total | 25 | | | | | | |
| **Pre S-post S** | Experimental 2 | Negative ranks | 6 | 9.67 | 58.00 | 30.00 | 32.00 | -2.227 | .026 |
| | | Positive ranks | 16 | 12.19 | 195.00 | | | | |
| | | Ties | 3 | | | | | | |
| | | Total | 25 | | | | | | |
| **Pre M-post M** | Experimental 2 | Negative ranks | 14 | 11.89 | 166.50 | 37.00 | 37.00 | -.472 | .637 |
| | | Positive ranks | 10 | 13.35 | 133.50 | | | | |
| | | Ties | 1 | | | | | | |
| | | Total | 25 | | | | | | |

AH: Academic Hardiness M: Motivation
S: Satisfaction

A Wilcoxon signed rank test detected a significant increase from pretest (*median = 42*) to posttest (*median = 46.50*) in academic hardiness ofstudents in the experimental group1 (*Z = -2.180, p <.05, r= .336*). An effect size *r=.336* according to Cohen (1988)is typical or medium. However, for experimental group2, the median is the same (39.00) for both observations namely pretest and posttest. So, there was no statistical difference between the two observations (*Z = -.175, p>.05*) in academic hardiness.On the other hand, experimental group2 made a significant move from pretest (*median=30*) to the posttest(*median=32*) in satisfaction (*Z=-2.227, p<.05, r=.314).* For non-parametric tests such as the Wilcoxon signed-rank test and Mann-Whitney U test, the Z-score is used to calculate correlation coefficients for effect size as $r = z/\sqrt{2n}$for Wilcoxon test and $r = z/\sqrt{n}$ for Mann-Whitney U test (Connolly, 2007; Tomczak & Tomczak, 2014)

Though it is expected to have similar outcomes at the end of the intervention, the two experimental groups show significant differences in their level of academic hardiness and motivation. There are two interrelated possible factors for this. The first one is the initial difference. That is, initially experimental group 2 students have lower level of academic hardiness as compared to experimental group 1(see sec 4.6.1). Thus, the two groups my not behave in a similar manner and also when more course works come into effect, students with low academic hardiness might lose their concentration and commitment. This is also evidenced by previous studies of Derntl and Motschnig-Pitri (2005),which reflected the unexpected result at the end of the intervention due to stress caused by exams and assignments.

However, academically hardy students have the composure to succeed in a challenging environment. Because, they expend considerable effort and engageduring challenging academic work inorder to obtain their academic excellence (Abdollahi & Noltemeyer, 2016; Benishek & Lopez, 2001; Kamtsios & Karagiannopoulou, 2013). The second factor might be due to the difference in perception and readiness. As it is explored by the qualitative data, students of experimental group2 tend to depend merely on lecture note given by their instructor(see sec 4.7.3). This implies that they are not ready to read more in order to understandthe courses effectively. As a result, they failed to benefit from the various learning opportunities provided by blended learning as that of the experimental group1. Further exploration of this situation is given in section 4.7.

### 4.6.3. Analysis of Group Difference on Posttest

Scores obtained from the posttest scores of all affective variables were analyzed by applying One-Way analysis of variance (ANOVA), which compares the means of the three groups as shown in tables 4.25 below. However, as the data violates the assumption, group difference in academic hardiness and motivation is separately investigated by using the non-parametric statistical test.

Table 4.25. Means and standard deviations comparing the three groups after the treatment by affective variable

| | | MA | | SRL | | Satisfaction | | Motivation | |
|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** |
| **Experimental- 1** | 22 | 44.1 | 8.16 | 74.9 | 8.35 | 35.7 | 4.83 | 43.7 | 4.96 |
| **Experimental- 2** | 25 | 42.3 | 2.77 | 64.8 | 11.4 | 32.3 | 3.64 | 35.7 | 6.54 |
| **Comparison** | 24 | 41.5 | 6.97 | 67.8 | 7.91 | 29.2 | 6.67 | 37.8 | 2.83 |
| **Total** | 71 | 40.7 | 7.19 | 68.9 | 10.2 | 32.3 | 5.75 | 38.9 | 5.99 |

The math anxiety mean score of students in the experimental group1 (44.1), which is nearly the same as that of both experimental group2 (42.3) and comparison group (41.5). This difference is also not statistically different at.05 level. The mean score of student in self-regulated learning seems different in each group. It was 77.9 for experimental group1, 64.8 for experimental group2 and 67.8 for comparison group. This difference is also significant at.05 level (see table 4.26). After checking the assumptions, one-way ANOVA was used to further examine the statistical difference if any between the three groups regarding affective aspects, and summarized in table 4.26 below.

Regarding the assumptions of one-way ANOVA, clearly the groups are independent. On the other hand, the assumption of normality of data and homogeneity of variance was also checked (see sec 4.3). Accordingly, the variables motivation and academic hardiness were not normally distributed for experimental group2. In this case the non-parametric test will be used later on.

It was also found that the test for homogeneity of variances is not significant for self-regulated learning ($p>.05$). This indicates that the homogeneity of variances assumption is met. Whereas, for the variables math anxiety and satisfaction, the homogeneity of variance is significant ($p<.05$), showing that the assumption of homogeneity of variance is not met. However,it is believed that if the sample sizes are equal, the effect of heterogeneity of variances is minimal(Elliott & Woodward, 2007). As the sample sizes of each group in the current study is not markedly different from each other, and to the fact that equal sample sizes mitigate the effect of unequal population variances, it warrants to use a one-way ANOVA. In this case, it is also possible to handle the effect of heterogeneity of variance by choosing appropriate post hoc tests(Morgan et al., 2004), where Games Howell test is appropriate for unequal variance.

Table 4.26. One-Way ANOVA Summary table comparing groups after the treatment on affective variables

| Source | | df | Sumof square | Mean square | F | p |
|---|---|---|---|---|---|---|
| **Math anxiety** | Between groups | 2 | 80.466 | 40.233 | 1.012 | .369 |
| | Within groups | 68 | 2702.858 | 39.748 | | |
| | Total | 70 | 2783.324 | | | |
| **Self-regulated learning** | Between groups | 2 | 1255.960 | 627.980 | 7.085 | .002 |
| | Within groups | 68 | 6026.913 | 88.631 | | |
| | Total | 70 | 7282.873 | | | |
| **Satisfaction** | Between groups | 2 | 488.484 | 244.242 | 9.069 | .000 |
| | Within groups | 68 | 1831.887 | 26.932 | | |
| | Total | 70 | 2319.887 | | | |

The result of the study shows that the three groups were found to be different from each other in a statistically significant extent on self-regulated learning (*F(2,68)=7.085, p<.05*), satisfaction (*F(2,68)= 9.069, p<.05*) and motivation to learn (*F(2,68)= 15.417, p<.05*). But, there is no evidence about which pair of groups differ statistically on the above variables of the study. Hence, the Post hoc Tukey HSD test was used for self-regulated learning as the Levene test of homogeneity was not significant and so the assumption of homogeneity of variance was met. On the other hand, Games Howell test was used for satisfaction, as the assumption of homogeneity of variance is violated. Regarding the variable academic hardiness and motivation, a non-parametric test called Kruskal-Wallis was used since the data is not normally distributed and hence violates the assumption of ANOVA.

Table 4.27. Post hoc Tukey HSD Test multiple comparisons, comparing groups on self-regulated learning

| Variables to be | (I)group | (J)group | Mean difference | P |
|---|---|---|---|---|

| compared | | | (I-J) | |
|---|---|---|---|---|
| **Self-regulated learning** | Experimental group1 | Experimental group2 | 10.155 | .001 |
| | | Comparison group | 7.163 | .032 |
| | Experimental group2 | Comparison group | -2.992 | .510 |

Post hoc Tukey HSD test indicated that for self-regulated learning, Experimental group1 and the comparison group shows a significant difference at the end of the treatment (*P<.05, d=.885*) with large effect size, but the difference between experimental group2 and the comparison group were not significant (*p>.05*). Confirming that students in the experimental group1 (*M=74.995*) improved their tendency to regulate their own learning better that the comparison group (*M=67.80*). Hence, it is evident that blended learning allows students to learn at their own pace. There was also a significant difference between experimental group1 and experimental group2 (*p <.05, d=.684*) on self-regulated learning. However, a significant difference was also detected on the pretest between the two experimental groups. On the other hand, experimental group 1 also shows a significant improvement in self-regulated learning from pretest to posttest, which experimental group 2 did not. Hence, it can be said that students of experimental group1 have improved their tendency to regulate their own learning. For the difference between groups on satisfaction, Games Howell test was used and summarized in table 4.28 below.

Table 4.28. Post hoc Games-Howell test multiple comparisons, comparing groups on satisfaction and motivation

| Variables to be compared | (I)group | (J)group | Mean difference (I-J) | P |
|---|---|---|---|---|
| | Experimental group1 | Experimental group2 | 3.493 | .023 |

| | | | | |
|---|---|---|---|---|
| **Satisfaction** | | Comparison group | 6.523 | .001 |
| | Experimental group2 | Comparison group | -3.030 | .137 |

Post hoc Games-Howell test shows that on the posttest measure, experimental group1 and experimental group2 students differ significantly in their satisfaction (*p<.05, d=.816*) and also experimental group1 and the comparison group differ significantly on their satisfaction (*p<.05, d=1.119*). But, there was no significant difference between experimental group2 and the comparison group on their satisfaction (*p>.05*).

The result of this study is in favor of experimental group1 in satisfaction. It does not mean that experimental group 2 totally not benefited from the intervention. This difference might be attributed to the difference in the perception and readiness of the two groups. As it is explored by the qualitative data, students of experimental group2 tend to depend on classroom lecture note given by their instructor (see sec 4.7.3) and perceive the supplementary materials and working at the lab as an additional work load added to them. This implies that they are not ready to comprehendthe course. As a result, they failed to enjoy the various learning opportunities provided by blended learning as that of the experimental group1. Further exploration of this situation is given in section 4.7.

The result of this study also shows that the two experimental groups have improved their satisfaction at the end of the intervention when compared with that of the pretest. The question is, why experimental group 2 did not show up a significant difference with that of the comparison group as experimental group1 did and also why such a strong significant difference is obtained when compared with that of experimental group1?. This situation is discussed in detail by referring the local context of the two experimental groups and using the

qualitative data (see sec 4.7.3). Additional data were also collected at this point to understand the root causes of this result. The general result however indicated that the problem is external to the nature of the blended learning approach.

As the data is not normally distributed, to compare the three groups on the variables academic hardiness and motivation, a non-parametric test called Kruskal-Wallis was used and summarized in table 4.29 below.

Table 4.29. Kruskal-Wallis test for academic hardiness and motivation in terms of the three groups

| Variable | Group | N | Mean rank | df | Chi-square | p |
|---|---|---|---|---|---|---|
| **Academic hardiness** | Experimental-1 | 22 | 48.95 | 2 | 13.204 | .001 |
| | Experimental-2 | 25 | 27.98 | | | |
| | Comparison | 24 | 32.48 | | | |
| | Total | 71 | | | | |
| **Motivation** | Experimental-1 | 22 | 53.27 | 2 | 23.110 | .000 |
| | Experimental-2 | 25 | 25.92 | | | |
| | Comparison | 24 | 30.67 | | | |
| | Total | 71 | | | | |

As there is a significant difference both in academic hardiness and motivation with respect to the three groups, the next thing is to determine the pair of groups that are significantly different from each other. However, there is no post hoc test built into the Kruskal-Wallis test (Morgan et al., 2004). Hence, three Mann-Whitney U test comparing each pair of group ranks wereemployed. The Mann-Whitney U test for the paired groups ofthe variablesacademic hardiness and motivation is given in table 4.30 below.

Table 4.30. Mann-Whitney U test for academic hardiness and motivation in each pair of groups

| Variable | Group | N | Mean rank | U | Z | p |
|---|---|---|---|---|---|---|
| **Academic hardiness** | Experimental-1 | 22 | 30.86 | 124.000 | -3.227 | .001 |
| | Experimental-2 | 25 | 17.96 | | | |
| | Total | 47 | | | | |
| | Experimental-1 | 22 | 29.59 | 130.000 | -2.955 | .003 |
| | Comparison | 24 | 17.92 | | | |
| | Total | 46 | | | | |
| | Experimental-2 | 25 | 23.02 | 250.500 | -.994 | .320 |
| | Comparison | 24 | 27.06 | | | |
| | Total | 49 | | | | |
| **Motivation** | Experimental-1 | 22 | 32.86 | 80.000 | -4.166 | .000 |
| | Experimental-2 | 25 | 16.20 | | | |
| | Total | 47 | | | | |
| | Experimental-1 | 22 | 31.91 | 79.00 | -4.084 | .000 |
| | Comparison | 24 | 15.79 | | | |
| | Total | 46 | | | | |
| | Experimental-2 | 25 | 22.72 | 243.000 | -1.145 | .252 |
| | Comparison | 24 | 27.38 | | | |
| | Total | 49 | | | | |

From the Mann-Whitney U test, it can be said that experimental group1 was significantly higher in academic hardiness than both experimental group2 *(U = 124.00, Z=-3.227, P<.05, r=.470)* and comparison group*(U = 130.00, Z=-2.955, P<.05, r=.443)*with medium effect sizes. Experimental group1 is also significantly better in their motivation than both experimental group1*(U = 80.000, Z=-4.166, P<.05, r=.607)* and comparison group*(U = 79.000, Z=-4.084, P<.05, r=.602)*at the end of the intervention. It can also be seen from table 4.30 that experimental group2 and comparison group did not differ statistically in academic hardiness and motivation.This shows that experimental group1 students were better than experimental group2 and comparison group students in both academic hardiness and motivation at the end of the treatment. On the other hand, experimental group2 and the comparison group tend to be similar in academic hardiness and in their motivation both before and after the treatment.

The result of this study is in favor of experimental group1again in academic hardiness and motivation. It does not mean that experimental group2 did not benefited from the intervention. With the same reason of differences in the perception and readiness of the two experimental groups, experimental group2 failed to benefit from the various ingredients of the blended learning intervention made. Further exploration of this situation is given in section 4.7.

### 4.6.4. Blended learning Approach and Students Affection

In this section, the overall effect of the treatment (BL) on affection is discussed in detail. To determine whether the baseline differences have any effect on the final posttest result, the Analysis of covariance (ANCOVA) has been employed. The Levene's test and normality checks were carried out and the assumptions were met to use ANCOVA for math anxiety and self-regulated learning. However, the affective variables academic hardiness, satisfaction and motivationviolates the assumption of normality and so the analysis of covariance was not used for those variables.Covariates are variables that may cause to draw incorrect inferences about the dependent variable. ANCOVA checks whether the independent variable (BL) still influences the dependent variables (SRL and MA) after the removal of influence of the covariate (pretest).

Table 4.31. Adjusted and unadjusted means and variability for MA and SRL

| **Variables** | **Groups** | | **Unadjusted** | | **Adjusted** | |
|---|---|---|---|---|---|---|
| | | **No** | **M** | **SD** | **M** | **SE** |
| **Self-regulated learning** | Experimental group1 | 22 | 74.95 | 8.352 | 73.102 | 2.033 |
| | Experimental group2 | 25 | 64.80 | 11.402 | 66.414 | 1.896 |
| | Comparison | 24 | 67.79 | 7.918 | 67.836 | 1.836 |
| **Math anxiety** | Experimental group1 | 22 | 44.09 | 8.164 | 43.602 | 1.283 |
| | Experimental group2 | 25 | 42.28 | 2.777 | 42.876 | 1.210 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Comparison | 24 | 41.50 | 6.972 | 41.322 | 1.220 |

Comparing the adjusted means on self-regulated learning, students of experimental group1 decreased from 74.95 to 73.102, where experimental group2 increased from 64.8 to 66.414 and the comparison group has increased from 67.79 to 67.836. To determine whether there is still a difference between the three groups in math anxiety and self-regulated learning, the covariance analysis is carriedout and summarized in table 4.32 below.

Table 4.32. ANCOVA result for affective variables

| **Variable** | **Source** | **df** | **Mean square** | **F** | **p** | **$\eta^2$** |
|---|---|---|---|---|---|---|
| **Self-regulated learning (SRL)** | **Pre SRL** | 1 | 607.634 | 7.512 | .008 | .101 |
| | **Group** | 2 | 472.517 | 2.621 | .061 | .080 |
| | **Error** | 67 | 5419.278 | | | |
| | Total | 71 | | | | |
| **Math anxiety (MA)** | PreMA | 1 | 316.206 | 8.877 | .004 | .117 |
| | Group | 2 | 31.724 | .891 | .415 | .026 |
| | Error | 67 | 35.622 | | | |
| | Total | 71 | | | | |

Comparing the estimated marginal means showed that the highest score in math anxiety(less anxious)was obtained on experimental group1 (*M=43.602*) compared to experimental group2 (*M=42.876*) and comparison group (*M=41.322*). However, the analysis of covariance presented in table 4.32 showsnon-significant difference between the three groups in math anxiety (*F (2, 67)= .891, P>.05*).

After statistically controlling the effect of the covariate (pretest), the difference between the three groups become non-significant on their tendency to regulate their own learning after the treatment (*F (2, 67) = 2.621, p >.05*). However, there is a marginal significance at $\propto = .06$,

which shows a positive contribution of the treatment on students' tendency to regulate their own learning. It can also be inferred from sec 4.5.2 that from pretest to posttest, experimental group1 have significantly improved their self-regulated learning(*t(21)=-2.222, p <.05, d= .474*), where experimental group2 and comparison group fail to improve significantly(*p>.05*). On the other hand the initial difference also shows a significantly better SRL tendency of experimental group1 than experimental group2. Basedon all this results, it can be inferred that there is a better gain in SRL practices by experimental group1 students. Thus, the use of ANCOVA on this variable created unnecessary adjustments which led to conclude that the three groups are nearly the same and the difference is not significant. This might lead that the difference between the two experimental groups after the intervention is not due to the initial difference, but a real difference.

The term 'marginal significance' is used to refer a significance which is not quite significant, but getting there(Pritschet et al., 2016).As a threshold, a p-value of .10 or less is marked as marginally significant(Guadagno, 2010). It is based on this assumption that experimental group1 is said to have marginal significance, as they possess a better self-regulatory skills than experimental group2 after the intervention.However, after controlling the effect of the pretest, the difference between the two experimental groups becomes non-significant and so this is due to the robustness of the statistical test (ANCOVA). Hence, it is evident that there was a positive effect of the intervention (BL) on self-regulated learning.

The affective variable math anxiety remains stagnant before and after the treatment. However, experimental group2 have made a significant improvement from pretest to posttest (*t(24)= -2.894, p<.05, d=.368*). Though initially non-significant difference was detected

between the three groups in math anxiety, experimental group 2 reported a slightly high level of math anxiety than the other groups. The math anxiety level of experimental group1 and comparison group was above average both before and after the intervention.

After controlling the effect of the covariate (pretest), the study shows non-significant difference between the three groups in math anxiety and a marginal significance in self-regulated learning. According to Guadagno (2010), if p-value is.10 or less, it is better to say the results were marginally significant. Such results could most likely be due to the reduced sample size(Petrisor, 2017). Thus, to determine the pair of groups that shows a marginal significant different in self-regulated learning, the post hoc Bonferonni test was carried out and summarized in table 4.33 below.

Table 4.33. Post hoc Bonferonni test multiple comparisons, comparing groups in self-regulated learning after controlling the effect of the covariate.

| **Variables to be compared** | **(I)group** | **(J)group** | **Mean difference (I-J)** | **P** |
|---|---|---|---|---|
| **Self-regulated learning** | Experimental group1 | Experimental group2 | 6.689 | .075 |
| | | Comparison group | 5.293 | .173 |
| | Experimental group2 | Comparison group | -1.395 | 1.000 |

The post hoc analysis shows that experimental group1 and experimental group2 are marginally significant (*p=.075*) favoring experimental group1 in SRL.The general result shows that experimental group1 was significantly better than the comparison group in motivation, SRL, AH and satisfaction after the treatment.

Though experimental group2 fail to show up significant difference with the comparison group in both satisfaction and motivation, it can be said that the strategy was effective in partially improving affection (academic hardiness, motivation, satisfaction, self-regulated learning, and math anxiety).This is because, referring sec 4.5.2, experimental group 1 has improved in self-regulated learning tendency, satisfaction, motivation,and academic hardiness. Additionally, their math anxiety level was also above average both before and after the treatment. On the other hand, experimental group 2 students have improved their math anxiety level, satisfaction and motivation.When looking for the comparison group, they fail to improve any of the affective variables considered in the study. Hence, it is evident to say that the intervention was successful in improving students' affection.

The result of this study shows that experimental group2 is not significantly better than comparison groupin motivation and satisfaction. However, students of experimental group1aresignificantly better than the comparison group in both motivation and satisfaction. In fact, the affection of students might decrease due to stress caused by taking different exams at the end of the semester. For instance, a study conducted by Derntl and Motschnig-Pitri (2005) found a decreased student motivation after the intervention made which is attributed to the interpersonal personalities of the instructors not the nature of the intervention.

Particularly in this study, to further investigate the situation, several triangulation methods such as instructor's view of the experimentation process, follow up interviews, student post-interview and field observation has been used. The result indicated the problem to descend on students' carelessness and misbehavior. The data obtained from the course instructorduring

the follow up interview confirmed the above argument. The course instructor pointed out as follows:

> There were problems on the part of students such as carelessness.Theydid not give any concern about their learning, because they do not want to study in general, not because it is blended. We are still under challenge of those group of students because of their lack of interest.

This is also argued by Harrison (2014) in that,online and blended learning requires students to be focused and in charge of their own learning. Experimental group2 students as can be evidenced in this study lack interest to learn. Because of this their affection was not significantly better than that that of the comparison groups, though they have improved some aspects of affect such as motivation, satisfaction and math anxiety from pretest to posttest.

Though blended learning has a potential in improving learning, it should not be taken for granted. There should be another mechanism that might raise students' interest to learn in general. This helps to obtain a satisfactorily improved learning. It is also argued that lack of motivation, ineffective communication, avoidance of online communication have affected the learning of the students in an online environments(Coffrin, Corrin, Barba, & Kennedy, 2014). Hence, at the presence of students'good interest to learn and bearing, blended learning is effective in both achievement and affection. Theexact blend therefore is dependent on an individual's learning position. That is why researchers contend the varied nature of blended learning (Aycock, Garnham, & Kaleta, 2002).

Regarding satisfaction of students in a blended learning environment, the qualitative investigation confirmed that students have enjoyed learning through the blended learning

approach. Figure 4.6shows that a large majority of students enjoyed the blended course experience.

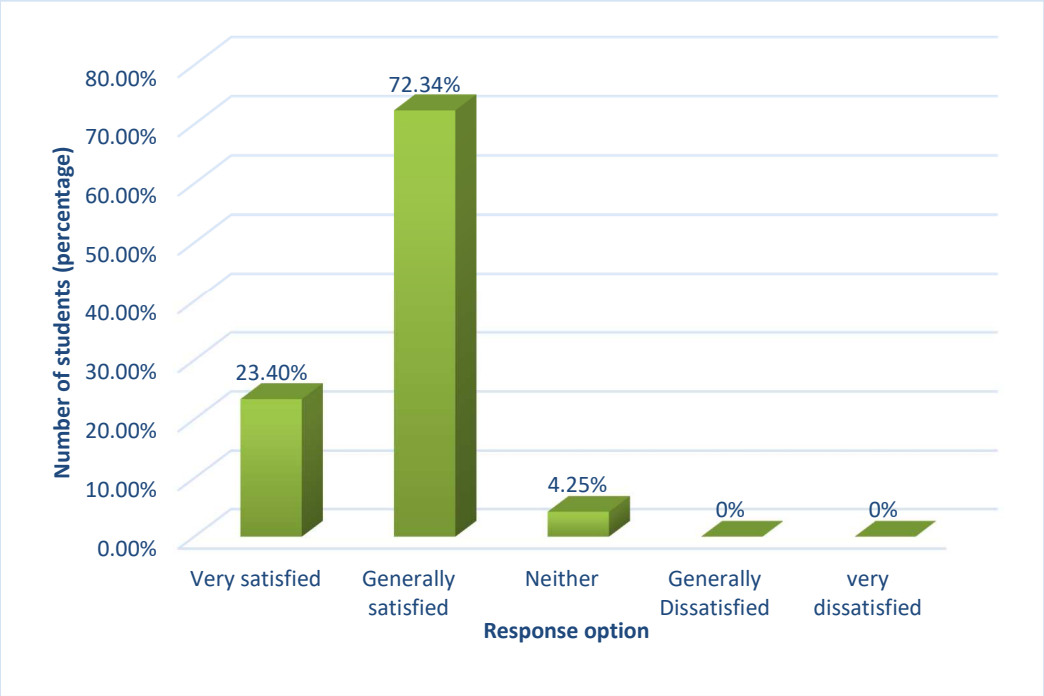


Figure 4.6. Percent of students who enjoyed the blended course experience.

The views of students shows that students generally hold a positive view about blended learning. Student respondents' agreed that online activities offer learning opportunities that are better than those in traditional classrooms. Students were also asked to respond to an open-ended question: What do you like most about blended course? Student responses were coded to reflect categories of response: ease of learning, flexibility, opportunity for interaction, immediate feedback, pace, self-checking mechanism, access to plenty of reference materials, and deep explanation and learning.

The category of ease of learning referred to the notion of simplicity and user friendliness of the designed online platform. Self-checking mechanism refers to the quiz available online at

the end of each chapter.  Pace on the other hand referred toworking at their own pace in the course. Flexibility referred to the possibility of accessing everywhere at any time using the mobile version or the web. The following illustrates some of the thoughts made by students:

- I really enjoyed that we had opportunity to evaluate ourselves
- We have access to all reference materials needed for the course
- I have enjoyed in the discussion forum, posting questions and getting feedback immediately
- I like it most because it focuses on deep knowledge
- I like it most because I became good in algebra
- I like it because it gives additional information on the contents
- It gives an opportunity to shift from the boring mechanism to an interesting and effective approach
- I like it because it is very attractive, and I eagerly look forward to enjoy the next lab session
- I am happy when I study in the lab room

The possibility for more learning activity is also another positive aspect that let students to work hard and engage. Working hard is at the heart of every success. One of the student respondent stated that “I felt that I was inquired to work harder in my blendedcourse and this helped me to improve my performance”. Other students’ comments included:“we could still contact our instructorthrough the online platform if we had questions and obtain feedback immediately”. The other respondent stated that “we do not try to copy everything during classroom lecture, because we can also get it on the online platform in a more detailed way”.

Generally, the results of this study are consistent with the existing literature on student satisfaction in blended learning. For instance, students valued ease and flexibility which are identified as benefits of a blended learning design by definition(Graham, 2006). This result is also in agreement with the previous finding of(Albano, 2012; Alebaikan, 2010; Lin et al., 2017; Manzoor, 2017; Mestan, 2019; Nguyen, 2016; Roff, 2017; Shantakumari, 2015), all of which reported a better satisfaction in blended courses than intraditional lectures. However, the finding of this study is against the findings ofRoberts (2004), who founds that blended learning environment are not able to meet students' requirements of convenience and service delivery. It is also against with the finding of (Schober & Keller, 2012) who found negative students response of the learning management system used (Moodle). In their research, students did not reflect any of the tools built in Moodlesuitable and as a result fail to communicate effectively via the learning management system, preferring Facebook. One reason for this is the group of students to be too dependent on Facebook and the version of the Moodle used at that time facing many limitations.

The result of this study is also consistent with the finding of (Akgündüz & Akınoğlu, 2017; EL-Deghaidy & Nouby, 2007; Hughes, 2007), who found an increased motivation in a meaningful way as a result of the blended learning as compared to face-to-face learning. So, this study found that blended learning environment were able to meet students' requirements of convenience, and students have appreciated and forwarded their positive thoughts. Hence, this study is in agreement with the findings of Mccombs and Vakili (2005)who claimed that effective use of blended approach can provide a more learner-centered education environment.

### 4.6.5. Gender Difference in Affection

Though there is always a fixing of mathematics as a male domain, gender differences on affective variables specific to mathematics learning are found to be small as compared to that of high cognitive level mathematical tasks (Forgasz, 1995). But, affect as an aspect that shapes cognitionShea (2007), has a huge influence on one's learning. That is, the difference in cognition is emanated from the affective orientation of an individual. The research question that would address this particular issue is "is there differences in gender on affection within groups?" which is directed to examine whether the intervention (BL) is gender friendly or able to cater gender difference. Thus, gender difference within both the experimental and comparison groups are investigatedusing independent samples t-test and the results are summarized in table4. 34 below:

Table 4.34. Comparison of male and female students on affective variables of the study within groups before the treatment

| Variable | Group | Sex | N | Group statistics | | t | df | p |
|---|---|---|---|---|---|---|---|---|
| | | | | M | SD | | | |
| **Math anxiety** | Experimental 1 | Male | 11 | 41.55 | 5.145 | .133 | 20 | .893 |
| | | Female | 11 | 41.09 | 9.741 | | | |
| | Experimental 2 | Male | 10 | 38.90 | 8.962 | .734 | 23 | .470 |
| | | Female | 15 | 36.87 | 4.897 | | | |
| | Comparison | Male | 7 | 44.71 | 3.988 | 1.958 | 22 | .063 |
| | | Female | 17 | 38.47 | 7.962 | | | |
| **Self-regulated learning** | Experimental 1 | Male | 11 | 71.18 | 7.236 | .476 | 20 | .639 |
| | | Female | 11 | 69.55 | 8.802 | | | |
| | Experimental 2 | Male | 10 | 60.10 | 9.871 | -.406 | 23 | .689 |
| | | Female | 15 | 61.53 | 7.772 | | | |
| | Comparison | Male | 7 | 68.29 | 8.341 | 1.208 | 22 | .240 |
| | | Female | 17 | 64.06 | 7.579 | | | |
| **Satisfaction** | Experimental 1 | Male | 11 | 32.18 | 5.095 | .280 | 20 | .783 |
| | | Female | 11 | 31.64 | 3.982 | | | |
| | Comparison | Male | 7 | 31.29 | 1.604 | .859 | 22 | .399 |
| | | Female | 17 | 30.06 | 3.596 | | | |
| **Academic hardiness** | Experimental 1 | Male | 11 | 42.09 | 5.166 | -.587 | 20 | .564 |
| | | Female | 11 | 43.18 | 3.371 | | | |
| | Experimental 2 | Male | 10 | 39.90 | 4.306 | .426 | 23 | .674 |
| | | Female | 15 | 39.20 | 3.840 | | | |
| | Comparison | Male | 7 | 43.71 | 4.231 | .989 | 22 | .334 |
| | | Female | 17 | 41.41 | 5.596 | | | |
| **Motivation** | Experimental 1 | Male | 11 | 39.27 | 5.850 | .624 | 20 | .540 |
| | | Female | 11 | 37.91 | 4.277 | | | |
| | Experimental 2 | Male | 10 | 37.10 | 5.724 | .287 | 23 | .777 |
| | | Female | 15 | 36.53 | 4.172 | | | |
| | Comparison | Male | 7 | 37.86 | 4.598 | .445 | 22 | .660 |
| | | Female | 17 | 36.82 | 5.365 | | | |

The result of independent samples t-test indicated in table 4.34, shows that male and female students possess nearly the same in all affective variables and there is no statistical difference within both the experimental and the comparison groups*(p>.05)*. This shows that there was no significant gender difference in affective variables of the study within both the experimental and comparison groups. The following table 4.35 summarizes statistical results

to examine whether these similarity of male and female students persist for both the experimental and comparison groups.

Table 4.35. Comparison of male and female students on affective variables of the study within groups after the treatment.

| Variable | Group | Sex | N | Group statistics | | t | df | p |
|---|---|---|---|---|---|---|---|---|
| | | | | M | SD | | | |
| **Math anxiety** | Experimental 1 | Male | 11 | 45.73 | 8.137 | .937 | 20 | .360 |
| | | Female | 11 | 42.45 | 8.238 | | | |
| | Experimental 2 | Male | 10 | 42.70 | 3.529 | .609 | 23 | .548 |
| | | Female | 15 | 42.00 | 2.236 | | | |
| | Comparison | Male | 7 | 45.57 | 5.028 | 1.943 | 22 | .065 |
| | | Female | 17 | 39.82 | 7.082 | | | |
| **Self-regulated learning** | Experimental 1 | Male | 11 | 79.00 | 6.017 | .345 | 20 | .019 |
| | | Female | 11 | 70.91 | 8.619 | | | |
| | Experimental 2 | Male | 10 | 64.00 | 7.498 | -.281 | 23 | .781 |
| | | Female | 15 | 65.33 | 13.636 | | | |
| | Comparison | Male | 7 | 73.43 | 4.158 | 2.475 | 22 | .022 |
| | | Female | 17 | 65.47 | 8.001 | | | |
| **Satisfaction** | Experimental 1 | Male | 11 | 37.82 | 3.400 | 2.151 | 20 | .044 |
| | | Female | 11 | 33.73 | 5.293 | | | |
| | Experimental 2 | Male | 7 | 32.30 | 4.083 | .022 | 23 | .983 |
| | | Female | 17 | 32.27 | 3.474 | | | |
| | Comparison | Male | 7 | 28.86 | 8.454 | -.181 | 22 | .858 |
| | | Female | 17 | 29.41 | 6.083 | | | |
| **Academic hardiness** | Comparison | Male | 7 | 43.86 | 4.880 | -.181 | 22 | .038 |
| | | Female | 17 | 39.53 | 4.155 | | | |
| **Motivation** | Experimental 1 | Male | 11 | 44.91 | 4.505 | 1.171 | 20 | .256 |
| | | Female | 11 | 42.45 | 5.298 | | | |
| | Comparison | Male | 7 | 39.00 | 3.367 | 1.320 | 22 | .200 |
| | | Female | 17 | 37.35 | 2.523 | | | |

The result of independent samples t-test indicated in table 4.35 detected gender differences in self-regulated learning (*df =22, t = 2.475, p <.05, d=1.248*) and academic hardiness (*df =22, t = 2.208, p <.05, d=.955*) for the comparison group in favoring male students in both cases. On the other hand, there is no statistical gender difference for both experimental groupson all

affective variables of the study except for self-regulated learning, which shows a significant gender difference within experimental group1(*df=20, t=.345, p<.05, d=1.088*), favoring male students. This could be attributed to comparatively better time management of male students during the intervention. However, there is a notable effect of the blended learning intervention, such a difference may not be observed in subsequent course. This is because, the gender difference in all other variables have been narrowed and this may initiate students to fill their gaps in their succeeding learning. Thegender difference in experimental group 1waslarger than typical (Cohen, 1988). Reporting effect size allows judging the magnitude of the differences between groups, which increases the capability to compare current research results to previous research and judge the practical significance of the results (Kotrlik, Williams, & Jabor, 2011).

Educational researchers have indicated that effect sizes around .20 are of policy interest when they are based on measures of academic achievement(Hedges & Hedberg, 2007). This shows that within the comparison group, male students were superior in self-regulated learning and academic hardiness after the intervention (BL). Similarly, within experimental group1 students,male students were significantly better than female students in regulating their own learning. Hence, gender difference becomes visible in a significant extent when course tasks and activities become higher for comparison group.For all affective variables except self-regulated learning, male and female students tend to be similar in all variables of the study in both experimental group1 and experimental group2. From this finding, it is evident to deduce that the intervention (BL) can have a potential to handle gender difference. Students become engaged and give concern for each activities of the course in a blended learning context, as a result the gap between male and female students has been narrowed in a considerable extent.

However, to determine gender difference within the experimental groups in academic hardiness and motivation, the non-parametric test called Mann-Whitney U test was used since the data are not normally distributed.

Table 4.36. Mann-Whitney U test for academic hardiness within the experimental group for gender comparison

| **Variable** | **Group** | **Sex** | **N** | **Mean rank** | **U** | **Z** | **p** |
|---|---|---|---|---|---|---|---|
| **Academic hardiness** | Experimental 1 | Female | 11 | 11.50 | 60.500 | .000 | 1.000 |
| | | Male | 11 | 11.50 | | | |
| | | Total | 22 | | | | |
| | Experimental 2 | Female | 15 | 11.20 | 48.000 | -1.502 | .133 |
| | | Male | 10 | 15.70 | | | |
| | | Total | 25 | | | | |
| **Motivation** | Experimental 2 | Female | 15 | 12.97 | 74.500 | -.028 | .978 |
| | | Male | 10 | 13.05 | | | |
| | | Total | 25 | | | | |

From the Mann-Whitney U test, it can be said that male and female students were not differ within both experimental group1 and experimental grou2 ($p>.05$). It also shows non-significant gender difference in motivation within experimental group2 after the intervention. This shows that within the experimental group,male and female students persist to be similar after the intervention. Confirming that the treatment is gender friendly.

This finding is in agreement with the findings of Divjak, Ostroski, and Hains (2010) which reported blended learning as an approach that cater different learning styles and gender differences. But, it is against with the findings of (Syzmanowicz & Furnham, 2011), which shows the superiority of male students in self-estimates than females in a meta-analyses conducted to examine the magnitude of sex differences in self-estimates of

general,mathematical/logical, spatial and verbal abilities. It is also against with the finding of Mutai (2016) who found superiority of boys in empathy and interest towards mathematics and rated mathematics to be more beneficial than their female classmates.

## 4.7. Students' and Instructors Perceptions of Blended Learning

This section is sought to address the research question "How do students and instructors perceive blended learning environment?" Perception is assumed to be the way people view and interpret the world around them (Alebaikan, 2010). It is clear that the perception of an individual depends on the particular event being experienced at a time. In this study, respondents' perceptions can be influenced by the intervention (BL) which include, interactivity and convenience. In this section, perceptions of both students and instructors is discussed in detail with the support of the data obtained from the focus group discussions and open ended questions.

### 4.7.1. Students' Perceptions of Blended Learning

One of the aims of this study was to explore how student participants perceive blended learning. This section deals with students' perceptions of blended learning as they participate in a blended algebra course. All of the participating students reported that they had never learned through this approach.

The automated assessment feature in the online quizzes allowed the students to receive prompt grading with feedback about their understanding and performance in the content being assessed, which students find it helpful in their learning. The thematic data analyses generated three themes regarding students' perception. These themes included: issues related

to interaction (collaboration), convenience (ease of learning), and overall satisfaction. In the following sectionsstudents'responses in these three factors are presented.

#### 4.7.1.1. Perceptions onStudent Interaction Provided by Blended Learning

Blended approach has increased student engagement and interactivity in a course(Aycock et al., 2002). Similarly,Lin et al. (2017) argued that online assessment and immediate feedback are at the forefront to improve learning effectiveness. Blended approach also inspires instructors to keep in contact with their students throughout the semester. One of the respondents puts it as:

> …additionally, we have also benefited a lot from the discussion forum. We are always in contact with our algebra instructor. We post difficult questions and get the feedback immediately. As a result of blended approach, my motivation for the course has improved.

Online discussion is a significant tool of web-based instruction, which is a discussion board where messages are posted online and participants can view and respond to them. Hence, it was designed to allow interactions between students and between student and the instructor in the online learning platform. Students were required to utilize these tools to interact with the teacher and their peers to discuss in each chapter. Students were encouraged to ask about any question that needs clarification. In this part of the platform, reasonable number of students have been participating and benefiting. On the other hand, all other students can see the conversations and learn from the discussions. Based on the observation and student interview, in this part of the platform, students were not actively participatingas expected due to their difficulty in typing. During interview one respondent underlined this situation as follows:

“The discussion is very helpful to get answers from my instructor and other students, but I have difficulty in typing, which consumes my time…”

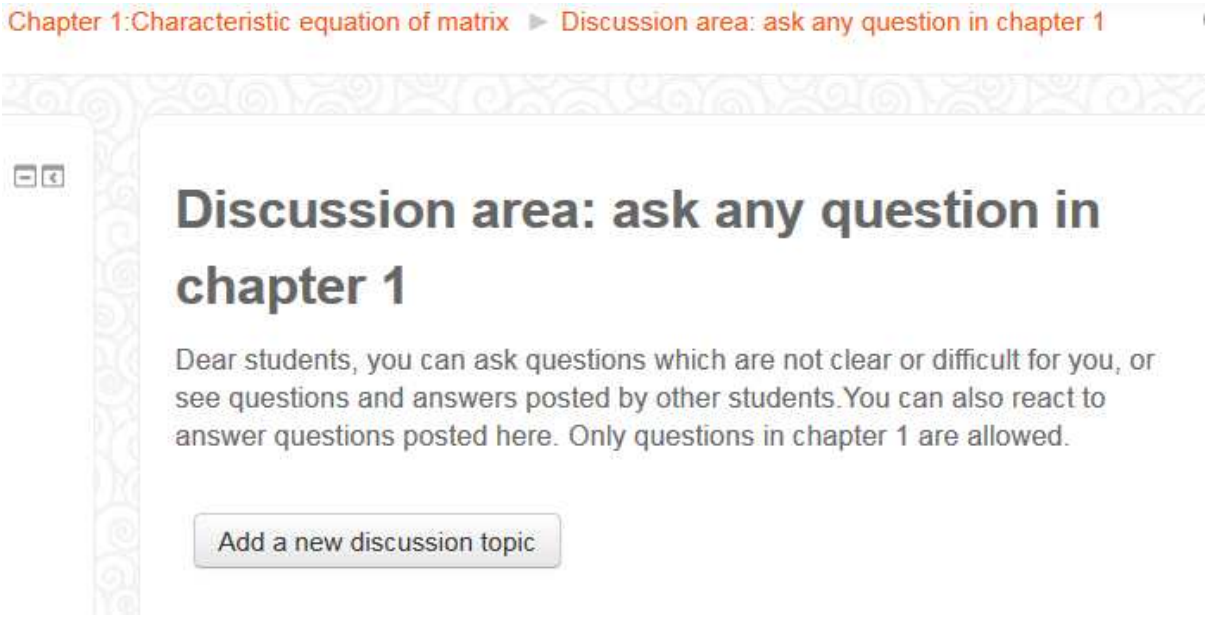


Figure 4.7. Discussion forum encouraging students to actively participate and benefit from the forum.

Online discussion was used as a communication tool to raise any queries and difficulties by students. The question that students raised in the discussion forum was left for them for discussion for about 10 to 30 minutes in line withdoing other things. Then the instructor responded to the indicated questions in detail and step by step manner.For example, figure 4.8is an excerpt of the discussions made on the forum. This type of communication offers a chance to solve any difficulties they face easily.

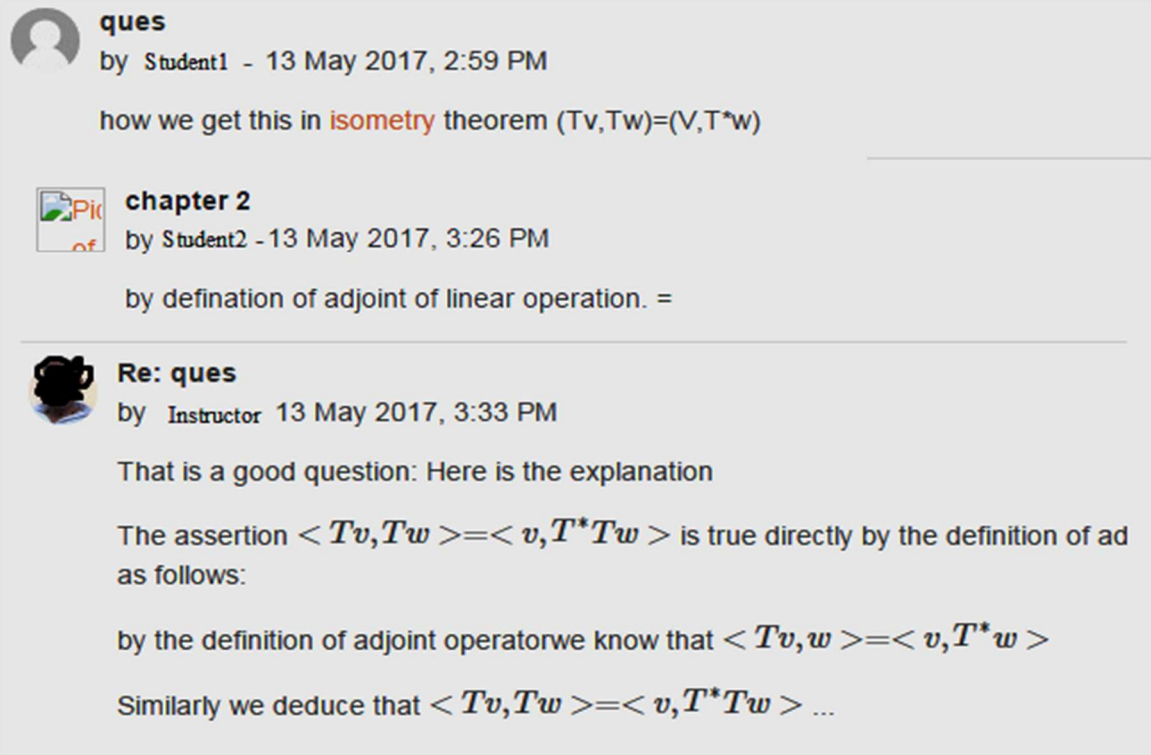


Figure 4.8. Student and instructor interaction on the discussion forum

As a result of blended learning intervention made, there was a considerable improvement in student interaction. This can be inferred from the satisfaction of students, which contains interaction between students and theinstructor. Using the quantitative results students' satisfaction in the experimental group were significantly better than that of the comparison group (see sec 4.7). This result is also confirmed from students' perception survey. Students of experimental group reported that they have got a good opportunity for collaboration as a result of blended learning. Students' response regarding the opportunity they got as a result of blended learning strategy is presented in figure 4.9.

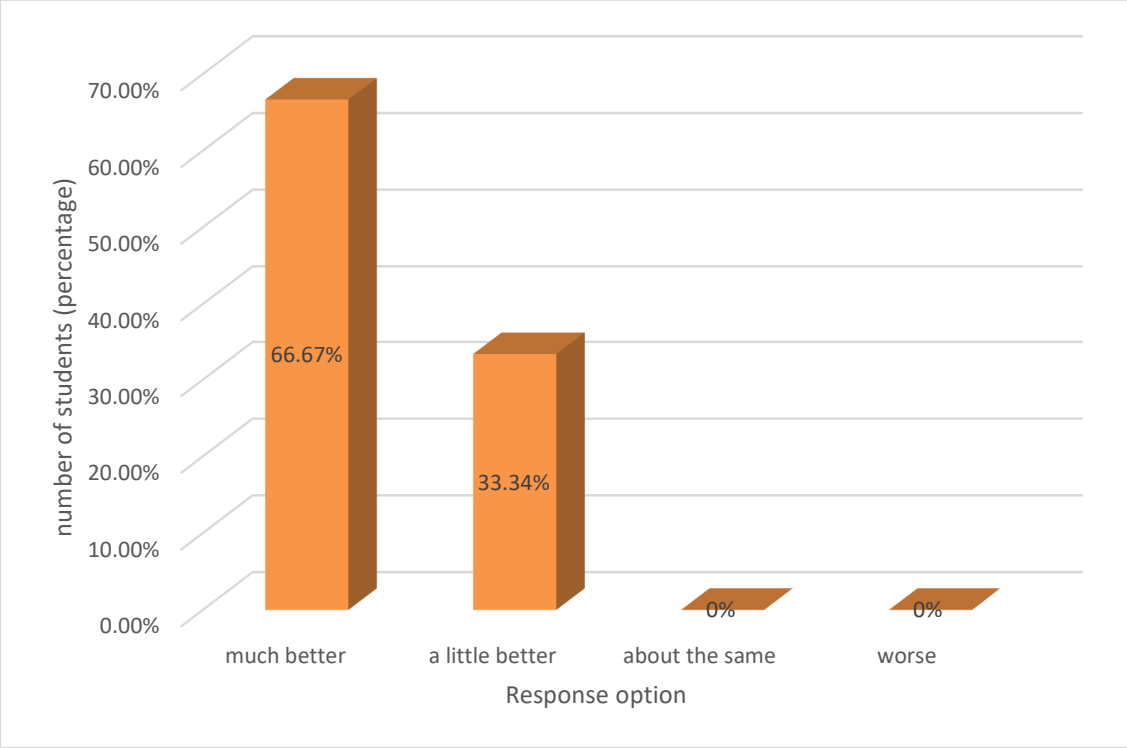


Figure 4.9. Perceptionson blended learning approach on the opportunity for collaboration.

From this result it can be inferred that blended learning enhances collaboration among students. This collaboration in tern helps to understand and learn in a better way.Generally, students saw the interactivity brought by the course discussion forum as important and helpful. They emphasized thepossibility to connect actively with others. Thus, these findings suggest that the core value of the course discussion forum lies in its role as a representative of student and teacher relationships, suggesting its potential effectiveness for building collaboration for common goal.It also gives a chance of expressing their thoughts. This will increase an opportunity to communicate their needs freely.

The overall result shows that blended learning further provides the opportunity to learn freely. This finding is in agreement with the previous finding of(Alebaikan, 2010; Fakhir,

2015; Keshta & Harb, 2013; Shantakumari, 2015)all of whomfound an increased level of communication and interaction between students and the teacher. The current finding is also in line with (Alshahrani, Ahmed, & Ward, 2017; Aycock et al., 2002; Garrison & Vaughan, 2008; Manzoor, 2017; Moura, 2010)whoalso reported a better student interactivity and student performance that students found beneficial.

#### 4.7.1.2. Perceptions on Convenience Provided by Blended Learning

Students have valued and enjoyed the ease and convenience associated with the digital aspects of the course. Students reported that using Moodle and the course discussion forum which isprepared chapter by chapter was easier and more convenient. One of the respondents stated as:

> I am comfortable with this approach. It would have been good, if this approach was used in the previous semester. Things that seems difficult are simple here. Algebra is the hardest course for me, but now it becomes simple. Everything on the online platform are helpful and helped me to understand and learn the course effectively. The interaction with my instructor is also improved as a result of the discussion forum. Wecan ask questions and get immediate feedback.

In addition, the views of other participants taken from the focus group discussion supports this opinion:

> Classroom lecture is not adequate to grasp everything needed. This way (blended learning approach) is important and helpful, since the classroom and online learning

creates a meaningful way to learnwhich provided sufficient opportunities for accessing learning resources and to collaborate.

With respect to the perceptions of students towards the intervention (BL), participants of this study perceived BL as a more effective and convenient approachthan the traditional in-class delivery approach. These results are in agreement with previous studies reporting that students show ease of learning in blended courses than in traditional lectures(Alebaikan, 2010). Students have expressed positive views about their experience of blended learning, which reflects the findings of other studies such as (Alebaikan, 2010; Melton et al., 2009; Yudko, Hirokawa, & Chi, 2008).Frequency distribution of perceptions of students towards the process of blended learning is summarized in table 4.37.

Table 4.37. Frequency distribution of perceptions of experimental group1students towards the process of blended learning

| Items | **Strongly agree (%)** | **Agree (%)** | **Neutral (%)** | **Disagree (%)** | **Strongly disagree (%)** |
|---|---|---|---|---|---|
| I'm more likely to ask questions in a blended course | 47.62 | 52.38 | - | - | - |
| There are more opportunities to collaborate with others in a blended course | 47.62 | 47.62 | 4.76 | - | - |
| Blended course experience has increased my opportunity to access and use information | 71.42 | 19.04 | 9.52 | - | - |
| I have more opportunities to reflect on what I've learned in blended courses | 45.23 | 45.23 | 9.52 | - | - |
| Blended learning helped me to better understand course material | 50 | 38.09 | 11.90 | 2.38 | - |
| I understand course requirements better in a blended course | 40.47 | 40.47 | 14.28 | 4.76 | - |
| Because of blended courses, I am more likely to get a better grade | 47.61 | 38.09 | 11.90 | 2.38 | - |
| I am very satisfied with this online course | 47.61 | 42.85 | 4.76 | 2.38 | - |
| The websites that were linked to this course facilitated my learning | 42.85 | 50 | 7.14 | - | - |

Additionally, the availability of the online lecture contents was perceived as important. One of the respondents stated it as "the short notes, explanations and examples provided on the online platform are helpful". However, participants from experimental group 2, found those additions as an extra load on their learning. They claimed the time limitation it created as a challenge. One of the participants from this group stated as follows:

> We have no previous experience of learning through blended approach. Also the classroom instruction does not cover every contents found on the online platform. There are many learning materials, but we have no time to read all of them in this

short and tight semester. It took our time, since it was an extra work added to the course.

The perceptions of students in the experimental group2, wereexceptional. To further examine this situation, the researcher conducted another follow up interview after having a deviant quantitative and qualitative results. The follow up interview was made in both experimental group1 and experimental group2. During this interview students were at their third year of study. The general result, however, confirmed the problem to lie on the part of students' readiness, carelessness, disobedience, poor time management skill and poor computer skill.

Students of experimental group2 believe that what the instructor gives in the classroom is enough to complete the course. This implies that they are not ready to read and explore more in order tounderstandthe course effectively as experienced in this study. Their intention is to complete the course not to understand. Hence, they have taken reading and working more as wasting of time. Furthermore, data obtained about these students from the course instructor and department head also confirmed that students have this type of mindset up of sticking on instructor's lecture note, and also misbehavior. The following is an excerpt of instructor'sopinion regarding students of experimental group 2: "the behavior of students is not good. They do not want to do activities, especially tutorial classes and also they do not accept the instruction given to them". According to Kuo, Bellandb, Schroder, and Walker (2014),large amount of self-discipline is required to fully benefit from a computer mediated learning environment.Thus, this might be the reason for which experimental group2 does not improve their affective component as that of experimental group1.

Student time-management practices are a significant contributing factors to succeed inhigher education, particularly in blended learning(Raadt & Dekeyser, 2009). There is always a difficulty in managing time for higher education students. According to Vaughan (2007), this difficulty can be tougher in a blended course where online activities are required to be completed between face-to-face classes. In this study, experimental group2 was found to be challenged of time management problems: one of the interviewee stated as follows:

> I encountered time limitation, we learn in class and also we come to lab and learn the same course and this takes my time. I am feeling that I am learning two different courses. Though I know it is a helpful technology, I am unable to manage my time. The reference books are too broad and complex as compared with the classroom lecture. I prefer only reading classroom lecture. At that time, it created some sort of disturbance.

The result of this study also identified the existence of fear of asking question among students of experimental group2. One of the respondents from this group underlined it as:

> I have limitation in managing my time which affected the overall impact of blended approach in my learning, but because of that experience I learnt managing time as a major factor in my learning. The classroom lecture is not clear most of the time, but we get more explanation on the online platform. The teacher constantly encourages to ask questions through the online platform and in class but, most of us do not ask questions.

Lack of sufficient skills in computer was also found to be another potential barrier for students especially for experimental group2. This is because, their previous exposure to

computers is very limited. They reported that instructors of computer courses did not give time to practice in computer lab. One respondent from experimental group2 stated it as follows:

> I and most of the students do not take the lab as a learning part, we take it as an entertainment. Also we have limited previous exposure to computers. We have taken three computer courses before this blended course, but still most of us do not have sufficient basic knowledge of using computer. The instructors did not give opportunity to practice in the lab, we don't know why? Does it mean that it is not that much needed for mathematics students?And because of that we did not give emphasis to computer courses.

This is unpleasant experience which significantly affected studentslearning in the current blended algebra course. Not only this, some students were observed trying to spend their time in playing games and watching movies in the lab. Though this situation has been handled immediately by the lab assistants, the attempt by itself had implication that such students are not ready to learn through the technology or they perceive the technology as an entertaining tool that might produce little for learning. According to this study the situation can be taken as a gap which could be controlled by creating students sense of ownership on their learning and making them aware of the benefits.This is therefore one of the reasons for the quantitative diverging results of experimental group 1 and experimental group2 in their affection (see sec4.5.4). However, there were students who managed everything and benefited from the platform created. One of the respondent from the experimental group2 put it as:

> I managed all my lab sessions, whether the network is good or not. The online lecture is very interesting and I prefer to read it, since it is complete and enables to grasp concepts. I have enjoyed and benefited. The notes and examples provided on the reference books are not clear but the online lecture is very clear and the examples are solved in a clear way. I wish this approach be used in other courses as well.

Computer skill is a problem not only for experimental group2 students, but also for some students of experimental group1. The limitation to practice in previous computer courses is also a problem for experimental group1. One respondent from experimental group1 stated it as follows:

> I personally have no sufficient prior knowledge of computers. As a result, I encountered a problem during the first lab sessions. I have an aspiration to improve my computer skill and proud to have such an exposure which lifted my knowledge up. This was the only opportunity that helped me to improve my computer skill. We have an opportunity to get into the computer lab during computer courses. But here the lab assistants are available and assist us every time we need, we do not afraid them. But, in computer courses that we have taken so far, we did not get the lab assistants. The instructor presents about what to do in the lab and then he go with no further assistance.

Most of the students indicated that blended learning helped them to practice and develop some essential computer skills. Hence, students have improved their computer skill as a result of blended approach. When asked about their computer skill experimental group1 students proudly spoke out about their progression, which students of experimental group 2 still doubt.

Regarding the improvement of their computer skill a respondent from experimental group1 responded as:

> Since we have no sufficient prior knowledge of computers, at the beginning, I was somewhat frustrated. When I press something it wiped out and I was impressed when the lab assistant regain it with a single click. The first lab session was full of confusion and the lab assistants were busy of helping all of us, but then it was no longer a problem. I can correctly open and browse the online platform and reference books. I became familiar with the platform quickly. It was a wonderful experience which I really desire to have it in the future. As a result of the blended approach we can now confidently manipulate a computer.

In contrast to this, the issue of computer skill when described by student respondent of experimental group2 indicated that this group has been severely affected. They failed to benefit from the platform as required. The following is an excerpt from the interview:

> The greatest challenge was the computer skill. We have a difficulty, for instance, posting question for discussion. When I try to post a question I faced a difficulty and some of the students were posting my question and I get the answer from the discussion made by other students and from the instructor. When I face a difficulty I am afraid to ask for a help.I feel that my computer skill is not adequate.

Though there was a considerable impact of blended approach, the experience of the two experimental groups has been inconsistent, favoring experimental group1 in improving their affective aspect.As presented above, there is a clue as to why students of experimental group2 failed to improve their affective component considered in the study as that of experimental

group1. This finding is in agreement with the finding of (Manzoor, 2017), who found that students with prior positive learning experiences were motivated towards blended learning environment and they have improved their motivation as the course progressed.To better understand the context of the two experimental groups, the following parallel comparison is made in different aspects.

Table 4.38. Comparison of the context of the two experimental groups

| Facet | Experimental group1 | Experimental group2 | Remark |
|---|---|---|---|
| **Internet speed** | Good throughout the study | Sometimes slow | |
| **Electricity breakout** | Severe breakout | Rarely | |
| **Students behavior** | Good | Bad, they do not follow instructions | |
| **Time management** | Good | Some students faced difficulty | |
| **Computer skill** | Initially not sufficient | Initially not sufficient | The same for both groups |
| **Previous exposure during computer courses** | Instructors do not give emphasis for the lab session | Instructors do not give emphasis for the lab session | The same for both groups |
| **Tendency to ask for a help** | Good | There was a fear to ask question | |
| **Improvement of computer skill at the end** | Considerable improvement | There is a doubt | |
| **The schedule of the university and continuous assessment** | Tight and students have freedom to decide assignment submission date and test dates | Tight and students have freedom to decide assignment submission date and test date | The same for both groups |

As presented in table 4.38 above, the context of the two groups are the same in some cases and different in some aspects. The result of the study confirmed that students of both groups have relatively similar previous exposure to computers. The major difference found was electricity break out. There was a severe electric breakout in experimental group 1 as compared to experimental group2. One of the respondents angrily put it as:

> Oh! The greatest challenge was the loss of electric power. One day I remember we stayed in the lab for up to two hours waiting for the electric power. It sometimes go for three days. Because of that not only the lab session, but also we fail to study other courses at the evening.

Going through all the above challenging contexts, experimental group1 have benefitted in improving their algebra achievement and affection better than the comparison group. When asked about their overall experience of blended approach one of the respondent from experimental group1 stated as follows during the follow up interview:

> I am highly comfortable with the blended approach. As it is obvious, algebra is a course that requires critical thinking. Since, the online platform collected all available reference materials, I can say that the approach is very beneficial. Whatever we need is there on the online platform. I am missing many aspects now in this semester.We are now bored, as there is no sufficient reference materials and support. So, additional support is essential for students. I remember at that time, what is not clear in the class lecture is clear enough on the online platform. The platform served as a good source of support.

Another student participant from experimental group1 similarly found it as a good experience and put her experience of blended approach as follows:

> You are doing a research, but I take it as a good support that I may not get even by paying. Till know we learn through the boring method (face-to-face), but this one (blended approach) is an interesting and very effective approach. It is like a study hour given to the course in an interesting and effective way. We usually have more

study hours than class lecture and so the lab session is taken as a study hour. There is no burden of wasting time.

Based on the above findings, students' time management skill, their behavior, and readiness plays a great role in blended learning approach. This is because students with good conduct and interest to learn have reported positively and benefitted from the approach. This finding is in agreement with the previous finding of Aycock et al. (2002), who found out time management, computer skill and problems of accepting responsibility for personal learning as a challenging constructs in blended learning. This is also in agreement with the finding of Vaughan (2007), who found out difficulty of students during the first days of blended learning experience in managing time, taking responsibility of their own learning and technological difficulty.

#### 4.7.1. 3. Students Overall Satisfaction with Blended Learning

Regarding satisfaction of students in a blended learning environment, both quantitative and qualitative results of the study confirmed that students have enjoyed learning through the blended learning approach. Particularly, the data obtained from both experimental group 1 and experimental group2 shows that 23.4% of students reported that they are very satisfied, while 72.34% of students reported that they are generally satisfied, the remaining 4.25% students failed to decide whether they are satisfied or not. But, the result shows no dissatisfaction report. Looking for students who are very satisfied and generally satisfied, it can be said that about 95.75% of respondents were satisfied with the current blended learning course.

The views of students shows that students generally hold a positive view about blended learning. Student respondentsagreed that online activities offer learning opportunities better thanthe traditional face-to-face approach. Students were also asked to respond to an open-ended question: What do you like most about the blended course? Student responses were coded to reflect categories of response: ease of learning, flexibility, opportunity for interaction, immediate feedback, pace, self-checking mechanism, access to plenty of reference materials,deep explanation and learning.

The possibility for more learning activity is also another positive aspect that let students to work hard and engage. Working hard is at the heart of every success, and it is the manifestation of academically hardy students. One of the student respondent stated that “I felt that I was inquired to work harder in my blendedcourse and this helped me to improve my performance”.

### 4.7.2. Instructor’s Perceptions of Blended Learning

Another research question raised in this study is “How do instructors perceive blended learning environment?” Accordingly, this section provides the perception of two algebra course instructors obtained from the two experimental universities. Their response can be categorized into three themes. Their satisfaction, the advantages of blended learning, and the challenges or the limitation they have observed.

Both of the participating instructors were asked about their satisfaction and convenience of blended course and they reported that they were very satisfied. Both instructors have no prior experience in teaching through blended learning approach. When asked about their general

satisfaction of blended learning after having implemented it, one instructor said that “though it is new for me, I am very satisfied with the blended course. When I exercise it, I liked it and plan to learn more about designing such a course for my future use”. The other added “this type of learning is very good in two ways, one way is to cover the course on time and the other is to equip students with the skill and knowledge of current technological advancement”.

Both course instructors have acknowledged the positive effect of blended learning. The following are the advantages they have listed when asked about the positive aspect of teaching a course using a blended learning approach:

- To cover course on time
- To get all reference materials needed for the course
- To increase the amount of interaction with students
- To allow students to learn by themselves
- To give immediate feedback which alerts students to think more
- To allow students to express their opinion on a given posted question on the discussion forum
- To make the course delivery process more attractive

Furthermore, the instructors have raised about the impact of blended learning approach on students course achievement and competency. One of the instructor respondent underlined the increased achievement as follows “there is an observable improvement in my students’ achievement and competency” the other instructor added “the achievement of students is better and has been improved”. Instructors were also asked about the negative aspect and the

challenges they have faced. They pointed out the power outage, internet connectivity,the tight schedule, the behavior of students at the experimental university 2,andinterest of students for learning in general.

### 4.8. Challenges of Implementing Blended Learning

The forth research question raised in this study is “What are the challenges of applying the blended learning method?”Though blended learning practice has advantages in promoting learning, there are also notable challenges that arise. The majority of students expressed their interestforfuture blended courses and presented some challenges as an issue that would be taken as abottleneck. This section reveals challenges observed during the implementation of blended learning in the current study. These challenges can be grouped into three major categories: the adaptation of blended learning in the traditional university; students’ exposure to computers, frequent power outage and demand on time.

#### 4.8.1. The Adaptation of Blended Learning in the Traditional University

The foremost challenge is institutional support and technological infrastructures. Blended learning requires that all students and teachers have a computer, tablet, or laptop and also asufficient internet connection at least around the campus. However, this is expensive to maintainfor a traditional university and the institution is not ready to do so. As a result, students were forced to work only at a selected computer laboratory. It would have been good, if they had sufficient access at digital library and dormitory. The number of computes in the digital library did not much with the number of students in the university. Traditional university in this sense is to mean, a university where all courses run in a traditional

classroom based (face-to-face only). The shortage of Internet labs is common and considered as a challenge forstudents. Even there were no proper computer laboratory rooms so as to accommodate the technology. There were also inappropriate use and management of existing computer labs. Most computers in the laboratory were not functioning properly. This is due to the fact that one computer can be used by many students and absence of continuous maintenance.

From its very nature, the institution is not ready for blended learning approach, all courses are running in a traditional face-to-face manner.As a result, therewas lack of awareness and coordination from the department and instructors. On the other hand, instructors are always in a hurry moodto cover course contents within the given time period. They do not give time to support students in the learning process. Hence, it requires a great reform in the current course delivery practices in Ethiopia.

Frequent power outage is another challenge that the researcher have observed while implementing the blended approach for one semester. Respondents also raised this issue during interview at the end of the intervention, as one respondent put it “we have benefited a lot except the limitation in power loss, which wasted our time.” Frequent power loss was common in the study site during the time of implementation. This situation creates a challenge in terms of time. Specially, the situation in experimental university 1 was worse. Hence, it is important that higher education institutionsto have electricity improvement packages to overcome the frequent power outages and the inconvenience it creates.

### 4.8.2. Students Exposure to Technology and Readiness

Though participants of this study were assumed to have reasonable competency in computers, some students were still seen having difficulty in manipulating the online platform. This is due to their lack of exposure/experience to computers. They never practiced in using computers satisfactorily, apart from the fulfillment of computer related courses. This is because, they do not get computers to practice enough.

Some students were also found to disregard the lab sessionsdue to the belief of extensive library study. This is also a result of resistance to the new approach, though the researcher made a one session orientation about the benefits of learning through blended learning approach. This situation is also considered by Alebaikan and Troudi (2010) in that taking online instruction requires students to have sufficient level of self-discipline and commitment. In support of this argument, Ryan (2013) identified difficulty of maintaining commitment of student in learning within an online environmentin the context of blended approach.

### 4.8.3. Demand on Time

Transforming traditional course into blended course requires more instructor time thandeveloping traditional courses, because of the necessity of redesigning the course.It also requires knowledge of technology. The researcher took too much time in redesigning the blended course for the purpose of this study. It may take even more time if the collaboration of algebra course instructorswas removed. Thus, instructors and students will experience an increase in the time they spendon learning new techniques and skills, and on interacting with each other in blendedlearning environments.

The main challenge is therefore, the extra load that it creates on the part of the instructor. This situation is not tolerated especially by Ethiopian instructors.Instructors may not be willing and not committed to invest additional effort and time to help students learn. The usual trend is giving class lecture and go, but blended learning requires continuous and unending follow-up of students' difficulty.This result is supported by the finding of Vandermolen (2010) who found that blended learning approach as more time consuming approach, where teachers are worrying about the time they spend on the online platform.

To one degree or another, most educational technology products and blended-learning models require schools to change reconfigure their existing resources and processes. A new instructional model certainly requires teachers to spend time in order to learn how to use new technologies and implement new classroom procedures. Even after figuring out the basics to launch a new model, blendedlearning teachers still spend the first year in adjusting, and adapting their blended learning model. Additionally, some schools and teachers that adopt blended learning decide to build their own online-learning content, which adds an additional time demand.

It is true that, time is one of the instructors' most valuable resources. It is therefore wise to get paid for their efforts in planning, designing and developing the blended learning environment. This is the stage that requires more time and collaboration with IT personnel.However, when universities and instructors amend themselves to the new instructional approach, the demand on time will hopefully be diminish over time. Proponents of blended learningargued that the initial huge amount of investment to make blended learning happen will definitely be changed to the cost-effective and reduces instructors effort

in course delivery (Graham, 2006).To reduce the initial challenge and to successfully implement blended learning program, it demands to get training on itsdevelopment and practices.

It is therefore, clear that the future teacher education program should include blended learning as the imminent promising instructional approach in the 21st century and train prospective teachers with all the skills required to plan, develop and implement blended learning.This is also emphasized by Shishigu, Gemechu, Michael, Atnafu, and Ayalew (2017b), that is,the need for a reform of the current teacher education program in Ethiopiaso as to equip prospective teachers with the knowledge of technology, pedagogy and content. And also to base the reform on continuous research outcomes(Gemechu, Shishigu, Michael, Atnafu, & Ayalew, 2017).Further research by Michael (2015)also shows the necessity of integrating technology, pedagogy and contentto fill gaps during instructional process. Thus, for the current dynamic world, teachers need to have the amalgam of all knowledge (TPCK).

## 4.9. Effectiveness of Blended Approach in AlgebraLearning

The last research question raised in this study was “How effective blended learning is in improving students’ algebra achievement and affection?”This section examines the results presented in the above sections about students’ algebra achievement and affection to determine whether the blended learning approach being used is effective in improving students’ algebra achievement and affection.Specifically, the learner characteristics being investigated forblended learning effectiveness include algebra achievement, self-regulation, satisfaction, motivation, academic hardiness, math anxiety and gender.Research shows that blended learning effectiveness is dependent on student characteristics, design features and

learning outcomes(Kintu, Zhu, & Kagambe, 2017). Thus, it is straight-forward that the effectiveness of blended learning examined in this study is based on the specific learner characteristics, nature of the course and the blended learning designed used.

The result of this study revealed that the blended learning approach being used has improved students' achievement scores in algebra as compared to the usual face-to-face learning. This is evidenced by comparing the results of the two experimental groups with the results of the comparison group. That is, at the end of the intervention, the two experimental groups achieved better than the comparison group in a significant extent. This confirms that the intervention (BL) made a significant positive effect on their achievement. Thus blended learning is effective in improving students' algebra achievement.

However, there were deviations in students' affection between experimental group1 and experimental group2 which indicates the need for additional investigation to mend students' affection. The findings of this study show that students have improved their affection at the end of the intervention. However, the result of the study is in favor of experimental group1. It was found that the deviation was due to the nature of students in experimental group2, who show poor readiness, carelessness, disobedience, poor time management skill and poor computer skill. Due to these factors, the affective aspect of students in experimental group2 has been affected. This is because, motivation can be a precursor to self-regulated learning, and also a result of self-regulated learning (Collins, 2009).

However, still there are notable improvements in affection of experimental group2 students. For instance, they have improved their math anxiety, motivation and satisfaction significantly, though it fails to show up a statistically significant difference with the

comparison group. On the other hand, experimental group1 have improved their tendency to regulate their own learning, satisfaction, motivation and academic hardiness, of which motivation, academic hardiness and satisfaction were statistically better than the comparison group.

On the other hand, the comparison group counterparts fail to improve any of the affective aspects considered in the study. This shows that blended learning is effective not only in improving achievement but also has a potential to improve students' affection. But, it should be noted that the affective component might not be explained only by the approach to learning. Hence, there should be another mediating mechanism that can improve students' readiness to learn in general. This is also evident in another study conducted by Shishigu, Bashu, Tesfaw, and Gadisa (2017a), they find out that a significant increase in achievement, but non-significant improvement on motivation of students to learn. Similar result is also found in a study conducted by Wijnen et al. (2017), which finds no difference between the experimental and control group in motivation, though the experimental group is better in feelings of relatedness in their problem based learning intervention. This indicates that the affective aspect of students depend not only on the way of teaching and learning process but largely on other external factors. Hence, at the presence of students' good interest to learn and bearing, blended learning is effective in both achievement and affection.

The study also investigates whether the blended learning approach is effective in catering the difference between male and female students. The result shows that gender difference becomes visible in a significant extent when course tasks and activities become higher for comparison group. But, within the experimental groups, gender difference was not detected

in any of the variables of the study ($p > .05$). That is male and female students tend to be similar in algebra achievement and affection. Therefore, the treatment (BL) caters gender difference effectively and so it is effective in catering the gender gap.

# Chapter 5:Summary, Conclusion and Recommendations

## 5.1. Introduction

This chapter provides a summary of the major findings, conclusion and recommendations of the study. The first section of the chapter begins with a brief overview of the research agenda, followed by a summary of the empirical findings. Finally, conclusion, further reflections and implications of the study with recommendations are forwarded.

## 5.2. The Research Agenda

Higher education institutions have long been considered important in the production of new ideas, and for the development of economy.However, till now, they function through the traditional classroom based approach (face-to-face) that hinders them achieve intended goals. Progressing in this way in the 21$^{st}$ century causes a failure in the teaching and learning to achieve the required competence. Because, with the current technological advancement, traditional ways of teaching and learning are considered as an oldest approaches which do not suit for an active learning required of this generation.The current and the next digital generation expects a technologically supported and interactive ways of learning. To this end, blended learning is one of the evolving approaches to learning. Such approach initially requires a huge amount of investment to make it fully happen and then it is very cost effective (Graham, 2006).

Accordingly, the blended learning trajectory have drawn the attention of many researchers in different countries of the world. But in Ethiopia, the concept is still new and challenging to implement in such contexts. This study, therefore, attempted to design and implement a blended learning course that fits into the context and find out the benefits in terms of academic achievement and affection. And also to explore thechallenges associated with it in the course of action.

Accordingly, the specific objectives of the study were: to investigate the effect of blended learning on algebraachievement and on students' affection, to examine students' and instructors' perceptions on the blended learning approach, to investigate whether there is gender difference with respect to the variables treated in the study within groups, and to examine the challenges of applying blended learning method.

For the purpose of guiding the processes of data collection and analysis, the main research objectives were broken down in to the following research questions: (i) Is there a statistically significant difference in mean gain of students' algebra achievement between the experimental and comparison groups(ii) Is there a statistically significantdifference in mean gain of students affection between the experimental and comparison groups? (iii) How do students and instructors perceive blended learning environment? (iv) Are there differences in gender on the variables treated in the study within groups? (v) What are the challenges of applying the blended learning method?

To this end, research issues were addressed from the critical review of existing literature on blended learning in Chapter 2.Blended learning is one of the strategies that aim to create conducive environment by combining the latest technology and face-to-face class room

instruction. To better examine its role, the course level blending model was used. Based on the nature of students, majority of the instruction was given in a face-to-face manner, which takes about 67% of the semester contact hour. Hence, the blended learning model in this study was designed to be a supplemental model which was implemented at stages. The first stage was enabler. At this stage students were given time to be familiar with the online platform and exactly face only things they have already learnt in the class.

At the enhancement stage of the blend, they begun to complete some tasks online with the help of additional resources and supplementary materials. The supplementary materials were, reference books, previous exam and worksheet collection and also online interactive notes. The stage of transformational blending as Graham, (2009) argued allows a radical transformation of the pedagogy, students were given with all available features of the online platform (Moodle), that includes self-checking mechanism (automated online quiz) which can also be attempted offline through the mobile version, discussion forum, immediate feedback mechanism and interactive notes.

The study was guided by the pragmatic philosophical paradigm. Apart from the objectives of a particular study, the choice of a research methodology and the method of analyses depend on the ontological and epistemological dimensions. As a result,the research methodology employed in this study was amixed-methodsapproach, giving priority for the quantitative part. This was due to the cause and effect nature of the study. The qualitative approach was employed to better understand the implementation process of the blended learning approach and to grasp the perceptions and challenges associated with it.

Three public Universities namely: U1, U2 and U3 were included in the study. The first two were experimental while the third was taken as comparison group. The intervention given for the two universities was the same apart from the local specific differences between them. This was to deeply look for the overall impact of the blended learning approach, rather than making it a snap shot of single study group context.The study participants include, (*N=22*) fromU1, (*N=25*) fromU2 and (*N=24*) fromU3.Hence, a total of seventy one (*71*) students have participated.

Questionnaires, achievement tests, focus group discussion, interviews, documents and observations were used to gather data for this study. To increase the validity of all of the instruments and the entire study, various strategies such as triangulation, expert review and face validity assessment were made. The content validity of the qualitative instrument was mediated and approved by the two supervisors and fellow colleagues. On the other hand, the internal consistency reliability of the instruments was tested through the pilot analyses using Cronbach alpha and Kuder-Richardsen (KR-20) reliability index.The quantitative and qualitative data were collected and analyzed sequentially. After facing a divergent result from the two experimental groups, a follow up data collection were wade to better justify the phenomenon. The total response rate of the questionnaire was 85.71% for comparison group, 91.67% for experimental group1 and 96.15% for experimental group2.

For analyzing the quantitative data, a statistical package called Statistical Package for Social Sciences (SPSS) version 20.0 was used by applying both descriptive and inferential statistics. The statistical tests used were: t-test, ANOVA, and ANCOVA.An alpha level of.05 was used to decide whether the observed differences were statistically significant. On the other hand,

the analyses and reporting of qualitative data were made by forming themes. Important ethical issues of human research were emphasized to treat the participants. Based on these, the following major findings, conclusions and recommendations were drawn from the study.

## 5.3. Summary of Findings

The study revealed that the supplemental blended learning approach improves students' achievement in algebra and their motivation to learn as compared to the usual face-to-face learning. This could be as a result of the supplement added to the face-to-face approach in the form of online learning, which led students to interact with additional materials. Summaries presented in this subsection are based on each of the research questions that are drawn from the findings in the preceding chapter.

### 5.3.1. Algebra Achievement

At the middle of pretest and posttest, algebra achievement test1 and test2 were administered to examine the progress of students. The results show that after successful implantation of blended learning strategy for one full semester, the two experimental groups achieved better than the comparison group in a significant extent. On the posttest measure, students of experimental group1 and experimental group2 show non-significant difference in algebra achievement ($p>.05$), which shows the convergence of their grades. This confirms that the treatment made a significant positive effect on their algebra achievement.

The improvement in achievement of students is therefore due to the vast learning opportunity they get as a result of blended learning approach. One of which is the opportunity they got to

interact and to consult sufficient supplementary materials. The improvement in achievement was also confirmed by the qualitative data obtained from instructors and students interview.

### 5.3.2. Affection

Affection refers to beliefs, feelings and moods of an individual. Such things have an influence on ones learning. In this study, affectionis conceptualized using the five affective variables namely: math anxiety, academic hardiness, satisfaction, affective aspect of self-regulation and motivation to learn. The findings of this study show that students have improved their affection at the end of the intervention. However, there were some variations in affection, as a result,the two experimental groups were examined separately.

The result of the study is in favor of experimental group1. To further examine why this situation has occurred, the context of the two experimental groups were examined in detail. The result however, indicated that the significant result of experimental group1 was not because they were favored during the experimentation period, but, it is due to the nature of students in experimental group2, who showedcomparatively lower level ofreadiness, carelessness, disobedience, time management skill and computer skills. Due to these factors, the affection of students in experimental group2 has been found to be low, as motivation can be a precursor to self-regulated learning, and also a result of self-regulated learning(Collins, 2009).

However, there were still notable improvements in affection of the experimental group2 students. For instance, they improved their math anxiety and satisfaction, though it fails to show up a statistically significant difference with the comparison group. On the other hand,

experimental group1 improved their tendency to regulate their own learning, satisfaction, motivation and academic hardiness, of which motivation, academic hardiness and satisfaction were statistically better than the comparison group. Their math anxiety level was also above average both before and after the intervention.

On the other hand, the comparison group counterparts fail to improve their affection. This shows that blended learning is effective not only in improving achievement but also has the potential to improvestudents' affection.It is also evident that students with prior positive learning experiences benefited a lot from the blended learning environment. Hence, students' time management skill, their behavior, and readiness played a great role in blended learning approach. This was because students with good conduct and interest to learn have reported positively and benefitted from the approach.

The qualitative data show positive views of students towards the blended learning approach.As a result of the blended learning intervention made, there was a considerable improvement in student interaction. The majority of students (99.91%) reported that they have got a good opportunity for collaboration as a result of blended learning better than the previous face-to-face approach. Generally, students' respondents found blended learning as a more interactive, engaging, convenient, and more resourceful. It is also evident that blended learning helped them to practice and develop some essential computer skills.

Course instructors also showed a positive view towards the approach. They reported the effectiveness of the approach in covering course contents within the given time, its resourcefulness, its potential in catching students' attention and in improving student performance.

Challenges observed include, students limitation in managing their time. This was evident in experimental group2. Additional challenges were tight schedule of the university, electricity break out, students' computer skill, internet connectivity, thenotion of sticking to the classroom lecture and teachers view that the approach was time demanding.The adaptation of blended learning in the traditional university was also another challenge that laid lack of support and awareness. It was also challenging to get appropriate lab with all requirements of blended learning approach.

The study also investigated the nature of the blend whether it is gender sensitive. The results show that gender difference becomes visible in a significant extent when course tasks and activities become higher for comparison group. But, within the experimental group, gender difference was not detected in any of the variables of the study ($p > .05$). That is male and female students tend to be similar in algebra achievement and affection. Therefore, the treatment (BL) caters gender difference effectively and so it is a gender friendly approach. This is due to the nature of the blend which inspire students to become engaged and give concern for each activities of the course.

### 5.4. Limitations of the Study

This study was not conducted without some limitations. One potential limitation was that the study containedself-reported data. It is hard to determine whether the students have answered the questions seriously according to their own feelings. Because, due to social desirability, students may respond not on the bases of what they really feel, but on the bases of what they think are socially acceptable. Though there were qualitative aspects, the results obtained from the questionnaire may not reflect students' actual feeling.

Another issue that might have affected the data quality of thisstudy was the low number of students in each group. This is due to the small number of students enrolled at the department of mathematics. The low number of participants likely affectedthe statistical results.

On the other hand, because of the low level of technologicalability of students in the groups involved, they mighthave failed to fully benefit from the approach, especially in the transformational level of the blend.The impact might have been more than this if such stage were practiced up to the expected level.

Another potential limitation that affected the smooth implementation of the intervention (blended learning approach) was electric break out. There was severe electric break out especially in the experimental group 1. This situation has affected the study, though the researcher worked up to his best to continue the experimentation by changing the time schedule. That wasby switching to the time when the generator of the university functions as a power supply for some spaces such as cafeteria and library.

## 5.5. Conclusion

This study shade light to the effectiveness of blended learning approach in Ethiopian context. This study was also conducted at the time when the Government of Ethiopia got aware and trying to expand technology integration at every stage of schooling. It is also evident that the current student generation is in need of technology support in the learning process. Blended learning as one of the emerging pedagogical approaches is found to be as a ‘free size fit to all’. This is because, it creates enormous learning experiences for students to be tuned based on their needs and preferences. Generally, the findings in this study were supported by many

of previous studies and it brings a unique model (a three step supplemental blended learning model) that fits with a developing country context. Based on the aforementioned discussion and the findings of the study, the following conclusions were drawn:

Within the scope of this study, it was aimed to investigate the role of blended learning approach upon students' algebra achievement and affection. Accordingly, the blended learning approach produceda positive effectonboth algebra achievement and affection of students. The partial eta square value ($\eta^2$) shows that the use of blended learning by the experimental group explains 27.3% of the variability in the algebra achievement posttest scores independently from the covariate variable (pretest and prior computer use).

The improvement in achievement of students can be attributed to the vast learning opportunity they have got as a result of blended learning approach. One of which werethe opportunity they got for interactivity and supplementary materials. What students' found important and attractive was: the automated online quiz, immediate feedback, discussion forum, the online interactive note and the supplementary materials such as the reference books and collection of previous exams and worksheets.

Blended learning can allow students to work on their own pace and choose to revisit materials.This type of control gave them the possibility to adapt the learning materials to their individual needs or preferences. As a result, their affectionimproved. Although there were notable improvements, the improvements could have been scaled up if other mediating mechanisms that could improve students' readiness to learn, motivation, and technical backup were enhanced. This is evidencedby another study conducted by Shishigu et al. (2017a), who found out improved in achievement but, no improvement on motivation of

students to learn. Similarly, Wijnen et al. (2017), found no difference between the experimental and control groups in motivation to learn, though the experimental group was better in feelings of relatedness in their problem based learning intervention. These indicate that the affective aspect of students depends not only on the way of the teaching and learning process but largely on other external factors of affection.

Hence, at the presence of students' good interest to learn and bearing, blended learning is effective in both achievement and affection. Moreover, blended learning as reported in this study had a huge positive impact on students learning. Especially it allows self-paced learning which gives an opportunity to evaluate themselves in the learning process, and this thing is not observed in the face-to-face approach. Hence, effective use of blended approach can provide a more learner-centered environment.

The study also underlined time management to be at the front of the success of blended learning. Students who used their time efficiently learned better than students who did not have good time management skills. They have also possessed an improved motivation and satisfaction better than those students having difficulty of managing their time.

It can also be concluded that blended learning approach is gender friendly. The result shows that gender difference becomes narrow for the experimental groups as compared with that of the comparison group, where male students outperform female students in algebra achievement and hold a relatively better affection. But, in experimental groups, male and female students tend to be similar in algebra achievement and affection. Thus, blended learning can engage students actively in mathematics, enable them to learn individually and in groups, get immediate feedback and lead them to construct meaning using a variety of

resources and instructional materials both online and offline. The equality in gender parity is attributed to these learning experiences.

The perceptions of students was fond to be positive towards blended learning approach, as student respondents' agreed that online activities offered learning opportunities that are better than those in traditional classrooms. The study found out that 95.74% of students were satisfied with the blended course offered in the study. Generally, student respondents found blended learning as an approach which is interactive, engaging, convenient, and more resourceful. Blended learning additionally allows students to be familiar with computers and build some essential skills needed in the world of work. Course instructors also showed a positive view towards the approach. They reported the effectiveness of the approach in covering course contents within the given time, its resourcefulness, its potential in catching students' attention, improving student performance.

Blended learning has also a pedagogical benefit. It had a potential to transform teaching and learning from face-to-face environment to the one with an increased focus on Information Communication Technology (ICT), which is the future most dominant factor in human life. Student respondents in this study reflected that although there are benefits to face-to-face interaction, they preferred the face-to-face delivery to be supplemented by the use of technology to make the teaching and learning experience more interactive and attractive. Thus, blended learning approaches is an effective means of optimizing student learning in mathematics.

The model for blended learning emanating from this study takes into consideration theoretical and practical aspects affecting the design of blended learning interventions and is also

cognizant of the local institutional context. Thus, the findings of this study have the potential to add value to educators as well as those who are interested in furthering the research in a more detailed way.

In general, the blended learning approach was found to be effective in improving students' achievement, affection, and perceptions. It also narrowed gender difference. Hence, it is concluded that it is worth and useful to integrate blended learning in the traditional face-to-face approach in the learning process at universities. This could be useful for both primary and secondary schools as well.

### 5.6. Recommendation

With the current rapid technological advancement, quality of education cannot be achieved without the integration of technology in education. That is why the Ministry of education of Ethiopia has planned to fulfill the technological infrastructures in the fifth education sector development plan(2015-2020)(MOE, 2015). However, the plan was only directed towards availing digital resources with the curriculum. It should also include the preparation of interactive ways of learning such as blended learningwhich was found to engage students in their learning, improve their achievement and affection. Thus, the Ministry of education and higher education institutions need to becognizant of the benefits of a blended approach in the current digital age and particular local contexts. In undertaking blended learning interventions it is recommended that all the stages within the proposed model to beconsidered.

To enhance both student learning and engagement, the design of online platform should exploit the use of simulations and with instant and continuous feedbacks. The Interviews with

students indicated those were the most effective components of the online content. Therefore, Educators and policy makers need to utilize the findings of the current research so that the latest developments and thinking in this emerging educational advancement could be incorporated into institutional curriculum design and course delivery process.

For the development of effective blended learning, it would be useful for instructors to directly involve in the creation of online content and resources for their students. Because, the online lessons provide more than just reading material for the students.

The current local parameters at universities are very less to execute a large range of blended learning program.Thus, infrastructures need to be considerably improved. There is also a need to improvethe instructors' technological competency, so that teachers possess the amalgam of all knowledge (technology, pedagogy, content knowledge). Therefore, universities should set proper infrastructure and train instructors.

Blended learning has the potential to expand possibilities for learning by combining the best practices of in-class instruction with the most useful online instruction. This is true only when students have basic computer skills. Otherwise, they might encounter a challenge in learning from the online platform. Thus, students need to have good exposure to computers at all levels during the ICT subject or course.

There are several models of blended learning being practiced by different universities though there was no one blended learning model that works for all contexts. The duration and the type of activities in each environment depend on the context and the reasons on why blended learning is being implemented, the nature of students, cultural practices and availability of technology. Thus, there is a need to evaluate these elements in order to come up with the

blend suitable to their context. The three step supplemental blended learning model used in this study is promising to effectively benefit from the blended learning approach in a developing country context like Ethiopia. Therefore, developing countries need to use the three stage supplemental blended learning model by fitting to their contexts.

Since this study was conducted on a single course, additional studies should be conducted in different courses to see the effectiveness of the method in other dimensions. Future research is also needed to establish whether prior training can be utilized to encourage students to engage in a blended learning approach. This is because, one of the observed challengeswas students' lack of sufficient ability toadapt the new learning environment with more learner control.

From this study, it is hoped to have a debate and increased research interest in Ethiopia. However, the difficulty of designing and delivering BL courses is often insufficiently appreciated(Medina, 2018), hence there is a need for greater interdisciplinary coordination amongst instructors in both the design and continuous maintenance of BL program.

### 5.7. Contribution of the Studyand theFuture of Blended Learning

The primary investigation of this dissertation was students' achievement and their affection as a result of blended learning.The study successfully appliedthe three stage supplemental blended learning model. The study has hopefully opened up eyes to progress with the current technology demandsand for researchers interested in this area.

It was found that the nature of the blended learning differs in different contests, which also varies in purpose. Thus, this study adds to the existing body of knowledge on using context

dependent blending by elaborating the context of developing country with a three stage supplemental model.

The study has revealed that blended learning has a potential to descend the notion of one-size-fit-all model, as the nature of blended learning addresses the diverse nature of students: learn on their own pace without any influence, ask for a help when they need, gain as many learning experiences as they can. Therefore, blended learning contributes to learners to intuitively know what works best for them rather than having it determined for them.

Designing the blended learning course required both subject matter knowledge and technological knowledge. So, for effective, continuing development and evaluation of blended learning, the course of this study showed the necessity of both technological and subject matter knowledge of the instructors. Thus, for the current vibrant world, teachers need to have the amalgam of all knowledge (technology, pedagogy, content) to effectively design and implement blended learning.

European countries and the United states (US) are continuously expanding the use of technology-enhanced learning(Davies, Mullan, & Feldman, 2017; Spring & Graham, 2017). Specifically, US institutions are actively exploring the development of next-generation digital learning environments(Allen & Seaman, 2016). This report shows that more than 25 percent of US students take at least onecourse online in 2014. Similarly, UK and Australian universities are looking at learning spaces that support blended learning, by spending a lot of financial resource (Davies et al., 2017). This shows that blended learning is on the rise and had a promising future. Thus, futurelearning environments will be predominantly BL. Thus, the concern of higher education shouldbe to meet the requirements for blend (infrastructure),

quality of the blend and working towards making instructors competent to teach in a BL environments.

Finally, the contribution of this research is suggesting the three stage incremental supplemental blended learning model that has emanated from the study.

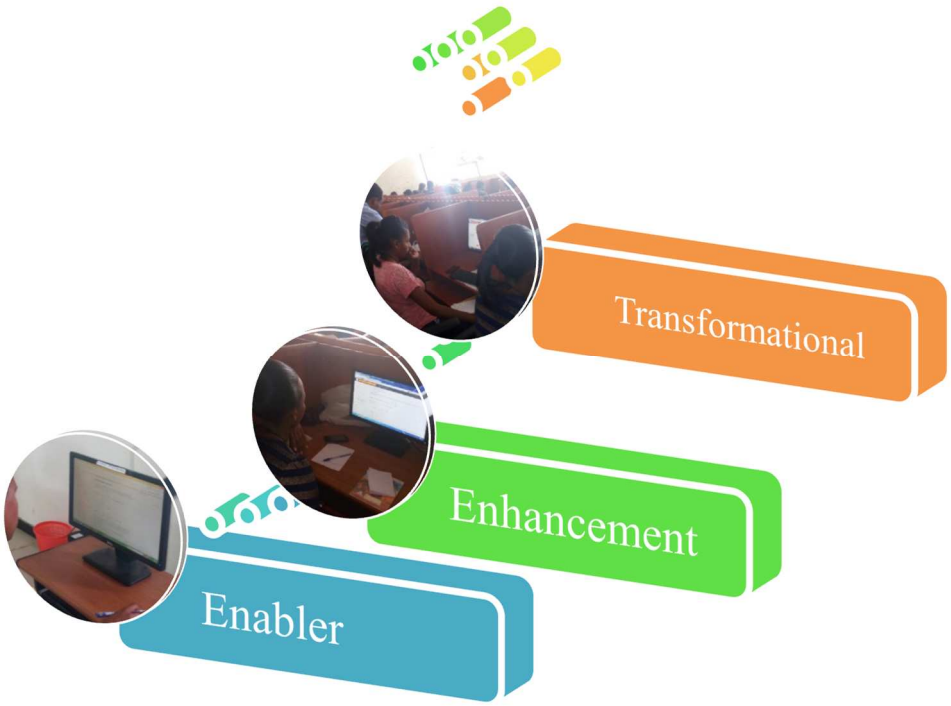


Figure 5.1. Proposedblended learning model:the three stage incremental supplemental blended learning model

## References


Abdollahi, A., & Noltemeyer, A. (2016). Academic hardiness: Mediator between sense of belonging to school and academic achievement? *The Journal of Educational Research, 111*(3), 1-8. doi:10.1080/00220671.2016.1261075

Abidoye, J. A. (2015). The Effect of Blended Learning Instructional Approach on Secondary School Students Academic Achievement in Geography in Akure, Ondo State, Nigeria *Research Journal of Educational Studies and Review, 1*(5), 106-110.

Abramovitz, B., Berezina, M., Berman, A., & Shvartsman, L. (2012). A Blended Learning Approach in Mathematics. In A. A. Juan, M. A. Huertas, S. Trenholm, & C. Steegmann (Eds.), *Teaching Mathematics Online: Emergent Technologies and Methodologies* (1 ed., pp. 23-42). United States of America: IGI Global.

Adams, C. (2001). Overcoming Math Anxiety *Mathematical Intelligencer* (Vol. 23, pp. 49-50).

Ahmad, W. F. B. W., Shafie, A. B., & Janier, J. B. (2008). *Students' perceptions towards Blended Learning in teaching and learning Mathematics: Application of integration* http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.506.3762&rep=rep1&type=pdf

Ahmadi, A., Zainalipour, H., & Rahmani, M. (2013). Studying the Role of Academic Hardiness in Academic Achievement of Students of Islamic Azad University, Bandar Abbas Branch. *Journal of Life Science and Biomedicine, 3*(6), 418-423.

Ajai, J. T., & Imoko, B. I. (2015). Gender Differences in Mathematics Achievement and Retention Scores: A Case of Problem-Based Learning Method *nternational Journal of Research in Education and Science (IJRES), 1*(1), 45- 50.

Akgündüz, D., & Akınoğlu, O. (2017). The Impact of Blended Learning and Social Media-Supported Learning on the Academic Success and Motivation of the Students in Science Education *Education and Science, 42*(191), 69-90 doi:10.15390/EB.2017.6444

Akkoyunlu, B., & Soylu, M. Y. (2008). A Study of Student's Perceptions in a Blended Learning Environment Based on Different Learning Styles. *Educational Technology & Society, 11*(1), 183-193.

Akpan, E. T. (2015). Blended learning opportunities and challenges in mathematics education: perspective in higher education. *South American Journal of Academic Research,, 2*(1).

Akyuz, H. I., & Samsa, S. (2009). The effects of blended learning environment on the critical thinking skills of students. *Procedia Social and Behavioral Sciences, 1*, 1744-1748.

Al-Ghassani, A., Shamsi, H. A., Islam, M., Al-Salti, N., & Al-Hasni. (2015). Enhancing the blended learning experience of Calculus I students. *Mathematics Education Trends and Research, 1*, 20-34. doi:10.5899/2015/metr-00073

Al-Madani, F. M. (2015). The Effect Of Blended Learning Approach On Fifth Grade Students' Academic Achievement In My Beautiful Language Textbook And The Development Of Their Verbal Creative Thinking In Saudi Arabia. *Journal of International Education Research –, 11*(4).

Alammary, A., Sheard, J., & Carbone, A. (2014). Blended learning in higher education: Three different design approaches *Australasian Journal of Educational Technology, 30*(4), 440-454.

Albano, G. (2012). Mathematics Education:Teaching and Learning Opportunities in Blended Learning. In A. A. Juan, M. A. Huertas, S. Trenholm, & C. Steegmann (Eds.), *Teaching Mathematics Online:Emergent Technologies and Methodologies* (pp. 60-89). United States of America: IGI Global.

Alebaikan, R., & Troudi, S. (2010). Blended learning in Saudi universities: challenges and perspectives. *ALT-J, Research in Learning Technology, 18*(1), 49-59. doi:10.1080/09687761003657614

Alebaikan, R. A. (2010). *Perceptions of Blended Learning in Saudi Universities* (PhD dissertation), University of Exeter.

Allen, E., & Seaman, J. (2016). *Tracking Online Education in The United States*. Retrieved from https://files.eric.ed.gov/fulltext/ED572777.pdf

Almasaeid, T. F. (2014). The Effect of Using Blended Learning Strategy on Achievement And Attitudes in Teaching Science Among 9th Grade Students. *European Scientific Journal, 10*(31).

Almeida, K. (2008). *Motivation and Learning in Mathematics Pre-service Teachers* (masters Honors Scholar Theses), University of Connecticut Retrieved from http://digitalcommons.uconn.edu/srhonors_theses/62 (62)

Alotaibi, K. N. R. (2013). The effect of blended learning on developing critical thinking skills. *Education Journa, 2*(4), 176-185.

Alshahrani, S., Ahmed, E., & Ward, R. (2017). The influence of online resources on student–lecturer relationship in higher education: a comparison study. *Journal od computer education, 4*(2), 87–106. doi:10.1007/s40692-017-0083-8

Amalou, D. (2006). *Technical and Pedagogical Comparative Study of e-Learning Platforms for Open and Distance Learning*. Retrieved from https://www.theseus.fi/bitstream/handle/10024/20419/TMP.objres.528.pdf;sequence=1

Anam, S. u., & Stracke, E. (2016). Language learning strategies of Indonesian primary school students: In relation to self-efficacy beliefs. *System, 60*(1-10). doi:10.1016/j.system.2016.05.001

Andale, A. (2017). What is the Kuder-Richardson 20? Retrieved from http://www.statisticshowto.com/kuder-richardson/

Arbaugh, J. B. (2014). What Might Online Delivery Teach Us About Blended Management Education? Prior Perspectives and Future Directions. *Journal of Management Education, 38*(6), 784-817. doi:10.1177/1052562914534244

Arhin, A. K., & Offoe, A. K. (2015). Gender Differences and Mathematics Achievement of Senior High School Students: A Case of Ghana National College *Journal of Education and Practice, 6*(33).

Asante, K. O. (2010). Sex Differences in Mathematics Performance among SeniorHigh Students in Ghana. *Gender & Behaviour, 8*(2), 3279-3289. doi:10.4314/gab.v8i2.61947

Ashcraft, M. H., & Kirk, E. P. (2001). The Relationships Among Working Memory, Math Anxiety, and Performance. *journal of experimental psychology, 130*(2), 224-237. doi:10.1037//0096-3445.130.2.224

Ashkraft, M. H., & Krause, J. A. (2007). Working memory, math performance and math anxiety. *Psychonomic Bulletin & Review, 14*(2), 243-248.

Aslam, M., & Kingdon, G. (2008). What can Teachers do to Raise Pupil Achievement? Retrieved from http://ceid.educ.cam.ac.uk/publications/WP19-MAs.pdf

Asseffa, T. (2017a). Educational Technology Implementation in Ethiopian High Schools: Benefits and Challenges of the Instructional Plasma TV. In A. Marcus-Quinn & T. Hourigan (Eds.),

*Handbook on Digital Learning for K-12 Schools*. Switzerland: Springer International Publishing.

Asseffa, T. (2017b). State of the Art Technologies in Ethiopia. Retrieved from https://ethio.wikispaces.com/Ethiopia

Associates, B. (2003). *Blended Learning: What Works?*

Atnafu, M. (2012). Motivation, Social Support, Alienation from the School and their Impact on Students' Achievement in athematics: The Case of Tenth Grade Students. *Ethiop. J. Educ. & Sc., 8*(1).

Awodeyi, A. F., Akpan, E. T., & Udo, I. (2014). Enhancing Teaching and Learning of Mathematics: Adoption of Blended Learning pedagogy in University of Uyo *International Journal of Science and Research, 3*(11), 40-45.

Aycock, A., Garnham, C., & Kaleta, R. (2002). Lessons Learned from the Hybrid Course Project. *Teaching scholars forum, 8*(6).

Balasubramaniam, S. M., Bhargava, S., Agrawal, N., Asif, R., Chawngthu, L., Sinha, P., . . . Sood, B. (2018). Blending virtual with conventional learning to improve student midwifery skills in India. *Nurse Education in Practice, 28*(163–167).

Barnard-Brak, L., Lan, W. Y., & Paton, V. O. (2010). Profiles in Self-Regulated Learning in the Online Learning Environment. *International Review of Research in Open and Distance Learning, 11*(1).

Barnard, L., Lan, W. Y., To, Y. M., Paton, V. O., & Lai, S.-L. (2009). Measuring self-regulation in online and blended learning environments. *Internet and Higher Education, 12*(1), 1-6. doi:10.1016/j.iheduc.2008.10.005

Barry, A.-A. (2017). *Alleviating Math Anxiety through the Integration of Technology in Elementary School* (master), University of Toronto Toronto Retrieved from https://tspace.library.utoronto.ca/bitstream/1807/76929/1/Barry_Ashley-Anne_201706_MT_MTRP.pdf

Bartone, P. T., Roland, R. R., Picano, J. J., & Williams, T. J. (2008). Psychological Hardiness Predicts Success in US Army Special Forces Candidates. *International Journal of Selection and Assessment, 16*(1).

Bass, H., Evia, G. B., & Seiler, R. (2006). *e-learning mathematics*, Madrid Spain.

Bauer, C., Derntl, M., Motschnig-Pitrik, R., & Tausch, R. (2006). Promotive Activities in Face-to-Face and Technology-Enhanced Learning Environments *The Person-Centered Journal, 13*(1).

Benishek, L. A., & Lopez, F. G. (2001). Development and Initial Validation of a Measure of Academic Hardiness. *journal of career assessment, 9*(4), 333-352.

Berg, B. L. (2001). *Qualitative Research Methods For the Social Science*. Boston: Allyn & Bacon.

Bernard, R. M., Borokhovski, E., Schmid, R. F., Tamim, R. M., & Abrami, P. C. (2014). A meta-analysis of blended learning and technology use in higher education: from the general to the applied. *Journal of Computing in Higher Education, 26*(1), 87–122. doi:10.1007/s12528-013-9077-3

Bersin, J. (2004). *The Blended Learning Book Best Practices, Proven Methodologies, and Lessons Learned*: John Wiley & Sons, Inc.

Bhatti, N. (2013). Comparative Study of CAI and Conventional Method in Attaining Matrix Algebra at Undergraduate Level. *ZENITH International Journal of Multidisciplinary Research, 3*(7), 61-69.

Bliuc, A.-M., Goodyear, P., & Ellis, R. A. (2007). Research focus and methodological choices in studies into students' experiences of blended learning in higher education. *Internet and Higher Education, 10*, 231-244.

Boekaerts, M., & Corno, L. (2005). Self-Regulation in the Classroom: A Perspective on Assessment and Intervention. *APPLIED PSYCHOLOGY: AN INTERNATIONAL REVIEW, 54*(2), 199–231. doi:10.1111/j.1464-0597.2005.00205.x

Bogdan, R. C., & Biklen, S. K. (2003). *Qualitative Research for Education: An Introduction to Theories and Methods (4th Edition)*. New York: Pearson.

Boitshwarelo, B. (2009). Exploring Blended Learning for Science Teacher Professional Development in an African Context *International Review of Research in Open and Distance Learning, 10*(4), 1-19.

Bomia, L., Beluzo, L., Demeester, D., Elander, K., Johnson, M., & Sheldon, B. (1997). The Impact of Teaching Strategies on Intrinsic Motivation. Available from ERIC. (ED418925). https://eric.ed.gov/?id=ED418925

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e‑learning and mobile learning in mathematics education. *ZDM Mathematics Education, 48*(5), 589-610. doi:10.1007/s11858-016-0798-4

Bretz, F., Hothorn, T., & Westfall, P. (2011). *Multiple Comparisons Using R*. United States of America: Taylor and Rfansis group LLC.

Brunner, M., Krauss, S., & Kunter, M. (2008). Gender differences inmathematics:Does the story need to be rewritten? *Intelligence, 36*(5), 403-421. doi:10.1016/j.intell.2007.11.002

Burgess, M. L. (2009). Using WebCT as a Supplemental Tool to Enhance Critical Thinking and Engagement among Developmental Reading Students. *Journal of College Reading and Learning, 39*(2), 9-33. doi:10.1080/10790195.2009.10850316

Burkhardt, H., & Schoenfeld, A. H. (2003). Improving Educational Research:Toward a More Useful,More Influential, and Better-Funded Enterprise. *EDUCATIONAL RESEARCHER, 32*(3). doi:10.3102/0013189X032009003

Burton, M. B. (1988). A Linguistic Basis for Student Difficulties with Algebra. *For the Learning of Mathematics, 8*(1).

Butler, R. (1998). Determinants of Help Seeking: Relations Between Perceived Reasons for Classroom Help-Avoidance and Help-Seeking Behaviors in an Experimental Context. *Journal of Educational Psychology, 90*(4), 630-643.

Cameron, B. (2003). The Effectiveness of Simulation in a Hybrid and Online Networking Course. *Tech Trends, 47*(5), 18-21. doi:10.1007/BF02763200

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental design for research*: Houghton Mifflin Company.

Caviola, S., Primi, C., Chiesi, F., & Mammarella, I. C. (2017). Psychometric properties of the Abbreviated Math Anxiety Scale (AMAS) in Italian primary school children. *Learning and Individual Differences, 55*(174–182). doi:10.1016/j.lindif.2017.03.006

Černá, M. (2017). *Deployment of Cognitive and Affective Determinants in Blended Learning - Case Study.* Paper presented at the 10th International Conference, ICBL 2017, Hong Kong, China.

Ceylan, V. K., & Kesici, A. E. (2017). Effect of blended learning to academic achievement. *Journal of human sciences, 14*(1), 308-320. doi:10.14687/jhs.v14i1.4141

Cho, M.-H., & Shen, D. (2013). Self-regulation in online learning. *Distance Education, 34*(3), 290-301. doi:10.1080/01587919.2013.835770

Cobanoglu, A. A., & Yurdakul, B. (2014). The Effect of Blended Learning on Students' Achievement, Perceived Cognitive Flexibility Levels and Self-Regulated Learning Skills. *Journal of Education and Practice, 22*(5).

Coffrin, C., Corrin, L., Barba, P. d., & Kennedy, G. (2014). *Visualizing patterns of student engagement and performance in MOOCs.* Paper presented at the the fourth international conference on learning analytics and knowledge Indianapolis, IN, USA.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Scieces* (2 ed.). Hillsdale, NJ: Lawrence erlbaum associates.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6 ed.): Routledge Taylor & Francis Group.

Cole, J., & Foster, H. (2008). *Using Moodle: Teaching with the popular open Sourse Course Management System* (I. Kunkel Ed. 2 ed.). USA: O'Reilly Media, Inc.

Collins, N. (2009). Motivation and Self-Regulated Learning: Theory, Research, and Applications. *The Journal of Higher Education, 80*(4), 476-479. doi:10.1080/00221546.2009.11779027

Connolly, P. (2007). *Quantitative Data Analysis in Education: A critical introduction using SPSS*. 270 Madison Ave, New York, NY 10016: Routledge.

Cracraft, L. (2015). *Effect of Blending Learning on Student's Percent Increase in Assessment Scores.* (masters master thesis), Northwest Missouri State University Missouri.

Creed, P. A., Conlon, E. G., & Dhaliwal, K. (2013). Revisiting the Academic Hardiness Scale: Revision and Revalidation. *journal of career assessment, 21*(4), 537-554. doi:10.1177/1069072712475285

Creswell, J. W. (2013). *Steps in Conducting a Scholarly Mixed Methods Study*. Paper presented at the Discipline-Based Education Research Group.

Creswell, J. W. (2014). *Research design: quantitative, qualitative and mixed research* (4 ed.): SAGE publication Inc.

Crisp, R. J., Bache, L. M., & Maitner, A. T. (2009). Dynamics of social comparison in counter-stereotypic domains: Stereotype boost, not stereotype threat, for women engineering majors. *Social Influence, 4*(3), 171-184. doi:10.1080/15534510802607953

Cross, J. (2006). Foreword. In C. J. Bonk & C. R. Graham (Eds.), *Handbook of Blended Learning: Global Perspectives, Local Designs* (1 ed., pp. xvii–xxiii). San Fransisco: Pfeiffer Publishing.

Dang, Y., Zhang, Y., Ravindran, S., & Osmonbekov, T. (2016). Examining Student Satisfaction and Gender Differences in Technology-Supported, Blended Learning *Journal of Information Systems Education, 27*(2), 119-130.

Darlington, Y., & Scott, D. (2002). *Qualitative research in practice Stories from the field*. Australia: Allen & Unwin.

Davies, S., Mullan, J., & Feldman, P. (2017). *Rebooting learning for the digital age: What next for technology-enhanced higher education?* Retrieved from UK:

Delaney, D., McManus, L., & Ng, C. (2010). *A Blended Learning Approach to Teaching First Year Accounting*. Paper presented at the Proceedings of ICERI2010 Conference. , Madrid, Spain.

Delialioglu, m., & Yildirim, Z. (2008). Design and development of a technology enhanced hybrid instruction based on MOLTA model: Its effectiveness in comparison to traditional instruction. *Computers & Education, 51*, 474-483.

Dennis, M. L., & Boruch, R. F. (1989). Randomized Experiments For Planning and Testing Projects in Developing Countries:Threshold Conditions. *EValuation review, 13*(3), 292-303.

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

Derntl, M., & Motschnig-Pitri, R. (2005). The role of structure, patterns, and people in blended learning. *Internet and Higher Education, 8*(2), 111-130. doi:10.1016/j.iheduc.2005.03.002

Divjak, B., Ostroski, M., & Hains, V. (2010). Sustainable student retention and gender issues in mathematics for ICT study. *International Journal of Mathematical Education in science and Technology, 41*(3), 293–310. doi:10.1080/00207390903398416

Driscoll, M. (2002). Blended Learning: Let's Get Beyond the Hype: IBM Global Services.

Drysdale, J. S., Graham, C. R., Spring, K. J., & Halverson, L. R. (2013). An analysis of research trends in dissertations and theses studying blended learning. *Internet and Higher Education, 17*, 90-100. doi:10.1016/j.iheduc.2012.11.003

Duncan, T. G., & McKeachie, W. J. (2005). The Making of the Motivated Strategies for Learning

Questionnaire. *Educational Psychologist, 40*(2), 117-128. doi:10.1207/s15326985ep4002_6

Dunn, K. E., Lo, W.-J., Mulvenon, S. W., & Sutcliffe, R. (2012). Revisiting the Motivated Strategies for Learning Questionnaire: A Theoretical and Statistical Reevaluation of the Meta-cognitive Self-Regulation and Effort Regulation Subscales. *Measurement Educational and Psychological, 72*(2), 312-331. doi:10.1177/0013164411413461

Dziuban, C., & Moskal, P. (2001). Evaluating distributed learning in metropolitan universities. *Metropolitan Universities, 12*(1), 41-49.

Dziuban, C., Moskal, P., Kramer, L., & Thompson, J. (2013). Student satisfaction with online learning in the presence of ambivalence: Looking for the will-o'-the-wisp. *Internet and Higher Education, 17*, 1-8. doi:10.1016/j.iheduc.2012.08.001

EIU. (2010). *Digital economy rankings 2010: Beyond e-readiness*. Retrieved from http://graphics.eiu.com/upload/eiu_digital_economy_rankings_2010_final_web.pdf

EIU. (2017). *The Inclusive Internet Index: Bridging digital divides*. Retrieved from http://teletime.com.br/wp-content/uploads/2017/03/The-Inclusive-Internet-Index-Bridging-digital-divides.pdf

EL-Deghaidy, H., & Nouby, A. (2007). Effectiveness of a blended e-learning cooperative approach in an Egyptian teacher education programme. *Computers & Education, 51*(3), 988-1006. doi:10.1016/j.compedu.2007.10.001

Elliott, A. C., & Woodward, W. A. (2007). *Statistical analysis quick reference guidebook: With SPSS examples* United States of America: Sage Publications, Inc.

Eryilmaz, M. (2015). The Effectiveness Of Blended Learning Environments. *Contemporary Issues In Education Research, 8*(4).

Eshetu, A., Dilamo, O., Ayele, T., & Zinabu, G. (2009). *Science and mathematics secondary education in Ethiopia*. Paper presented at the Technical workshop on science and mathematics secondary education in Africa, Tunis. http://info.worldbank.org/etools/docs/library/245746/day9%207b.%20Ethiopia%20Options%20Paper.pdf

Fakhir, Z. (2015). *The Impact of Blended Learning on the Achievement of the English Language Students and their Attitudes towards it.* (masters thesis), Middle East University.

Flick, U. (2006). *An Introduction to Qualitative research* (3 ed.). Oliver's Yard 55 Ciry Road, London ECIY ISP: Sage Publications Ltd.

Forgasz, H. J. (1995). Gender and the Relationship between Affective Beliefs and Perceptions of Grade 7 Mathematics Classroom Learning Environments. *Educational Studies in Mathematics, 28*(4), 219-239. doi:10.1007/BF01274174

Freihofner, U., Campbell, C., & Smala, S. (2018). Digital Tool Use and Self-Regulated Strategies in a Bilingual Online Learning Environment. In D. Sampson, D. Ifenthaler, M. Spector, & P. Isaías (Eds.), *Digital Technologies: Sustainable Innovations for Improving Teaching and*

*Learning* (pp. 131-160). Gewerbestrasse 11, 6330 Cham, Switzerland: Springer International Publishing AG.

Gamal, S. E., & Aziz, R. A. E. (2011). The Perception of Students Regarding E-Learning Implementation in Egyptian Universities. *eL&mL*.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education, 7*, 95-105.

Garrison, D. R., & Vaughan, N. D. (2008). *Blended Learning in Higher Education:Framework, Principles and Guidelines*. San Francisco: John Wiley & Sons, Inc.

Gebremeskel, H. H., Ahmedb, A. Y., Getahunc, D. A., Debele, M. L., Tiruneha, D. T., & Wondema, D. T. (2017). Revisiting Teacher Educators' Training in Ethiopia: Implications for a New Approach to Curriculum Development *Bahir Dar journal of education, 17*(2), 89-105.

Gecer, A., & Dag, F. (2012). A Blended Learning Experience. *Educational Sciences: Theory & Practice, 12*(1), 438-442.

Gemechu, E., Michael, K., & Atnafu, M. (2013). Effect of Using the Geometer's Sketchpad Animation on Grade Nine Students' Attitude on Plane Geometry. *Staff and Educational Development International, 17*(1), 21-36.

Gemechu, E., Shishigu, A., Michael, K., Atnafu, M., & Ayalew, Y. (2017). Reforms of teacher education in Ethiopian: a historical analys *Research journal of educational science, 5*(2), 1-6.

Geta, M., & Olango, M. (2016). The impact of blended learning in developing students' writing skills: Hawassa University in focus *African Educational Research Journal, 4*(2), 49-68.

Giannousi, M., Vernadakis, N., Derri, V., Michalopoulos, M., & Kioumourtzoglou, E. (2009). *Students' satisfaction from blended learning instruction.* Paper presented at the The TCC Worldwide Online Conference

Graham, C. R. (2006). Blended learning systems: Definitions, current trends and future directions. In C. J. B. C. R. Graham (Ed.), *The handbook of blended learning: Global perspectives, local designs*. San Francisco: John Wiley and Sons.

Graham, C. R. (2009). *Blended learning models*. Manuscript. Retrieved from http://ebooks.narotama.ac.id/files/Encyclopedia%20of%20Information%20Science%20and%20Technology%20(2nd%20Edition)/Blended%20Learning%20Models.pdf

Graham, C. R., Henrie, C. R., Gibbons, A. S., & Gibbons, A. S. (2014). Developing models and theory for blended learning research. In A. G. Picciano, C. D. Dziuban, & C. R. Graham (Eds.), *Blended learning: Research perspectives* (Vol. 2, pp. 13-33). New Yor: NY: Routledge.

Gronlund, N. E. (1977). *Constructing Achievement Tests*. United States of America: Prentice-Hall, Inc.

Guadagno, R. (2010). Writing up your results – Guidelines based on APA style. Retrieved from http://ich.vscht.cz/~svozil/lectures/vscht/2015_2016/sad/APA_style2.pdf

Guay, F., Vallerand, o. J., & Blanchard, C. (2000). On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS). *Motivation and Emotion, 24*(3).

Guba, E. G., & Lincoln, Y. S. (1994). Competing Paradigms in Qualitative Research. In Y. S. l. N. K. L. Denzin (Ed.), *Handbook of Qualitative Research*. Thousand Oaks: Sage.

Güzer, B., & Caner, H. (2014). The past, present and future of blended learning: an in depth analysis of literature. *Procedia - Social and Behavioral Sciences, 116*, 4596 – 4603.

Halverson, L. R., Graham, C. R., Spring, K. J., & Drysdale, J. S. (2012). An analysis of high impact scholarship and publication trends in blended learning. *Distance Education, 33*(3), 381-413. doi:10.1080/01587919.2012.723166

Halverson, L. R., Graham, C. R., Spring, K. J., Drysdale, J. S., & Henrie, C. R. (2014). A thematic analysis of the most highly cited scholarship in the first decade of blended learning research. *Internet and Higher Education, 20*. doi:10.1016/j.iheduc.2013.09.004

Hannula, M. S. (2002). Attitude Towards Mathematics: Emotions,Expectations and Values. *Educational Studies in Mathematics, 49*, 25–46. doi:10.1023/A:101604882

Hannula, M. S. (2006). Motivation in mathematics: Goals reflected in emotions. *Educational Studies in Mathematics, 63*(2), 165-178. doi:10.1007/s10649-005-9019-8

Hanushek, E. A., & Wößmann, L. (2007). *Education Quality and Economic Growth*. Retrieved from Washington, DC:

Harrison, C. (2014). Four Types of Learning Environments. Retrieved from https://prezi.com/oiwlk8ptvky3/four-types-of-learning-environments/

Hedge, N., & Hayward, L. (2004). Redefining Roles: university e-learning contributing to lifelong learning in a networked world? *E–Learning, 1*(1).

Hedges, L. V., & Hedberg, E. C. (2007). Intraclass Correlations for Planning Group Randomized Experiments in Rural Education. *Journal of Research in Rural Education, 22*(10).

Hellum-Alexander, A. (2010). *Effective Teaching Strategies for Alleviating Math Anxiety and Increasing Self-Efficacy in Secondary School.* (PhD), The Evergreen State College. Retrieved from http://archives.evergreen.edu/masterstheses/Accession89-10MIT/Hellum-Alexander_AMIT2010.pdf

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematics Anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46. doi:10.2307/749455

Hermans, C. M., Haytko, D. L., & Mott-Stenerson, B. (2009). Student Satisfaction in Web-enhanced Learning Environments *Journal of Instructional Pedagogies, 1*(1), 1-19.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*(1), 75-105.

Hill, F., Mammarella, I. C., Devine, A., SaraCaviola, Passolunghi, M. C., & DénesSzűcs. (2015). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and Individual Differences, 2015*. doi:10.1016/j.lindif.2016.02.006

Hoff, K. E., & DuPaul, G. J. (1998). Reducing Disruptive Behavior in General Education Classrooms: The Use of Self-Management Strategies. *School psychology review, 27*(2), 290-303.

Hofmann, J. (2006). Why blended learning hasn't yet fulfilled its promises: Answers to those questions that keep you up at night. In C. J. Bonk & C. R. Graham (Eds.), *The Handbook of Blended Learning: Global perspectives and local design*. San Fransisco: John Wiley and Sons.

Huang, C. (2018). Social Network Site Use and Academic Achievement: A Meta-Analysis *Social Network Site Use and Academic Achievement: A Meta-Analysis, 119*(4), 76-83. doi:10.1016/j.compedu.2017.12.010

Hubackova, S., & Semradova, I. (2016). Evaluation of Blended Learning. *Procedia - Social and Behavioral Sciences, 217*, 551-557. doi:10.1016/j.sbspro.2016.02.044

Hughes, G. (2007). Using blended learning to increase learner support and improve retention. *Teaching in Higher Education, 12*(3), 349-363. doi:10.1080/13562510701278690

Hydea, J. S., & Mertz, J. E. (2009). Gender, culture, andmathematics performance. *National Academy of Sciences, 106*(22). doi:10.1073/pnas.0901265106

Idris, N. (2006). Exploring the Effects of Ti-84 Plus On Achievement And Anxiety in Mathematics. *Eurasia Journal of Mathematics, Science and Technology Education, 2*(3).

Ignacio, N. G., Nieto, L. B., & Barona, E. G. (2006). The Affective domain in mathematics learning. *International Electronic Journal of Mathematics Education Trends and Research, 1*(1), 16-32.

Iossi, L. (2007). *Strategies for reducing math anxiety in post-secondary students.* Paper presented at the the Sixth Annual College of Education Research Conference: Urban and International Education Section, Miami: Florida International University.

Jackson, E. (2008). Mathematics anxiety in student teachers. *Practitioner Research in Higher Education, 2*(1), 36-42.

Juan, Á. A., Huertas, M. A., Cuypers, H., & Loch, B. (2012). Mathematical e-Learning. *Universities and Knowledge Society Journal (RUSC), 9*(1), 278-283.

Kamtsios, S., & Karagiannopoulou, E. (2013). Conceptualizing students' academic hardiness dimensions: a qualitative study. *European Journal of Psychology of Education, 28*(3), 807–823. doi:10.1007/s10212-012-0141-6

Katz, Y. J. (2014). Cognitive and Affective Aspects of SMS based Learning at the University Level. *Athens Journal of Education, 1*(3).

Katz, Y. J., & Yablon, Y. B. (2011). Affect and digital learning at the university level. *Campus Wide Information Systems, 28*(2), 114-123. doi:10.1108/10650741111117815

Kazu, I. Y., & Demirkol, M. (2014). Effect of Blended learning Environment Model on High school Students' Academic Achievement. *The Turkish Online Journal of Educational Technology, 13*(1).

Kebualemang, G. K., & Mogwe, A. W. (2017). An Empirical Investigation into Blended Learning Effects on Tertiary Students and Students Perceptions on the Approach in Botswana. *International Journal of Advanced Computer Science and Applications, 8*(6), 187-197.

Kedir, A. (2006). Contradictions, Challenges, and Chaos in Ethiopian Teacher Education. *Journal for Critical Education Policy Studies, 4*(1).

Keshta, A. S., & Harb, I. I. (2013). The effectiveness of a blended learning program on developing Palestinian tenth graders' English writing skills. *2*(6), 208-221. doi:10.11648/j.edu.20130206.12

Khatoon, T., & Mahmood, S. (2010). Mathematics Anxiety Among Secondary School Students in India and its Relationship to Achievement in Mathematics. *European Journal of Social Sciences, 16*(1).

Khine, M. S., Al-Mutawah, M., & Afari, E. (2015). Determinants of Affective Factors in Mathematics Achievement: Structural Equation Modeling Approach. *Journal of Studies in Education, 5*(2). doi:10.5296/jse.v5i2.7484

Kim, H.-Y. (2015a). Statistical notes for clinical researchers: A one-way repeated measures ANOVA for data with repeated observations. *Open lecture on statistics, 40*(1), 91-95. doi:10.5395/rde.2015.40.1.91

Kim, S.-W. (2015b). Effectiveness of a satellite educational television program for Ethiopian secondary education. *Distance Education, 36*(3), 419-436. doi:10.1080/01587919.2015.1019966

King, K. P. (2002). Identifying success in online teacher education and professional development. *Internet and Higher Education, 5*, 231-246. doi:10.1016/S1096-7516(02)00104-5

Kintu, M. J., Zhu, C., & Kagambe, E. (2017). Blended learning effectiveness: the relationship between student characteristics, design features and outcomes. *International Journal of Educational Technology in Higher Education, 14*(7), 1-20. doi:10.1186/s41239-017-0043-4

Kitchenham, A. (2011). *Blended Learning across Disciplines: Models for Implementation*. United States of America: IGI Global.

Kiwanuka, H. N., Damme, J. V., Noortgate, W. V., Anumendem, D. N., & Namusisi, S. (2015). Factors affecting Mathematics achievement of first-year secondary school students in Central Uganda *South African Journal of Education, 35*(3), 1-16.

Kobayashi, K., & Little, A. (2011). Learner perceptions on the usefulness of a blended learning EFL program. *jaltcalljournal, 7*(1), 103-117.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? . *Journal of Research on Technology in Education, 9*(1), 60-70.

Korkmaz, Ö., & Karakus, U. (2009). The Impactof Blended Learning Model on Student Attitudes towards Geography Course and Their Critical Thinking Dispositions and Levels. *The Turkish Online Journal of Educational Technology, 8*(4).

Kotrlik, J. W., Williams, H. A., & Jabor, M. K. (2011). Reporting and Interpreting Effect Size in Quantitative Agricultural Education Research. *Journal of Agricultural Education, 52*(1), 132-142. doi:10.5032/jae.2011.01132

Kuhn, T. S. (1996). *The Structure of Scientific Revolutions* (3 ed.). United States of America: The University of Chicago Press.

Kuo, Y.-C., Bellandb, B. R., Schroder, K. E. E., & Walker, A. E. (2014). K-12 teachers' perceptions of and their satisfaction with interaction type in blended learning environments. *Distance Education, 35*(3), 360-381. doi:10.1080/01587919.2015.955265

Kurland, D. M., & Kurland, L. C. (1987). Computer Applications In Education: A Historical Overview. *Ann. Rev. Comput. Sci, 2*, 317-361. doi:10.1146/annurev.cs.02.060187.001533

Kwame, B.-K., McCarthy, P., McCarthy, P., & Gyan, E. (2015). Gender differences in Elective Mathematics Achievements of Senior Secondary School Students (SSS3) in Central and Western Regions of Ghana *International Invention Journal of Education and General Studies, 1*(2), 18-24.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2005). *SPSS for Intermediate Statistics: Use and Interpretation* (2 ed.). Mahwah, New Jersey 07430: Lawrence Erlbaum Associates, Inc.

Lesh, R., & Doerr, H. M. (2003). *Beyond Constructivism Models and Modeling Perspectives on Mathematics Problem Solving, Learning, and Teaching*. New Jersey: Lawrence Erlbaum Associates, Inc.

Lifton, D. E., Seay, S., & Bushko, A. (2000). Can Student "Hardiness" Serve as an Indicator of Likely Persistence to Graduation? Baseline Results from a Longitudinal Study. *Academic Exchange Quarterly, 4*(2), 73-81.

Lin, Y.-W., Tseng, C.-L., & Chiang, P.-J. (2017). The Effect of Blended Learning in Mathematics Course. *EURASIA Journal of Mathematics Science and Technology Education, 13*(3), 1305-8215. doi:10.12973/eurasia.2017.00641a

Lindberg, S. M., Hyde, J. S., & Petersen, J. L. (2010). New Trends in Gender and Mathematics Performance: A Meta-Analysis. *Psychol Bull, 136*(6), 1123-1135. doi:10.1037/a0021276

Luo, X., Wang, F., & Luo, Z. (2009). Investigation and Analysis of Mathematics Anxiety in Middle School Students. *Journal of Mathematics Education, 2*(2), 12-19.

Lwoga, E. T., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries *International Journal of Education and Development using Information and Communication Technology, 3*(2), 57-67.

Lynch, R., & Dembo, M. (2004). The Relationship between Self-Regulation and Online Learning in a Blended Learning Context *International Review of Research in Open and Distance Learning, 5*(2), 1-16.

Maddi, S. R. (2005). On Hardiness and Other Pathways to Resilience. *Journal of Humanistic Psychology, 50*(3), 261-272. doi:10.1177/0022167809331860

Maddi, S. R., Harvey, R. H., Khoshaba, D. M., Fazel, M., & Resurreccion, N. (2009). The Personality Construct of Hardiness, IV Expressed in Positive Cognitions and Emotions Concerning Oneself and Developmentally Relevant Activities. *Journal of Humanistic Psychology, 49*(3), 292-305. doi:10.1177/0022167809331860

Mahmood, S., & Khatoon, T. (2011). Development and Validation of the Mathematics Anxiety Scale for Secondary and Senior Secondary School Students. *British Journal of Arts and Social Sciences, 2*(2).

Manzoor, A. (2017). Blended Learning in Higher Education: A Developing Country Perspective. In T. Kidd & L. R. Morris (Eds.), *Handbook of Research on Instructional Systems and Educational Technology* (pp. 58-68). USA: IGI Global.

Massie, E. (2006). Reasons for creating blended learning. In C. Bonk & C. Graham (Eds.), *The handbook of blended learning: Global perspectives, local designs*. San Francisco: John Wiley and Sons.

Mccombs, B. L., & Vakili, D. (2005). A learner-centered framework for e-learning. *Teachers College Record, 107*(8), 1582–1600. doi:10.1111/j.1467-9620.2005.00534.x

Mcleod, D. B. (1992). Research on affect in mathematics education. In W. s. u. a. s. d. s. university (Ed.). Canada, Toronto.

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The Effectiveness of Online and Blended Learning: A Meta-Analysis of the Empirical Literature. *Teachers College Record, 115*(3).

Medina, L. C. (2018). Blended learning: Deficits and prospects in higher education *Australasian Journal of Educational Technology, 34*(1), 42-56. doi:10.14742/ajet.3100

Melesse, K. (2014). The Influence of E-Learning on the Academic Performance of Mathematics Students in Fundamental Concepts of Algebra Course: The Case in Jimma University. *Ethiopian Journal of Education & Science, 9*(2).

Melton, B. F., Bland, H. W., & Chopak-Foss, J. (2009). Achievement and Satisfaction in Blended Learning versus Traditional General Health Course Designs. *International Journal for the Scholarship of Teaching and Learning, 3*(1). doi:10.20429/ijsotl.2009.030126

Mestan, K. (2019). Create a fine blend: An examination of institutional transition to blended learning *Australasian Journal of Educational Technology, 35*(1), Australasian Journal of Educational Technology. doi:10.14742/ajet.3216

Michael, K. (2015). *Integrating Content, Pedagogy and Technology for Enhancing Quality of Education.* Paper presented at the The 5th Annual International Conference on Quality Education, Mekele University.

MOE. (2015). *Education Sector Development Programme V (ESDP V)*. Addis Ababa: Federal Ministry of Education Retrieved from http://www.cmpethiopia.org/content/download/2267/9609/file/ESDP%20V%20FINAL.pdf.

MOE. (2017). *Strategic Policy for National Science, Technology and Mathematics Education* Retrieved from http://www.moe.gov.et/policies-and-strategies/-/asset_publisher/soxXYHoJ1nxs/document/id/42818?inheritRedirect=false.

Morgan, G. A., Leech, N. L., Gloeckne, G. W., & Barret, K. C. (2004). *SPSS for introductory statisticsuse and interpretation* (2 ed.). New jersey London: Lawrence Erlbaum associates Inc.

Motschnig-Pitrik, R., & Standl, B. (2012). Person-centered technology enhanced learning: Dimensions of added value. *Computers in Human Behavior, 29*(2), 401-409. doi:10.1016/j.chb.2012.04.013

Moura, A. P. d. (2010). Food consumer science post-graduate courses: comparison of face-to-face versus online delivery systems. *British Food Journal, 112*(5), 544 - 556. doi:10.1108/00070701011043781

Mulugeta, W. (2015). *Enhancing secondary students' understanding of descriptive statistics using contextual and socio-critical modeling: the case of west shewa zone, Ethiopia. .* (PhD dissertation), Addis Ababa.

Mushtaq, I., & Khan, S. N. (2012). Factors Affecting Students' Academic Performance. *Global Journal of Management and Business Research, 12*(9).

Mutai, C. C. (2016). *Gender Differences in Mathematics Performance Among Secondary School Students in Bureti Sub-country, Kericho Country Kenya* (master thesis), Kenyatta University Kenya.

Mutemeri, J., & Mugweni, R. (2005). The extent to which mathematics instructional practices in early childhood education in Zimbabwe relate to or make use of children's experiences. *African Journal of Research in SMT Education, 9*(1), 49-54 doi:10.1080/10288457.2005.10740576

Nazarenko, A. L. (2014). Information Technologies in Education: Blended Learning (an Attempt of a Research Approach) *Procedia - Social and Behavioral Sciences, 154*(2014), 53 – 56. doi:10.1016/j.sbspro.2014.10.111

NEAEA. (2014). *Early Grade Mathematics Assessment (EGMA) in Ethiopia: Baseline Study Report*. Retrieved from Addis Ababa, Ethiopia:

Nguyen, V. A. (2016). *Examining Students' Satisfaction with Online Learning Activities in Blended Learning Course: A Case Study.* Paper presented at the ICERI2016 Conference, Seville, Spain.

O'Leary, P. F., & Quinlan, T. J. (2007). Learner–Instructor Telephone Interaction: Effects on Satisfaction and Achievement of Online Students. *American Journal of Distance Education, 21*(3), 133–143. doi:10.1080/08923640701341661

Obiedat, R., Eddeen, L. N., Harfoushi, O., Koury, A., AL-Hamarsheh, M., & AlAssaf, N. (2014). Effect of Blended-Learning on Academic Achievement of Students in the University of Jordan. *International Journal of Emerging Technologies in Learning (iJET), 9*(2).

OED. (Ed.) (2017).

Offermann, P., Levina, O., Schönherr, M., & Bub, U. (2009). *Outline of a Design Science Research Process*. article. Germany.

Olelewe, C. J., & Agomuo, E. E. (2016). Effects of B-learning and F2F learning environments on students' achievement in QBASIC programming. *Computers & Education, 103*(12), 76-86. doi:10.1016/j.compedu.2016.09.012

Oliver, M., & Trigwell, K. (2005). Can 'Blended Learning' Be Redeemed? *E–Learning, 2*(1).

Osei, Y. (2013). *Gender difference in academic performance in mathematics among senior highschoo final year students in the Tamale Metropolis in northern Ghana.* (master thesis), University for development studies, Tamale, Ghana.

Owen, H., & Dunham, N. (2015). Reflections on the Use of Iterative, Agile and Collaborative Approaches for Blended Flipped Learning Development. *Education Science, 5*, 85–103. doi:10.3390/educsci5020085

Owston, R., & York, D. N. (2018). The nagging question when designing blended courses: Does the proportion of time devoted to online activities matter? *The Internet and Higher Education, 36*, 22-32. doi:10.1016/j.iheduc.2017.09.001

Özerem, A., & Akkoyunlu, B. (2015). Learning environments designed according to learning styles and its effects on mathematics achievement. *Eurasian Journal of educational researcher, 61*, 61-80. doi:10.14689/ejer.2015.61.4

Pappas, C. (2014). How to create a Blended eLearning Strategy. Retrieved from https://elearningindustry.com/free-ebook-prepare-for-elearning-success

Paulsen, M. F. (2003). Experiences with Learning Management Systems in 113 European Institutions. *Educational Technology & Society, 6*(4), 134-148.

Petrisor, A.-I. (2017). [One way ANOVA detected a significant difference but, the post hoc Tuky HSD does not detect any significant difference between any pair of groups].

Pintrich, P. R. (2003). A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts. *Journal of Educational Psychology, 95*(4), 667-685. doi:10.1037/0022-0663.95.4.667

Pintrich, P. R., & Groot, E. V. D. (1990). Motivational and Self-Regulated Learning Components of Classroom Academic Performance. *Journal of Educational Psychology, 82*(1), 33-40.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & Mckeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801–813. doi:10.1177/0013164493053003024

Plenty, S., & Heubeck, B. (2013). A multidimensional analysis of changes in mathematics motivation and engagement during high school. *An International Journal of Experimental Educational Psychology, 33*(1), 14-30. doi:10.1080/01443410.2012.740199

Pohjolainen, S., Nykänen, O., Venho, J., & Kangas, J. (2018). Analysing and Improving Students' Mathematics Skills Using ICT-Tools. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(4), 1221-1227. doi:10.29333/ejmste/81869

Poon, J. (2013). Blended Learning: An Institutional Approach for Enhancing Students' Learning Experiences. *MERLOT Journal of Online Learning and Teaching, 9*(2).

Preez, M. d. (2018). The factors influencing Mathematics students to choose teaching as a career. *South African Journal of Education, 38*(2), 1-13. doi:10.15700/saje.v38n2a1465

Pritschet, L., Powell, D., & Horne, Z. (2016). Marginally Significant Effects as Evidence for Hypotheses: Changing Attitudes Over Four Decades. *Psychological science, 27*(7), 1-7. doi:10.1177/0956797616645672

Raadt, M. d., & Dekeyser, S. (2009). *A simple time-management tool for students' online learning activities.* Paper presented at the ascilite Auckland.

Rahmana, N. A. A., Hussein, N., & Aluwi, A. H. (2015). Satisfaction on Blended Learning in a Public Higher Education Institution: What Factors Matter? . *Procedia - Social and Behavioral Sciences, 211*, 768 – 775 doi:10.1016/j.sbspro.2015.11.107

Rajabi, S. (2012). Towards self-regulated learning in school curriculum *Procedia - Social and Behavioral Sciences, 47*(2012), 344 – 350 doi:10.1016/j.sbspro.2012.06.661

Ramakrisnan, P., Yahya, Y. b., Hasrol, M. N. H., & Aziz, A. A. (2011). Blended Learning: A Suitable Framework For E-Learning In Higher Education. *Procedia - Social and Behavioral Sciences, 67*, 513-526.

Reissman, J. (2017, 2017). Math Anxiety: Finding a Better Way to Learn. Retrieved from https://jfynet.org/1563/math-anxiety-finding-better-way-learn/

Reyes, L. H. (1984). Affective Variables and Mathematics Education. *The Elementary School Journal, 84*(5), 558-581.

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: psychometric data. *Journal of Counseling PsycMogv, 19*(6), 551-554. doi:10.1037/h0033456

Richardson, M., Bond, R., & Abraham, C. (2012). Psychological Correlates of University Students' Academic Performance: A Systematic Review and Meta-Analysis. *Psychological Bulletin, 138*(2), 353–387. doi:10.1037/a0026838

Roberts, E. (2004). *Disengaged and denied, or supported and skilled: the journey to a learner-centred model for rural and remote older learners*. Australia: Australian National Training Authority.

Roff, K. (2017). *An Examination of Student Satisfaction In Blended Learning Environments a Mixed Methods Study.* (masters thesis), Empire State College ate University of New York (10258051)

Rovai, A. P., & Jordan, H. M. (2004). Blended Learning and Sense of Community: A comparative analysis with traditional and fully online graduate courses *International Review of Research in Open and Distance Learning, 5*(2).

Rozeboom, A. M. (2017). *Blended Learning Versus the Traditional Classroom Model.* (master thesis), Northwestern College, Iowa. Retrieved from https://nwcommons.nwciowa.edu/cgi/viewcontent.cgi?article=1025&context=education_masters

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology, 25*, 54-67. doi:10.1006/ceps.1999.1020

Ryan, R. S. (2013). *The Effect of Online Discussion Forums on Student Learning and Student Perception of Learning in a Science Course at the Community College Level.* (PhD Dissertation), University of Southern Mississippi. (207)

Saks, K., & Leijen, Ä. (2014). Distinguishing Self-Directed and Self-Regulated Learning and Measuring them in the E-learning Context. *Procedia - Social and Behavioral Sciences, 112*, 190-198.

Salvucci, S., Walter, E., Conley, V., Fink, S., & Saba, M. (1997). *Measurement Error Studies at the National Center for Education Statistics*. New Jersey Avenue NW: Synectics for Management Decisions, Inc.

Scarpello, G. V. (2005). *The Effect of Mathematics Anxiety on the Course and Career Choice of High School Vocational-Technical Education Students.* (PhD Thesis), Drexel University.

Schober, A., & Keller, L. (2012). Impact Factors for Learner Motivation in Blended Learning Environments *International Journal of Emerging Technologies in Learning (iJET), 7*(2). doi:10.3991/ijet.v7iS2.2326

Schoonenboom, J., & Johnson, B. (2017). How to Construct a Mixed Methods Research Design. *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie, 69*(2), 107–131. doi:10.1007/s11577-017-0454-1

Schunk, D. H. (1982). Progress Self-Monitoring. *The Journal of Experimental Education, 51*(2), 89-93. doi:10.1080/00220973.1982.11011845

Selçuk, G. S. (2010). The effects of problem-based learning on pre-service teachers' achievement, approaches and attitudes towards learning physics. *International Journal of the Physical Sciences, 5*(6), 711-723.

Selcuk, G. S., Caliskan, S., & Sahin, M. (2013). A Comparison of Achievement in Problem-Based, Strategic and Traditional Learning Classes in Physics. *International Journal on New Trends in Education and Their Implications, 4*(1).

Shachar, M., & Neumann, Y. (2010). Twenty Years of Research on the Academic Performance Differences Between Traditional and Distance Learning: Summative Meta-Analysis and Trend Examination *MERLOT Journal of Online Learning and Teaching, 6*(2).

Shannon-Baker, P. (2016). Making Paradigms Meaningful in Mixed Methods Research. *Journal of Mixed Methods Research, 10*(3), 319–334. doi:10.1177/1558689815575861

Shantakumari, P. S. (2015). Blended Learning: The Student Viewpoint. *Annals of Medical and Health Sciences Research, 5*(5), 323-328. doi:10.4103/2141-9248.165248

Sharpe, R., Benfield, G., Roberts, G., & Francis, R. (2006). *The undergraduate experience of blended e-learning: a review of UK literature and practice*.

Shea, P. (2007). Towards a Conceptual Framework for Learning in Blended. In A. G. Picciano & C. D. Dziuban (Eds.), *Blended Learning Research Perspectives*. United States of America: Sloan consortium.

Sheard, M. (2009). Hardiness commitment, gender, and age differentiate university academic performance. *British Journal of Educational Psychology, 79*, 189-204. doi:10.1348/000709908X304406

Sheard, M., &Golby, J. (2007). Hardiness and undergraduate academic study: The moderating role of commitment. *Personality and Individual Differences, 43*, 579-588.

Sheffield, D., & Hunt, T. (2007). How Does Anxiety Influence Maths Performance and What Can We do About It? *MSOR Connections, 6*(4).

Shishigu, A. (2013). Mathematics Anxiety And Its Impact On Students' Achievement: With Specific Reference To Grade Nine Students Of East Shoa Zone In Oromia Region. *Journal of educational research, 3*(1).

Shishigu, A. (2018). Mathematics Anxiety and Prevention Strategy: An Attempt to Support Students and Strengthen Mathematics Education. *Mathematics Education Trends and Research, 2018*(1), 1-11. doi:10.5899/2018/metr-00096

Shishigu, A., Bashu, B., Tesfaw, B., & Gadisa, S. (2017a). The Effect of Problem Based Learning (PBL) Instruction on Students' Motivation and Problem Solving Skills of Physics. *EURASIA Journal of Mathematics Science and Technology Education, 13*(3), 857-871. doi:10.12973/eurasia.2017.00647a

Shishigu, A., Gemechu, E., Michael, K., Atnafu, M., & Ayalew, Y. (2017b). Policy Debate in Ethiopian Teacher Education: Retrospection and Future Direction *International Journal of Progressive Education, 13*(3), 61-70.

Siew-Eng, L., Ariffin, S. R. B., Rahman, S. B., & Kim-Leong, L. (2010). Diversity in education using blended learning in Sarawak. *US-China Education Review, 7*(2).

Simamora, S. J., Simamora, R. E., Sinaga, B., & Calderon, O. (2017). Application of Problem Based Learning to Increase dents' Problem Solving Ability on Geometry in Class X SMA Negeri 1 Pagaran. *International Journal of Sciences Basic and Applied Research, 36*(2), 234-251.

Sinclair, R. R., & Tetrick, L. E. (2000). Implications of Item Wording for Hardiness Structure, Relation with Neuroticism, and Stress Buffering. *Journal of Research in Personality, 34*, 1-25. doi:10.1006/jrpe.1999.2265

Sinclaire, J. K. (2011). Student satisfaction with online learning: Lessons from organizational behavior. *Research in Higher Education Journal, 11*, 1-20.

Singh, H. (2003). Building Effective Blended Learning Programs. *Educational Technology,, 43*(6), 51-64.

Smyth, S., Houghton, C., Cooney, A., & Casey, D. (2012). Students' experiences of blended learning across a range of postgraduate programmes. *Nurse Education Today, 32*, 464-468. doi:10.1016/j.nedt.2011.05.014

So, H.-J., & Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors. *Computers & Education, 51*, 318–336. doi:10.1016/j.compedu.2007.05.009

Sparks, S. (2011). Researchers Probe Causes of Math Anxiety. *Education Week, 30*(31), 1-16.

Spring, K. J., & Graham, C. R. (2017). Blended learning citation patterns and publication networks across seven worldwide regions *Australasian Journal of Educational Technology, 33*(2). doi:10.14742/ajet.2632

Spring, K. J., Graham, C. R., & Ikahihifo, T. B. (2018). Learner Engagement in Blended Learning. In M. Khosrow-Pour (Ed.), *Encyclopedia of Information Science and Technology, Fourth Edition* (4th ed., pp. 1487-1498). USA: IGI Global.

Stacey, K., & MacGregor, M. (1999). Implications for Mathematics Education Policy of Research on Algebra Learning. *Australian Journal of Education, 43*(1), 58-71. doi:10.1177/000494419904300105

Stevens, J. P. (2009). *Applied Multivatiate Statistics for the Social Sciences* (5 ed.). USA: Taylor & Francis Group, LLC

Strachota, E. (2006). *The Use of Survey Research to Measure Student Satisfaction in Online Courses*. Paper presented at the Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, University of Missouri-St. Louis.

Suinn, R. M., & Winston, E. H. (2003). The Mathematics Anxiety Rating Scale, A Brief Version. *Psychological Repom, 92*, 167-173. doi:10.2466/pr0.2003.92.1.167

Sun, Y., & Pyzdrowski, L. (2009). Using Technology as a Tool to Reduce Mathematics Anxiety *The Journal of Human Resource and Adult Learning, 1*(5).

Sungur, S., & Tekkaya, C. (2006). Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning. *The Journal of Educational Research, 99*(5).

Suratno, J. (2016). *The Development of Students Worksheet Using GeoGebra Assisted Problem-Based Learning and Its Effect on Ability of Mathematical Discovery of Junior High Students.* Paper presented at the 3rd International Conference on Research, Implementation and Education of Mathematics and Science, Yogyakarta.

Syarif, I., & Sofyan, H. (2012). *The Effect of Blended learning on The Motivation and learning achievement of the Student of SMKN 1 Paringin* Paper presented at the International Conference on Vocational Education and Training (ICVET). http://eprints.uny.ac.id/24485/

Syzmanowicz, A., & Furnham, A. (2011). Gender differences in self-estimates of general, mathematical, spatial and verbal intelligence: Four meta analyses. *2011, 21*(5), 493–504. doi:10.1016/j.lindif.2011.07.001

Tadesse, W. (2014). Assessment of Students' Mathematical Competency, a case Study in Dire-Dawa University. *Ethiop. J. Educ. & Sc., 9*(2).

Tesfa, M. (2014). *The validity of University Entrance Examination and High school Grade point average for predicting first year university students' academic performance. .* (master thesis), University of Twente, University of Twente. Retrieved from http://essay.utwente.nl/66652/1/Tesema%20M.%20-%20S1397257%20-%20masterscriptie.pdf

Teshome, A. (2012). Teachers' Perceptions and Practices of Active Learning in Haramaya University, Eastern Ethiopia: The Case of Faculty of Education *Science, Technology and Arts Research Journa, 1*(4), 74-83.

TGE. (1994). *Transitional Government of Ethiopia: Education and Training policy*. Ethiopia: St. George Printing Press.

Tham, K., & Tham, C. (2011). Blended Learning – A Focus Study on Asia *International Journal of Computer Science, 8*(2), 136-142.

Thompson, N. A. (2013). Assessment Systems. USA: Assessment Systems Worldwide, LLC.

Thorne, K. (2003). *Blended Learning: How to Integrate Online and Traditional Learning*. Great Britain and the United States: Kogan Page Limited.

Tobias, S., & Weissbrod, C. (1980). Anxiety and Mathematics: An Update. *Harvard Educational Review, 50*(1). doi:10.17763/haer.50.1.xw483257j6035084

Tokpah, C. L. (2008). *The Effects of Computer Algebra Systems on Students' Achievement in Mathematics.* (PhD Dissertation), Kent State University College USA.

Tomczak, M., & Tomczak, E. (2014). The need to report effect size estimates revisited: An overview of some recommended measures of effect size. *TRENDS in Sport Sciences, 1*(21), 19-25.

Toothaker, L. E. (1993). MultipleComparison Procedures. In U. o. Oklahoma (Ed.), *Paper series on Quantitative Applications in the Social Sciences* (1 ed.). Newbury Park, California: Sage Publications, Inc.

Tseng, S.-C., Liang, J.-C., & Tsai, C.-C. (2014). Students' self-regulated learning, online information evaluative standards and online academic searching strategies *Australasian Journal of Educational Technology, 30*(1), 106-121. doi:10.14742/ajet.242

Tshabalala, M., Ndeya-Ndereya, C., & Merwe, T. v. d. (2014). Implementing Blended Learning at a Developing University: Obstacles in the way *The Electronic Journal of e-Learning, 12*(1), 101-110.

Twigg, C. A. (2003a). Improving Learning and Reducing Costs for Online learning. *Education Review, 38*(5), 28-38.

Twigg, C. A. (2003b). Improving learning and reducing costs: New models for online learning. *EDUCAUSE Review, 38*(5), 28-38.

Vandermolen, R. M. (2010). *The Examination of the Implementation of Blended Learning Instruction on the Teaching and Learning Environment in Two West Michigan School Districts.* (PhD Dissertation), Eastern Michigan University. (296)

Vanslambrouck, S., Zhu, C., Lombaerts, K., Brent Philipsen, & Tondeur, J. (2018). Students' motivation and subjective task value of participating in online and blended learning environments. *The Internet and Higher Education, 36*, 33-40. doi:10.1016/j.iheduc.2017.09.002

Vaughan, N. (2007). Perspectives on blended learning in higher education. *International Journal on E-Learning, 6*(1), 81-94.

Vermunt, J. D. (1996). Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenomenographic analysis *Higher Education, 31*(25-50). doi:10.1007/BF00129106

Vernadakis, N., Giannousi, M., Derri, V., & Michalopoulos, M. (2012). The impact of blended and traditional instruction in students' performance. *Procedia Technology, 1*, 439-443.

Vinales, J. J. (2015). The learning environment and learning styles: a guide for mentors. *Britis Journa of Nursing, 24*(8), 454-457. doi:10.12968/bjon.2015.24.8.454

Viz, D., & Kaur, N. (2017). Effect Of Blended Learning Approach On Achievement In Geography at Secondary School Stage. *Scholarly research journal for humanity science and English language, 4*(22), 5478-5485.

Vogt, D. S., Rizvi, S. L., Shipherd, J. C., & Resick, P. A. (2008). Longitudinal Investigation of Reciprocal Relationship Between Stress Reactions and Hardiness. *Personality and Social Psychology Bulletin, 34*(1), 61-73. doi:10.1177/0146167207309197

Vosniadou, S. (2001). How children learn. *The International Academy of Education*.

Wang, J. (2007). A Trend Study of Self-Concept and Mathematics Achievement in a Cross-Cultural Context. *Mathematics Education Research Journal, 19*(3), 33–47.

Warren, E., Trigueros, M., & Ursini, S. (2016). Research on the Learning and Teaching of Algebra In Á. Gutiérrez, G. C. Leder, & P. Boero (Eds.), *The Second Handbook of Research on the Psychology of Mathematics Education: The Journey Continues*. The Netherlands: Sense Publishers.

Wei, Q. (2010). *The Effects of Pedagogical Agents on Mathematics Anxiety and Mathematics Learning.* (PhD Dissertation), Utah State University. Retrieved from http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1620&context=etd (624)

Wijnen, M., Loyens, S. M. M., Wijnia, L., Smeets, G., Kroeze, M. J., & Molen, H. T. V. d. (2017). Is problem-based learning associated with students'motivation? A quantitative and qualitative study. *Learning Environ Reserch*, 1-21. doi:10.1007/s10984-017-9246-9

Williams, T., & Williams, K. (2010). Self-Efficacy and Performance in Mathematics: Reciprocal Determinism in 33 Nations. *Journal of Educational Psychology, 102*(2), 453–466. doi:10.1037/a0017271

Wilson, D., & Smilanich, E. (2005). *The Other Blended Learning: A Classroom-Centered Approach*. San Francisco: John Wiley & Sons, Inc.

Winne, P. H., & Jamieson-Noel, D. (2002). Exploring students calibration of self reports about study tactics and achievement. *Contemporary Educational Psychology, 27*, 551-572.

Witt, M. (2012). The Impact of Mathematics Anxiety on Primary School Children's Working Memory. *Europe's Journal of Psychology, 8*(2), 263-274. doi:10.5964/ejop.v8i2.458

Wlodkowski, R. J. (2008). *Adult Motivation to Learn: A Comprehensive Guide for Teaching All Adults* (3 ed.): John Wiley & Sons, Inc.

Woltering, V., Herrler, A., & Spitzer, K. (2009). Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: results of a mixed-method evaluation. *Advances in Health Sciences Education, 14*(5), 725-738. doi:10.1007/s10459-009-9154-6

Wolters, C. A. (2011). Regulation of motivation: Contextual and social aspects. *Teachers College Record, 113*(2), 265-283.

Wu, J.-H., Tennyson, R. D., & Hsia, T.-L. (2010). A study of student satisfaction in a blended e-learning system environment. *Computers & Education, 55*, 155–164. doi:10.1016/j.compedu.2009.12.012

Wu, W.-S. (2008). The application of Moodle on an EFL collegiate writing environment. *Journal of Education and Foreign Languages and Literature, 7*(6), 45-58.

Xiaoqing, G. (2017). Blended Learning at East China Norman University: Promissing Practices and Challenges. In L. C. Ping & W. Libing (Eds.), *Blendede Learning for Quality higher education:Selected Case Studies on Implementation from Asia-Pacific*. 7, place de Fontenoy, 75352 Paris 07 SP, France: UNESCO.

Yilmaz, M. B., & Oghan, F. (2010). Pre-Service English Teachers in Blended Learning Environment in Respect to Their Learning Approaches. *The Turkish Online Journal of Educational Technology, 9*(1), 157-164.

Yin, R. K. (2003). *case study research: design and methods, 3rd edition*. California: Sage publications, Inc.

Yin, R. K. (2009). *Case study research design and method* (4 ed. Vol. 5). Thousand Oaks, California: SAGE Publications, Inc.

Yudko, E., Hirokawa, R., & Chi, R. (2008). Attitudes, beliefs, and attendance in a hybrid course. *Computers & Education, 50*(2008), 1217-1227. doi:10.1016/j.compedu.2006.11.005

Zakaria, E., & Daud, M. Y. (2013). The role of technology: Moodle as a teaching tool in a graduate mathematics education course. *Asian Journal of Management Science & Education, 2*(4), 46-52.

Zakaria, E., Zain, N. M., Ahmad, N. A., & Erlina, A. (2012). Mathematics Anxiety and Achievement among Secondary School Students *American Journal of Applied Sciences, 9*(11), 1761-1765. doi:10.3844/ajassp.2012.1828.1832

Zapata, G., & Sagarra, N. (2007). CALL on Hold: The delayed benefits of an online workbook on L2 vocabulary learning. *Computer Assisted Language Learning, 20*(2), 153-171. doi:10.1080/09588220701331352

Zaslavsky, C. (1994). *Fear of Math: How to get over it and get on with your life*. New Brunswick, New Jersey: Rutgers University Press.

Zawojewski, u., Chamber, M., Hjalmarson, M. A., & Lewis, C. (2008). Developing Design Studies in Mathematics Education: Professional Development Studying Teachers' Interpretive Systems In A. E. Kelly, R. A. Lesh, & J. Y. Baek (Eds.), *Handbook of Design Research Methods in Education* Madison Ave, New York: Routledge, Taylor & Francis

Zhang, W., & Lu, J. (2011). Dynamic Synchronization of Teacher - Students Affection in Affective Instruction *International Education Studies* 238-241.

Zhang, W., & Zhu, C. (2017). Review on Blended Learning: Identifying the Key Themes and Categories *International Journal of Information and Education Technology, 7*(9), 673-678. doi:10.18178/ijiet.2017.7.9.952

Zhao, Y., & Breslow, L. (2013). *Literature review on hybrid/blended learning*. review. Retrieved from https://tll.mit.edu/sites/default/files/library/Blended_Learning_Lit_Reveiw.pdf

Zimmerman, B. J. (1990). self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3-17.

Zimmerman, B. J. (1998). Academic studing and the development of personal skill: A self-regulatory perspective. *Educational Psychologist, 33*(2/3), 73-86. doi:10.1080/00461520.1998.9653292

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory into Practice, 41*(2), 64-70. doi:10.1207/s15430421tip4102_2

Zumbach, J., Schwartz, N., Seufert, T., & Kester, L. (2008). *Beyond knowledge: the legacy of competence, a meaningful computer-based learning environment*: Springer science + business memdia B.V.

Zumbrunn, S., Tadlock, J., & Roberts, E. D. (2011). *Encouraging Self-Regulated Learning in the Classroom: A Review of the Literature*. Paper presented at the Metropolitan Educational Research Consortium (MERC), Virginia Commonwealth University.

## Appendix A: Students' Perception Survey

**Addis Ababa University**

**School of Graduate Studies**

**Department of Science and Mathematics Education**

**Blended Course Student perception Survey**

University:_____ **Course**: ***Linear algebra II***, Sex: Male:____Female:____

**Please answer the following questions as clearly as you can by checking the box or line, as appropriate.** ***Note that BLENDED courses have some face-to-face class, but also have some class sessions that are replaced with online instruction*****.**

| | **Very satisfied** | **Generally Satisfied** | **Neither** | **Generally dissatisfied** | **Very dissatisfied** |
|---|---|---|---|---|---|
| In general, how satisfied were you with the blended course? | | | | | |

**Please share any comments you have about blended courses**

_____

_____

_____

_____

| | **Definitely** | **Possibly** | **Undecided** | **Not Possibly** | **Definitely not** |
|---|---|---|---|---|---|
| Given a choice, would you enroll in another blended course? | | | | | |

**In general, how do you feel the technology component of your blended course affects the following, when compared with your face-to-face courses?**

| | **Much better** | **A little better** | **About the same** | **A little worse** | **Much worse** |
|---|---|---|---|---|---|
| The opportunity you get to interact with other students | | | | | |
| The opportunity you get to interact with your instructor | | | | | |
| The opportunity you get to access learning materials | | | | | |

| | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| I'm more likely to ask questions in a blended course | | | | | |
| There are more opportunities to collaborate with others in a blended course | | | | | |
| Blended course experience has increased my opportunity to access and use information | | | | | |
| I have more opportunities to reflect on what I've learned in blended courses | | | | | |
| Blended learning helps me better understand course material | | | | | |
| I understand course requirements better in a blended course | | | | | |
| Because of blended courses, I am more likely to get a better grade | | | | | |
| I am very satisfied with this online course | | | | | |
| The websites that were linked to this course facilitated my learning | | | | | |

**What do you like most about blended courses?**

_____

_____

_____

_____

_____

**What do you like least about blended courses?**

_____

_____

_____

_____

## Appendix B: Instructor Perception Survey

**Addis Ababa University**

**School of Graduate Studies**

**Department of Science and Mathematics Education**

**Blended Course instructor perception**

**Course: Linear Algebra II** **Univrsity:_____**

**Gender**: Male_____ Female:_____ **Age**: _____

**I would like to ask you some questions regarding your teaching experience. Please answer the questions that apply to you, and your experience with the blended format.**

1. How satisfied you have been with your blended courses?

| Very Satisfied | Generally Satisfied | Neutral | Generally Dissatisfied | Very Dissatisfied |
|---|---|---|---|---|
| | | | | |

Comments:_____

_____

_____

_____

2. If, on question 1, you indicated you have been dissatisfied with your blended experience, what do you feel has contributed most to your dissatisfaction?

_____

_____

_____

_____

_____

3. Would you consider teaching a course in the blended format in the future?

| Definitely | Probably | Probably not | Definitely not |
|---|---|---|---|
| | | | |

Comments:_____

_____

_____

_____

_____

4. If, on question 3, you indicated you would probably or definitely not teach using a blended format in the future if you had a choice, why not?

_____

_____

_____-

5. How would you rate the quality of the educational experience in your blended courses compared to the face-to-face format?

| Much better | Better | About the same | Worse | Much worse |
|---|---|---|---|---|
| | | | | |

Comments:_____

_____

_____

Consider the amount of interaction in your blended class. How would you say it compared with the amount of interaction in a face-to-face course with no web components?

| Increased | Somewhat increased | About the same | Somewhat decreased | Decreased |
|---|---|---|---|---|
| | | | | |

Comments:_____

_____

Consider the quality of interaction in your blended class. How would you say it compared with the quality of interaction in a face-to-face course with no web components?

| Much Better | Better | About the same | Worse | Much worse |
|---|---|---|---|---|
| | | | | |

Comments:_____

_____

6. Is there any additional support, technology, or training you feel could be provided that could help you in your blended courses? Please explain._____

_____

_____

7. How does your assessment of student achievement in blended classes differ from your face-to-face sections with no web components?

_____

_____

_____

8. What are the most positive aspects of teaching a course using the blended format?

---

What are the least positive aspects of teaching a course using the blended format?

_____

_____

_____

9. Has your experience of teaching blended courses influenced your face-to-face course(s)?

   If yes, how?

_____

_____

_____

## Appendix C: Student Questionnaire for Control Group

**Addis Ababa University**

**School of Graduate Studies**

**Department of Science and Mathematics Education**

**Questionnaire to be filled by Students (CG)**

ID. No:_____Age:_____University_____Sex: Male___Female: ____

**Instructions**: This questionnaire is designed to assess your opinion in different dimension. There is no right or wrong answer for each question. However, it is essential to respond as accurately and as honestly as possible by checking the most appropriate response. Indicate tick (√) mark under the five alternatives given below. The five alternatives are: Strongly Agree (**SA**), Agree (**A**), Neutral (**N**), Disagree (**D**), and Strongly Disagree (**SD**).

**Part I Motivation Scale**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | Learning algebra is interesting | | | | | |
| 2 | I am curious about problems in algebra | | | | | |
| 3 | The algebra I learn is relevant to my life | | | | | |
| 4 | Learning algebra makes my life more meaningful | | | | | |
| 5 | I enjoy learning algebra | | | | | |
| 6 | Scoring high on algebra tests matters to me | | | | | |
| 7 | It is important that I get an ‘‘A’’ in algebra | | | | | |
| 8 | Getting a good algebra grade is important to me | | | | | |
| 9 | I like to do better than other students on algebra tests | | | | | |
| 10 | I will use algebra problem-solving skills in my career | | | | | |

**Part II. Academic Hardiness Scale (AHS)**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | I take my work as a student seriously | | | | | |
| 2 | I am a dedicated student | | | | | |
| 3 | I work hard to obtain a good grades | | | | | |
| 4 | I give concern for all my classes | | | | | |
| 5 | Regardless of the class, I do my best | | | | | |
| 6 | I make personal sacrifices to get good grades | | | | | |
| 7 | Doing well is as important to me as to my parents | | | | | |
| 8 | I am more involved and interested in outside activities | | | | | |
| 9 | I enjoy challenge of difficult class | | | | | |
| 10 | if I am not confident to do well, it is not important to attend the class | | | | | |
| 11 | Difficult classes are the best way to improve one's knowledge | | | | | |

**Part III: Satisfaction scale**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1. | The course documents – lessons or lecture notes used in this class facilitated my learning | | | | | |
| 2. | The assignments in this course facilitated my learning | | | | | |
| 3. | The learning activities in this curse required critical thinking which facilitated my learning | | | | | |
| 4. | In this class, the teacher was an active member of the discussion group offering direction for activities | | | | | |
| 5. | I received timely feedback from my instructor | | | | | |
| 6. | In algebra class, the instructor has facilitated the course by continuously encouraging communication | | | | | |
| 7. | The algebra course created a sense of community among students | | | | | |
| 8. | I am very satisfied with this algebra course | | | | | |

**Part IV: Self-regulated Learning Questionnaire (SLQ)**

| **No** | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1. | I set goals to help me manage my studying time for my course | | | | | |
| 2. | I choose the location where I study to avoid too much distraction. | | | | | |
| 3. | I find a comfortable place to study | | | | | |
| 4. | I know where I can study most efficiently | | | | | |
| 5. | I choose a time with few distractions for studying | | | | | |
| 6. | I try to take more thorough notes for my algebra courses because notes are more important for learning | | | | | |
| 7. | I prepare my questions before contacting the instructor | | | | | |
| 8. | I work extra problems in my algebra course in addition to the assigned ones to master the course content | | | | | |
| 9. | I allocate extra studying time for my algebra course because I know it is time-demanding. | | | | | |
| 10. | I try to schedule the same time every day or every week to study for my algebra course, and I observe the schedule | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11. | Although we don't have to attend daily classes, I still try to distribute my studying time consistently across days | | | | | |
| 12. | I find someone who is knowledgeable in course content so that I can consult him or her when I need help | | | | | |
| 13. | I share my problems with my classmates so we know what we are struggling with and how to solve our problems | | | | | |
| 14. | I always ask my instructor for a help, if I encountered a difficulty | | | | | |
| 15. | I summarize my learning of algebra to examine my understanding of what I have learned | | | | | |
| 16. | I ask myself a lot of questions about the course material when studying for algebra course | | | | | |
| 17. | I communicate with my classmates to find out how I am doing in algebra classes | | | | | |
| 18. | I communicate with my classmates to find out what I am learning that is different from what they are learning | | | | | |

**Part V: Mathematics Anxiety Rating Scale (MARS)**

| No | Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | Algebra makes me feel comfortable | | | | | |
| 2 | Algebra is the most horror subject for me | | | | | |
| 3 | My mind goes blank when the instructor asks algebra questions | | | | | |
| 4 | I find algebra interesting | | | | | |
| 5 | algebra is one of my favorite subjects | | | | | |
| 6 | I am always afraid of algebra exams | | | | | |
| 7 | I feel nervous when I am about to do algebra homework | | | | | |
| 8 | I feel happy and excited in algebra class as compared to any other class | | | | | |
| 9 | I would prefer algebra as one of my specialization in further study | | | | | |
| 10 | Algebra is a headache for me | | | | | |
| 11 | I am afraid to ask questions in algebra class | | | | | |

*These instruments have been used for pretest of both groups and only for comparison group in the posttest

## Appendix D: Student Post Questionnaire for Experimental Groups

**Addis Ababa University**

**School of Graduate Studies**

**Department of Science and Mathematics Education**

**Questionnaire to be filled by Students (post) EG**

ID. No:_____Age:_____University_____Sex: Male___Female: ____

**Instructions**: This questionnaire is designed to assess your opinion in different dimension. There is no right or wrong answer for each question. However, it is essential to respond as accurately and as honestly as possible by checking the most appropriate response. Indicate tick (√) mark under the five alternatives given below. The five alternatives are: Strongly Agree (**SA**), Agree (**A**), Neutral (**N**), Disagree (**D**), and Strongly Disagree (**SD**).

**Part I: The Situational Motivation Scale (SIMS)**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | Learning algebra is interesting | | | | | |
| 2 | The algebra I learn is relevant to my life | | | | | |
| 3 | I am curious about problems in algebra | | | | | |
| 4 | Learning algebra makes my life more meaningful | | | | | |
| 5 | I enjoy learning algebra | | | | | |
| 6 | Scoring high on algebra tests matters to me | | | | | |
| 7 | It is important that I get an ‘‘A’’ in algebra | | | | | |
| 8 | Getting a good algebra grade is important to me | | | | | |
| 9 | I like to do better than other students on algebra tests | | | | | |
| 10 | I will use algebra problem-solving skills in my career | | | | | |

**Part II Academic Hardiness Scale (AHS)**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | I take my work as a student seriously | | | | | |
| 2 | I am a dedicated student | | | | | |
| 3 | I work hard to obtain a good grades | | | | | |
| 4 | I give concern for all my classes | | | | | |
| 5 | Regardless of the class, I do my best | | | | | |
| 6 | I make personal sacrifices to get good grades | | | | | |
| 7 | Doing well is as important to me as to my parents | | | | | |
| 8 | I am more involved and interested in outside activities | | | | | |
| 9 | I enjoy challenge of difficult class | | | | | |
| 10 | If I am not confident to do well, it is not important to attend class | | | | | |
| 11 | Difficult classes are the best way to improve one's knowledge | | | | | |

**Part III: Satisfaction scale**

| NO | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | The course documents – lessons or lecture notes used in this class facilitated my learning | | | | | |
| 2 | The assignments in this course facilitated my learning | | | | | |
| 3 | The learning activities in this curse required critical thinking which facilitated my learning | | | | | |
| 4 | In this class, the teacher was an active member of the discussion group offering direction to posted comments | | | | | |
| 5 | I received timely feedback from my instructor | | | | | |
| 6 | In algebra class, the instructor has facilitated the course by continuously encouraging communication | | | | | |
| 7 | The online discussion board provided opportunity for problem solving with other students | | | | | |
| 8 | The algebra course created a sense of community among students | | | | | |

**Part IV: Online Self-regulated Learning Questionnaire (OSLQ)**

| **No** | **Statements** | **SA** | **A** | **N** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | I set goals to help me manage studying time for my online courses | | | | | |
| 2 | I choose the location where I study to avoid too much distraction | | | | | |
| 3 | I find a comfortable place to study | | | | | |
| 4 | I know where I can study most efficiently for my online course | | | | | |
| 5 | I choose a time with few distractions for studying online | | | | | |
| 6 | I try to take more thorough notes for my online course because notes are even more important for learning online than in a regular classroom | | | | | |
| 7 | I prepare my questions before joining in the discussion forum | | | | | |
| 8 | I work extra problems in my online course in addition to the assigned ones to master the course content | | | | | |
| 9 | I allocate extra studying time for my online course because I know it is time-demanding | | | | | |
| 10 | I try to schedule the same time every day or every week to study for my | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | online course and I observe the schedule | | | | | |
| 11 | Although we don't have to attend daily classes, I still try to distribute my studying time consistently across days | | | | | |
| 12 | I find someone who is knowledgeable in course content so that I can consult him or her when I need help | | | | | |
| 13 | I share my problems with my classmates online so we know what we are struggling with and how to solve our problems | | | | | |
| 14 | I always ask my instructor for a help through discussion forum or any if I encountered a difficulty | | | | | |
| 15 | I summarize my learning in online course to examine my understanding of what I have learned | | | | | |
| 16 | I ask myself a lot of questions about the course material when studying for an online course | | | | | |
| 17 | I communicate with my classmates to find out how I am doing in my online class | | | | | |
| 18 | I communicate with my classmates to find out what I am learning that is different from what they are learning | | | | | |

**Part V: Mathematics Anxiety Rating Scale (MARS)**

| No | Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 1 | Algebra makes me feel comfortable | | | | | |
| 2 | Algebra is the most horror subject for me | | | | | |
| 3 | My mind goes blank when the instructor asks algebra questions | | | | | |
| 4 | I find algebra interesting | | | | | |
| 5 | algebra is one of my favorite subjects | | | | | |
| 6 | I am always afraid of algebra exams | | | | | |
| 7 | I feel nervous when I am about to do algebra homework | | | | | |
| 8 | I feel happy and excited in algebra class as compared to any other class | | | | | |
| 9 | I would prefer algebra as one of my specialization in further study | | | | | |
| 10 | Algebra is a headache for me | | | | | |
| 11 | I am afraid to ask questions in algebra class | | | | | |

## Appendix E: Semi-structured Interview for Students

**Addis Ababa University**

**School of Graduate Studies**

**Department of Science and Mathematics Education**

**Semi-structured interview for students**

This interview is designed to access your views/perception on the blended learning approach. There is no right or wrong answer for each question. However, it is important to respond as honestly as possible by describing your feelings. Thank you for your voluntary participation in this study.

1. Do you think that the blended approach helped you with your learning? Give reasons.
2. What are the advantages you obtained from BL?
3. What did you like the most about BL?
4. What are your feelings about the online tests?
5. What did you find most difficult or challenging about a blended course?
6. What is the worst thing you observed from this type of learning?
7. So, what changes you suggest to create better learning environment?
8. How do you see the benefits in terms of supporting your learning?

9. How was your interaction with your instructor as a result of BL?
10. Would you like to use this type of learning in the future?
11. Would you recommend this type of learning for other students? Why?

**Follow up interview with students**

This interview is designed to access your views/perception on the blended learning approach. There is no right or wrong answer for each question. However, it is important to respond as honestly as possible by describing your feelings. Thank you for your voluntary participation in this study.

1. How was your experience of blended learning?
2. What were the challenges at that time?
3. Does it create a load or unnecessary addition to your regular learning?
4. Does it take too much of your time which affect other courses?
5. How was the continuous assessment in all courses, does it affect your blended learning algebra course? How?
6. Do you have really benefited?
7. Do you have affected negatively in your learning in general?

## Appendix F: Observation Checklist

**Addis Ababa University**

**College of Education and Behavioral Studies**

**Department of Science and Mathematics Education**

**Observation Checklist Tool**

**University_____observer_____**

| No | | Yes | No |
|---|---|---|---|
| | **Learning Environment** | | |
| 1. | Students collaborate with peers through online discussion area | | |
| 2. | the online environment is rich in resource and it is user friendly for students | | |
| 3. | Using blended learning,course objectives are achieved in a better way. | | |
| 4. | During the face-to-face classroom setting,students get opportunity to further grasp the lessons. | | |
| 5. | Comp. Laboratory room is well structured with internet access | | |
| 6. | Students become familiar with Moodle easily. | | |
| 7. | The presentation of contents and arrangement is well organized | | |
| 8. | Students are comfortable with the self-checking session | | |
| 9. | Blended learning provides an opportunity to control ones progress | | |
| 10. | Blended learning allows students to express themselves in a written form. | | |
| | **Course Delivery Process** | | |
| 11. | The course instructor is well aware of the purpose of blended learning. | | |
| 12. | The course instructor gives time to assist students in an online discussion session. | | |
| 13. | Students appear comfortable with the blended learning approach | | |
| 14. | The blended learningapproach addresses the diverse nature of | | |

| | | | |
|---|---|---|---|
| | students. | | |
| 15. | The learning resources attached to the online environment contribute little in the learning process. | | |
| 16 | Online and face-to-face instruction was relevant to each other | | |
| 17 | During the online discussion forum, students get a chance to pose question and forward their views. | | |
| 18 | The classroom instructor encourages students to actively participate in activities. | | |
| 19 | Students got enough time to do activities with peers. | | |

**Comments**:

1. How the instructor links the face-to-face and online sessions?
2. What were the challenges observed during the implementation of blended learning for mathematics course?

## Appendix G: Algebra Achievement Tests

### 1. Algebra Achievement Pretest

**Linear Algebra II (pretest) Time allowed 1:30hrs.**

Name_____Id. _____

No_____University_____Sex_____

Do you have an experience in using internet or computer to learn algebra? Yes__ No__

***Instruction*: attempt all questions and choose the best answer among the given alternatives**

_____1. What are the eigenvalues of $A = \begin{bmatrix} 4 & 7 & 1 \\ 0 & -3 & 8 \\ 0 & 0 & 2 \end{bmatrix}$?

A) -3, 2, 4 B) 1, 4, 6 C) -3, -1, 4 D) 0, 2, 4

_____2. If $\begin{pmatrix} -6 \\ 1 \end{pmatrix}$ is an eigenvector of $\begin{pmatrix} 1 & -6 \\ 0 & 2 \end{pmatrix}$, what is the corresponding eigenvalue?

A) 0 B) 1 C) 2 D) 3

_____3. Let an eigenvalue of matrix $A$ be λ= -1and let $A + I$ reduces to $\begin{bmatrix} 1 & 0 & -2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$, then which one of the following is an eigenvector of $A$ corresponding to the eigenvalue λ= -1 ?

A) $\begin{pmatrix} 2t \\ s \\ t \end{pmatrix}, t, s \in \mathbb{R}$ B) $\begin{pmatrix} 2t \\ 0 \\ t \end{pmatrix}, t \in \mathbb{R}$ C) $\begin{pmatrix} t \\ s \\ 2t \end{pmatrix}, t, s \in \mathbb{R}$

D) $\begin{pmatrix} t \\ 0 \\ t \end{pmatrix}, t \in \mathbb{R}$

_____4. For the matrix $A = \begin{pmatrix} 2 & 1 \\ 3 & 0 \end{pmatrix}$ which of the following is correct?

A) $v_{1=} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$ is an eigenvector of A C. $v_3 = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$ is an eigenvector of A

B) $v_2 = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$is an eigenvector of A D. $v_4 = \begin{pmatrix} -3 \\ 1 \end{pmatrix}$ is an eigenvector of A

_____5. Which of the following is the characteristic equation of A= $\begin{pmatrix} 1 & -6 \\ 1 & 2 \end{pmatrix}$?

A)$\lambda^2 - 3\lambda+8$ B) $\lambda^2 + 3\lambda+4$ C) $\lambda^2 + 3\lambda+4 = 0$ D) $\lambda^2 -$

$3\lambda + 8 = 0$

_____6. If $f\ (t)$ is the characteristic polynomial of a square matrix A, then

$f\ (0)$=_____

A) $a_1$ B) $a_0 + a_1$ C) $a_0$ D. Undetermined

_____7. Let A=$\begin{pmatrix} 1 & -2 \\ 4 & 5 \end{pmatrix}$ be given. If $f(t) = t^2 + 3t + 7$, then $f(A)$=_____

A) $\begin{pmatrix} 7 & 0 \\ 0 & 7 \end{pmatrix}$ B) $\begin{pmatrix} -3 & -6 \\ 12 & 9 \end{pmatrix}$

C) $\begin{pmatrix} 3 & -18 \\ 36 & 39 \end{pmatrix}$ D) $\begin{pmatrix} -4 & -18 \\ 36 & 32 \end{pmatrix}$

_____8. Which of the following is **true**?

A. The eigenvalue of a matrix are on its main diagonal

B. $A$ and $A^2$ have the same eigenvectors

C. The degree of the characteristic polynomial of an $n \times n$matrix is at most $n-1$.

D. If two matrices have the same characteristic polynomial, then they have the same eigenvectors.

_____9. Let A and B are square matrices such that $AB = I$, then zero is an eigenvalue of_____

A) matrix $B$B) Matrix $A$C) Both matrices $A$ and $B$ D) Neither matrix $A$ nor $B$

_____10. If a $2 \times 2$ matrix $A$has eigenvalues $\lambda$ =-1 and $\lambda = 4$, then what are the eigenvalues of $3A$?

A) -1& 4 B) 2 & 7 C) -3 &12 D) Cannot be determined

## 2. Algebra Achievement Test1

**Linear Algebra II (Test I) Time allowed 1:30hrs.**

Name_____Id.

No_____University_____

Do you have an experience in using internet or computer to learn algebra? Yes__ No__

***Instruction*: attempt all questions and choose the best answer among the given alternatives**

1. If $A = \begin{pmatrix} 0 & -2 \\ 1 & 3 \end{pmatrix}$, then $A^{10}$=_____

A) $\begin{pmatrix} 0 & 1024 \\ 1 & 59049 \end{pmatrix}$ B) $\begin{pmatrix} 1022 & 2046 \\ 1023 & 2045 \end{pmatrix}$

C) $\begin{pmatrix} -1022 & -2046 \\ 1023 & 2047 \end{pmatrix}$ D) $\begin{pmatrix} 0 & -1024 \\ 1 & -59049 \end{pmatrix}$

2. Let $A$ be a $2 \times 2$ matrix whose eigenvalues are $\lambda_1 = 4$ and $\lambda_2 = 5$ and the associated eigenvectors are $v_1 = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$ and $v_2 = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$ respectively. Then find a diagonal matrix $D$ that is similar to $A$.

A) $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$ B) $\begin{pmatrix} 4 & 0 \\ 0 & 5 \end{pmatrix}$ C) $\begin{pmatrix} 5 & 0 \\ 0 & 2 \end{pmatrix}$ D) $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

3. Which of the following matrix is diagonalizable?

A) $\begin{pmatrix} 5 & -3 \\ 3 & -1 \end{pmatrix}$ B) $\begin{pmatrix} 16 & -9 \\ 25 & 14 \end{pmatrix}$ C) $\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$ D) $\begin{pmatrix} 2 & 0 \\ -5 & 3 \end{pmatrix}$

4. Which of the following is true?

A) If an $n \times n$ matrix has $n$ distinct eigenvectors, then it is diagonalizable

B) If two matrices have the same characteristic polynomial, then they have the same eigenvector

C) A diagonal matrix is diagonalizable

D) Every diagonalizable $n \times n$ matrix has $n$ distinct eigenvalues

5. Find a $2 \times 2$ matrix having eigenvalues $\lambda_1 = 7$ and $\lambda_2 = -4$,with the corresponding eigenvectors $v_1 = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$ and $v_2 = \begin{pmatrix} 1 \\ -2 \end{pmatrix}$ respectively.

A) $\begin{pmatrix} -26 & -11 \\ 66 & 29 \end{pmatrix}$ B) $\begin{pmatrix} -7 & -4 \\ 21 & 8 \end{pmatrix}$ C) $\begin{pmatrix} 26 & 5 \\ 6 & -9 \end{pmatrix}$ D) $\begin{pmatrix} 2 & 1 \\ 3 & 1 \end{pmatrix}$

6. Find the minimal polynomial of $A = \begin{pmatrix} 2 & 1 & 1 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}$.

A) $m(t) = (t-2)^3$ C) $m(t) = t - 2$

B) $m(t) = (t-2)^2$ D) $m(t) = t + 2$

7. What is the spectral radius of $A = \begin{pmatrix} 3 & -2 \\ 4 & -1 \end{pmatrix}$?

   A) 2 B) $\sqrt{2}$ C) 5 D)$\sqrt{5}$

8. Find a matrix $P$ that diagonalizes$A = \begin{pmatrix} -9 & 12 \\ -6 & 9 \end{pmatrix}$.

   A) $P = \begin{pmatrix} 3 & -3 \\ 4 & -1 \end{pmatrix}$ B) $P = \begin{pmatrix} 1 & 2 \\ 4 & -1 \end{pmatrix}$ C) $P = \begin{pmatrix} 1 & 2 \\ 1 & 1 \end{pmatrix}$ D) $P = \begin{pmatrix} 1 & -2 \\ 1 & 1 \end{pmatrix}$

9. Which of the following is Cayley-Hamilton theorem about an $\boldsymbol{n \times n}$matrix$\boldsymbol{A}$?

   A) There exists a unique monic polynomial $f$ of lowest degree such that $f(A) = 0$

   B) The minimal polynomial of $\boldsymbol{A}$ divides every polynomial that satisfies $f(A) = 0$

   C) Matrix $\boldsymbol{A}$satisfies its own characteristic equation

   D) Every eigenvalue of $\boldsymbol{A}$ is a zero of the minimal polynomial

10. If a square matrix of order 10 has exactly 5 distinct eigenvalues, then the degree of the minimal polynomial is_____

    A. At least 5 B) exactly 10 C) at most 5 D) Cannot be determined

## 3. Algebra Achievement Test2

**Linear Algebra II (Test II) Time allowed 1:30 hrs.**

Name_____Id. No_____University_____

***Instruction*: attempt all questions and choose the best answer among the given alternatives**

_____1. Consider$f(t) = 3t - 5$ and $g(t) = t^2$ in the polynomial space $p(t)$ with inner product defined by $\langle f,\ g\rangle = \int_0^1 f(t)g(t)dt$ then$\langle f,\ g\rangle$=_____

A) $\frac{29}{12}$ B) $\frac{11}{12}$ C) $\frac{-11}{12}$ D) $\frac{-29}{12}$

_____2. In question 1, find $\|f\|$

A) $\sqrt{3}$ B) 3 C) 13 D) $\sqrt{13}$

_____3. Let $= \begin{pmatrix} 2 \\ -1 \\ 3 \end{pmatrix}$ , $w = \begin{pmatrix} 1 \\ 4 \\ -2 \end{pmatrix}$, $z = \begin{pmatrix} -8 \\ 3 \\ 2 \end{pmatrix}$then which pairs of these vectors are orthogonal?

A) $v$ & $w$ B) $z$ & $w$ C) $v$ & $z$ D) None of the above

_____4. Compute the distance between the vectors $v = (7, 6)$ and $w = (5, 3)$

A) $2\sqrt{3}$ B) $\sqrt{3}$ C) $2\sqrt{5}$ D) $\sqrt{13}$

_____5.Find $k$ so that $v = (1, 2, k, 3)$ and $w = (3, k, 7, -5)$ in $\mathbb{R}^4$ are orthogonal

A) 12 B) 9 C) $\frac{3}{4}$ D) $\frac{4}{3}$

_____6. Construct an orthogonal set of vectors from the linearly independent sets $\{v_1, v_2, v_3\}$, where $v_1 = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$, $v_2 = \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$, $v_3 = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$ (**Hint**: use the Gram-schmidt orthogonalization process)

A) $\left\{ \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} -\frac{1}{2} \\ \frac{1}{2} \\ 1 \end{pmatrix}, \begin{pmatrix} \frac{2}{3} \\ -\frac{2}{3} \\ 2/3 \end{pmatrix} \right\}$ C) $\left\{ \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} \frac{1}{2} \\ \frac{1}{2} \\ 1 \end{pmatrix}, \begin{pmatrix} \frac{2}{3} \\ \frac{2}{3} \\ 1 \end{pmatrix} \right\}$

B) $\left\{\begin{pmatrix}\frac{1}{\sqrt{2}}\\ \frac{1}{\sqrt{2}}\\ 0\end{pmatrix}, \begin{pmatrix}1\\0\\1\end{pmatrix}, \begin{pmatrix}\frac{2}{3}\\ \frac{1}{3}\\ 1\end{pmatrix}\right\}$ D) $\left\{\begin{pmatrix}1\\1\\0\end{pmatrix}, \begin{pmatrix}\frac{2}{3}\\ -\frac{2}{3}\\ \frac{1}{3}\end{pmatrix}, \begin{pmatrix}\frac{1}{\sqrt{2}}\\ \sqrt{2}\\ 1\end{pmatrix}\right\}$

_____7.Which of the following is **true**?

A) A linear operator $T$ is said to be isometry if it preserves length

B) Operators and their adjoint have the same eigenvector

C) In QR factorization of matrix both factors are upper triangular matrix

D) Every linear operator preserves dot product

_____8. Which of the following is orthogonal sets?

A) $\{(1,-1,2),(0,2,-1),(-1,1,1)\}$ C) $\{(0,1,0,-1),(1,0,1,1),(-1,1,-1,2)\}$

B) $\{(3,5,4),(3,-5,4),(4,0,-3)\}$ D) $\{(1,0,0,0),(2,1,1,1),(-1,2,3,1)\}$

_____9. Which of the following is orthonormal set?

A) $\left\{\left(\frac{1}{3},\frac{2}{3},\frac{2}{3}\right),\left(\frac{2}{3},\frac{1}{3},-\frac{2}{3}\right),\left(\frac{2}{3},-\frac{2}{3},\frac{1}{3}\right)\right\}$ C) $\{(0,2,2,1),(1,1,-2,2),(0,-2,1,2)\}$

B) $\left\{\left(\frac{1}{\sqrt{2}},0,-\frac{1}{\sqrt{2}}\right),\left(\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}}\right),(0,1,0)\right\}$ D)$\{(3,5,4),(3,-5,4),(4,0,-3)\}$

_____10. Which of the following is an orthogonal matrix?

A) $\begin{pmatrix}2 & -1 & -2\\ 2 & 2 & 1\end{pmatrix}$ C) $\begin{pmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 1 & 0 & 0\end{pmatrix}$

B) $\begin{pmatrix}1 & 1\\ 1 & -1\end{pmatrix}$ D) $\begin{pmatrix}1 & 1 & 1\\ 1 & -1 & 1\\ 1 & 0 & -2\end{pmatrix}$

## 4. Algebra Achievement Posttest

**Linear Algebra II (Posttest) Time allowed 1:30 hrs.**

**Name_____Id. No_____University_____**

**Instruction: attempt all questions and choose the best answer among the given alternatives**

_____**1.** Which of the following matrix is invertible over $F$E***rror***! ***Bookmar***k not defined.?

A) $A = \begin{pmatrix} 1 & x \\ x+1 & x+3 \end{pmatrix}$ B) $B = \begin{pmatrix} x & x \\ x+1 & x+3 \end{pmatrix}$

C) $C = \begin{pmatrix} x & x \\ x & x^2+1 \end{pmatrix}$ D) $D = \begin{pmatrix} x & x-1 \\ x+1 & x \end{pmatrix}$

_____2. Find the Jordan canonical form of $A = \begin{pmatrix} 1 & 2 & -1 \\ 0 & 2 & 0 \\ 1 & -2 & 3 \end{pmatrix}$

A) $\begin{pmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}$ B) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$ C) $\begin{pmatrix} 2 & 0 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 2 \end{pmatrix}$ D) $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{pmatrix}$

_____3. Find the normal canonical form of matrices similar to the matrix A given in question 2

A) $\begin{pmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 2 \end{pmatrix}$ B) $\begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 8 & -8 & 6 \end{pmatrix}$ C) $\begin{pmatrix} 2 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -4 & 4 \end{pmatrix}$ D) $\begin{pmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 0 & 4 & -4 \end{pmatrix}$

_____4. Find the 2nd -order minor of $A = \begin{pmatrix} x & 2 & 0 \\ 0 & 2 & x \end{pmatrix}$

A. $\{2x, x^2\}$ B) $\{2x, 2x^2\}$ C) $\{0, 2x^2\}$ D) $\{0, 2x, 2x^2\}$

**For question 5-7 consider the matrix** $\boldsymbol{B} = \begin{pmatrix} \mathbf{1} & \mathbf{0} & \mathbf{2} \\ \mathbf{0} & \mathbf{6} & \mathbf{1} \\ \mathbf{3} & \mathbf{1} & \mathbf{-2} \end{pmatrix}$

_____5. Find the determinantal divisors of matrix B

A) $\{d_1 = 2, d_2 = 12, d_3 = 432\}$ B) $\{d_1 = 1, d_2 = 2, d_3 = 49\}$

C) $\{d_1 = 1, d_2 = 1, d_3 = 49\}$ D) $\{d_1 = 1, d_2 = 12, d_3 = 432\}$

_____6. Find the invariant factors of matrix B

A) $\{f_1 = 2, f_2 = 12, f_3 = 432\}$ B) $\{f_1 = 1, f_2 = 2, f_3 = 49\}$

C) $\{f_1 = 1, f_2 = 1, f_3 = 49\}$ D) $\{f_1 = 1, f_2 = 12, f_3 = 432\}$

_____7. Find the smith canonical form of matrix B

C) $\begin{pmatrix} 2 & 0 & 0 \\ 0 & 12 & 0 \\ 0 & 0 & 432 \end{pmatrix}$ B) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 49 \end{pmatrix}$ C) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 49 \end{pmatrix}$ D) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 12 & 0 \\ 0 & 0 & 432 \end{pmatrix}$

_____8. Find the rational canonical form of $A = \begin{pmatrix} 5 & 1 \\ -9 & -1 \end{pmatrix}$

A) $\begin{pmatrix} 0 & 1 \\ 4 & -4 \end{pmatrix}$ B) $\begin{pmatrix} 0 & 1 \\ -4 & 4 \end{pmatrix}$ C) $\begin{pmatrix} 0 & 1 \\ -4 & -4 \end{pmatrix}$ D) $\begin{pmatrix} 0 & 1 \\ 4 & 4 \end{pmatrix}$

_____9. Which of the following is true about smith canonical form?

A) Diagonal entries are invariant factors B) Every entry off diagonal is positive

C) Diagonal entries are eigenvalues D) Diagonal entries are block matrices

_____10. If the similarity invariants of matrix A are $\{1,1,1,(x+2)^2,(x-2)(x+2)^2\}$ then find the rational canonical form of A

$A)\ \begin{pmatrix} 0 & 1 \\ 4 & 4 \end{pmatrix}$ B $\begin{pmatrix} 0 & 1 \\ 4 & 4 \end{pmatrix}$ C) $\begin{pmatrix} 0 & 1 & 0 & 0 \\ -4 & -4 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & -4 & 0 \end{pmatrix}$ D)

$\begin{pmatrix} 0 & 1 & 0 & 0 \\ 4 & 4 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 4 & 0 \end{pmatrix}$

## Appendix H: Permission Letters from Addis Ababa University

### 1. Letter to Experimental Group1

አዲስ አበባ ዩኒቨርስቲ
ሥነ-ትምህርትና ጠባይ ጥናት ኮሌጅ
የላይንስና ሒሳብ ትምህርት ክፍል
አዲስ አበባ፣ኢትዮጵያ

Addis Ababa University
College of Education and Behavioral Studies
Department of Science & Mathematics Education
Addis Ababa, Ethiopia

**Date: February 01, 2017**
**Ref. No.: SMED/070/2009-17**

To: Wachemo University
Hossana

**Subject: requesting cooperation for research work**

Mr. Aweke Shishigu is a PhD candidate at the department of science and mathematics education. He has requested the department to write him an official letter to collect data from your institution.

The department has ratified his research entitled "Learning Mathematics through Blended Learning Approach and Students' Affection" as requiring intensive computer Laboratory with internet access. This is therefore; to kindly request your usual cooperation for Aweke shishigu in permitting him to use comp. Laboratory, use your local server as needed by the study and other necessary support during his stay in your institution for the smooth execution of the research work.

With Regards,

Kassa Micheal (PhD)
Chairman, Department of Science and Mathematics Education

☎ 011 1 22 07 67 ✉ 1176

## 2. Letter to Experimental Group2

አዲስ አበባ ዩኒቨርስቲ
ሥነ-ትምህርትና ጠባይ ጥናት ኮሌጅ
የሳይንስና ሒሳብ ትምህርት ክፍል
አዲስ አበባ፣ኢትዮጵያ

Addis Ababa University
College of Education and Behavioral Studies
Department of Science & Mathematics Education
Addis Ababa, Ethiopia

**Date: February 01, 2017**
**Ref. No.: SMED/072/2009-17**

To: Wolkite University
Wolkite

**Subject: requesting cooperation for research work**

Mr. Awoke Shishigu is a PhD candidate at the department of science and mathematics education. He has requested the department to write him an official letter to collect data from your institution.

The department has ratified his research entitled "***Learning Mathematics through Blended Learning Approach and Students' Affection***" as requiring intensive computer Laboratory. This is therefore; to kindly request your usual cooperation for Mr. Awoke Shishigu in permitting him to use comp. Laboratory, as needed by the study and other necessary support during his stay in your institution for the smooth execution of the research work.

With Regards,

Kassa Micheal (PhD)
Chairman, Department of Science and Mathematics Education

☎ 011 1 22 07 67 ✉ 1176

## 3. Letter to Comparison group

አዲስ አበባ ዩኒቨርስቲ
ሥነ-ትምህርትና ባሕሪይ ጥናትኮሌጅ
የሳይንስና ሒሳብ ትምህርትክፍል
አዲስ አበባ፣ኢትዮጵያ

Addis Ababa University
College of Education and Behavioral Studies
Department of Science & Mathematics Education
Addis Ababa, Ethiopia

**Date: March 21, 2017**

**Ref. No.: SMED/094/2009-17**

**To: Hawassa University**
**Hawassa**

**Subject: Requesting Cooperation for Research Work**

Mr. Aweke Shishigu is a PhD candidate at the department of science and mathematics education. He has requested the department to write him an official letter to collect data from your institution. The department has ratified his research entitled "Learning Mathematics through Blended Learning Approach and Students' Affection"as requiring intensive computer Laboratory. This is therefore; to kindly request your usual cooperation for Aweke shishigu in permitting him to use comp. Laboratory, as needed by the study and other necessary support during his stay in your institution for the smooth execution of the research work.

With Regards

Kassa Micheal (PhD)
Chair, Department of Science & Mathematics Education

☎ 011 1 22 07 67
✉ 1176

## Appendix I: Blended Learning Course outline

# Blended Learning Course Outline

| | | |
|---|---|---|
| Department | Mathematics | |
| Module name | Linear algebra | |
| Module no. | 04 | |
| Module code | M2041 | |
| Course title | Linear algebra II | |
| Course code | Math2042 | |
| Pre-requisite | Math2041 | |
| Status of the course | compulsory | |
| Credit hour | 3 | |
| Course EtCTS | 5 | |
| Target group | Second year mathematics students | |
| Semester | II | |
| Instructor information | Name: (removed)<br>Mobile No: (removed)<br>E-mail: (removed)<br>Consultation hour: T/A | |

**Method of instruction – Blended learning**

***What Does Blended Learning Mean in this Course?***

This course will be offered in a blended learning format incorporating teaching and learning activities which use information communications technologies particularly the Internet. This is characterized by slight reduction of the scheduled face-to-face lecture and tutorial time. You will be working with a Web-based learning management system called Moodle. Materials and assignments will be provided through the site indicated below. Discussion ideas or questions will be formed by any one of you and all students have a chance to participate and access all conversation usually written as a solution to questions being raised. The instructor and course administrator will follow and shape all conversations. Completing all activities is mandatory.

| | |
|---|---|
| **Course learning platform** | Website: https://aweblendedlearning.moodlecloud.com<br>Enrolment key: 2121<br>Course Administrator: Aweke Shishigu<br>Mobile No: 0913012770<br>E-mail: awekeu@gmail.com<br>Request ***mobile version*** from the course administrator |
| **Computer Labs** | Computer Labs with internet access will be arranged for your use outside of regular class at least once a week. |

**Course Description:** This course covers the characteristic equation of a matrix, orthogonality, matrix factorizations, canonical forms, direct sum decomposition of vector spaces, bilinear, quadratic and positive definite forms

**Course Objectives:** On completion of the course, successful students will be able to:

- Find the eigenvalues and eigenvectors of a square matrix,
- Identify similar matrices,
- Diagonalize matrix when it is possible,
- Define inner product space,

| | | |
|---|---|---|
| o Find and apply the LU factorization of a matrix, - understand the Gram-Schmidt process,<br>o Find an orthogonal basis for a subspace,<br>o Find an orthogonal complement of a subspace,<br>o Recognize and invert orthogonal matrices,<br>o Comprehend the three canonical forms of matrices. | | |
| **Date** | **Content** | **Remark** |
| Week 1 | **Chapter 1:The characteristic equation of a matrix**<br>1.1 Eigen values and eigenvectors<br>1.2 The characteristic polynomial | *No lab work, only classroom lecture* |
| | **Algebra achievement pretest** | |
| Week 2 | 1.3 Similarity of matrices and characteristic polynomial<br>1.4 The spectral radius of a matrix | *Lecture + Lab work* |
| Week 3 | 1.5. Diagonalization<br>1.6. Decomposable matrices<br>1.7. Minimal polynomial and Cayley-Hamilton theorem | *Lecture + Lab work* |
| | **Algebra achievement test1** | |
| Week 4 | **Chapter 2: Orthognality**<br>2.1. The inner product<br>2.2. Inner product spaces | *Lecture + Lab work* |
| Week 5 | 2. 3. Orthonormal sets<br>2.4. The Gram-Schmidt orthogonalization process<br>2.5. Cauchy-Schwartz and triangular inequalities | *Lecture + Lab work* |
| Week 6 | 2.6. The dual space<br>2.7. Adjoint of linear operators<br>2.8. Self-adjoint linear operators | *Lecture + Lab work* |
| Week 7 | 2.9. Isometry<br>2.10. Normal operators and the spectral theorem | *Lecture + Lab work* |
| Week 8 | 2.11. Factorization of a matrix (LU, Cholesky, QR)<br>2.12. Singular value decomposition | *Lecture + Lab work* |
| | **Algebra achievement test 2** | |
| Week 9 | **Chapter 3: Canonical forms**<br>3.1. Elementary row and column operations on matrices<br>3.2. Equivalence of matrices of polynomials<br>3.3. Smith canonical forms and invariant factors | *Lecture + Lab work* |
| Week 10 | 3.4. Similarity of matrices and invariant factors<br>3.5. The rational canonical forms | *Lecture + Lab work* |
| Week 11 | 3.6. Elementary divisors<br>3.7. The normal and Jordan canonical forms | *Lecture + Lab work* |
| | **Algebra achievement posttest** | |
| Week 12 | **Chapter 4: Bilinear and quadratic forms**<br>4.1. Bilinear forms and matrices | *Lecture + Lab work* |
| Week 13 | 4.3. Symmetric bilinear forms and quadratic forms | *Lecture + Lab work* |
| Week 14 | 4.4. Real symmetric bilinear forms ,positive definite forms | *Lecture + Lab work* |
| | **Quiz** | |
| Week 15 | **Chapter 5: Direct sum decomposition of vector** | *Lecture + Lab* |

| | | |
|---|---|---|
| | **spaces**<br>5.1. Definition of a direct sum of vector spaces<br>5.2. Projection and invariant subspaces of a linear operator | *work* |
| Week 16 | 5.3. Primary decomposition theorem | *Lecture + Lab work* |
| **Assignment + presentation** | | |
| **Final Examination (chapter 4&5)** | | |
| **Assessment** | 1. Test (1,2,3)……..…30%<br>2. Assignment…….…… 10%<br>3. Quiz…….……5%<br>4. Presentation…….5%<br>5. Final exam……..…50%<br>6. Total……..….100%<br>**Grading**: as per the university grading system | |
| Course policy | A student has to:<br>✓ Attend all classes including lab sessions<br>✓ Take all continuous assessments<br>✓ Take final exam<br>✓ Respect all the university rules and regulations | |
| **Text books**<br>**1.** Demissu Gemeda. (2005). *Topics in linear algebra*, Addis Ababa University<br>**2.** Seymour Lipschutz (2009). *Shaum's Outline Series: Theory and Problems of Linear Algebra (4th edition)*, McGRaw-Hill Inc, USA.<br>**References**<br>1. Lawrence E. Spence, A. Insel and S. Friedberg (2008). *Elementary linear Algebra*, Pearson education, USA.<br>2. Stephen H. Friedberg, Arnold J. lnsel, and Lawrence E. Spence (1989). *Linear Algebra (4th edition)*, Prentice-Hall, USA.<br>3. Kenneth Hoffman,. (1971). , *Linear Algebra, (2nd edition*, Prentice-Hall Inc, New Jersey.<br>4. Richard Bronson and Gabriel B. Costa. (2007). ***Linear** Algebra, an Introduction (2nd edition).*Elsevier Inc, USA. | | All text books and other supplementary materials are available on the platform |

## Appendix J: Table of Specification for Algebra Achievement Tests

| Test | Understanding of algebra concepts (40%) | Computations (30%) | Logical reasoning (30%) |
|---|---|---|---|
| Algebra achievement pretest | 4 | 3 | 3 |
| Algebra achievement test1 | 4 | 3 | 3 |
| Algebra achievement test2 | 4 | 3 | 3 |
| Algebra achievement posttest | 4 | 3 | 3 |