UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

Assessing the Effectiveness of Online Collaborative Learning on Students' Knowledge Construction in Higher Education

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A research project submitted to the School of Computing and Informatics in partial fulfillment of the requirements for the award of the degree of Master of Science in Information Technology Management of the University of Nairobi.

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DECLARATION

Student Declaration

I Ruth Awuor Okoth, student registration number P54/85649/2016, hereby declare that this MSc. Project entitled Assessing the Effectiveness of Online Collaborative Learning on Students' Knowledge Construction in Higher Education to the best of my knowledge and belief, is my original work and has not been submitted for examination in this university or other universities for an award of any other degree.

Signature ……. Date……..

RUTH AWUOR OKOTH

P54/85649/2016

Supervisor's declaration

This research has been submitted for review with my approval as a university supervisor.

Signature…… Date …….....

PROF. ROBERT O. OBOKO

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DEDICATION

This work is dedicated to my dear parents, uncle and my entire family members.

ACKNOLEDGMENT

I am deeply grateful to God Almighty for the strength, good health and financial support granted during this project.

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ABSTRACT

Online collaborative learning is characterized by a number of elements: high level of negotiation, common goal and interaction. Effective online learning in a group, is a useful way of helping learners acquire skills and enhance learning skills such as self-reflection, critical thinking, and co-construction of knowledge. However, executing online collaborative learning are not always constructive and learners facing of challenges during interaction. To resolve this, it is essential to discover and understand the elements that contribute to knowledge construction in a CSCL environment. In this paper, we conducted research on first-year students of different disciplines at the university (Jkuat-Karen Campus) in Kenya. A census strategy from the selected group was drawn and questionnaire administered for data collection. Qualitative data was collected from the Moodle Learning management system platform at the end of the semester. The content theme was guided by a coding scheme developed by Harasim 2012.

Based on the results, the predictor variables Educational technology, instructional design, students' characteristics and discourse strategies contributed to knowledge construction on online learners. The research further analyzed qualitative data using quantitative content analysis to establish the presence of collaboration and the level of knowledge construction. The level of knowledge construction was higher at idea organization compared to idea generation.

Research findings are useful to the Higher Learning institutions offering online courses, as well as provide favorable standards and guidance for effective collaborative learning for the 21st century learning skills. The framework could also be used by instructional online designers and developers.

Keywords:

Online learning collaboration, effective e-collaboration, Students' knowledge construction, effective online interaction, Learning Management System (LMS), CSCL.

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LIST OF ACRONYMS AND ABREVIATIONS

CSCW	Computer supported collaborative work.
LMS	Learning Management System
CSCL	Computer-supported Collaborative Learning
ICT	Information Communication Technology
HLI	Higher Learning Institution
CTs	Collaborative Technologies
ACT	Asynchronous conferencing technologies
ODeL	Open Distance and e-Learning
HE	Higher Education
JKUAT	Jomo Kenyatta University of Agriculture and Technology
BPCM	Bachelor of Purchase and Contract Management
BCOM	Bachelor of Commerce
IT	Information Technology

DEFINITION OF TERMS

Scaffolding – Gradually building on participants' previous experience Salmon (2013). It can also be referred to as processes that support individual learning efforts.

Metacognitive skills - Salmon (2013), people's understanding and control of their own thinking.

Pedagogy- Teaching strategies, techniques and approaches instructors use to deliver contents and facilitate learning.

Corpora- collection of writings used for learning.

Learning Management System (LMS): Web-based software used for tracking, delivery of online learning in the institution and interaction among e-learners. It's used as a communication tool by the online knowledge community, track learner's competencies and operate as instructional resource repository.

Online learning- an education that occurs only through the Web. It does not consist of any physical learning materials issued to students or actual face-to-face contact.

Collaboration- Two or more people working together on a common task (Zigurs & MUNKVOLD, 2014), and can take different forms like learner-instructor, learner-learner and learner–content interaction.

Knowledge Construction- Knowledge construction is considered as an inquiry-based theory of learning Dillenbourg and Fischer (2007), and it's acquired in stages or phases.

Educational Technology: Tools and applications committed to the development and promotion of learning. Michael Spector defines Educational technology as the application of knowledge for the purpose of improving learning and students' performance.

Instructional Design: It's the execution of online learning platforms' design, development, management and utilization of learning resources. A good instructional design is expected to present content in simple and meaningful ways.

Students' characteristics: Various student's traits that eventually influence students' academic performance.

Discourse Strategies: Discourse refers to speaking or writing authoritatively about a topic. Depending on the context with which discourse strategy is used, it's referred to as communication strategy, teaching strategies, online discussion devices or strategies.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Rapid advances in information and communications technologies have enabled businesses and institutions to become truly global in scope. The growing number of students' enrollment in Kenyan universities and the declining number of qualified lecturers have created demand and challenge to universities in attending to students' learning needs as required. The ratio of lecturer to student has been a critical issue for the last decade.

Online learning in Kenyan universities is facilitated by the use of Learning Management System (LMS), e-collaboration tools, instructors and or incorporate e-collaboration tools on LMS. Lwoga, (2012) noted the great pressure for tertiary education in Africa not matching the growth of existing resources and facilities, and is not offered to remarkable portions of the population. According to Blackmon (2012), the university classrooms or lecture halls has been expanding beyond the traditional accommodations of brick and mortar buildings to the virtual classroom space. This remains a test for most universities especially when the first-year intake is done, as lecture halls are limited. Insufficient allocation of funds to public universities has forced universities to invent new ways to earn income, expand infrastructure through e-learning to accommodate for the growing number of students joining universities (KNBS, 2015) and ensure effective teaching, learning and research. Another factor that led to the introduction of ODeL is the family commitment among women (Nyerere, Gravenir, & Mse, 2012), the invention of ODeL has enabled women to access education at the comfort of their homes any time, and at the same time attending to their families. Social values and critical thinking are some of the skills expected of university graduates by employers or the society at large. However, this has been a challenge according to the debates in the public domain. The quality of online knowledge construction by university graduates keep raising questions with which e-learning courses are conducted compared to face-to-face teaching and learning in normal classrooms.

In order to serve the new demands, universities have started to find new educational technologies to adjust instructional teaching. Virtual campuses are established in Open and Distance learning (ODel) departments in campuses to promote learning methodologies that enhance learning through interactions among learners. The adoption of LMS assists universities to address the growing numbers of learners, the shortage of lecturers and limited space or infrastructure, where students

enroll for online courses and access the content at their own convenient time and place. The main factors that have made e-learning the most promising educational technology are cost, services, speed and quality (Arkorful & Abaidoo, 2015). The integration of e-learning and e-collaboration technologies can be used to encourage active learning, where instructors are facilitators and assessors of learning activities. E-collaborative technologies and systems are integrated on e-learning platforms to enhance learning and teaching, and to help manage the growing demand for education. In addition, these tools enhance teamwork and develop competence. Web 2.0 is a sample of a collaborative technology used on e-learning as supported by (Mbatha, 2014; Brindley, Blaschke, & Walti, 2009) in their studies.

Dillenbourg and Fischer (2007), supports the notion that knowledge construction develops in a collaborative learning environment where learners communicate and share information for solving a given task or problem. Knowledge construction is considered as an inquiry-based theory of learning, as this is evident from the most literature on knowledge building (Yücel & Usluel, 2016; Rahman et al., 2011). Individual learners should understand that knowledge is neither complete nor certain but with good judgment, careful reasoning and arguments, it's possible to construct and attain knowledge. The 21st-century learners require more avenues for creativity, innovation, and collaboration, accommodated by online learning environments through various instructional models providing services anytime anywhere. In tandem with Binkley *et al*., (2012), the success of 21st-century skills' consist of one being able to share, communicate and use information acquired to solve problems, innovate and respond to changing demands, create new knowledge and increase productivity. Therefore there is greater need to ensure these skills are achieved in CSCL platforms. The intention of advancing effective knowledge construction through a collaborative investigation is to provide a supporting culture and encourage understanding of a theme or topic rather than memorization. The researcher, therefore, attempts to clarify undisclosed major elements of CSCL environment enhancing students' knowledge construction and meaning making at the university level. Institutions and online participants use knowledge in different important ways to create value, taking into account the richness of ideas that arise under the online discussion platforms (LMS).

The Kenyan ICT government strategy initiated and introduced the use of online learning as a means to deliver and enhance learning in schools. The desire to implement online learning started in the year 2006, but a serious implementation started in 2013, where the school of Open Distance

and eLearning was established to run and manage online programs. Currently, there are about 400 postgraduate students of JKUAT in Distance eLearning and more than 1,000 first-year students doing common units online i.e HIV/AIDS and communication skills, according to the statistics provided by the office. Kihoro (2014) noted that the introduction of online learning contributed to cost reduction on teaching the units. Online learning was introduced at Karen-Campus in the year 2016 January, since then, first-year students have been equally undertaking common units online.

1.2. Problem Statement

Most universities in Kenya have embraced the use of technology in teaching, learning and research activities (Makokha & Mutisya, 2016). Open Distance and e-Learning platforms are developed to enable learners to access learning materials from anywhere and at their own convenient time, however, students are unable to collaborate actively and attain knowledge during the learning process. Learning in a CSCL environment is transforming the nature of how knowledge is constructed and higher order meaning is achieved online. Irrespective of Kenyan universities embracing the use of instructional technologies, most are unaware of how to effectively utilize online learning platforms in order to enhance learning and construct knowledge as required. In addition, there are a number of perceived challenges experienced by online learners as discussed by Muuro et al. (2014) and Le, Janssen, and Wubbels, (2018), which must be addressed to promote effective online learning. From the report of the status of e-learning in Kenya shows that most learners use online learning to download notes and access CATs online Makokha and Mutisya, (2016), instead of actively utilizing the online platform to construct knowledge and make meaning. Häkkinen et al., (2010), also noted that challenges of online collaboration are derived from participants' cognitive, emotional and social activities. This, therefore, leads to lack of constructive learning and knowledge creation among online university learners. Despite positive effects of using asynchronous platforms by students, Koutsabasis et al., (2011) mentions that it is still largely unclear about how to apply online collaboration in the 21st-century education. The possibility of increased use of asynchronous platforms and high potential for improving teamwork performance, completion of learning activities, shared learning experiences and most importantly knowledge creation on a CSCL environment, leads us to this research. Lastly, Muuro, Wagacha, Kihoro, and Oboko, (2014) gave a suggestion to examine the effectiveness of collaborative learning in

enhancing students' critical thinking and improve their level of knowledge in a blended e-learning platform, this gave us more incite to conduct a research on the proposed topic.

1.3 Objectives of the Study

The study were guided by the following objectives:

1.3.1 General Objective.

To assess the effectiveness of online collaborative learning on students' knowledge construction in HE: JKUAT.

1.3.2 Specific Objectives

i. To determine the effect of Educational technology on students' knowledge construction in a CSCL environment.
ii. To investigate the effect of instructional design on students' knowledge construction in a CSCL environment.
iii. To establish the effect of students characteristics on students' knowledge construction in a CSCL environment.
iv. To find out the effect of discourse strategies on students' knowledge construction in a CSCL environment.
v. To propose a model for establishing the effectiveness of online collaborative learning on students' knowledge construction in HE.

1.4 Research Hypothesis

H_1: Educational Technology has a significant effect on students' knowledge construction.

H_2: Instructional design has a significant effect on students' knowledge construction.

H_3: Student's characteristics have a significant effect on students' knowledge construction.

H_4: Discourse strategies have a significant effect on students' knowledge construction.

1.5 Significance of Study

The findings of the study are expected to be useful to the **university management**, by helping them identify ways of increasing knowledge construction among online learning students, hence making necessary decisions on the technology adoption and support.

To the **policymakers**, the information from this study will help policymakers properly formulate policies and strategies on the best practice on effective utilization of CSCL environment.

To the **instructors**, the findings will enhance teaching and communication techniques and give guidance on how to actively and effectively engage students online for a better learning outcome.
The research will help **students** know the benefits of utilizing e-learning tools and how to utilize learning platforms to gain skills in their life-long learning competencies and how to apply the online learning techniques.
The research findings will inform **instructional designers** on factors and elements/features promoting quality online learning in a CSCL environment, where student's knowledge construction is a priority. The study will add value to the growing body of literature on constructive online learning. The study identified gaps for further research.

1.6 Scope of the Study

The research was limited to the effectiveness of CSCL platform on students' knowledge construction at Jomo Kenyatta University of Agriculture and technology, Karen Campus. The research was limited to undergraduate students, it never interviewed post-graduate students or any member of staff. The presence and construction of knowledge examined was on a text-based forum on a Moodle platform in an asynchronous environment.

1.7 Assumptions

One of the main characteristics of this online learning is that it's active and interactive. The study was done in English, a link between higher order thinking and learning was expected. Students were required to construct/co-construct meaning from the learning materials provided online and from the texts posted by the e-moderator and peers. The Moodle platform provided for social interaction and the e-moderator should motivate students in using a variety of texts and materials. E-moderators assume the roles of meditating and facilitating learning than just imparting knowledge and information.
We assumed that all respondents answered questionnaires honestly and to the best of their knowledge and that the study instrument provided attributes required for the research study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter outlines the literatures that are related to the topic under study. It presents the theories related to the topic and a conceptual framework is developed and variables discussed. Empirical Review is discussed and research gap identified.

2.1.1 Online Collaborative Learning in a CSCL

Collaborative learning approach is based on Vygotsky's views of learning in a social, cultural and individual context and on constructivist learning theory. The concept of E-Learning in the educational environment is changing from the closed internal process to the global and open space. Technology-oriented e-learning focuses on the actual use of ICT in learning and training while pedagogically oriented e-learning focuses on the interactive processes that are in between the teacher the student. Online learning collaboration can be individual or group learning. According to de la Torre, Heradio, Jara, Sanchez, Dormido, Torres, and Candelas, (2013), collaborative tool supports learning paradigms, this includes; Reciprocal teaching here the session director is in control of the session and starts a collaborative session by inviting other virtual members, Problem-based learning here Students work in small groups to achieve a certain task or solve a problem, the teacher coordinates the learning, which helps to develop the students understanding and confidence, Cooperative work here division of tasks among members, where each member is responsible for a portion of the task to be achieved. Collaborative learning is defined by Zhu (2012), as a social interaction that involves a community of learners and teachers, where members acquire and share experience or knowledge. In online collaborative communities, learners can generate and share information, negotiate, practice critical thinking/reflection and build consensus. Activities in an online collaborative learning can take these forms; Sharing documents and edit documents online, synchronous communication like online chat and texting, online courses or workshops to learn something new and course instructors distributes assignments, guides the conversation, and responds to participants' questions either through email or comments.

Learning can be defined as the knowledge building process with an intention of building knowledge. Laurillard (2012) considered e-collaborative learning as the communicative shared-knowledge building process with shared-knowledge building goals through networked electronic tools and devices. E-collaborative tools enhance e-learning by enabling learners to interact socially, watch learning materials online, hold an online discussion, share documents online,

online chat and share knowledge. E-collaborative tools are also considered to enhance educational values, qualities, and effectiveness of various learning activities. The design of an online collaborative course according to Breen (2015), is organized to provide opportunities for learners to construct or build knowledge as a group toward a common goal.

2.1.2 Taxonomy of E-Collaborative tools

Supporting technologies differ in various uses and can attain a wide range of functionalities, such as publishing, communication, programming, mapping/navigation and immersion (Duncan, Miller, & Jiang, 2012). In order to fully understand the impact of such systems in groups and organizations, one has to have a good understanding of its typical features, alternative systems, as well as emerging new technologies available to people in context (Riemer, & Frößler, 2007).

Bafoutsou and Mentzas, (2002), did a research and classified e-collaboration tools according to the functions of those tools, such as; electronic workspace, Electronic meeting systems, computer conferencing and Group file and document handling. According to Gibbs, Ellis and Rein, (1991), the first approach to providing a classification of e-collaborative tools, is to distinguish them by when and where (time and space) the interaction takes place. Collaborative tools can be either at the same place or at the different place and the interaction can happen at the same time (synchronous) or at different times (asynchronous). Our study focuses on different time different place square.

Table 2.1: Time and place Matrix

	Same time (synchronous)	**Different time** (asynchronous)
Same place	Face to face meetings in classrooms / traditional classes	Electronic project rooms
Different place	Chats, videoconference	E-mails, discussion forums, LMS

Kraemer and King (1988) categorized GDSSs according to the software required, the hardware required, people they involve and the organizational data needed. Ellis et al (1991), classified e-

collaboration tools according to application-functionality and system coordination where they embraced four types of control models; form, procedure, conversation, or communication-structure oriented.

Jackson (2010), classified e-collaboration tools according to the features; security, ease of use and Integration. E-collaboration technologies can be categorized into two forms i.e. user participation and socialization. In user participation, software or user-generated content is shared or jointly used with members of a group. Examples include; Skype, the eBay seller evaluation, the Amazon recommendation service, or Wikipedia. In socialization, online social networks connect people with common interests and maybe blogs, Facebook or MySpace.

Lanubile, et al., (2010), classified Collaboration tools as used by software engineers or project-based software collaborators as follows; Version-Control Systems: allowing team members to share software artifacts in a controlled manner, Trackers: are used to cope with issues such as defects, requests for support, changes, and sits on a database where all team members can access through the web, Build tool: let projects maintain remote repository, create and schedule workflows. Modelers: help developers create formal or semiformal software artifacts, Communication tools: both asynchronous and synchronous. Web 2.0 applications enable direct contributions, rich interactions, and community building.

2.1.3 Expected Learning Outcomes within a CSCL

Learning outcomes of each individual learner or groups in a CSCL environment refers to a specific skill, knowledge, attitudes and behaviors acquired during collaborative learning. Stahl, Ludvigsen, Law, and Cress, (2014), coined Koschmann's definition of CSCL as a research community producing papers concerned with intersubjective meaning and the practices of meaning-making as a joint activity and how best to design CSCL artifacts to moderate these practices. Collaborative learning in our study focuses on a situation in which learners get together to discuss a topic asynchronously and make meaning and construct knowledge. Learners assess and question other's contribution and questions, seek help from learning mates and elaborate on their thinking. This process helps in enhancing knowledge and skills.

Mishra and Kereluik (2011), supports a number of the learning skills most cited in the 22st-century and which must be reconfigured on online learning platforms, the three broad areas of knowledge identified include; a) Foundational knowledge: this involves core content knowledge, information literacy and cross-disciplinary knowledge, where students are expected to understand, connect and

organize information. b) Meta-knowledge: processes considered here involves problem-solving and critical thinking, communication/collaboration, creativity and innovation. c) Humanistic knowledge: which offers a vision of e-learners' self and its location in a broader social, and global context.

2.1.4 Impact of Collaborative technologies on online learning

In asynchronous online interaction, students can choose to participate when they feel prepared to do so. Technology can be used to enhance existing strategies for instruction and alter the roles of teacher and students. LMS can affect the performance of the users either positively or negatively. Potential performance impact to the instructors includes both effectiveness of teaching and instructor efficiency or productivity (McGill, Klobas, & Renzi, 2011). Students utilize chat tools to communicate and coordinate both their studies and social activities.

Writing for learning can be flexibly employed in formal and non-formal learning setting Calvo, et al., (2011), and collaborative writing requires deep cognitive engagement with content which leads to better learning. In a collaborative writing environment according to (Sharples, 2012), writers must be able to express their ideas and attitudes towards the document being prepared, to other members of the group, they must share and discuss their ideas if the group has to establish a shared understanding of the task, and they must negotiate about the constraints on the task and the strategies for carrying out the tasks. There are perceived benefits of collaboratively writing a document such as socialization, learning innovation of new ideas and produce more quality document. Despite the advantages Calvo, et al., (2011), argues that motivating and helping students to learn to write effectively in a collaborative environment poses many challenges which can be overcome by technologies. Working in an online collaborative community increases motivation, the perception of skill development, and solution satisfaction as reported by Hiltz, (1998).

Asynchronous communication offers convenience, storage, and retrieval for review and ways to focus and re-arrange message segments across time zones and distributed locations that have revolutionized distributed work (Watt, Walther, & Nowak, 2002). It's easier for students to participate and learn without being interrupted in an asynchronous collaborative environment. Stream video or audio can be used to distribute course content to students. Homer et al., (2008), carried a research on how video affects learners' experience of cognitive load, social presence and knowledge construction on online learning. A significant effect was found for cognitive load,

however, there was no effect on social presence. Social interaction enables learners to learn more about their peers and understand their customs and culture. The increased amount of interaction helps to build personal relationships, this grows trust where learners are open to others' ideas and suggestions. An open ended questionnaire on students' knowledge construction process by Rahman, et al., (2011) showed that students learn from each other, overcome psychological barriers and motivates e-learners to do deep processing of the topic of discussion. Online collaborative knowledge building can lead to learners reflecting on meta-cognitive opinions and revealing cognitive products (Yücel & Usluel, 2016). Online interaction capability on LMS is approved as a constructive element to online learning.

2.1.5 Effective online Discussion

According to (Gao, Zhang, & Franklin, 2013), learning through discussion consists of a wide variety of cognitive and social activities. A proposed productive discussion model by Gao, Wang and Sun (2009), includes:

1) Discuss to comprehend: where learners actively engage in the cognitive process as interpretation, elaboration and making connections to prior knowledge.
2) Discuss to critique: Learners/participants carefully examine other people's views and eventually being sensitive and analytical to conflicting views. The learner may build or add new insights or ideas to other contributors post, challenge ideas in the text or the post.
3) Discuss to construct knowledge: Learners actively negotiate meaning and be ready to reconsider, refine and revise their thinking. Learners compare and contrast views, facilitate thinking by raising questions and refine or revise different views.
4) Discuss to share improved understanding: here learners actively synthesize knowledge and express enhanced understanding based on a review of previous discussions. Learners are able to summarize learning experiences, synthesize discussion content and generate new topics.

The function of scripts in a CSCL environment is to make learners engage in activities that are related to knowledge construction such as elaboration of arguments, and encourage motivation and self-regulation Weinberger (2011). Some of the overall functions of scripts are; Regulate learning activities, Provide complementary procedural knowledge, Provide process-oriented instruction, alleviate coordination and Foster awareness (Weinberger, 2011). Characteristics of a healthy online learning communities should include; a) Participants shows concern and support for each

other; b) Regular posts by participants; c) Online communities express honest and skillful opinions and suggestions; d) Venting about the facilitator, support, content and technology; e) Collaboration and teaching is present and evident.

2.1.6 Elements of Effective Learning Environments

Online learning environment consists of interactions between learners and the environment; therefore online learning environment can be referred to as the technology-supported learning environment in the right time and place based on individual learner's needs. The environment can be analyzed via learners' performance and behaviors. In one of the unpublished papers by Kemboi and Oboko (2016), defines learning environment as a support system organizing the state in which humans learn best and are able to accommodate the distinctive learning needs of every learner, and sustain positive human relationship required for effective learning. Khan (2000b), in his WBL framework, discussed some of the dimensions of a learning environment. The framework was designed to be applied to any learning platform or web-based training and instruction. Khan posits that a learning environment should include: pedagogy, management, resource support, technology, interface design, ethics, evaluation and the academic institution. A good and effective online learning environment improve students' engagement and collaboration, enhance effective facilitation, support assessment techniques and design capacity programs (Oncu, & Cakir, 2011). Knowledge can be gained best in a learning environment which provides authentic context that reflects the way knowledge will be used in real-life, authentic activities, scaffolding, and environment promoting reflection. It is believed that scaffolds engage students on academically related materials and activities, because they encourage students to express and construct their opinions (Yücel & Usluel, 2016).

Johnson and Aragon (2003) declared principles to be used in a powerful online learning environments in the instructional strategy framework: a) Encourage social interaction, b) Avoid information overload, c) Encourage student's reflection, d) Address individual differences, e) Provide hands-on activity, f) create a real-life context and g) Motivate the students. Kintu, Zhu, and Kagambe (2017), confirmed the importance of considering online learning environments. The results showed learner environment structuring emerging the highest at 76.3% among the other indicators influencing learner background/characteristics.

2.2 Theoretical Framework

The theories related to the topic of study are viewed as follows:

2.2.1 Constructivist Theory

Constructivists view learners as being active and not passive. Harasim (2012), recognized that constructivism refers to both learning theory and epistemology of learning. Where the constructivist learning theory explains how learners construct meaning, while the constructivist epistemology explains that knowledge is constructed through our interactions with one another, community, and the environment. One of the critical concepts of this constructivist theory is the belief that learning is a procedure taking place in students referred to as 'knowledge constructor'. Learning activities or procedures changed from concentrating on external factors to internal factors/stimulus e.g thinking processes, cognitive processes and comprehension and knowledge. According to Zhu (2012), students are able to enhance knowledge construction through online collaborative written assignments, group discussions, debates and critiques of arguments.

This constructivism theory of learning has been adopted in HLIs in Kenya where students are engaged in discussions by tutorial fellows (Muuro, Wagacha, Kihoro, & Oboko, 2014). They argue that learning only occurs when a learner creates internal representations for his/her distinct version of knowledge. Constructivists assume that knowledge is constructed from learners' past knowledge and experience, regardless of how they were taught therefore, even listening to an instructor demands active attempts to construct new knowledge. Knowledge cannot be acquired from the outside or from someone else; rather, it's the individual learner's explanation and processing of what is acquired through the senses that create knowledge (Ally, 2004). They assume individuals learn better when they control the pace of learning and when they learn to discover things by themselves. Karagiorgi and Symeou, (2005), conclude that learning and teaching cannot be synonymous as we can teach, even well, without having students learn. According to de la Torre, Heradio, Jara, Sanchez, Dormido, Torres, and Candelas, (2013), online collaborative communication includes a practical and constructivist method to exchange knowledge and experience from the teacher to students, overcoming the distance problem and isolation.

There are various types of constructivism: radical constructivism who insist that every reality is unique to the individual. Social constructivism believs that shared reality grows out of social constraints placed on the constructive process of the individual (Karagiorgi & Symeou, 2005). Vygotsy (1978), perception of interaction on instructors moderating knowledge about the culture

and society, raises a question of whether this knowledge is already formed. If that the case, then this would be referred to as knowledge transmission. Considering the influence ICT has on education, knowledge development is a technologically supported. Some of the used e-learning platforms are Moodle and Blackboard with a great influence on students. The major concepts in constructivist view of learning are: 1) Learning is an active process of constructing rather than acquiring knowledge; 2) Knowledge can be socially constructed involving a discovery of different perspectives and shared meanings; 3) interpretation of knowledge is dependent on prior knowledge (Ene, Goulding, & John, 2015). In addition, some key elements include self-directed, experiential and reflective learning.

2.2.2 Coding Scheme Models

1 By Van der Meijden (2005)

This was developed by Van der Meijden (2005), to evaluate students' knowledge construction in asynchronous and synchronous online discussions. The scheme is categorized into low-level cognitive and High-level cognitive. Shukor, Tasir, Van der Meijden, and Harun (2014) used this coding scheme and categorized it into; Cognitive 1 – asking questions, Cognitive 2 – giving answers, and Cognitive 3 – Giving information, indicating both high and low level cognitions scenarios.

2 The Five-stage Framework

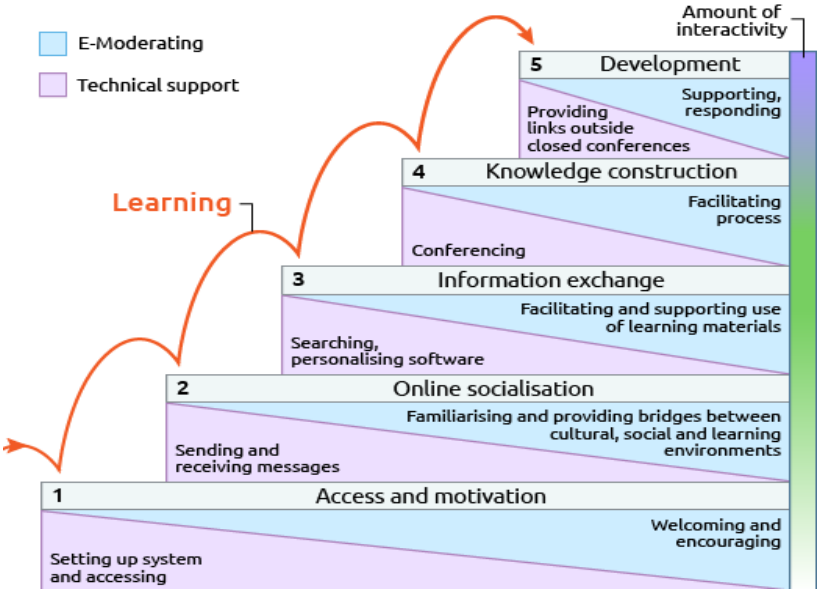

Figure 2.1: Adopted form Salmon (2013)

Salmon argues that for online learners to be effective, they have to be supported and guided through a learning process. The model suggests some of the e-activities which should be used by e-moderators to enhance online learning. In stage1: access and motivation, participants take part in online activities that motivate and are relevant to them. E-moderators focus on activities which encourage learners to start learning and create or construct skills. In Stage2: Online socialization, this helps online participants know each other better plus their intentions and goals. Stage3: Information exchange, at this stage learners require access to information and knowledge sharing. Participants are satisfied when they are able to find and exchange information productively. Stage4: Knowledge construction, this promotes activities supporting active thinking and online interaction. Stage5: Development, at this stage, learners start to construct on the ideas gained through the e-activities and apply them when solving a problem.

3 Online Collaborative Learning Theory

The model was developed by Linda Harasim in 2012, the theory was derived from computer-mediated communication theory. Harasim argues that learners never finish generating, organizing and synthesizing ideas, but progressively continue the process to deeper levels. The instructor/facilitator leads the group in online learning and it takes the form of constructivist. The teacher does not just facilitate and provide learning resources but also ensure core concepts and practices of the domain are understood. Core principles of OCL according to Harasim (2012) are:

1. **Idea generation**: includes brainstorming, divergent thought gathering.

2. **Idea organizing**: idea comparison, analysis and categorized through discussion and argument.

3. **Intellectual convergence**: Intellectual synthesis and consensus occurs such as agreeing to disagree.

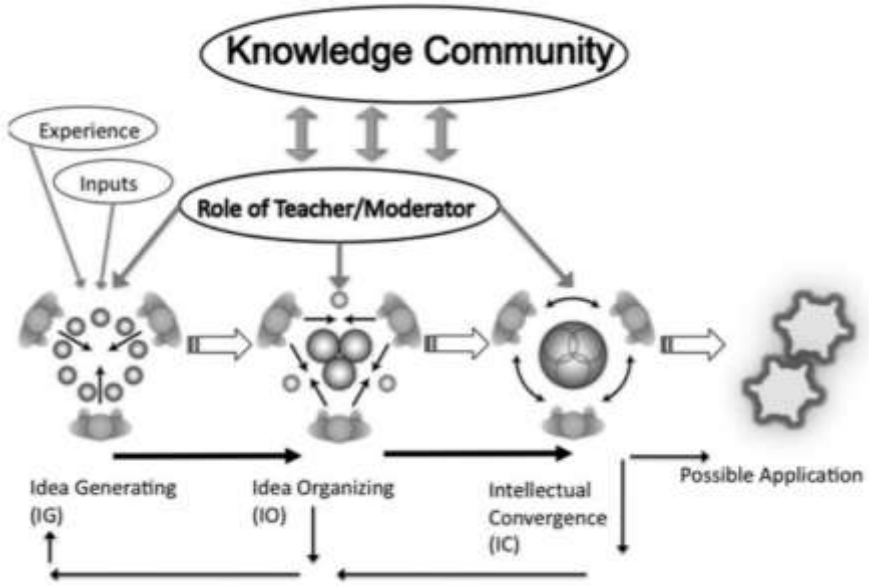

Figure 2.2: Online Collaborative Learning Model (Harasim, 2012).

2.2.3 Online Interaction Learning Model

The model was developed by Benbunan-Fich, Hiltz & Harasim, (2005), and it was generated from the constructivist theory. The model explains the e-learning context (input), process and finally the outcome (output). Online Interaction Learning model supports collaborative learning in regard to cognitive presence, social presence and teaching presence. These three characteristics are similar to Community of Inquiry Model by Garrison, Anderson and Archer (2000). The learning process stage of Online Interaction Learning model addresses interactions in terms of social presence, cognitive presence and teaching presence incorporating teaching, learning and communication techniques. Technology, course design and participants are considered at the contextual factors of online learning environments. Knowledge must be practiced, discovered, constructed and lastly validated by every learner, for learners to attain this knowledge, they must collaborate with knowledgeable community of learners (Benbunan-Fich, Hiltz & Harasim, 2005). The model supports instructional activities like learner online engagement, collaboration, group discussions; and the knowledge to be obtained and the activities must be closely connected. The backbone of the model is on the interaction section at the stage of learning processes so as to predict learning outcome (Benbunan-Fich, *et al*., 2005).

The context block of the model consists of: technology, participants' and course characteristics acting as moderator variables and affect how online learning is conducted. Benbunan-Fich, *et al*.,

(2005), suggests for a favorable learning outcome to occur, there should be minimal levels of input variables (communication and interaction) reached.

Benbunan-Fich, *et al*., (2005), illustrate technology in terms of communication and technical aspects. The technical aspect refers to technology capability of LMS such as reliability, quality and functionality. In communication, technology is considered synchronous and asynchronous. The model supports that every learner poses different study processes, and the quality of online learning outputs on personal attributes. The course attributes covers the design, type, subject type, size, and the context of the institution. Song (2010), used online interaction learning model to confirm the proposition that, the levels or types of interactions mediates between inputs and outcomes of students' learning and satisfaction. In their study, student-instructor interaction and service interaction had a strong effect between contextual and outcome elements.

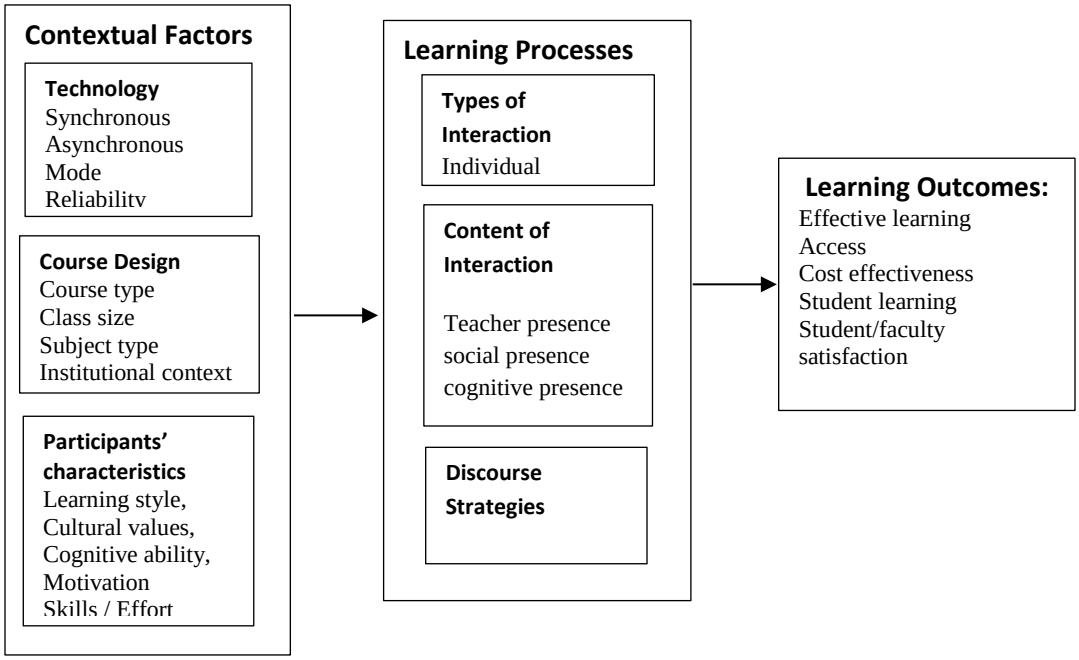

Figure 2.3: Online Interaction Learning Model (Benbunan-Fich, Hiltz & Harasim, 2005)

2.3 Justification of the Models

Online interaction learning model by Benbunan-Fich, Hiltz and Harasim, (2005), incorporates contextual factors, process factors and outcomes which most models lack. OCL model by Harasim (2012), appreciates the processes through which knowledge is constructed and later synthesized and retained by the individual. OCL model can better analyze knowledge construction level and

it's able to characterize and categorize the meaning of messages in a consistent and qualitative technique. The two, are therefore, a comprehensive combination in assessing the effectiveness of online collaborative learning on knowledge construction in higher education. The model is applicable in order to understand CSCL factors contributing to knowledge construction and development of students' education.

2.4 Empirical literature

2.4.1 Knowledge construction

Knowledge construction in an online collaborative environment is a top priority in the assessment of online learning technologies. Construction involves the use of conversation to construct new knowledge and new meaning-making. Salmon, (2013), support a number of learning skills which can be achieved under knowledge construction stage, these include *Critical thinking* (judging, assessing evaluating, comparing), *creativity* (inventing, discovering, and hypothesizing) and lastly *practical thinking* (using, applying and practicing). Knowledge construction is one of the outcomes of effective collaborative learning, among other 21st-century learning outcomes. Collaborative knowledge construction is used in the field of research to describe learners' cognitive process during collaborative learning (Lin, Duh, Li, Wang, & Tsai, 2013). A common aspect of categorizing knowledge construction is by Gunawardena et al., (1997), which conceptualizes the knowledge construction process in five phases: Sharing Information, Exploring Dissonance, Negotiating Meaning, Testing and Modifying, and Summarizing and Applying. Although the IAM has been largely criticized, where the model has a higher result at its first phase of the model (Lucas, Gunawardena, & Moreira, 2014). The analysis is based on text-based posts, hence losing important information about sequencing. The widespread use of Interaction Analysis Model in knowledge construction studies makes it most coherent and empirically validated tool in the field of research. Singh (2002), noted the three fields of knowledge device, namely, production, re-contextualization and reproduction, re-contextualization can only take place after the production, and reproduction can proceed after the re-contextualization of knowledge. Rahman et al., (2011), discussed he stages students undergo while acquiring knowledge online, these include; pre-construction, high-level thinking and re-construction. Harasim (2012), proposes three processes of knowledge construction, however, our study looked at the first two stages as discussed below:

Idea generation

Online learners think differently and have different views on the topic of discussion, brainstorm and share ideas and positions. Learners engage and contribute to the discussion. The indicators include divergent thinking, posting of a new topic and learners shifting focus by offering new prospects and opinions (Puntambekar, 2006).

Idea organization

This stage provides evidence of change, intellectual progress, and the beginning of convergence where different ideas and opinions become clarified, identified and categorized in different positions (e.g agreement/disagreement, questioning/elaboration) and how they relate to each other.

2.4.2 Educational technology and students' Knowledge Construction

Cheung and Slavin, (2013) referred to the Educational technology as a collection of applications and electronic tools that support the delivery of learning content and learning process. In this study, we focused on online collaborative learning in higher education. Instructional technology can be classified into different categories: a) Learning Content Management System (LCMS)- used for tracking, delivery, reporting and management of online content; b) Learning Management Systems (LMS): for activity tracking and integration with other systems; c) Learning technologies for chatting, online discussions, forums, mentoring, online meeting and virtual classroom sessions (Kundi, Nawaz & Khan, 2010). The use of technology in a pedagogical environment has gained momentum over the last decade, the effective use of these instructional tools by participants (teachers and students), can deliver desirable knowledge construction. Olson et al., (2011) support that, technology should be used as an engager and facilitator of thinking and knowledge construction. Technology roles in supporting effective learning according to Jonassen, Peck, and Wilson, (1999) include:

1) Technology as tools to support knowledge construction: represents learners' ideas, understandings, and beliefs and produce organized multimedia knowledge bases.

2) Support learning-by-constructing: help access needed information, compare view, beliefs, and understandings.

3) Support learning-by-doing: depict and simulate meaningful real-world problems, situations, and contexts. Provides a safe and controllable space for student thinking.

4) Support learning by conversing: collaboration with others, discussing, arguing, and building consensus among learners and support discourse among knowledge-building environments.

5) Support learning-by-reflecting: helping learners to articulate and represent what they know on what they have learned and how they understand it, support internal negotiations and meaning-making among learners and support mindful thinking.

6) Acts as a vehicle for exploring knowledge online:

The National Educational Technology Standards for Students, 2017 heighten technology as a tool for decision making, problem-solving, knowledge constructor, Innovative designer, communication/collaboration hence students become an empowered learner, which are essential skills in the 21st Century.

a) **Empower learner**: Students understand technology concepts and demonstrate competency and operations in their learning goals. Instructional technology provides students with an opportunity to understand the basic concepts of how to use LMS, provides feedback and informs the learning practice. Technology facilitates creativity and enhance students learning (Lock, & Kingsley, 2007).
b) **Digital citizenship**: The learning technology assist students recognize societal, cultural and human concerns related to technology, hence practice ethical behaviors.
c) **Creative Communication**: Learners use LMS to communicate to the online community.
d) **Innovation**: Students solve problems by creating new and useful ideas.
e) **Collaboration**: Students use media to learn together and contributes to or support learning of peers.
f) **Computational thinking**: LMS help students use critical thinking skills to solve problems and discover solutions, design systems, and make informed decisions (Wing, 2006).

Roberts (2004), the book stated that Computer-mediated communications acquire many form, but asynchronous threaded discussions, gives learners time to think about a problem and the opportunity to discuss possible solutions. Students read each other's responses or comments, and over a time can also contribute to the topic of discussion, thereby actively participating in the construction of knowledge. Online collaboration can be categorized into two different modes; asynchronous and synchronous. Communication in synchronous happen in real-time and messages appear immediately after they are typed. This synchronous environment is, therefore, best where a rapid exchange of information, ideas and opinions are required.

Immediacy: It's the degree to which CTs enables learners to instantly communicate with others online. Asynchronous technologies offers the ability to communicate at different times, even if

involving parties are not available. Communication may still occur and could prove a faster way to complete a task collaboratively rather than finding a shared time to communicate or work on a task (Brown, Dennis, & Venkatesh, 2010)

2.4.3 Instructional design and students' Knowledge construction

Instructional design is a systematic development of instructional descriptions using learning theories or models to ensure quality of online learning. It involves analyzing learning needs, goals and delivery to meet those learning needs (University of Michigan). The Instructional design gives ways for facilitating the transfer of knowledge and skills to the learners. A good instructional design presents learning content in a simple and eminent way. Instructional design role is to create learning experiences facilitate knowledge acquisition in an effective and appealing manner to students (Reiser & Dempsey, 2012). The focus of design according to instructional design theories should be on customization according to the learners' needs and not standardization of the content with a goal of motivating students to gain deeper levels of understanding and knowledge. Instructional design focuses on controlling and monitoring the learner plus the learning environment in order to bring the desirable knowledge construction (Lund & Hauge, 2011). A good instructional design instruct learners on how to construct meaning, as well as how to effectively monitor, evaluate and update constructs, and lastly, align and design experiences for the learner so that authentic and relevant context can be felt or experienced (Ertmer & Newby, 2013). Generalizing the effectiveness of OCL is not recommended. The instructional designers should concentrate on identifying and testing design principles of online learning and implementation models like ADDIE and others, for specific learners and environment. From Ku, Lohr & Cheng, 2004) research findings, students identified some critical elements in a successful online course: Frequent instructor-to-student and peer-to-peer communication (55%), Clear objectives, materials, and course outlines (33%), Useful mini-lectures (20%). Strong instructor support, Opportunities to access and view previous projects, User-friendly features on Blackboard, Superior organizational skills and Just in time resources registered lower percentages. Proficiency in technology (10%), and Periodic online discussion (10%). This shows that the designer should concentrate on enhancing frequent communications. Reiser and Dempsey (2012), in their book, asserts that instructional design platforms are systematic process and must be student-centered and goal oriented, organized in helping learners acquire meaningful skills and knowledge. Some of the

proposed characteristics that should be present in all instructional design projects for an effective learning outcome include:

1) Instructional design is student-centered and goal oriented.
2) Focus on meaningful performance.
3) It assumes outcome can be measured in a reliable and valid way.
4) Instructional design is iterative, self-correcting and requires team effort (Reiser & Dempsey, 2012).

Jaggars and Xu (2013), developed four quality rubric to address the online course quality; organization and presentation, learning objectives and assessments, interactions and technology use. Felder (2010), noted different ways through which students prefer learning; such as visual imagery, verbal explanations, some tend to try things out and see what happens and others are more inclined to think things through first; some reason in a relatively sequential manner and others have a more holistic orientation; some are more comfortable with concrete ("real-world") information and others are more drawn to abstract theories and symbolism. Research has shown that students whose preferences matched the dominant instructional environment performed better than those with opposite preferences. Unnecessary complexity should be eliminated and course design rendered simple and intuitive (Elias, 2011). A simple learner interface increases the platform use and hence promote learning outcome and construction of knowledge. This study adopted and coined the Quality Matters rubric standards elements in assessing the instructional design of the platform as follows:

Clear online instruction: Consistent and clear structure like navigational documents and instructions, guiding students on where to go and what to do online is a vital element to students' success (Jaggars, & Xu, 2013).

Online cause introduction and training: A guide helping students easily understand how to begin online learning, understand what the cause is all about and what online participants expect from each other.

Online learning Objectives: The basis upon which the course is underpinned and with which the standards must align to. The objectives must be learner-centric and enabling students to demonstrate successful learning outcomes learning objectives must be clearly communicated, measurable and consistent with the learning requirements (Quality matters program, 2011).

Course grading and assessment: clear grading guidelines and appropriate assessment are important to online learners.

Instructional materials: Learning materials which are thoughtfully selected, current, researched and contain multiple perspectives. It must provide adequate resource for students to achieve their learning objectives

2.4.4 Participants characteristics and students' knowledge construction

Students

The success of online collaborative learning also depends on participants'/learners' willingness to collaborate and support one another. The students, need to be motivated in order to trigger a high-level of engagement in a CSCL environment for the purpose of knowledge construction. A number of authors studied the significance of students' characteristics in online learning (Kintu, Zhu, & Kagambe, 2017; Kintu, & Zhu, 2016). These authors used self-regulation, attitude, age, gender, social support, computer competence and management of work-load as key indicators of student's characteristics. The first authors established self-regulation and social support as significant predictors to knowledge construction, while, Kintu and Zhu established workload as the significant predictor to knowledge construction.

This study took a different approach to students' characteristics as guided by the literature compared to most researchers.

Motivation: Students who are interested in a task or skill are motivated to learn, but students who lack interest will remain disengaged. Lim and Kim (2003), created a topology of six motivating factors promoting online learning: a) reinforcement: help learning motivation, b) course relevance: the value of course content related to learner's jobs and studies, c) interest: promotes learner involvement during learning, d) self-efficacy: ones feeling of self-worth, e) affect: involves a learner's feeling and emotion during the learning experience, and lastly, f) learner control. Russell (2013), for learners to adopt and internalize academic skills, learners will have to have autonomous motivation and self-regulation, which Self-determination Theory (SDT) provides. SDT regards humans as creatures that innately pursue and engage challenges in their surroundings, try to actualize their potential, sensibility, and capability. SDT provides three different approaches to motivation (intrinsic motivation, extrinsic and amotivation). Our study considered two motivations; 1) extrinsic motivation: a person performing a task in order to gain some reward, and

2) intrinsic motivation: a person performing a task out of interest and innate satisfaction. OCL environments can be developed to promote learners' motivation to learn and thus produce knowledge and or good learning outcomes. Russell (2013), denotes that motivation has been excluded in online learning environment research except in one study.

Self-efficacy: makes a difference in how people feel, think and act. Self-efficacy cares about perceived capabilities and competencies to handle a given assignment on academics. The statements should be termed as 'can do'. This variable was developed by Bandura Alfred (1993) to assess human behavior on his social-cognitive theory. A low sense of self-efficacy is associated with depression, anxiety, and helplessness leading to low academic performance, while high self-efficacy facilitates cognition process and high performance. Cheung and Vogel (2013), self-efficacy is the student's beliefs regarding their ability to perform in an interactive online environment. Self-efficacy is believed to start in infancy and gradually develops by various factors such as social and cultural influence, family influence and educational influence. It affects the extent to which learners engage and persist at challenging and handling tasks. This can affect students' performance and the general knowledge construction. Schraw, Crippen, and Hartley, (2006), considered the two ways of increasing self-efficacy namely: 1) use both expert and non-expert models, and 2) provide as much informational feedback as possible.

Self-efficacy theory is explained by Schunk and Pajares (2009), they noted self-efficacy can influence the choices a person makes and actions to pursue. There is little engagement in incentives that don't produce desired consequences. They noted that self-efficacy ultimately influence a person's accomplishment, as it's referred to perceived capabilities for learning to the desired level. Some of the effects of self-efficacy are motivation, effective learning, self-regulation, and achievement. Schunk and Pajares (2009) supports the social cognitive theory and explains that it can be used by learners and educators to ensure learners succeed by increasing their emotional states, self-regulation, academic/cognitive skills and makes the environment more conducive. Encouraging words as (I believe you can do it) is used. This eventually influences knowledge construction and learning performance of the students.

Attitudes towards technology: Cheung & Vogel, (2013), the degree to which a learner is interested in using and interacting with the system, which in turn will influence communication and the expected knowledge construction. Students' attitude could be: a) *Ease of use*: As the extent to which the learner believes that using online platform would be free of effort. b) *Perceived*

usefulness: use of online platforms enhance learners' performance and help them co-construct knowledge.

Metacognition: the process of organizing knowledge and the belief people have about their thinking. Akturk & Sahin, (2011) metacognition is considered an essential process for cognition effectiveness. Mental activities are involved in metacognitive processes and are very difficult to be observed therefore, researchers use three methods to inquire about metacognition (Garrett et al., 2007). Students assess their knowledge in an expression of feeling-of-knowing, ease of learning or judgment of learning. When engaging in critical thinking, students need to undergo specific metacognitive skills like monitoring thinking process, checking progress made towards an appropriate goal, ensuring accuracy, and making decisions about the use of time and mental effort (Magno, 2010). Metacognition provides a very important task in education today as it assists learners to embrace learning processes. John Flavell was the first intellect to use metacognition concept, he divided metacognition into two elements: a) Knowledge of cognition: concerned with how much learners understand about their memories and the way they learn and b) Regulation of cognition: concerned with how well learners can regulate their own memory and learning. Abdellah, (2015), asserts that training on cognitive strategies to students improve students' metacognition and academic performance. There is an ineffective learner and effective learner of cognition, the effective metacognition learner uses problem-solving heuristics, good at predicting results and is strategic in nature. When these metacognition skills are utilized effectively, students are able to construct knowledge and improve learning.

Epistemological belief: It is a belief about the nature and origin of knowledge and learning. Students who are believed to be constructionist and relativistic, tend to demonstrate more understandings of concepts, critically evaluate and synthesize knowledge. Taxonomy of epistemology according to Schommer as quoted by (Schraw, Crippen, & Hartley, 2006), which include: a) innate ability (learning is driven by native ability), b) quick learning (learning takes place immediately or not at all), c) simple knowledge (most important ideas are simple) and d) certain knowledge (important ideas do not change over time). Schommer realized that a set of core beliefs may influence learners' default interpretation of knowledge and learning approach. Epistemological traditions state that knowledge is gained through experience, knowledge is negotiated through experience and thinking and knowledge in constructed (Siemens, 2014).

Barzilai, & Zohar, (2012), discovered three categories of the nature and source of knowledge. 1) Amount of information - learners believed if a source of information provides all necessary information, then it's good while some believed the single source of information is not enough. 2) Trustworthiness - learners believed if a single source of information is credible and reliable, then it is preferred, while others questioned the reliability of the single source of information. 3) Multiple perspective - some argue that different sources give different views and that a single source is sufficient only if it can give a two-sided explanation.

2.4.5 Discourse Strategies and students' knowledge construction

Discourse and arguments are the tools through which individuals or learners can compare thinking ability, explore ideas, shape agreements and identify or solve disagreements (De Liddo, Shum, Quinto, Bachler, & Cannavacciuolo, 2011). Cook (2002) describes discourse in terms of discourse types: spoken and written discourse, they further subdivides them into speaking, listening, writing and reading. Discourses diverge according to the manner of production, the number of speakers, type of content and the medium of production (written/oral). Walker (1994) refers to discourse strategy as a strategy for communication between or/and among participants. Discourse strategy has received various definitions depending on the context with which it is being referred to; e.g communication strategy, teaching strategies, conversational devices or learning strategies. Lemke (1990), categorized instructor/teacher strategies into two; dialogue and monologue. Online learning environment composed of a written discourse that is expressed in diverse corpora such as learning journals, discussions, reviews, and essays. Rendered via various tools such as threaded forums, chat boards, blogs, wikis and social networking sites. Chakraborty and Nafukho, (2015), discussed two strategies for virtual learning environments: teacher presence and teaching immediacy. They found out that the leadership role of the instructor triggered discussions online and facilitated a higher level of thinking and knowledge construction. Studies prove that teacher immediacy has a significant effect on students' motivation, critical thinking, and effective learning. However, York and Richardson, (2012), established factors influencing interaction among online participants which need to be considered in a productive CSCL environment; these include, immediacy behaviors, discussion questions, discourse guidelines and instructor participants. McLoughlin, and Luca, (2000), supported various kinds of interactions that are cognitively productive among online learners; a) Engaging in collaborative tasks, b) concept elaboration, c) share resources and information, d) negotiations to solving problems, and e) offer assistance.

Social Interaction: Sung and Mayer, (2012) refers to social presence as the degree to which students feel connected personally with other learners within an online learning platform. Five categories of online social presence was revealed in their exploratory study; social respect (timely response), social sharing (information sharing), open mind (receiving agreement/feedback), social identity (referred to by name) and intimacy (personal experience sharing). Interaction between students and or with the instructors, this occurs when instructors adopt strategies to promote interpersonal encouragement or social integration (Jung, et al., 2002). Kreijns et al., (2013) refer to social presence as the degree of psychological sensation in which the illusion exists that participants in the communication appear to be a real person. Collaboration technologies with high social presence convey a social and personal environment (Brown, Dennis, & Venkatesh, 2010). The absence of social presence in an online collaborative environment can reduce the effectiveness, efficiency and learners performance, as these CTs can slow interaction and hence, difficulty in communication.

Online collaboration: When a group of students work collaboratively on a specific topic or share ideas and materials to solve a given problem (Jung, et al., 2002).

In the table below are some of the teaching strategies used in learning according to (Tomáš & Seidel, 2013).

Table 2.2: Teaching strategies used in learning

Instructing moves	**Teacher mastery course of discussion**
Cue elicitation of students' online contributions	Teacher asks questions while simultaneously providing heavy clues, such as the wording of question, intonation, pauses, gestures or demonstrations to the information required.
Sequence of repeated questions	Teacher asks the same similar questions repeatedly to seek a particular answer, and continues asking until answer is provided by the students.
Selecting and/or ignoring students' contributions	Teacher ignores the students' contribution, or select a particular contribution from a chorus of different ideas stated by the students.
Reconstructive paraphrase or recap	Teacher recast or paraphrases what students has said in a more complete or acceptable form, or in preferred terminology,

	including the teacher adds to or changes the meaning of what the student has said.
Narrative	Lecturer review storyline, lesson, or activity or capture uninterrupted flow attention to students.
Marking significance	Making students feel teachers' presence online
Promoting / establishing consensus	Teacher encourages students to agree or come to a consensus online.
Providing evaluative responses	Teacher clearly indicates, that a students' comment(s) is correct or incorrect

Reinhardt (2010) provides additional guidelines instructors could use to set the stage for the deep learning process among students: Setting clear predictions including examples of great posts, that guide students in the correct direction. Posting first in the discussion thread which sets the tempo and allows the opportunity to bring in associated mini-topics. Offering positive support or reinforcement and if possible directing students into a different direction by use of question prompt. Staying present in the discussion thread throughout the week and reply faster to questions. Sharing instructor particular experiences and how they relate to the current topic helps the student connect the discussion to individual experience and usefulness. Making the subject matter real for the students through current examples and application. Offer additional information, web sites, contents or links about the topic to encourage additional reading, understanding or research.

1 Dialogue

Dialogue strategies mainly feature teacher and student constructing meaning in collaboration. Involving learners in a high-quality argument is never an easy task, good argument generation is complex and requires cognitive thinking and e-activities. Educational success and failure may be more as a result of the quality of educational dialogue, rather than the individual capabilities of the students and the instructors' competence. How learners engage in dialogue is an indication of how they engage with other learner's ideas, how they compare those ideas with their personal understanding, and finally how they account for their point of view (De Liddo, Shum, Quinto, Bachler, & Cannavacciuolo, 2011). The dialogue strategies include; Instructor high-level questions, instructor probing questions, student participation and student to student participation. The questions are meant to make learners think, whereas statements are open to debate or

challenge. The dialogue discourse appears chronologically in an online environment. For individual ideas to have a social effect, we must either communicate or act them out to other learners in ways that will enhance learning outcome. To improve the quality of interaction in an online learning environment, one needs to understand the techniques and mechanisms by which dialogue works. Dialogue can be identified into three different form: exploratory, cumulative and disputation. In exploratory dialogue, there is a high possibility of learners engaging in more in-depth, critical, constructive and reflective learning, whereas in disputation dialogue is very less productive. Juwah (2006) concurs that, dialogue which can be written and mediated by technology enables the learner to 1) Verbalize and articulate their learning needs and understanding, 2) Question, analyze and synthesize information to make new meaning. The dialogue strategies include; informing, questioning, discussions (which promotes negotiation and challenges the learner to actively think and improve learning), giving and receiving feedback, provide motivation and encouragement and assessment to sustain learning. As explained by constructivists, epistemology asks: what is knowledge? How do we know? The nature of questions are important for today's knowledge construction.

2 Monologue

Monologue strategies involve the learner as the primary contributor of ideas with very minimal contributions from other students and the instructor. It consists of ways in which the instructor provides information, explains a topic, gives narratives, gives response to students, summarize a discussion García, Márquez, Bustos, Miranda and Espíndola, (2008) and the way the teacher elaborate ideas to students.

2.5 Conceptual Framework

Conceptual framework is used to develop awareness and more understanding of the topic under study and communicate it effectively. Conceptual framework involves forming ideas about relationships between variables in the study and showing the relationships diagrammatically. The framework is based on the model developed by Benbunan-Fich, Hiltz and Harasim (2005), and Harasim (2012) knowledge construction process.

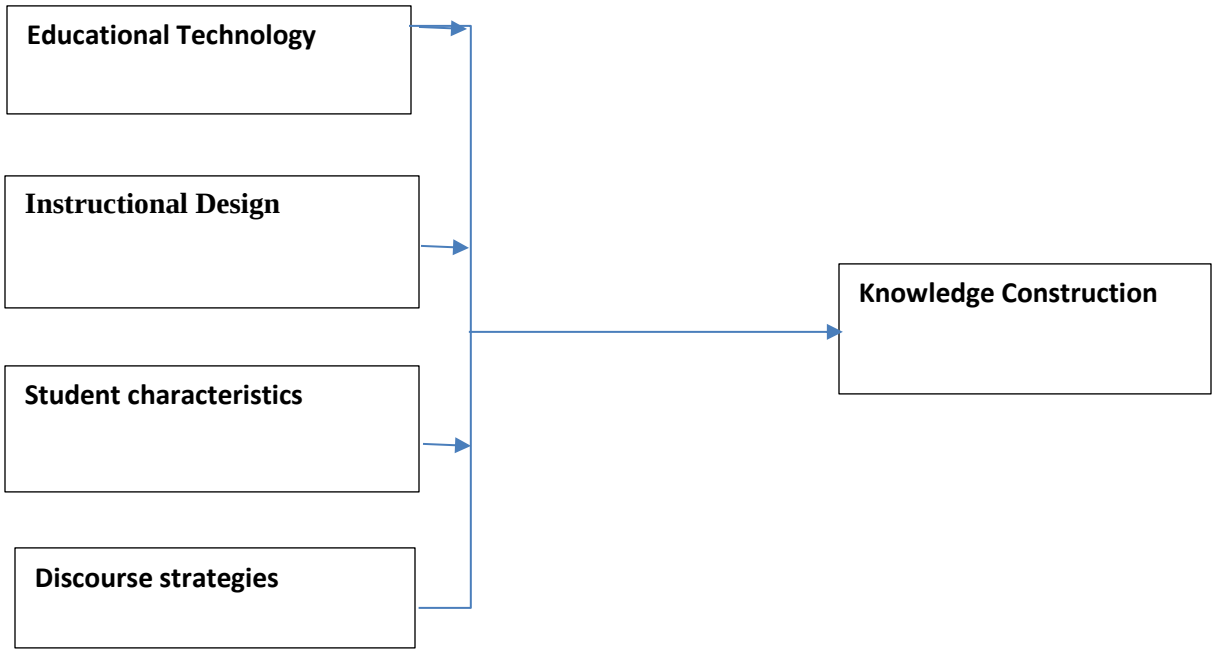

Figure 2.4: Conceptual Framework

2.6 Summary of articles

Table 2.3: Summary of articles

Variable	Model	Author	Research Approach
Educational Technology	Lag sequential analysis.	Lin, Duh, Li, Wang and Tsai (2013).	Experimental Control
	Innovation and knowledge processes	Jarle Gressgård, Amundsen, Merethe Aasen and Hansen (2014).	Case study
	Review	Baran (2014).	Case study Case study

	Theoretical propositions TAM	(Davison, Ou, & Martinsons, 2013). (Hidayanto & Setyady, 2014). Chu and Kennedy (2011) Nawaz, A. (2013) Thieman, G. (2008).	Survey
Instructional Design	Objectivist Constructivist Situated and constructivist 21CL ICT design thinking framework Bruner's 5E lenses	Chen (2014). Järvelä, et al. (2015) (Dawley, & Dede, 2014). (Koh, Chai, Benjamin, & Hong, 2015) Kivunja (2015).	Experimental
Student Characteristics	Knowledge integration Environment framework. Social cognitive T, Theory of planned behavior and TAM.	Rienties, et al. (2012). Schraw, Crippen, and Hartley (2006) Liaw et al. (2008).	Quasi-experimental Experimental
Discourse strategies	DOI Social cultural theory Literature guided by Venn-Diagram. Literature	De Wever et al (2010). (Shukor, Tasir, Van der Meijden, & Harun, 2014) Chakraborty and Nafukho, (2015). York and Richardson (2012).	Cross-over design Qualitative design
Knowledge construction	Social cultural theory IAM	(Shukor, Tasir, Van der Meijden, and Harun 2014). van Aalst (2009). Lucas, Gunawardena, and Moreira (2014).	Sequential analysis Content Analysis

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

The procedure used in conducting the study is provided in this chapter. It entails targeted population, research design, data collection tools to be used and data analysis techniques.

3.1 Research Philosophy

The study employed positivism study approach. Researchers maintained very minimal interaction with participants during the research period and the study was grounded on facts and objective. Positivism approach employs these major research evaluation criteria: a good research should be able to replicate, make controllable observation, generalize and should make use of formal logic (Cavaye, 1996). A positivist tries to study phenomenon and explains phenomenon in relation to construct and correlation between those constructs (Cavaye, 1996). This concluded in empirical and a framework for understanding effective online collaborative learning and students' knowledge construction. Choosing the right research methodology requires philosophical solutions as to why research is done. Researchers need to make two dimensional assumptions when developing philosophical perspectives: the nature of society and the nature of science. The science entails, objective or subjective approach, the two portray assumptions regarding ontology (reality), human nature, epistemology (knowledge) and methodology (Holden, & Lynch, 2004). The society is viewed as radical or regulatory change: researchers view regulatory society as a society that is cohesive and unified, while in radical, society is viewed in constant conflict where people tussle for freedom from societal structures (Holden, & Lynch, 2004).

3.2 Research Approach

This study adopted deductive research approach where research design and hypotheses were developed and corroborated against the adopted models and standards. Deductive reasoning is a theory testing process, commencing with established theory and seeks to find out whether the theory or model applies to specific case in point (Spens, & Kovács, 2006). Deduction is a way of validating theories or models according to the standards of natural sciences.

3.3 Research Design

Research design is the structure of the ground plan of the study. Research design is an ideal structure within which research is administered, and it comprise a blueprint for the collection, measurement, and analysis of data (Garg & Kothari, 2014). This study adopts a descriptive study

research design, to obtain views from students in regard to the effectiveness of online collaborative learning and knowledge construction at JKUAT-Karen Campus.

Within the first week of the semester, students were trained on how to navigate through the e-Learning system and any necessary technical assistance were provided. The LMS was and could be accessed through (sodel2.jkuat.ac.ke/common/karen). Rules stating the nature of expected students' participation in the discussion board were provided, each student had minimum requirements of participation. Each participant was expected to apply some level of critical thinking during the discussions. There were weekly live session with the lecturer for about thirty (30) minutes with the students. The lecturer does not give concrete and direct answers to students, but rather provide structural feedback. For the rest of the days, the students were discussing with their peers. During the period, the lecturer used discourse strategies to engage students on the topic and interact. In addition, the lecturer and the students were expected to summarize, elaborate a topic and ask or answer questions online.

Online learning materials were prepared by the experts in the field of health, therefore, were of quality and very useful to the students. Learning materials/notes were uploaded on the platform per topic, about 10 quizzes and the final CAT were available on the platform, where every student was required to have completed the quizzes and CAT before sitting their end semester exam.

Student's conversations were transcribed and coded, this was analyzed to determine the level of knowledge construction achieved by students. The emphasis of transcripts were the accuracy of content, knowledge generation and knowledge organization.

3.4 Target Population

The population is the total collection of elements which we wish to make some inferences. The target population is a large collection of individuals or objects which are the focus of a scientific study. The target population in this study constituted all first-year students taking common units online. About 224 undergraduate degree students (source: Admissions department), this number will be sufficient to form a rich understanding of the topic of discussion. The justification of the population is that these students are the majority users of LMS and are affected by the system design and effective utilization.

3.5 Sample design

The study employed convenience samples. In convenience sample, a researcher obtains a convenience sample by selecting whatever sampling units conveniently available. We selected

first-year degree students studying one of the common units (HIV & AIDS) taught in the university. We then used census as a sample strategy on the convenient group selected for the sample size. Five groups were identified on interviewed group according to the course of study. We used the formula developed by Yamane (1967) in determining the sampling strategy.

$$n = \frac{N}{1 + N(e)^2}$$

Where: n = Sample size,

e= Level of precision (acceptable sampling error)

N = Population size

Sample size for Law students = (130)/ {1+ (130(0.05^2))} = 98

Sample size for Commerce students = (23)/ {1+ (23(0.05^2))} = 21

Sample size for IT students = (40)/ {1+ (40(0.05^2))} = 36

Sample size for Actuarial students = (15)/ {1+ (15(0.05^2))} =14

Sample size for BPCM students = (16)/ {1+ (16(0.05^2))} = 15

Table 3.1: Sample size

Course Category	**Target Population**	**Sample size target**	**Accessed Sample size per Course**
BSc.Law	130	98	80
BSc. Bcom	23	21	15
BSc IT	40	36	30
BSc. Actuarial	15	14	11
BSc. Purchase & Contract Mngt. (BPCM)	16	15	12
TOTAL	**224**	**184**	**148**

Source: Author (2018)

3.6 Data Collection Tools and Methods

The data were collected from students of Jkuat–Karen Campus, a public university offering e-learning teaching platform on Moodle platform. Structured questionnaires were printed and personally administered to students/respondents at the end of the semester. Hard copy questionnaires were used since students rarely participate in online questionnaires (from my experience), and also to increase the response rate. Questionnaires collected quantitative and

qualitative data, with closed questions. The questionnaire helped examine the effectiveness of online collaborative learning and knowledge construction. Each set of question designed to address research objectives and questions under study. One major advantage of the questionnaire is that it allows the researcher to control and focus responses to research objectives. Scripts from the discussion board were retrieved, coded and organized in an Excel program to fit the two indicators of knowledge construction under study.

3.7 Measuring Instrument

Tests of validity and reliability were used to establish the soundness of the research instrument.

3.7.1 Validity testing

After data collection, questionnaires were verified for consistency, completeness and then organized for analysis. Garg and Kothari, (2014), refers to validity as the degree to which an instrument measures what it is truly supposed to measure. We employed construct and face validity in the study.

Construct validity-the degree to which scores are accounted for, by explanatory constructs of a model or theory. Correlation analysis was done to establish the degree to which two variables are correlated.

Face validity- this is a non-statistical method of validation used to source for opinions on whether the testing instrument can measure what it's meant to measure. The questionnaire was administered to two experts, in order to check whether the instrument was in-line with the research topic and to enhance clarity and to avoid ambiguity. Necessary amendments were made based on the corrections suggested by the reviewers.

3.7.2 Reliability

Measuring the degree to which the instrument provides consistent results. The study used Cronbach alpha coefficient to measure research framework under study.

Cronbach's alpha for this data was established at 0.949, which is within the acceptable reliability margin.

Table 3.2: Overall Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.949	.936	4

Source: Author (2018)

Table 3.3: Reliability Measurement for the Proposed Model

Construct	Operational definition	No. of Items	Alpha (α)	Adapted from
Educational Technology	Collection of applications and electronic tools that support the delivery of learning content and learning processes.	6	.931	National Educational technology standards for students (2017 and 2007)
Instructional design	Systematic development of instructional descriptions using learning theories or models to ensure quality of online learning.	6	.830	Quality matters rubric standards for students. Russell (2013), Lim and Kim (2003); Schunk and Pajares (2009) , Bandura Alfred (1993)
Students characteristics	Students attributes to effective online learning. Examples: motivation self-efficacy, metacognitive beliefs and epistemological beliefs.	4	.921	; Abdellah, (2015), Magno, (2010), Akturk & Sahin, (2011); Schraw, Crippen, and Hartley (2006), Siemens (2014), Barzilai, and Zohar, 2012),
Discourse strategies	Learning principles and techniques to effective online interaction.	7	.922	Communication and learning principles, instructional scaffolds.

Source: Author (2018)

The table above shows a summary of how the measuring instrument was constructed and the resulting alpha values.

3.7.3 Conversation reliability

Researchers applied the inter-rater reliability in the analysis of contents to determine inter-rater consistency. Two judges were used to analyze the posts submitted by students on the learning forum. Inter-rater reliability (Kohens Kappa technique) was used to establish the degree of agreement between the encoders. From the findings, kappa coefficients indicated a significant reliability value of the level of knowledge construction was at 0.72.

The scale of 0.61-0.80 means a substantial agreement, while 0.81-1.00 exhibit almost ideal agreement between the raters (Landis & Koch, 1977). Therefore, the coding scheme for this study is reliable.

3.8 Data analysis

Statistical analysis was done using SPSS v.24. The results of the analysis are affected a lot by the form of the data, therefore, data must be appropriately prepared to get trustable results (Garg & Kothari, 2014). Data analysis consisted of examining, categorizing, tabulating and or combining the evidence to address the initial proposition of a study. Data collected from participants (students) was cleaned, organized, coded, verified and validated in order to generate descriptive statistics and various significance tests.

We employed frequencies, Pearson correlation, multiple regression analysis and single factor ANOVA. Qualitative data were presented thematically in line with the study objectives and interpretation done. Quantitative content analysis technique was used on the discussion texts extracted from the learning platform. The descriptive statistic is a measure of central tendency, measures of association and dispersion. Descriptive data findings were presented using tables and graphs.

1 Conversation analysis:

Content analysis entails codifying qualitative and quantitative data into pre-defined categories and categorization lies with the coders (Spens, & Kovács, 2006). Researchers used supervised learning technique in the classification of online data. In an online discussion, there are task related and non-task related knowledge construction. Non-task related issues were categorized according to Veerman and Veldhuis-Diermanse, (2001), who categorized non-task discussions into Planning, Technical and social. On task-oriented contents, we used a directed approach by (Harasim, 2012) coding scheme, rather than the conventional approach. However, this study was more concerned with the task and knowledge-oriented contents. Contents were cleaned, categorized according to

themes and then coded. The study used quantitative content analysis, where results were presented in the form of actual numbers of classes, percentages, and frequencies. As the research seeks to answer what level of knowledge construction is achieved among online learners.

We were guided by the process described by Bengtsson (2016), to code the text messages.

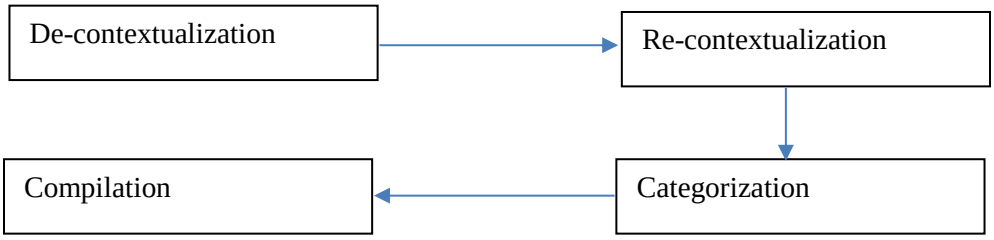

Figure 3.1: Text Code Process (Bengtsson, 2016).

De-contextualization – Reading through the transcribed messages and breaking them into smaller units labeled with a code.

Re-contextualization – The original messages are re-read along with the established unit codes.

Categorization – The smaller unit codes are grouped based on our two indicators under study.

Compilation – Writing down the report/result.

Table 3.4: Clustering Data

Data classification	**Data Characteristics**	**Online Activities**
Idea generation	New topics, New opinion, New questions, Insight, Statements	Brainstorming, gathering divergent ideas/thoughts
Idea organization	Elaboration/Explanation, Answers/feedback, Questions to posts	Comparison of ideas, concept analysis, idea categorization, disagreement/agreement, Concurring with the idea

Source: Author (2018)

2 Correlation Analysis

The findings of the data were subjected to Pearson's correlation coefficient analysis to determine whether any relationship exists and the strength of the relationship between independent variables and the dependent variable. The strength of the relationship between the variables were established too.

3 Analysis of Variance (ANOVA)

ANOVA assist researchers to examine the significance of the difference amongst more than two sample means at the same time (Kothari & Gaurav, 2014). ANOVA was used to indicate the level of significant variation on predictor variables; Educational technology, students' characteristics, discourse strategies and instructional design on knowledge construction. Analysis of variance was used because it made the use of F-test in terms of squares and residual. The F-test was done to test the significance of each independent variable at a confidence level of 95%.

4 Regression analysis

Regression analysis measured the relative significance, cause-effect of every variable on knowledge construction. The model sought to establish the relationship between dependent and independent variables of the study. The variables include technology, students' characteristics, discourse strategies and instructional design. Below is the regression model:

$$\textbf{Knowledge construction} = \beta o + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + \varepsilon$$

Where X_1 = Educational Technology

X_2 = Students' characteristics

X_3 = Discourse strategies

X_4= Instructional design

ε = model significance error term from f-significant results obtained from ANOVA

B_{1-4} = regression coefficients.

Bo = Model's constant

3.9 Research design and Analysis Matrix

Table 3.5: Research design and analysis summary

Hypothesis	Variable	Indicators	Instrument/ Measurement Scale	Data collection	Data Analysis
H_1: Educational Technology has a significant effect on students' knowledge construction.	Educational Technology	Creative communication, collaboration, Computational thinking, Digital citizenship, Empower learner, Innovation	Questionnaire 5-Point Likert	Census	Frequency Correlation Regression
H_2: Instructional design has a significant effect on students' knowledge construction	Instructional design	Course overview, Introduction and training, Course objectives, Grading and assessment, learning materials, Use of materials.	Questionnaire 5-Point Likert	Census	Frequency Correlation Regression
H_3: Student's characteristics have a significant effect on students' knowledge construction.	Students characteristics	Motivation, self-efficacy, metacognitive belief, epistemological belief	Questionnaire 5-Point Likert	Census	Frequency Correlation Regression
H_4: Discourse strategies have a significant effect on students' knowledge construction	Discourse strategy	critical reflection, engagement and attention, elaborated online notes, online collaboration, online social interaction, Feedback to online questions, Online learning questions	Questionnaire 5-Point Likert	Census	Frequency Correlation Regression
H_5: There is higher level of knowledge construction and presence of collaboration.	Idea generation Idea organization		Online Discussion forum	Census	Frequency
H_6: There is statistically significant difference among groups in terms of educational technology	Educational technology		Questionnaire 5-Point Likert	Census	Frequency Single Factor Anova
H_7: There is statistically significant difference among groups in terms of Instructional design	Instructional design		Questionnaire 5-Point Likert	Census	Frequency Single Factor Anova
H_8: There is statistically significant difference among groups in terms of students characteristics	Students' characteristics		Questionnaire 5-Point Likert	Census	Frequency Single Factor Anova
H_9: There is statistically significant difference among groups in terms of discourse strategies (communication and learning)	discourse strategies		Questionnaire 5-Point Likert	Census	Frequency Single Factor Anova

3.10 Operationalization of Research Framework

This is a process where research variables are defined into quantifiable factors.

Table 3.6: Independent and Dependent variables

NO.	Variable	Perceived Indicators
1	Educational Technology	Empower learner, Digital citizenship, Innovation, Creative communication, collaboration, Computational thinking.
2	Instructional Design	Course overview, Introduction and training, Course objectives, Grading and assessment, learning materials, Use of materials.
3	Students' characteristics	Self-efficacy, Motivation, Metacognitive belief, Epistemological belief.
4	Discourse strategies	Critical reflection, Engagement and attention, Elaboration/ explanation, Collaboration and discussion, Social interaction, Feedback, Questions
5	Knowledge construction	Idea generation, idea organization

Source: Author (2018)

3.11 Ethical Consideration

The researcher never influenced or bribed any of the respondents to fill in the questionnaire. The researcher represented data as collected, and will never conceal any of the respondents' personal information or identity unless a consent is given. The sample study was informed in advance about the research topic, purpose and benefits of the data to be collected.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discusses findings as obtained from the field of study. Quantitative data analysis was conducted using a statistical tool of analysis mainly SPSS version 24. The findings were discussed in three different categories, namely: descriptive analysis, inferential analysis and finally the interpretation of the data findings based on the objectives of the study. Five-point Likert scale items were categorized into two: 4 & 5, as agree and 3, 2 &1 as disagree. To compare the variables among the groups (courses), we only analyzed the responses indicating agree (4&5) for this study.

4.2 Response rate

University students studying Law, IT, Actuarial science, Commerce, and BPCM were the main respondents of this study. One hundred and twenty one (121) questionnaires were submitted back, however, 12 questionnaires were incomplete and therefore removed/excluded from this study. We then ended up with 109 questionnaires for this study. As shown in the table below, the study targeted a population of 184, however, the researcher only managed to access 148 respondents. The access rate is 80% of the targeted sample size, and a response rate of 74% was attained.

Table 4.1: Response Rate

Target Population	Sample size target	Sample size Accessed	Response Number	Response Rate
224	**184**	**148**	**109**	**74%**

Source: Author (2018)

Table 4.2: Response per Course

	Study	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Law**	56	51.38	51.38	51.38
	BPCM	8	7.34	7.34	58.72
	IT	25	22.93	22.93	81.65
	B. Com	11	10.09	10.09	91.74
	Actuarial	9	8.26	8.26	100
	Total	**109**	**100**	**100**	

Source: Research Findings, 2018

4.3 General information

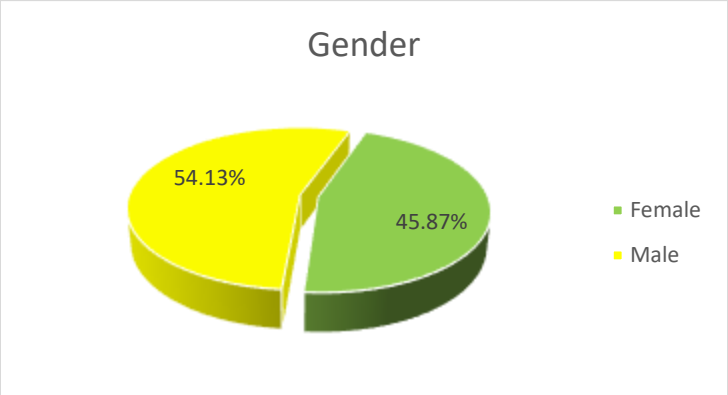

Figure 4.1: Gender rate
Source: Research findings, 2018

From the number of respondents who took part in the study, 54.13% were male and the remaining 45.87% were female as demonstrated in the chart above.

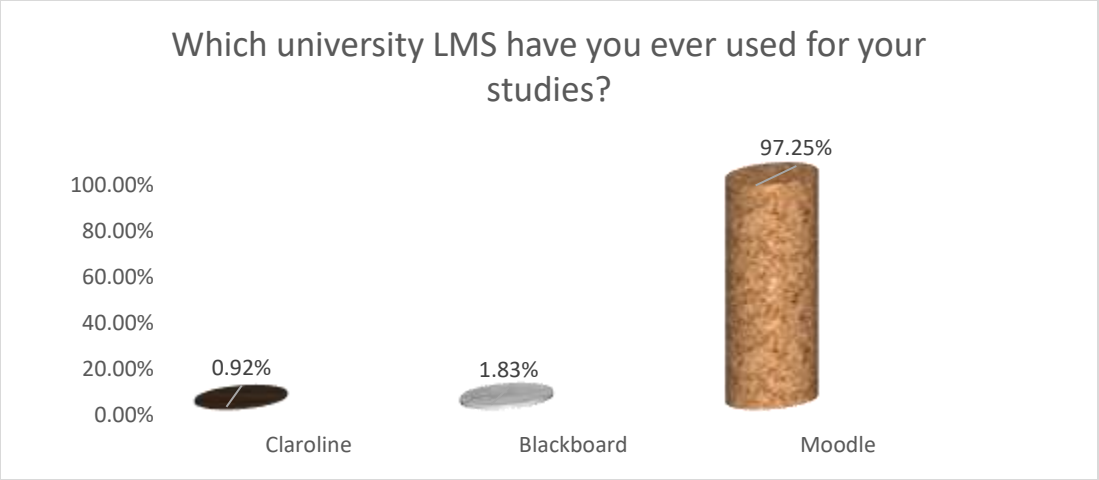

Figure 4.2: LMS Platform
Source: Author (2018)

The study went further to establish if the respondents have ever used any of the University LMS platforms for their studies. The findings from the analyzed data were 97.25% of the respondents have interacted with Moodle platform, 0.92% Claroline, while 1.83% Blackboard LMS as summarized in figure 4.2 above.

4.4 Descriptive Analysis: Analysis of responses

Using a Likert scale of 1-5 (1- Strongly disagree, 2- disagree, 3- neutral, 4- agree, 5- strongly agree), the study sought to find out how the respondents gauged the variables (both dependent and independent) under study. We used percentage, standard deviation and mean/average of the observations, standard deviation (σ) is used to measure how a set of data is distributed or dispersed around the mean. The smaller the σ, the more the data cluster closely to the mean score. The findings from the respondents are as discussed below:

4.4.1 Knowledge Construction

Researchers applied the inter-rater reliability in the analysis of contents, we used two judges to analyze the posts submitted by students on the learning forum. Inter-rater reliability (Kohens Kappa technique) is used to establish the degree of agreement among/between the raters. From the findings, reliability value of the level of knowledge construction was at 0.72

The scale of 0.61-0.80 means a substantial agreement, while 0.81-1.00 exhibit almost ideal agreement between the raters (Landis & Koch, 1977). Therefore, the coding scheme for this study is reliable.

Table 4.3: Percentage and number of posts as analyzed by OCL Model

Indicators (I)	Measures	Number of post	Total post per (I)	%	% per indicators
Idea Generation	New topic	16		5.73	
	New questions	86		30.82	
	Statements	6		2.15	
			108		38.71
Idea Organization	Elaboration/ Explanation	10		3.58	
	Feedback to questions	135		48.39	
	Questions to posts	9		3.23	
	Argument	17		6.09	
			171		61.29

Source: Author (2018)

Source: Research findings, 2018

According to the table above, out of a total of 279 posts (135posts or 48.39%) are feedback to questions, new questions (86 posts, 30.82%), argument and elaboration/explanation shared (10 posts, 3.58%), and finally new topic and questions to post shared (16 posts, 5.73%) each. The majority of the posts (171) showed a 61.29% of Idea Organization and then followed by Idea generation at (108 posts, 38.71%). It is presumed that frequency shows the importance of the subject matter, when it comes to quantitative scale in content analysis (Spens, & Kovács, 2006). The results proved there was the presence of collaboration activities within the learning platform.

Elaboration/Explanation: Providing clear understanding to the questions and topic of discussion.

Feedback to questions: Answer queries in the discussion platform, students develop knowledge by assisting each other.

Questions to posts: Providing insightful questions to posts (discussions).

Argument: Involves agreeing or disagreeing with posted points, explaining the logics and promote deep learning.

New topic: This can trigger discussion and can create new knowledge.

New questions: Gives learners an opportunity to explore beyond the course coverage and learn more.

Statements: Provides clues and hints to students and it encourages the flow of discussion.

4.4.2 Percentage response of Educational Technology

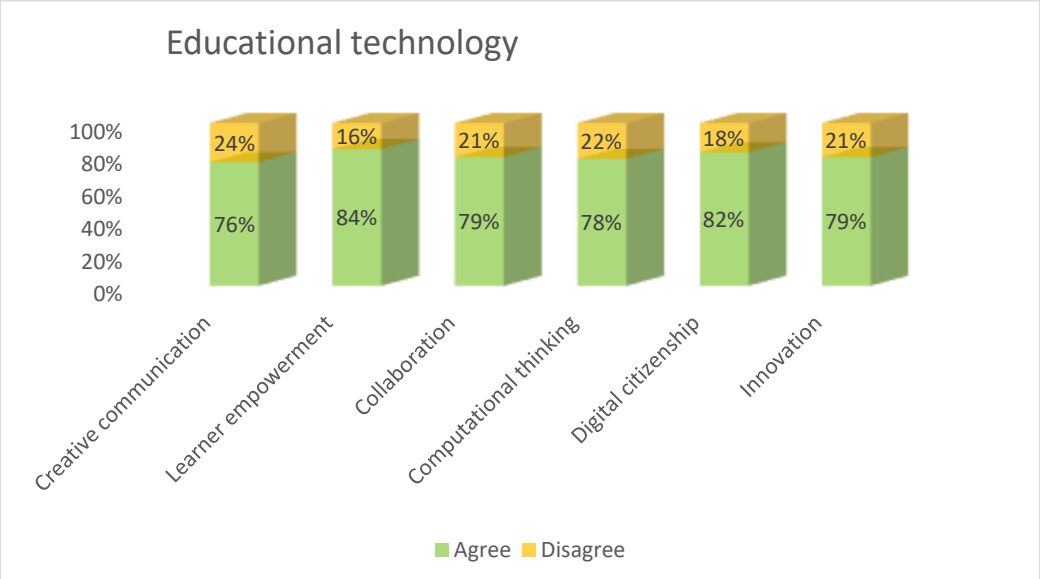

Figure 4.3: Descriptive statistics for Educational technology

Source: Author (2018)

From the figure above, the majority of respondents agreed that creative communication (76%), Learner empowerment (84%), Collaboration (79%), Computational thinking (78%), Digital citizenship (82%), and Innovation (79%) contributes to knowledge construction in a CSCL environment. From the figures above, respondents agreed that creative communication, empower learner, collaboration, computational thinking, digital citizenship, and innovation contributes to students' knowledge construction.

Table 4.4: Descriptive statistics for Educational technology (mean)

Variable	Observation	Mean(M)	Std. Dev(SD)	Min	Max
Creative communication	109	3.926606	1.111442	1	5
Empower learner	109	4.036697	.9711258	1	5
Collaboration	109	3.825688	1.137281	1	5
Computational thinking	109	3.87156	1.139371	1	5
Digital Citizenship	109	3.844037	1.210864	1	5
Innovation	109	3.899083	1.261576	1	5

Source: Author (2018)

4.4.3 Percentage response of Instructional Design

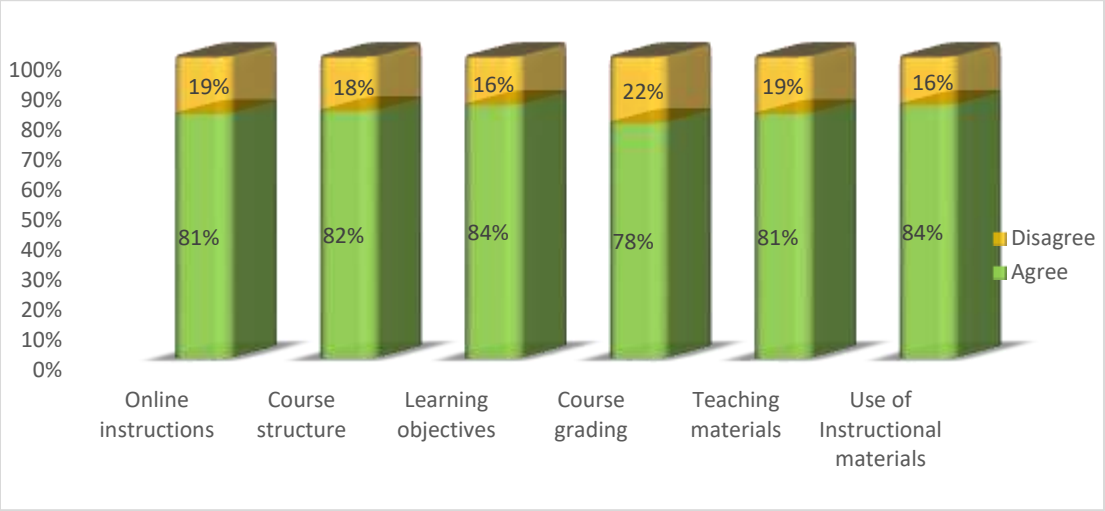

Figure 4.4: Descriptive statistics for Instructional Design

Source: Author (2018)

From figure 4.4 above, majority of respondents agreed that online instructions (81%), Course structure (82%), Learning objectives (84%), Course grading and assessment (78%), Teaching materials (81%), and Use of online materials (84%) contributes to knowledge construction in a CSCL environment.

4.4.4 Percentage response of Student's characteristics.

Motivation

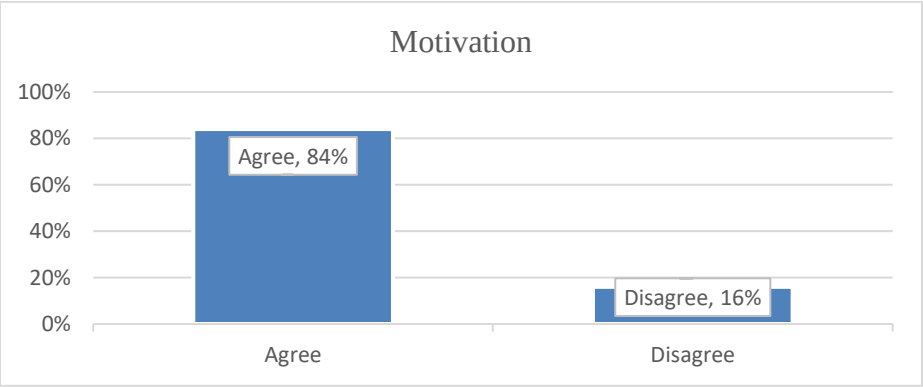

Figure 4.5: Descriptive statistics for motivation
Source: Author (2018)

The study sought to find out the respondents' views on whether students' motivation influences students' characteristics in an online learning environment. 16% of the respondents disagreed and 84% of respondents agreed respectively. This is summarized in figure 4.5 above.

Self-efficacy

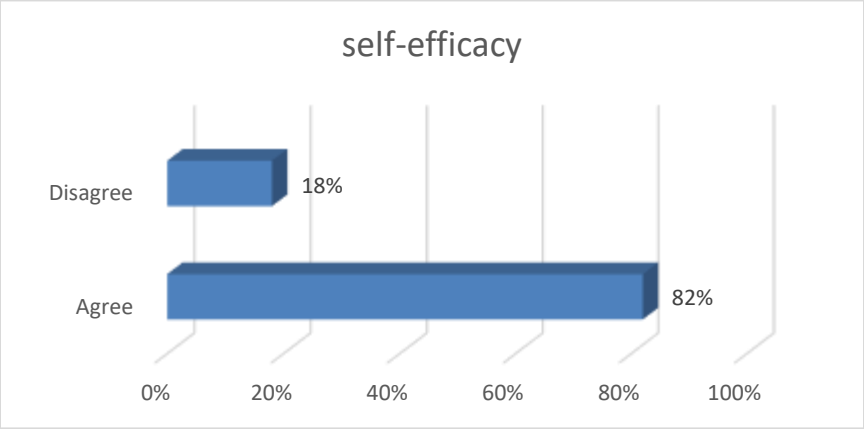

Figure 4.6: Descriptive statistics for self-efficacy
Source: Author (2018)

Results above shows 18% of respondents disagreed and 82% of respondents agreed on self-efficacy characteristic as a contributor to students' characteristics.

Metacognitive belief

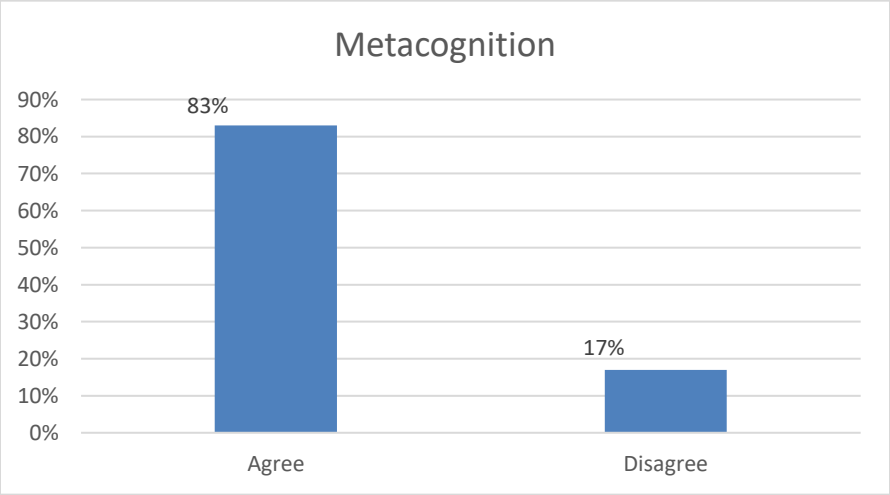

Figure 4.7: Descriptive statistics for metacognition
Source: Author (2018)

As shown in figure 4.7 above, 17% of respondents disagreed while 83% of respondents agreed on metacognitive belief as a character affecting students' characteristics.

Epistemological belief

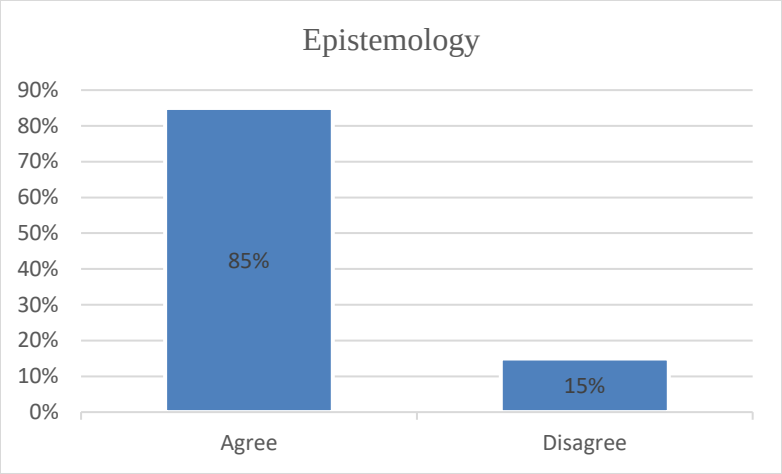

Figure 4.8: Descriptive statistics for Epistemological belief
Source: Author (2018)

Figure 4.8 above shows, 15% of respondents disagreed and 85% of the respondents agreed that epistemological character has an impact on students' characteristics in an online learning environment.

4.4.4 Percentage response of Discourse Strategies.

Table 4.5: Descriptive statistics for discourse strategies

Items	Agree	Disagree
Critical reflection (active and careful consideration towards self-constructed knowledge) on online learning materials improve knowledge.	82%	18%
Student's engagement and attention on the tasks (discussions, quiz, and reading) online enhance learning.	85%	15%
Clearly explained and elaborated online notes and discussions improves learning.	89%	11%
Online collaboration and discussion generate ideas.	84%	16%
Online-social behavior/interaction (sharing information, receiving timely responses, expressing agreement) improve learning.	86%	14%
Online feedback to questions posted online improves learning.	87%	13%
Online learning questions facilitates generation of ideas on the topic of discussion.	86%	14%

Source: Research findings, 2018

Table 4.6: Descriptive statistics for discourse strategies (mean)

Variable	Observation	Mean(M)	Std. Dev(SD)	Min	Max
Critical reflection	109	3.917431	0.9825179	1	5
Student's engagement	109	4.009174	0.8107543	1	5
Online notes	109	4.165138	0.8109638	1	5
Online collaboration	109	4.201835	0.8796024	1	5
Social behavior	109	4.091743	0.9183448	1	5
Feedback	109	4.229358	0.823644	1	5
Learning questions	109	4.201835	0.869012	1	5

Source: Research findings, 2018

4.4.2 Comparison of Students' Percentage response per Group

The level of agreement (%) according to the respondents of various course disciplines were displayed as below.

Educational technology on students' knowledge construction

Table 4.7: Frequency comparison of Educational Technology among groups

Educational technology Indicators	Courses				
	Actuarial	B.Com	IT	Law	BPCM
Creative Communication	67%	77%	89%	82%	63%
Learner empowerment	77%	86%	84%	85%	88%
Collaboration	72%	77%	83%	75%	87%
Computational thinking	68%	82%	88%	77%	75%
Digital citizenship	70%	83%	86%	75%	94%
Innovation	79%	82%	82%	78%	75%

Source: Author (2018)

Instructional design on students' knowledge construction

Table 4.8: Frequency comparison of Instructional design among groups

Instructional design Indicators	Courses				
	Actuarial	B.Com	IT	Law	BPCM
Clear online instructions on how to get started and where to find various course components improve learning.	62%	86%	92%	89%	75%
Online course structure, introduction and online training enhance learning.	67%	91%	90%	79%	81%
Online learning objectives improves learning outcomes	69%	89%	88%	87%	88%
Clearly stated online course grading and online assessment improve performance.	72%	73%	87%	84%	75%
Comprehensive online teaching materials enhances learning process and learning skills.	59%	82%	90%	80%	94%
Use of online instructional materials improves knowledge	74%	77%	92%	91%	88%

Source: Author (2018)

Students' characteristics on students' knowledge construction.

Table 4.9: Frequency comparison of Students' characteristics among groups

Items	Actuarial	B.Com	IT	Law	BPCM
Motivation	73%	82%	92%	80%	94%
Self-efficacy	65%	77%	90%	84%	93%
Metacognition	70%	82%	89%	86%	90%
Epistemology	68%	96%	94%	87%	81%

Source: Author (2018)

Discourse strategies on students' knowledge construction

Table 4.10: Frequency comparison of Discourse strategies among groups

Factors affecting instructional design	Courses				
	Actuarial	B.Com	IT	Law	BPCM
Critical reflection (active and careful consideration towards self-constructed knowledge) on online learning materials improve knowledge.	67%	82%	88%	81%	94%
Student's engagement and attention on the tasks (discussions, quiz, and reading) online enhance learning.	71%	83%	86%	86%	100%
Clearly explained and elaborated online materials and discussions improves learning.	89%	82%	84%	89%	100%
Online collaboration and discussion generate ideas.	87%	77%	80%	86%	89%
Online-social behavior/interaction (sharing information, receiving timely responses, expressing agreement) improve learning.	74%	86%	87%	87%	98%
Online feedback to questions posted online improves learning.	77%	82%	89%	89%	97%
Online learning questions facilitates generation of ideas on the topic of discussion.	67%	86%	91%	89%	98%

Source: Author (2018)

4.5 Inferential Statistics

4.5.1 Data Screening

Data screening was done to test for the qualification of parametric/non-parametric tests. As shown in appendix 2, all the variables had a Condition Index (CI) value of less than 30, indicating no collinearity. We further tested for normality on the variables, the Shapiro-Wilk p-values were larger than 0.05 (Ghasemi, & Zahediasl, 2012), hence failed to reject the normality tests. Sullivan and Artino (2013), if the data are nearly normal or normally distributed, parametric tests can be used even with Likert scale data.

4.5.2 Correlation between Variables

Researchers employed Pearson correlation to find out the degree of association between variables and courses under study. The values of Pearson correlation scale from -1 to +1, where positive

values show positive correlation and negative values show a negative correlation between the two variables. A Zero (0) correlation coefficient stipulates there is completely no relationship between the variables. Correlation coefficient > 0.81 shows very strong correlation, correlation coefficient > 0.61< 0.80 shows strong correlation, correlations > 0.41< 0.60 indicate moderate relation, >0.21 and <0.40 indicate weak correlation and coefficient <0.20 shows very weak correlation (Fraenkel, Wallen & Hyun, 2012).

Educational technology on students' knowledge construction

Table 4.11 Relationship between students on Educational Technology

	B.Com	BSc. Law	BSc. IT	BSc. Actuarial	BPCM
B.Com	1.0000				
BSc. Law	0.7580	1.0000			
BSc. IT	0.9390	0.7255	1.0000		
BSc. Actuarial	0.0770	-0.4141	0.2116	1.0000	
BPCM	0.3846	-0.1240	0.3326	0.4623	1.0000

Source: Research findings, 2018

Table 4.11 gives a summary of the relationship between the responses received from different courses of the respondents on how educational technology affects students' knowledge construction. There was a strong positive relationship between students pursuing Bcom and those pursuing BSc. Law, BSc. Actuarial and BSc. IT. There was equally a strong positive relationship between BSc. Law students and BSc. IT students. However, we noted weak positive relationship between students pursuing BPCM and B.Com, BSc. IT and BSc. Actuarial. The study established that there was weak negative relationship between students pursuing BSc. Law with those pursuing BSc. Actuarial and BPCM.

Instructional design on students' knowledge construction

Table 4.12 Relationship between students on Instructional design

	B.Com	BSc. Law	BSc. IT	BSc. Actuarial	BPCM
B.Com	1.0000				
BSc. Law	0.9126	1.0000			
BSc. IT	0.9561	0.8831	1.0000		
BSc. Actuarial	0.9512	0.9006	0.8452	1.0000	
BPCM	0.9448	0.8426	0.9335	0.8448	1.0000

Source: Research findings, 2018

The research responses indicated that there was a strong positive relationship among all the respondents in the study. This is clearly evidenced in table 4.12.

Students' characteristics on students' knowledge construction

Table 4.13: Relationship between students on Students' characteristics

	B.Com	BSc. Law	BSc. IT	BSc. Actuarial	BPCM
B.Com	1.0000				
BSc. Law	0.8322	1.0000			
BSc. IT	0.9524	0.9526	1.0000		
BSc. Actuarial	0.7213	0.5822	0.7130	1.0000	
BPCM	0.7138	0.3478	0.5477	0.4497	1.0000

Source: Research findings, 2018

The table above depicts a strong positive relationship between respondents doing Bcom with students doing Law (0.8322), IT (0.9524), BSc. Actuarial (0.7213) and BPCM (0.7138). It was equally established that there was a strong positive relationship between BSc. Law with BSc. IT (0.9526) and BSc. Actuarial (0.5822). However, there is weak positive relationship between BPCM with BSc. Law (0.3478) and BSc. Actuarial. There is equally a moderate positive relationship (0.5477) between BSc.IT and BPCM.

Correlation Analysis

Pearson correlation was used to analyze the relationship between the variables, since the data was normally distributed.

Table 4.14: Model Correlation Matrix

		Knowledge Construction	Educational Technology	Instructional Design	Students Characteristics	Discourse Strategy
Knowledge Construction	Pearson Correlation	1	.771	.209	.726	.745
	Sig. (2-tailed)		.000	.041	.000	.000
	N	109	109	109	109	109
Educational Technology	Pearson Correlation	.771	1	.420	.754	.772
	Sig. (2-tailed)	.000		.000	.000	.000
	N	109	109	109	109	109
Instructional Design	Pearson Correlation	.209	.420	1	.347	.192
	Sig. (2-tailed)	.041	.000		.000	.045
	N	109	109	109	109	109
Students Characteristics	Pearson Correlation	.726	.754	.347	1	.635
	Sig. (2-tailed)	.000	.000	.000		.000
	N	109	109	109	109	109
Discourse Strategy	Pearson Correlation	.745	.772	.192	.635	1
	Sig. (2-tailed)	.000	.000	.045	.000	
	N	109	109	109	109	109

**. Correlation is significant at 0.05 level (2-tailed).*

Source: Research findings, 2018

Table 4.14 above shows correlation coefficient between predictors and dependent variables measured in the study. A positive and significantly strong relationship was noted between educational technology and knowledge construction; (r = 771; p= .000), therefore significant. Discourse strategy followed with a strong correlation coefficient (r = 0.745; p= .000), hence significant. The relationship between knowledge construction and students characteristics was strong and positive at; (r = 0.726; p= 0.000), therefore significant. Lastly, there was very weak positive correlation between Instructional design and knowledge construction at (r = 0.209; p= 0.041), but significant.

4.5.3 Testing Significance Difference between the Groups (Courses).

ANOVA is a batch of statistical models and their linked procedures (change between and among groups) for analyzing differences among group means. When critical f-value is smaller than the F Value, null hypotheses aren't rejected unless the p-value is less too. The research seeks to find out factors contributing to students' knowledge construction in an online collaborative environment among different groups of students. Respondents were categorized into five groups according to the courses that they are doing. The study used a Linkert scale of 1-5 to find out the respondents' opinion on the topic. The tables below show summaries of the various variables that the research sought to find information about.

Test if the views of the five groups differ from each other significantly on each of the four independent variables. We used a single factorial ANOVA to compare means across the four variables for the research model.

Educational technology on students' knowledge construction

Table 4.15: (Comparing Mean Difference for Educational Technology)

Anova: Single Factor

SUMMARY

Groups	***Count***	***Sum***	***Average***	***Variance***
BCOM	11	44	4	1.6
Law	56	210	3.75	0.190909
IT	25	98	3.92	0.076667
Actuarial	9	31	3.444444	0.277778
BPCM	8	32	4	0

ANOVA

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	2.391906	4	0.597977	3.034851	0.094889	2.459057
Within Groups	30.56222	105	0.293868			
Total	32.95413	109				

Source: Research findings, 2018

On average, most Bcom, Law, IT, Actuarial Science and BPCM students agreed educational technology influencing student's knowledge construction. The analysis of variance of educational technology on students' knowledge construction indicated that the sum of squares between groups was 2.391906 with four degrees of freedom and a mean square of 0.597977. The F statistics

between groups was 3.034851 with a p-value of 0.094889, which is greater than 0.05 suggesting there is no statistically significant difference for educational technology among the groups mean.

BCOM and PBCM students had a competitive perceptual edge over the other group of students in the field of educational technology on students' knowledge construction in a collaborative learning environment.

Instructional design on students' knowledge construction

Table 4.16: (Comparing Mean Difference for Instructional design)

Anova: Single Factor

SUMMARY

Groups	***Count***	***Sum***	***Average***	***Variance***
BCOM	11	47	4.272727	0.618182
Law	56	215	3.839286	0.137338
IT	25	99	3.96	0.04
Actuarial	9	31	3.544444	0.277778
BPCM	8	30	3.75	0.214286

ANOVA

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	3.784223	4	0.946056	5.342158	0.000594	2.459057
Within Groups	18.41761	105	0.177092			
Total	22.20183	109				

Source: Research findings, 2018

Table 4.16 above display a brief of how respondents in different courses indicated their view on the relationship between instruction design and students' knowledge construction. The analysis of variance between groups indicated that the sum of squares was 3.784223 with four degrees of freedom and a mean square of 0.946056. The F-statistics between groups was 5.342158 with a p-value of 0.000594 that is less than 0.05 signifying there was a statistically significant difference for instructional design among the groups mean at ($p = 0.000594 < 0.05$).

BCOM students had a competitive perceptual edge over the other group of students in the field of instructional design on students' knowledge construction in a collaborative learning environment.

Student's characteristics on students' knowledge construction

Table 4.17: (Comparing Mean Difference for Students' characteristics)

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
BCOM	11	43	3.909091	0.290909
Law	56	218	3.892857	0.097403
IT	25	98	3.92	0.076667
Actuarial	9	30	3.333333	0.25
BPCM	8	32	4	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.829546	4	0.707387	6.076886	0.000196	2.459057
Within Groups	12.10623	105	0.116406			
Total	14.93578	109				

Source: Research findings, 2018

The analysis of variance between groups demonstrated a sum of squares of 2.829546 with a mean square of 0.707387 and F-statistic of 6.076886. The p-value of 0.000196, which is less than 0.05 signifying that at least one-group mean is significantly different from the other groups, hence there was a statistically significant difference at ($p = 0.00019 < 0.05$). The analysis of variance within groups is as summarized in the table above.

PBCM students had a competitive perceptual edge over the other group of students in the field of students' characteristics on students' knowledge construction.

Discourse strategies on students' knowledge construction

Table 4.18: (Comparing Mean Difference for Discourse strategies)

Anova: Single Factor

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.365793	4	0.091448	1.022214	0.399445	2.459057
Within Groups	9.303932	105	0.089461			
Total	9.669725	109				

Source: Research findings, 2018

Table 4.18 above shows the analysis of variance between groups, the study found out the sum of squares was 0.365793 with four degrees of freedom and a mean square of 0.091448. The F-statistics from the data are 1.022214 and a p-value of 0.399445, which is greater than 0.05 signifying there is no statistically significant difference for discourse strategy among the groups mean.

IT and PBCM students had a competitive perceptual edge over the other groups of students in the field of discourse strategies on students' knowledge construction.

4.5.4 Testing Goodness of Fit Model

The study used multiple regression analysis, where we included all the predictor variables into the equation.

Table 4.19: Goodness of Fit

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.864[a]	.749	.728	.444

a. Predictors: (Constant), Educational Technology, Instructional design, Discourse strategies, students' characteristics.

Source: Research findings, 2018

From the table above, the results depict a good measure of linear relationship between the independent variables and dependent variable under study. This is evident by a correlation (R) coefficient of 0.864. R^2 (coefficient of determination) is a statistical term showing how good one can predict another, a 1 (one) indicates perfect prediction. A larger value of R-Square means one can better determine the outcome of one term from another.

R^2 value of more than 50% is viewed as good indication. From the findings, R-Square indicated a strong relationship between the four independent variables and the dependent variable of value 0.749 representing (74.9%). This is evidence that the independent variables studied are important factors that influence the dependent variable, students' knowledge construction in an online collaborative learning environment. However, this shows that there are other determinants (25.1%) contributing to students' knowledge construction.

Table 4.20: ANOVA Model

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.084	4	13.771	69.883	.000[b]
	Residual	20.494	105	.197		
	Total	75.578	109			

a. Dependent Variable: Knowledge construction

b. Predictors: (Constant), *Educational Technology, Instructional design, students' characteristics, Discourse strategies.*

Source: Research findings, 2018

Table 4.20, above, assesses the statistical significance of the regression model. The results were as follows: variation between the group sum of squares = 55.084, F-value of 69.883 and a significance evidence on the Sig. column where P value = 0.000^b less than 0.05. This shows a probability of 0% of the correlation model giving false data. Thus, the model is fit to predict students' knowledge construction in an online collaborative learning environment.

4.5.5 Cause-Effect and Hypotheses testing

Table 4.21: Regression Coefficient

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	7.401	0.605		12.239	.000
	Educational Technology	0.538	0.127	0.430	4.237	.000
	Instructional Design	0.376	0.094	0.232	4.001	.000
	Students' characteristics	-0.651	0.159	-0.321	-4.088	.000
	Discourse strategies	0.384	.126	0.254	3.048	.003

a. Dependent Variable: Knowledge Construction

Source: Research findings, 2018

The study was interested in comparing the contribution of every independent variable on the dependent variable. This was done by getting the beta values on Standardized Coefficients column, to find out which beta value has a stronger effect and disregarding negative/positive sign. Independent variable with the highest value means that it made the strongest unique contribution

to the dependent variable. A less value would mean it contributes less to the dependent variable. The column marked "Sig." shows whether a variable is making a statistically significant contribution to the equation. If the Sig.-value is less than 0.05, then there is a significant contribution to the dependent variable, but when the value is greater than .05, then the independent variable isn't making a significant contribution to the predicted outcome. The findings of our research were as follows: Educational Technology made a stronger unique contribution of 0.430 and the variable is statistically significant to the equation at p = 0.000. Instructional Design at 0.232 making a unique contribution and the variable has a significance of 0.000, which is statistically significant to Knowledge construction because it is less than 0.05. Similarly, students' characteristics contributed uniquely at 0.321 and the contribution is statistically significant to the equation at 0.000. Finally, discourse strategies made a unique contribution of 0.254. This is statistically significant to the equation at 0.003.

From the findings, Educational technology made the highest contribution.

The technique was used to test hypotheses. The Rule of the thumb is when the p-value is $< \alpha$ fail to reject the hypothesis, and when the p-value is $> \alpha$ reject the hypothesis. This study assumed $\alpha = 0.05$ and compared against p-values in table 4.21 above.

Hypothesis (H_1): educational technology has a significant effect on students' knowledge construction in an online collaborative learning environment. The results indicated that educational technology has coefficients negatively associated with students' knowledge construction and had a significant effect [$\beta 1 = -0.430$, p-value =0.000 less than $\alpha = 0.05$]. This signifies that with every 1-unit increase in educational technology, students' Knowledge construction reduces by 0.430 units. We failed to reject the alternate hypothesis and it's inferred that educational technology has a statistically significant effect on students' knowledge construction in an online collaborative learning environment.

Hypothesis (H_2): Instructional design has a significant effect on students' knowledge construction. The results established coefficients of $\beta 1 = 0.232$ and $p = 0.000$ significant as it is less than 0.05. This signifies that with, a 1-unit increase in Instructional design, students' Knowledge construction increases by 0.232. We failed to reject the alternate hypothesis and it was concluded that Instructional design contributes to student's knowledge construction, the predictor is statistically significant on students' knowledge construction.

Hypothesis (H_3): Student's characteristics have a significant effect on students' knowledge construction. The results showed students' characteristics had coefficients of $\beta = -0.321$ and p-value =0.000 less than $\alpha = 0.05$. We inferred that with a 1-unit increase in students' characteristics, student knowledge construction decreases by 0.321 units. We failed to reject the alternate hypothesis and it was deduced that students' characteristics have a statistically significant effect on students' knowledge construction as evidenced in Table 4.21 above.

Hypothesis (H_4): Discourse strategies have a significant effect on students' knowledge construction. We found that discourse strategies had coefficients of $\beta = -0.254$ and p-value = 0.003 less than $\alpha = 0.05$. This implies that with a 1-unit increase in discourse strategies, students' knowledge construction will decrease by 0.254 units. This further suggests discourse strategy has a statistically significant effect on student knowledge construction considering the p-value. Hence, we failed to reject the alternate hypothesis and it was theorized that discourse strategies have a statistically significant effect on student knowledge construction in an online collaborative learning platform.

Table 4.22: Hypotheses Testing

Hypotheses	Coefficient P- Values	Conclusion
H_1: educational technology have significant effect on students' knowledge construction	P= **.000** < 0.05	**Fail to reject H_1**
H_2: instructional design have significant effect on students' knowledge construction.	P=**.000** < 0.05	**Fail to reject H_2**
H_3: students' characteristics have significant effect on students' knowledge construction.	P=**.000** < 0.05	**Fail to reject H_3**
H_4: discourse strategies have significant effect students' knowledge construction.	P=**.003** < 0.05	**Fail to reject H_4**

Source: Research findings, 2018

4.6 Fitting the model

Below is the Regression equation to form Students' knowledge construction in an online collaborative learning environment:

$$\mathbf{Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon.}$$

$$\mathbf{Y= 7.401-0.538X_1+ 0.376X_2- 0.651X_3 – 0.384X_4 + \varepsilon}$$

Where,

Y= Students' knowledge construction

β_o = Model's Constant

β1- β4 Are the regression coefficient or change induced on y by change in x

X1 = Educational technology

X2 = Instructional design

X3 = Students' characteristics

X4 = Discourse strategies

e = Model's significance error obtained from ANOVA

4.7 Discussion of the findings

The research results established a correlation between Students' knowledge construction and predictor variables; Educational technology, Instructional design, Students' characteristics and Learning discourse strategies. There was a satisfactory linear correlation between the independent variables and dependent variable as indicated in table 4.19 above, (Correlation = 86.4%).

4.7.1 Educational Technology and Students' knowledge construction

The study established respondents' view towards educational technology on knowledge construction, with a statistical significance of p=0.000. This study looked at educational technology as a tool for creative communication (76%), Learner empowerment (84%), Collaboration (79%), Computational thinking (78%), Digital citizenship (82%), and Innovation (79%) in a CSCL environment.

The findings concurs with the study of Bester and Brand, (2013), on effect of technology on learners, the group which was subjected to use of technology in class were more attentive compared to the group not using educational technology. They also support that unless the attention of students is acquired, effective learning would not take place. The roles of education technology as supported by the National Educational technology standards (NETS) are; innovation, collaboration, empower learner, digital citizenship, computational thinking and creative communication. In the same view, Robertson and Al-Zahrani, (2012), did a study to unearth how ICT in education affects teachers' self-efficacy and motivation, the findings revealed that teacher exposure and access to educational computers boosted their motivation, self-efficacy and technology habits. Use of e-learning technologies has proven a potential in maintaining

concentration and motivation in e-learning environments, this also depends on how the technology is used to support learners.

Bullock, (2014), more studies should be done on how technology can support knowledge acquisition and improve participation in the workplace. He established a correlation between use of technology and information access and knowledge sharing. Incorporating current learning technology is not enough, but rather incorporate technology that provides learners with more control over their interactions and encourage learner reflection to support learning (Jaggars, & Xu, 2013).

4.7.2 Instructional Design and Students' knowledge construction

This study established clear online instructions (81%), Course structure (82%), Learning objectives (84%), Course grading and assessment (78%), Teaching materials (81%), and Use of online materials (84%) contributes to a good instructional design in a CSCL environment. The study also found instructional design having a statistical significance of p=0.000 on knowledge construction.

These findings echo Rienties, Toetenel, and Bryan, (2015), on the evaluation of the LMS design and the learning performances, where the findings revealed that learning design activities highly influenced how learners were engaging online and on learning performance. Kintu, Zhu, and Kagambe (2017), established design features like technology quality and interactions, contributing to knowledge construction in an online blended learning. In addition, the findings agree with Effiong, and Igiri, (2015), there was a positive achievement in learners who were exposed to instructional learning materials and concluded that instructional materials promote knowledge retention, enhance academic achievement and make studying very real.

The preferred design of online learners could motivate learners and support learning intentions, this could go a long way by enhancing constructive information accessibility and learning experience. LMS design can cause learners /teachers make a comparative judgment between using LMS and using conventional methods for learning activities and experiences.

Strategies like 1) early warning systems could be integrated into LMS to monitor students who are not active online. The system could alert the online instructor and then, the instructor tries to intervene. 2) Improvement, this requires advancements in LMS design, online learner support, faculty professional growth and course/LMS appraisal used to improve the design and online learning.

4.7.3 Students' characteristics and Students' knowledge construction

This construct was guided by motivation, self-efficacy, metacognition and epistemological beliefs. Students gave their opinion to how these influence students' characteristics on learners; epistemological belief took a lead of 85%, followed by motivation at 84%, metacognition at 83% and self-efficacy at 82%. The study on students' characteristics had a statistical significance of p=0.000 on knowledge construction within an online learning environment.

Motivation: Motivation can be improved through curiosity, challenge, recognition, control, competition and cooperation (Ciampa, 2014). Yau, Joy and Dickert, (2010), revealed motivation as the most important factor in determining participants' concentration levels, higher motivation led to higher concentration levels at $p < .001$. Instructor's autonomy-supportive interaction and online environmental factors need to be looked into as the predictors of students' self-regulated motivation as reported in one of the unpublished paper by (Russell, 2013). All the stakeholders need to be aware of the significant tasks they take in shaping online learner motivation when they are constructing learning activities online.

Metacognition: The findings support a study by Abdellah (2015) the study, found out that metacognition improves on the academic achievements and teaching performances to both students and teachers.

Self-efficacy: Pellas (2014), the study ascertained that computer self-efficacy were significant predictors of cognitive factors in an online learning environment, students who believed that online instruction is enthralling enhanced students' meta-cognitive and cognitive outcomes. However, it is advised when self-efficacy is overestimated, then there is a need for sufficient experience to solve and adjust the judgment.

Educators should focus on ways of building learners' self-efficacy as it helps students become academically engaged and motivated in a learning environment. There are factors which could hinder the learners' self-efficacy, such as learning environment, social factors, cultural dimensions, political factors, and inadequate finances (Schunk, & Mullen, 2012). These factors should be looked at carefully for a successful and effective learning to occur.

Epistemological belief: Sinatra (2016), noted that not all meta-cognition is epistemic thinking, reflective or meta-cognitive, and not all meta-cognition is epistemic in nature. Epistemological

belief systems are flexible and can be activated through learning experiences and shaped by online learning. This is evidenced where an online learner relies on several websites for information to conclude a point. Institutions should encourage and train learners in a way that prompts higher learning outcomes and knowledge construction.

Epistemic cognition is an important skill to online learners: students are able to identify multiple sources of information, Students compare sources of information, and lastly, learners use multiple sources of information to construct meaning or argument (Barzilai, & Zohar, 2012).

4.7.4 Discourse strategies and Students' knowledge construction

This particular variable focused on learning and communication techniques which can be applied in an online collaborative learning environment. The study found a statistical significance of discourse strategy p=0.003 on knowledge construction within online environment. The students agreed on critical reflection (82%), students' engagement (85%), online elaborative notes (89%), online collaboration (84%), social behavior (86%), online feedback (87%) and learning questions (86%) influencing discourse strategy.

Critical Reflection: Predominantly, respondents agreed on critical reflection at 82% influencing students' knowledge construction. The outcome results concurred with Sobral, (2000) findings, where results showed 81% of the students had an increase of reflection at the end of the course and students with higher level of reflection in learning acquired higher grades-points and greater diagnostic ability. When there is an effective practice of critical reflection during the discussion on the learning platform, students are able to construct knowledge. According to a study by Sobral, (2000), the students with high reflection in learning achieved a higher grade-points and better diagnostic ability compared to the students with lower reflection skills.

A reflection is an act of thinking about what one learned before and how it was learned. Critical thinking is viewed differently by these two categories of people: a) absolutist-see critical thinking as a tool for establishing false or truth of a point, while b) Evaluativist-view critical thinking as a tool for enhancing sound judgment and understanding. Learners who develop reflection activities like setting a goal, seeking answers to their concerns and self-monitoring, tend to gain the most out of their studies and participate in problem-solving.

Students' Engagement: Student's engagement is referred to as quality of work students commit to educational activities promoting high-quality learning. Educationally purposeful activities

increasing levels of engagement are parental education and student academic preparation Hu and Kuh, (2002), active and collaborative learning and student-faculty interaction (Laird, & Kuh, 2005). The effectiveness of learning outcomes depends on the course content and the reason for the learners' engagement.

The findings were in support with the results of Carini, Kuh, and Klein, (2006), students' involvement in effective educational practices had a correlation with preferable learning outcomes such as higher grades and critical thinking. In addition, Mohammadi, Abrizah, and Nazari, (2017) findings revealed that students' performance increased significantly when engaged in digital learning platform (Farsi WBLRs).

Gebre, Saroyan, and Bracewell, (2014), discovered four aspects of students' engagement, namely social, cognitive and applied, reflective and goal clarity engagement. Students' engagement in an online learning environment can be encouraged by the design of the learning platform, as it provides the learning activities and tools.

Elaborated notes: Elaboration involves challenging the credibility of the information and trying to link new information with preexisting knowledge. Cognitive strategies namely 1) deep learning (elaboration of learning materials) and 2) surface learning (memorization) as studied by (Murayama, Pekrun, Lichtenfeld, Vom, & Hofe, 2013). They got positive results after hypothesizing that deep learning through elaboration would lead to academic success in mathematics and academic growth. Elaboration increases the receiver's or student's thinking in a cognitive learning environment. This shows that elaborated learning materials hold an important role in online academics.

Online collaboration and discussion: The findings were not in tandem with Sormunen, Tanni, and Heinström, (2013), their findings supported the claim partially, where students reported learning experiences by citing two sources of information literacy. The broadest learning experience, was shown by the students who worked individually, they believed that they did not gain much from group work.

The study results showed collaboration as a means for achieving knowledge, the findings could lead to a better design of CSCL. Collaboration requires learners' willingness to do so and a feeling of responsibility.

Collaborative learning activities provide learning through production, practice, discussion, and acquisition. The outcomes of collaborative learning go beyond knowledge construction, as students are able to learn some of the social skills for example; helping each other learn, explaining new experience and understanding, solving problems and constructive argumentation. Therefore, instructors should encourage collaborative performance and practices than paying more attention to rating students' academic performance.

Online social interaction: The results were similar to a research done by Smith, et al., (2009), the results showed that peer discussions were effective for knowledge awareness of difficult ideas even when initially none gets the right answer. They concluded that peer discussion is an effective method for active learning. Jung, et al., (2002), found social interaction as the highest predictor of students' satisfaction with their learning achievements. The findings were in contrary to Kuo, Walker, Belland, and Schroder, (2013), where student-student interactions were found as a non-predictor to student's learning satisfaction.

This study proves that, different methods of interaction must be incorporated on online CSCL platforms. Social interaction is also supported to encourage elaboration of theoretical knowledge.

Feedback to questions: Erhel and Jamet, (2013), carried out an experimental study on the effect of feedback on learning, the results confirmed that if students are given regular feedback, the entertainment learning resulted in deep learning. Their results revealed a significant effect of feedback enhancing learners' motivation, skills, displayed ability to succeed in learning and engagement in the tasks.

The role of the feedback is to foster the execution of cognitive processing, the presence of correct feedback not only enhanced deep learning under entertainment condition but also promoted memorization.

Online learning questions: In tandem with Chin and Chia, (2004), in a view to establish how questions govern students' knowledge construction. Students' learning were motivated by the learners' questions, and students' interest in learning project were sustained with the capacity to ask constructive questions and how effective the questions are answered. King (1994), revealed the significance of using constructive questions, training students to ask questions advocate for association among ideas and result in a more complex knowledge construction than the lesson-

based questioning students. Online instructors and educators should encourage and teach how to develop these constructive questions.

Learning questions, guide and assist students in thinking. Questions can be used to introduce a topic of discussion, to acquire clarity, provide hints or more information from peer learners and tutors. Learning and communication design techniques are, therefore, important as they promote effective teaching and learning and promotes the integration of teamwork into learning.

4.7.5 Knowledge Construction

The result is inconsistent with Häkkinen, *et al*., (2010), the research established the influence of scripting to knowledge construction, the results show that the scripts succeeded in guiding the students to collaborate. The students were able to share their views, engage in critical analysis and lastly construct knowledge. This was also in agreement with a study done by Noroozi, *et al*., (2013), a topic "Facilitating argumentative knowledge construction through a trans-active discussion script in CSCL". Sormunen, Tanni, and Heinström, (2013), studied how students are motivated to enroll for an online course, the result showed 86% of learners being motivated by the desire for knowledge enrichment and growth.

This, therefore, showed there was evidence of collaboration in order to construct knowledge in an OCL environment in this study. Online educators could also think of assigning roles to students at the start of the discussion to enhance or increase constructive discussions. These roles; moderators, summarizers and theoreticians reflected high impact on knowledge construction (De Wever, *et al*., 2010).

4.8 Summary of Discussion

The study had 109 respondents representing a response rate of 74% from five different cohorts of university online learners.

Quantitative content analysis technique was used to cluster discussion text messages as guided by the coding scheme in order to establish the presence of online collaborative activities and knowledge construction. The results revealed idea generation (38.71%) and Idea organization of 61.29%.

We examined the correlation between educational technology, instructional design, students' characteristics and discourse strategies with the students' knowledge construction in an online learning platform. A positive and significantly strong relationship was noted between educational

technology and knowledge construction; (r = 771; p = .000), therefore significant. Discourse strategy followed with a strong correlation coefficient (r = 0.745; p = .000), hence significant. The relationship between knowledge construction and students characteristics was strong and positive at; (r = 0.726; p = 0.000), therefore significant. Lastly, there was very weak positive correlation between Instructional design and knowledge construction at (r = 0.209; p = 0.041), but significant.

The next objective was to establish the significant difference of how students perceive the four independent variables in an online learning. The results revealed a statistically significant difference for Instructional design (p=0.000594) and Student's characteristics (p=0.000196), while there was no statistically significant difference among the groups for Educational technology (p=0.0948) and Discourse strategy (p=0.399). This was achieved by using a Single Factor ANOVA, where only the two variables met the threshold of ($p<0.05$) for it to be declared statistically significant difference.

IT and PBCM students had a competitive perceptual edge over the other groups of students on discourse strategies. BPCM students had a competitive perceptual edge on Student's characteristics, Bcom students had a competitive perceptual edge on Instructional Design and finally, Bcom and BPCM students had a competitive perceptual edge on Educational Technology. The final phase was to find out the significant effect of Educational technology (p-value =0.000), Instructional design (p = 0.000), Students' characteristics (p-value =0.000) and Discourse strategies (p-value = 0.003) on students' knowledge construction. The results revealed a significant effect for all the variables on Students' knowledge construction in a CSCL environment. Educational technology (innovation) and instructional design (online course grading and online assessment), never had an effect on knowledge construction.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Introduction

The research analyzed the possible incidents of effective online collaborative learning on knowledge construction in a university. We identified the predictors by examining online learning models, standards, and empirical literature. Educational technology, instructional design, students' characteristics and discourse strategies had a significant impact on learners' knowledge construction at JKUAT. We finally analyzed and established the level of knowledge construction achieved in this study.

5.2 Conclusions

This research found out that the predicted determinants of an effective online collaborative learning played a significant role in learners' knowledge construction. Therefore, a clear understanding of these determinants must be explained to online learners, LMS designers and developers, and online instructors accordingly.

Transcribed messages helped students rationalize based on the understanding of peers and engage in constructive and critical discussions. Interactive discussion is considered the major engine of collaborative knowledge construction online. Online interactive discussions assist students in the elaboration of a topic, help coordinate learning activities, hence knowledge construction. Häkkinen *et al*., (2010), in collaborative discussion, learners engage in specific activities which are assumed to contribute to higher level cognitive processing and finally to the better learning outcome.

5.3 Study Achievements and Contributions

It was earlier revealed that there was insufficient information on how to effectively and constructively learn in a CSCL environment in most Kenyan universities. The study, therefore, contributes a significant value to Kenyan universities in as far as online collaborative learning and knowledge construction is concerned.

The main objective of the study was to assess the effectiveness of online collaborative learning on students' knowledge construction in a higher learning institution. It was identified that lack of sufficient information on how to operate in a collaborative learning environment had led to the problem of this study. The key predictors of the study adopted were; educational technology, instructional design, students' characteristics, and discourse strategies.

The final task was to establish the level of knowledge construction achieved in the study. We analyzed the discussion content (messages) on the discussion forum which took place from September 2017 to December 2017. Using the first two indicators of knowledge construction adapted from Linda Harasim (2012); Idea generation and Idea organization.

In order to effectively utilize online learning platform and overcome perceived challenges experienced by online learners, this paper gave a theoretical contribution, specifically testing and refinement (Crane, Henriques, Husted, & Matten, 2016). We therefore, propose below model as modified according to the research findings of this study. Effective application of the model will provide constructive learning and knowledge creation among university students in a CSCL environment.

The study realized and gained an understanding of the effect of research predictors as follows:

Educational Technology: The study concluded that educational technology had a significant impact on students' knowledge construction. This implied that lack of knowledge construction in a CSCL environment is as a result of inadequate Instructional Technology characteristics or standards.

Instructional Design: The study established a positive effect of instructional design on students' knowledge construction in an online learning environment. This study proved that if the quality matters rubric standard is utilized effectively to facilitate the transfer of knowledge and skills to the learners, then student knowledge construction should be realized.

Most e-Learning designers or developers and stakeholders in Kenya still take the issue of e-Learning design lightly even after the awareness and numerous research studies on the benefits of online collaborative learning. This could be because of the lack of standard guide and procedures of designing and supporting collaborative e-Learning platforms.

Students' Characteristics: The study concluded that students' characteristics are indeed a major factor to be considered in an online collaborative learning environment. Other studies support good guidance of students by the online instructor, as a factor enhancing knowledge construction. The study found the following students' characteristics as crucial to online learners: motivation, self-efficacy, metacognitive belief, and epistemological belief.

We are of the school of thought that learners' characteristics can be developed and molded for effective learning. Yeager and Dweck, (2012), asserts that learners need a mindset representing

difficulties as items they can face and overcome with time and effort, learning, strategies, patience, and assistance from peers or seniors.

Discourse Strategies: The study indicated a great influence of discourse strategies (communication and learning) on the research. The study revealed that the concept of online discourse technique is a challenge and confusing, and learners need to be guided. Therefore, learners should be engaged in a structured and effective manner during online learning for a better learning outcome. Both the online instructor and the students should be involved in achieving this objective in order to avoid the obstacles to effective collaboration as discussed by (Le, Janssen, & Wubbels, 2018).

Group Difference: Differences between the sub-constructs of effective online collaborative learning of students with regard to the area of study. The study found a significant difference among the groups on Instructional design and Students' characteristics therefore, it shows that there is a need of creating awareness and training of the two variables. The study too revealed that there was no significant difference among the groups on Educational technology and Discourse strategies.

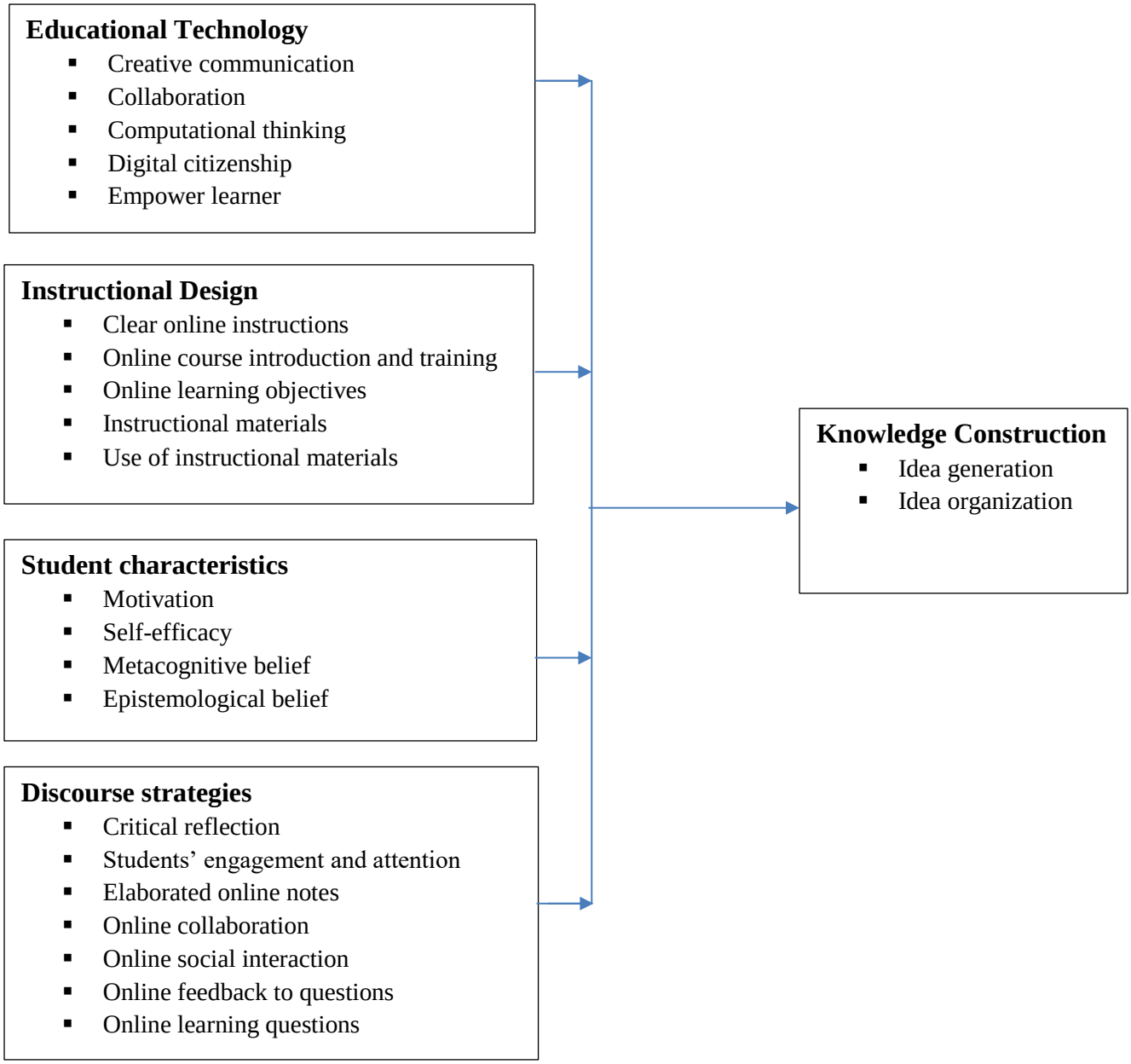

Figure 5.1: Proposed Framework for Constructive Online Collaborative Learning in Higher Education

5.4 Limitations and challenges of the Research

The study was done on an asynchronous platform, where learners access non-printed materials in text-based form. The research was limited to learners' knowledge construction in an online collaborative learning environment. The study was limited to the four constructs (Educational technology, instructional design, students' characteristics and learning/communication strategies) and to finally establish the level of knowledge.

The study failed to balance the numbers in the groups or to bring to a near-equal number, there was quite a big difference in some of the courses.

Due to limited budget and time constraints allocated, the study only examined JKUAT-Karen Campus first-year (September-December, 2017) students. This may have limited the actual findings if a larger population may have been considered.

5.5 Recommendations

The study recommends that effective application of the model should be used in providing constructive learning and knowledge creation among online learners in a CSCL environment especially to university students. Embrace educational technologies which motivate learner-reflection, knowledge construction, and collaboration to support constructive online learning. Learners should be engaged in a structured and effective manner during online learning for a better learning outcome. Learners should be assisted in acquiring, developing and molding their learning characteristics, for a better and effective learning outcome. Both, the online instructor and the students should be involved in practicing the discourse strategy objective in order to avoid the obstacles to effective collaboration. Instructional designers and online educators should think of integrating different online scaffolds in order to improve on learners' meta-cognitive thinking.

The emphasis on learner-centered design environment should not totally hinder or limit instructional developers and educators from adopting teacher-centered strategy, but requires diligent thinking about effective online learning and the learning outcome.

5.6 Suggestion for Further Research

Based on the findings from learner-centered perspective, the tested factors had a correlation with learner's knowledge construction, as well as effective online learning. Despite the broader scope of the study, it is recommended that further study covers a large range of contexts, e.g learners from a number of different universities in Kenya. From the results, the elements of the study only contributed 74.9%, this shows that other studies could be done to determine the 25.1% contributing

to students' knowledge construction. The results could be used to improve the quality and design of online collaborative learning and the success of online learning.

A similar study should be conducted, including the online instructor perceptions and views, which will be used to improve the quality and design of online collaborative learning and the success of online learners. Lastly, with the integration of new and enhanced LMS, it’s very crucial to think about professional growth of online instructors and designers in order to deliver effective learning to students.

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APPENDICES

UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

RESEARCH INSTRUMENT

Assessing the Effectiveness of Online Collaborative Learning on Students' Knowledge Construction in Higher Education

Introduction: Questionnaire Cover Letter

Dear participants, am carrying out a research on assessment of the Effectiveness of online collaborative learning on students' knowledge construction in JKUAT-KAREN CAMPUS. The purpose of the study is to determine whether effective online collaborative learning influence students' knowledge construction, either positively or negatively. It is therefore my most gratitude if you could spare your time to respond to this questionnaire. We guarantee your identity and your responses will be highly confidential and the data collected will only be used for academic purposes.

APPENDIX 1: Structured Questionnaire

Please mark with an **(X)** or a tick **(✓)** to indicate your response or as guided.

PART A: GENERAL INFORMATION

1. Name of respondent (Optional): ……

2. Gender: Female ☐ Male ☐

3. Have you ever use the University LMS for your studies? **YES [ ] NO [ ]**

If yes, which one: Moodle ☐ Claroline ☐ Blackboard ☐

3. What is your area of study:

BSc. Law ☐

BSc. Commerce ☐

BSc. IT ☐

BSc. Actuarial ☐

Other [please specify]: ……

PART B: Educational Technology on Students' knowledge construction

Online Learning Management Systems (LMS) enhances students' knowledge construction.

I AGREE [ ] DO NOT AGREE [ ]

Indicate your level of agreement with the following statements relating to **Learning Management System and its effectiveness on Students' knowledge construction** by ticking the appropriate box. Ratings are as**: [1] Strongly Disagree, [2] Disagree, [3] Neutral, [4] Agree and [5] Strongly Agree.**

S.NO	Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
	Creative Communication					
1	LMS offers online interaction among learners.					

2	Through LMS, am able to communicate ideas and information clearly online to several other learners at the same time.					
	Empower Learner					
3	LMS provides online feedback and awareness which improves and informs learning practice.					
4	LMS help learners understand the basic concepts of how to use and operate technology, hence improve learning skills.					
	Collaboration					
5	Through the use of LMS, am able to engage with multiple online learners, hence broaden my understanding and learning.					
6	Online constructive contribution (OCC) help learners produce original work and solve problems.					
	Computational thinking					
7	Threads of online discussions facilitate problem solving and decision making.					
8	LMS help one understands how automation works within online leaning.					
9	Use of LMS helps me develop learners' skills in ICT.					
	Digital Citizenship					
10	LMS exhibit leadership for digital citizenship, hence increase digital literacy.					
11	LMS categorize online information into a coherent meaningful idea or conclusions, hence improving students' knowledge.					
	Innovation					
12	LMS enable the transfer of current knowledge to learning of new ideas.					
13	LMS support the active building of knowledge and pursue solutions to online learning.					

PART C: Instructional Design on Students' knowledge construction

The way an online learning platform is organized (design and content) contributes to students' creation of knowledge.

I AGREE [ ] DO NOT AGREE [ ]

Indicate your level of agreement with the following statements relating to **Online Learning platform organization and its effectiveness on Students' knowledge construction** by ticking the appropriate box. Ratings are as**: [1] Strongly Disagree, [2] Disagree, [3] Neutral, [4] Agree and [5] Strongly Agree.**

S.NO	Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1	Clear online instructions on how to get started and where to find various course components improve learning.					
2	Online course structure, introduction and online training enhance learning.					
3	Online learning objectives improves learning outcomes					
4	Clearly stated online course grading and online assessment improve performance.					
5	Comprehensive online teaching materials enhances learning process and learning skills					
6	Use of online instructional materials improves knowledge					

PART D: Student's Characteristics on Students' knowledge construction

Students' characteristics including but not limited to interest to learn, ability to perform, thinking capacity, nature/origin of knowledge and learning influence students' knowledge construction.

I AGREE [ ] DO NOT AGREE [ ]

Indicate your level of agreement with the following statements relating to **Student's Characteristics and its effectiveness on Students' knowledge construction** by ticking the

appropriate box. Ratings are as**: [1] Strongly Disagree, [2] Disagree, [3] Neutral, [4] Agree and [5]Strongly Agree.**

S.NO	Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
	a)Motivation					
1	Its' a useful practice to collaborate online					
2	Discussing online prepares me for the final exams					
	b) Self-efficacy					
3	I can organize my work and assignments well online					
4	I can finish my assignments online before the deadline					
5	I can freely express my opinions online					
6	I can discuss constructively with others online					
	Metacognitive belief (high order thinking)					
7	Elaborated (detailed explanation) and summarized concepts online improves learning.					
8	Critical thinking (intellectual reasoning or constructive thinking) increases learning					
9	Online help-seeking improves problem-solving.					
10	Good memory improves online idea generation					
	Epistemological belief (nature and origin of knowledge)					
11	Online support and concern by participants enhance knowledge					
12	Regular online posts by participants improves learning					
13	Honest and skillful opinions/suggestions by participants are helpful					

PART E: Discourse Strategies on Students' knowledge construction

Effective online learning techniques and communication techniques improves students' leaning and performance.

I AGREE [ ] DO NOT AGREE [ ]

Indicate your level of agreement with the following statements relating to **Learning techniques and its effectiveness on Students' knowledge construction** by ticking the appropriate box. Ratings are as**: [1] Strongly Disagree, [2] Disagree, [3] Neutral, [4] Agree and [5] Strongly Agree.**

S.NO	Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1	Critical reflection (active and careful consideration towards self-constructed knowledge) on online learning materials improve knowledge.					
2	Student's engagement and attention on the tasks (discussions, quiz, and reading) online enhance learning.					
3	Clearly explained and elaborated online notes and discussions improves learning.					
4	Online collaboration and discussion generate ideas.					
5	Online-social behavior/interaction (sharing information, receiving timely responses, expressing agreement) improve learning.					
6	Online feedback to questions posted online improves learning.					
7	Online learning questions facilitates generation of ideas on the topic of discussion.					

END

Thank you very much for your feedback and God bless

APPENDIX 2: Preliminary Test for Regression

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Educational Technology	Instructional Design	Students' Characteristics	Discourse Strategies
1	1	4.973	1.000	.00	.00	.00	.00	.00
	2	.013	19.338	.09	.10	.21	.07	.01
	3	.007	22.464	.20	.05	.51	.01	.10
	4	.005	26.302	.01	.24	.01	.90	.08
	5	.002	28.642	.70	.61	.28	.02	.81

a. Dependent Variable: Knowledge Construction

Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Knowledge Construction	.472	109	.040	.506	109	.054
Educational Technology	.158	109	.059	.920	109	.061
Instructional design	.236	109	.073	.886	109	.067
Students' characteristics	.194	109	.061	.942	109	.110
Discourse strategies	.178	109	.053	.895	109	.080

a. Lilliefors Significance Correction

We considered the Shapiro-Wilk test since it's considered for elements below 2000, p-values are larger than 0.05 hence we failed to reject the hypotheses.

APPENDIX 3: Correlations

Correlations for Educational Technology

			Creative communication	Empower Learner	collaboration	Computational thinking	Digital citizenship	innovation	Edu Tech
Correlation	Creative communication	Correlation Coefficient	1.000	.964	-.889	.347	.463	-.207	.557
		Sig. (2-tailed)	.	.000	.000	.000	.000	.031	.000
		N	109	109	109	109	109	109	109
	Empower Learner	Correlation Coefficient	.964	1.000	-.861	.261	.454	-.266	.573
		Sig. (2-tailed)	.000	.	.000	.006	.000	.005	.000
		N	109	109	109	109	109	109	109
	collaboration	Correlation Coefficient	-.889	-.861	1.000	-.374	-.271	.270	-.286
		Sig. (2-tailed)	.000	.000	.	.000	.004	.005	.003
		N	109	109	109	109	109	109	109
	Computational thinking	Correlation Coefficient	.347	.261	-.374	1.000	.131	.398	.207
		Sig. (2-tailed)	.000	.006	.000	.	.175	.000	.031
		N	109	109	109	109	109	109	109
	Digital citizenship	Correlation Coefficient	.463	.454	-.271	.131	1.000	.106	.801
		Sig. (2-tailed)	.000	.000	.004	.175	.	.274	.000
		N	109	109	109	109	109	109	109
	innovation	Correlation Coefficient	-.207	-.266	.270	.398	.106	1.000	.131
		Sig. (2-tailed)	.031	.005	.005	.000	.274	.	.175
		N	109	109	109	109	109	109	109
	Edu Tech	Correlation Coefficient	.557	.573	-.286	.207	.801	.131	1.000
		Sig. (2-tailed)	.000	.000	.003	.031	.000	.175	.
		N	109	109	109	109	109	109	109

Correlations for Instructional Design

			instructions	Course structure	objectives	Couse grading	Teaching materials	Online materials	Instr design
Correlation	Instr Design	Correlation Coefficient	1.000	.243	.949	-.690	.056	-.687	.251
		Sig. (2-tailed)	.	.011	.000	.000	.561	.000	.008
		N	109	109	109	109	109	109	109
	Course structure	Correlation Coefficient	.243	1.000	.310	-.272	.622	-.394	.762
		Sig. (2-tailed)	.011	.	.001	.004	.000	.000	.000
		N	109	109	109	109	109	109	109
	Objectives	Correlation Coefficient	.949	.310	1.000	-.706	.052	-.664	.280
		Sig. (2-tailed)	.000	.001	.	.000	.591	.000	.003
		N	109	109	109	109	109	109	109
	Couse grading	Correlation Coefficient	-.690	-.272	-.706	1.000	-.090	.555	.057
		Sig. (2-tailed)	.000	.004	.000	.	.349	.000	.558
		N	109	109	109	109	109	109	109
	Teaching materials	Correlation Coefficient	.056	.622	.052	-.090	1.000	-.329	.743
		Sig. (2-tailed)	.561	.000	.591	.349	.	.000	.000
		N	109	109	109	109	109	109	109
	Online materials	Correlation Coefficient	-.687	-.394	-.664	.555	-.329	1.000	-.225
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.018
		N	109	109	109	109	109	109	109
	Instr design	Correlation Coefficient	.251	.762	.280	.057	.743	-.225	1.000
		Sig. (2-tailed)	.008	.000	.003	.558	.000	.018	.
		N	109	109	109	109	109	109	109

Correlations for Students' characteristics

			Motivation	Self efficiency	Metacognition	Epistemology	Student Characterstc
Correlation	Motivation	Correlation Coefficient	1.000	-.429	-.126	-.272	.210
		Sig. (2-tailed)	.	.000	.193	.004	.045
		N	109	109	109	109	109
	Self efficiency	Correlation Coefficient	-.429	1.000	.249	.808	.693
		Sig. (2-tailed)	.000	.	.009	.000	.000
		N	109	109	109	109	109
	Metacognition	Correlation Coefficient	-.126	.249	1.000	.132	.681
		Sig. (2-tailed)	.193	.009	.	.170	.000
		N	109	109	109	109	109
	Epistemology	Correlation Coefficient	-.272	.808	.132	1.000	.705
		Sig. (2-tailed)	.004	.000	.170	.	.000
		N	109	109	109	109	109
	Student Characteristc	Correlation Coefficient	.210	.693	.681	.705	1.000
		Sig. (2-tailed)	.045	.000	.000	.000	.
		N	109	109	109	109	109

Correlations for Discourse Strategies

			Critical reflection	Students engagement	Online notes	Online collaboration	Social interaction	feedback	Learning questions	Discourse Strategy
Correlation	Critical reflection	Correlation Coefficient	1.000	-.905	-.004	-.801	-.837	.845	-.804	.277
		Sig. (2-tailed)	.	.000	.968	.000	.000	.000	.000	.004
		N	109	109	109	109	109	109	109	109
	Students engagement	Correlation Coefficient	-.905	1.000	.035	.833	.900	-.767	.838	.473
		Sig. (2-tailed)	.000	.	.716	.000	.000	.000	.000	.000
		N	109	109	109	109	109	109	109	109
	Online notes	Correlation Coefficient	-.004	.035	1.000	.283	.140	-.047	.266	.725
		Sig. (2-tailed)	.968	.716	.	.003	.148	.627	.005	.000
		N	109	109	109	109	109	109	109	109
	Online collaboration	Correlation Coefficient	-.801	.833	.283	1.000	.905	-.793	.988	.661

		Sig. (2-tailed)	.000	.000	.003	.	.000	.000	.000	.000
		N	109	109	109	109	109	109	109	109
	Social interaction	Correlation Coefficient	-.837	.900	.140	.905	1.000	-.763	.914	.592
		Sig. (2-tailed)	.000	.000	.148	.000	.	.000	.000	.000
		N	109	109	109	109	109	109	109	109
	feedback	Correlation Coefficient	.845	-.767	-.047	-.793	-.763	1.000	-.789	-.205
		Sig. (2-tailed)	.000	.000	.627	.000	.000	.	.000	.032
		N	109	109	109	109	109	109	109	109
	Learning questions	Correlation Coefficient	-.804	.838	.266	.988	.914	-.789	1.000	.656
		Sig. (2-tailed)	.000	.000	.005	.000	.000	.000	.	.000
		N	109	109	109	109	109	109	109	109
	Discourse Strategy	Correlation Coefficient	.277	.473	.725	.661	.592	-.205	.656	1.000
		Sig. (2-tailed)	.004	.000	.000	.000	.000	.032	.000	.
		N	109	109	109	109	109	109	109	109