

## **Online Competency Based Education Framework using Moodle LMS: A Case of HEIs in Kenya**

**Kennedy Hadullo**  
**Technical University of Mombasa, Kenya**

### **ABSTRACT**

The purpose of this study was to develop a Framework that can be used to implement an online Competency-based education (CBE) program using a Learning Management system such as Moodle. CBE refers to a system of instruction, assessment, grading, and academic reporting that is based on students demonstrating that they have the knowledge and skills they are expected to learn as they progress through their educational path. However, little is known regarding how an online supported CBE program can be planned, designed, and implemented, to ensure learners complete activities and thus develop competency. This study advances theoretical perspectives of CBE as steps taken towards the development of an online CBE Framework suitable for Higher Education Institutions (HEIs) in Kenya. The study found that: Planning (Technology Infrastructure, organization and program design and development); Design (competency standards, instructional design, content development, LMS installation and customization); Implementation (learning activities, Moodle competency framework, assessments, and discussion forums); Improvement (Moodle Analytics) and Achieving (attainment of competency) were the most influential factors in determining the successful implementation of an Online CBE program in HEIs.

**Keywords:** *Online; Competency Based Education; Framework; Blooms Taxonomy; Moodle, LMS, HEIs.*

### **INTRODUCTION**

The application of Information and Communication Technology (ICT) to education has transformed teaching and learning in Higher Educational Institutions (HEIs) beyond recognition with the following benefits: synchronous or real-time teaching, asynchronous in which the learner studies at his own convenience, easy access to the teacher and the learning content, ability to present education in a standard form, reduced administrative burden for the teacher and reduced costs for the student (Abed,2019).

As education serves as a foundation to global stability, globalization and education then come to affect one another through the mutual goals of preparing young people for successful futures. To achieve this, the ever-increasing use of technology and demanding forces of globalization have introduced curriculum reform, a worldwide-practiced marvel that is involved in striving for the best educational practices, primarily with the demands of the twenty-first-century knowledge economy (Ruth & Ramadas,2019). The use of the knowledge-based curriculum which emphasizes high academic achievement in national exams, traditional teacher focused pedagogy and a lack of digital technology use by most African countries, has caused discontent among graduates of the current educational system, terming it too academic and lacking skills and knowledge as required by the job market (Ministry of Education, 2020).

The Ministry of Education in Kenya is currently in the process of implementing Competency Based Education (CBE) in Technical and Vocational Education and Training (TVET) institutions aimed at producing a globally competitive workforce (Ministry of Education, 2020). The CBE system is designed to produce graduates that have skills to match the job market. One of the justifications of

this move is that Kenya is experiencing increasing unemployment among young people and the present TVET system is a fragmented qualification system resulting in a poor quality graduate who is unable to respond to the anticipation of employers (Ministry of Education, 2020). The report by the Ministry of Education adds that a large number of individuals in Kenya develop skills through the traditional apprentice programme, for which currently they obtain no certification and hence no formal recognition of their competency.

## **BACKGROUND**

A competency is a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation (Sturgess, 2012). A CBE system is one in which: students are empowered to make important decisions about their learning experiences, assessment is meaningful, positive, and empowering, students receive timely, differentiated support based on their individual learning needs and students' progress is based on evidence of mastery and not time spent taking courses (Biemans et. al, 2004). When developed and implemented correctly, CBE can be a dependable and justifiable indicator of the knowledge and skills learned regarding the set competency (Brockmann et, al. 2008; Mulder, Weigel, and Collins 2007).

With the growth of ICT coupled with the high demand for education globally, many researchers have considered research in technology-enhanced competency-based learning and training (Ally, 2019; Johnstone & Soares, 2014; Ehlers, 2007; Saul et, al.2011; Quan and Yanning, 2017). With the world facing the COVID-19 pandemic which had led to the global closure of thousands of schools, Universities and Higher Educational institutions (HEIs) to implement mitigation measures (Al-Baadani and Abbas, 2020), there is even more demand to move educational systems online. The global epidemic opened up several chances for countries to re-shape their educational systems and focus on emerging ICTs. Most countries in the world have thus been forced to embrace online learning in order to continue progressing in education.

To this end, there exist a number of challenges such as: how can an online CBE program be planned for, designed, and successfully implemented? How would the courses be developed? How would the competency be developed and integrated with the learning activities in a Learning Management System (LMS)? How would the competency be accessed by the learners and finally, how would the learners receive feedback regarding completion of a competency? Based on these questions, the study proposes an online based CBE Framework using modular object-oriented dynamic learning environment (Moodle) LMS for HEIs in Kenya.

## **PURPOSE**

The purpose of this study is to create a CBE Framework that can be supported by Moodle LMS to successfully offer online courses at HEIs in Kenya.

### **Specific Objectives of Study**

Specifically, this study sought to:

- a) Determine the factors needed to create a CBE Framework that can be supported by Moodle LMS to offer online Courses
- b) Integrate a Framework based on other frameworks and factors identified in part (a) for successfully implementing a CBE system in Kenya

## BLOOM'S TAXONOMY

Benjamin Bloom led a team of educational psychologists trying to examine and classify the varied domains of human learning. The efforts resulted in a series of Taxonomies in each domain, known today as Bloom's Taxonomy (Bloom et, al. 1979). Bloom's Taxonomy helps in organizing objectives for easy clarification of the content to instructors and students alike. The instructor may benefit from this arrangement by having the ability to: plan and deliver appropriate instruction, design valid assessment tasks, and ensure that instruction and assessment are aligned with the said objectives. To make learners become competent in their studies, Bloom uses five "verbs" to describe the cognitive processes by which learners encounter and work through knowledge: remember, understand, apply, analyze, evaluate, and create.

For further clarification, the learning objectives are divided into three interrelated domains namely *cognitive* (knowledge), *affective* (attitude) and *psychomotor* (skills) (Bloom et, al. 1956). The cognitive domain involves knowledge and the development of intellectual skills. The affective domain describes the way people react emotionally, such as feelings, values, emotions, motivations and attitudes and the psychomotor domain is based on learning physical skills, which includes movement, coordination, and manipulation. Instructors should attempt to construct more holistic lessons by using all 3 domains of learning in constructing educational tasks. This diversity helps create more well-rounded learning experiences and facilitates a number of learning styles and learning modalities. Mixing domains of learning and using more diversity in delivering lessons also helps students retain and recall the knowledge and skills learned.

Besides the instructors benefitting from the domains of learning, the students equally benefit by an exposure to an organized way of understanding and attaining learning objectives. Bloom does this via the use of six cognitive learning categories: remember, understand, apply, analyze, evaluate, and create. The taxonomies specify the four types of knowledge that might be addressed by a learning activity: factual (terminology and discrete facts); conceptual (categories, theories, principles, and models); procedural (knowledge of a technique, process, or methodology); and metacognitive (including self-assessment, ability and knowledge of various learning skills and techniques) (Adams, 2015).

## ONLINE SUPPORTED CBE

### Learning Management System (LMS)

An LMS is a software application for the administration, documentation, tracking, reporting, automation, and delivery of educational courses (Kaya, 2017). E-learning which is facilitated by an LMS plays an important role in an online learning process. It facilitates acquisition and distribution of knowledge by the means of electronic devices such as computers, laptops and tablets which are connected to the internet (Nunamaker, 2003). LMSs are available as either commercial or open-source software. Higher Education Institutions (HEIs) in recent years have increasingly preferred the use of open source LMS platforms such as: Claroline, A Tutor and Moodle because they are free to download, provides control over content and allows course customizability.

The features of the Moodle LMS that can facilitate design of the Framework are explored below.

### Moodle LMS

According to Moodle.org (2020), Moodle is the most widely used platform for online learning powering hundreds of thousands of learning environments globally. It is used in 240 countries, having over 160,000 sites, 29,000,000 courses and 232 million users across both academic and

enterprise level usage making it the world's most widely used LMS. Moodle has a considerable range of features such as online news and online calendar, course browsing, course material (browsing, reading, and downloading), assignment downloading and submitting, doing assignment online, grade distribution, online discussion, Moodle mail, online quizzes, instant chat within course, survey within course and completion tracking for students. These features can be implemented to support content delivery, collaboration, and individual achievement in a CBE learning environment.

### ***Moodle Competency Framework***

From Moodle 3.1 upwards, it is possible to create and apply competency frameworks for evaluating students against competency in their courses. Site administrators have the capability to manage competency frameworks at site or category level, create, import, and export a competency framework and define associated competencies for a given course.

Once a site administrator enables "Competency" the process of creating a competency framework can begin. The process includes creating a framework by adding taxonomies similar to Bloom's and a grading scale followed by attaching the framework to an activity. The learning template is then created, a competency is added to the template and learning plans are finally assigned to individually selected students or to whole cohorts. Students can then view the activities assigned to every competency in their course and attempt the activities (Moodle.org, 2020).

### ***Activity Completion with Activity Competency***

In order to determine an activity completion, a student must demonstrate a skill four times before they achieve a competency. This can be done by creating four activities (such as four assignments) with activity completion set to receiving a grade and setting a pass grade from the assignment setting screen. For successive assignments, access is restricted until the previous assignments have been completed. In the assignment settings for the final assignment, 'Course competency' is expanded, the required competency is selected and 'Upon activity completion' is set to 'Complete the competency'. The student submits work as normal. The teacher grades work as normal. If all four assignments obtain a pass grade, the competency is automatically achieved by the student (Moodle.org, 2020).

### ***Moodle Analytics***

Learning Analytics refers to the collection and analysis of data about learners and their environments for the purpose of understanding and improving learning outcomes (Yu & Jo, 2014). It is most used by instructors to identify learning difficulties and opportunities for learning support and improvement of course development. Moodle version 3.5 and above contains some useful analytics that can be used to improve learning. The Moodle Learning Analytics Application Programming Interface (API) contains five Models: Students at risk of not starting; students at risk of dropping out; students who have not accessed the course recently; students who have not accessed the course yet and upcoming activities due. Models can contain indicators or predictors, targets - the outcome we are trying to predict, insights - the predictions themselves, notifications - messages sent as a result of insights, and actions - offered to recipients of messages, which can become indicators in turn (Moodle.org, 2020).

## **LITERATURE REVIEW**

Johnstone & Soares (2014) postulated that competency-based education (CBE) can fit into an educational system if certain principles are followed. One of their observations was that a CBE program should reflect robust and valid competency. This can be achieved by aligning the

curriculum with both industry and academic expectations with the competency reflecting the skills and knowledge required by the students. There is also need to have a mechanism for student and employer feedback to faculty and program designers.

Secondly, students should be able to learn at a variable pace with support in their learning. To achieve this, learners need to have access both to the course materials and to faculty who can step in when they need help. This requires providing an orientation program, and asynchronous availability of the learning resources, coupled with flexible access to academic assistance. There is also need to have a means to identify when a student is struggling and needs help. There should be a way of monitoring student progress via an intervention model in the LMS which sends alerts to the instructors when students are in danger of failing or dropping out of a course.

Another important factor noted by Johnstone & Soares (2014) is to create quality effective and reusable learning content that are available throughout for the learners. The content must be accurate and current, engaging, at the appropriate level of difficulty, well matched to the learning objectives defined for the course, and diverse in nature: text, audio, video, and images. Further to this, there should also be a clear process for mapping competency to courses, learning outcomes, and assessments in the correct hierarchy.

In a related study Ehlers (2007) earlier observed that the greatest challenge for e-learning in HEIs is that it has been used mostly to transfer and distribute learning materials rather than support competency development of the learners. To overcome this challenge, the study opted for a collaborative model of learning to stimulate competency development in higher education. This model advocated for the students to socially interact with other students, as well as instructors. In essence, learners work together to expand their knowledge of a particular subject or skill. However, the study did not explain how this model can be implemented among the different actors in an e-learning environment, such as: course designers, instructors, and students. There is need for a model that diagnoses the level of competence the student has reached during learning and helps students to assess their own learning process.

Saul et al. (2011) developed a competency-based approach to support the implementation of learning objectives in learning a content management system called EDMedia (Klett and Pharow, 2006). EDMedia LMS provides learning, communication, self-assessment, authoring and content management options with easy-to-access information in an accurate, well-designed user interface. Saul et al. (2011) noted the need for competency to be written by building their structures upon the Bloom's taxonomy, from the lowest to highest level in the *cognitive, psychomotor, and affective domains*.

In EdMedia, each learning object has to be classified according to preselected taxonomies. Such learning objects can be pictures, videos, audio files, animations, and text. The Learning Objective Statements must be defined with each objective having descriptions based on a variety of recommended verbs proposed by Bloom's taxonomy. Regarding course evaluation, the study proposed the use of pre- and post-tests for assessing the course objectives. The pre-test is used to find out, which learning objects of the course are already known by the student by using simple question types like true-false or multiple-choice. The post-test is conducted after the accomplishment of the pre-test of the course using essay type of questions.

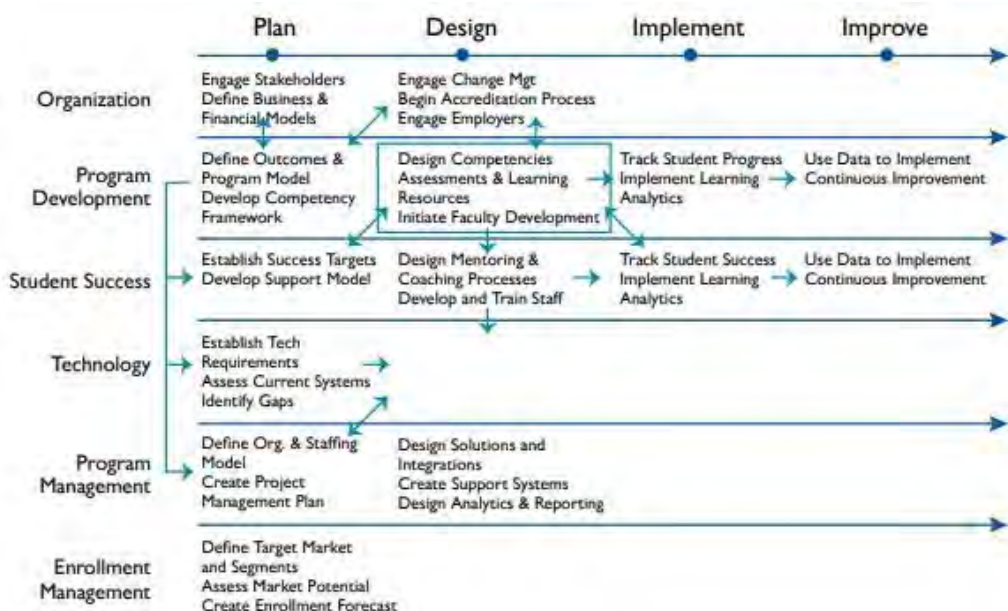
Sampson and Fytros (2008) investigated how to model, present, and assess competency in a meaningful way using a TECBL environment. Based on the different issues emerging from the competence definitions Identified in the literature, the study identified three core dimensions of the term competence shown in Table 1 below.

**Table 1:** *Dimensions of TECBL Model*

<b>Dimension</b>	<b>Description</b>
Individual's Characteristics.	a set of characteristics such as knowledge, skills, attitudes, abilities, behaviors, traits, values, motives, self-concepts, aspects of one's self-image, social role and/or self-control
Individuals Competence Proficiency level.	Levels used to classify competences at specific levels, according to the performance of the individual when demonstrating the competence by an action. According to the sample of the definitions, the proficiency level may include superior and average performance, effective and superior performance, or a range from the basic level of proficiency to the highest levels of excellence performance of an activity.
Context	Where the individual's competence is applied. The context may refer to a specific area of a job, to an occupation or function, to a life outcome, to work-related situations, to a specific situation, or to a specific task.

Secondly, the study added that a TCBEL model should have a name, a description providing a complete description of the competence and a proficiency level (PL). The PL should describe the proficiency level of the competence consisting of two sub-elements, namely "level" and "scale". First, the sub-element "level" aims to describe different types of proficiency level based on the facets of the dimension "personal characteristics" (for example, skills, knowledge, attitudes). For the sub-element "scale", different qualitative or quantitative scales may be used to represent proficiency levels.

In a response to growing CBE demand, Pearson (2015) addressed the pros and cons of CBE models, tactical challenges, with focus on specific program areas, such as technology. The author presented an organizing framework to help institutional leaders develop a CBE program in an online environment. The core of the work consists of seven workstreams that organize the areas of functional decision-making and effort required to launch a CBE program: organization, program development, student success, technology and infrastructure, program management and enrollment and marketing. Each workstream represents a set of functions, key decisions, and strategy areas that form the building blocks of a comprehensive CBE program initiative. The workstreams when used in the CBE development are guided by the projects: planning, design, implementation, and improvement towards achieving program success. Figure 1 below illustrates how the work of designing competency, assessments, and learning resources is interdependent with other activities across workstreams.

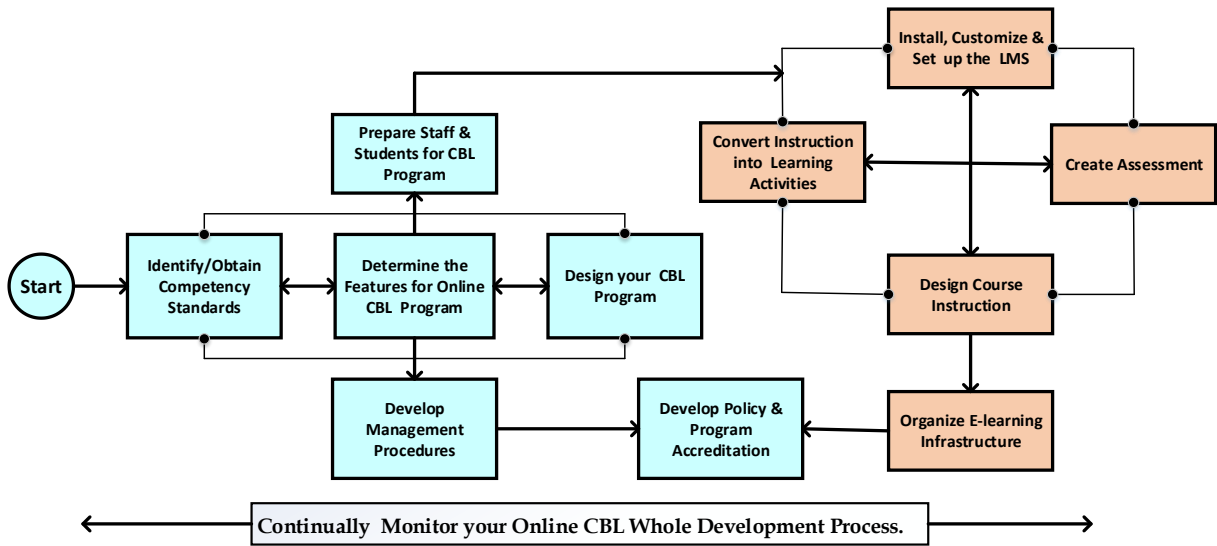


**Figure 1:** Designing CBE Framework using workstreams. Source: Pearson (2015)

Quan and Yanning (2017) formulated the development process and the learning process in an online CBE. The two processes: technology enhanced CBE process; and technology enhanced CBE learning process, are explained below.

#### a) Online Supported CBE Development Process

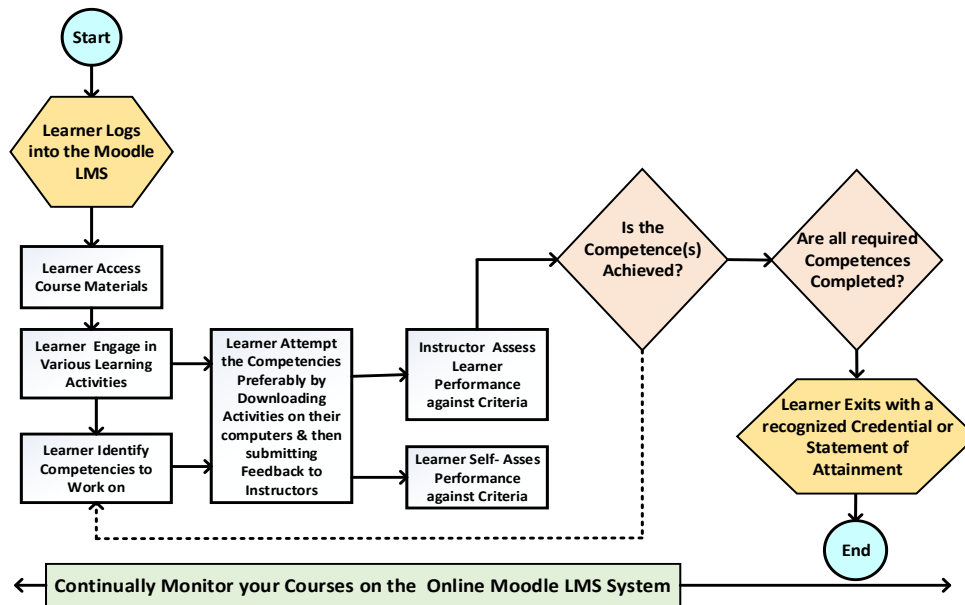
The creation of an online education program in competency-based mode needs careful planning, design, and continuous quality monitoring during the development process. The development process is illustrated in Figure 2 below. The first step is to identify the competency standards required - this stage is divided into 3 categories: the management level, operational level, and support level. Each level would have their own competences required in the CBE program which must be considered before accomplishing the program design. Secondly, it is also important to create a policy framework for implementing the program together with ensuring that the program is accredited. This can be done while the learning environment is being prepared. The preparation should involve organizing the online education infrastructure, carrying out instructional design, installing an LMS and converting course content into digital format including stating the assessment strategies.



**Figure 2:** Development of Online program for competency-based Learning (CBL)  
Adopted from (Quan and Yanning ,2017)

**b) Online Supported CBE Learning Process**

Regarding the process for CBE students during learning, Quan and Yanning (2017) added that once the learner logs into the LMS, they should be able to access and engage the course materials and, in the process, identify the competency in accordance with the flow illustrated in Figure 3 below.



**Figure 3:** Competency Based Online Education Course Learning Flow  
(Source: Quan and Yanning (2017)



Most of the activities may require the learners to download learning content on their computers and attempt offline before submitting to the instructors. The instructor after assessing the activities can give feedback to the learner through the LMS interface and the learner can self-asses the performance against a set criterion and determine whether a competency has been achieved or not. The results of the assessments will be used to confirm whether all required competencies have been achieved. Any pending competency forces the learner to repeat the activity attached to that competency until it is achieved.

### Summary of Literature Review

A summary of the literature discussed in this paper is presented in Table 2. The summary identifies the factors found to be relevant and useful for building the conceptual framework for the study.

**Table 2: Summary of Literature Review**

SN	Author	Title	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	Johnstone & Soares (2014),	Principles for Developing Competency-Based Education Programs”,	Robust and valid competency	Students support mechanism Early warning system	Quality learning materials	Competency Mapping	Piloting of assessments
2	Ehlers (2007)	Making the Difference in E-Learning: Towards Competence Development and E-Irritation”,	collaborative model of learning to boost CBE	Competency modeling to be developed for different courses	Student to be able to view their own learning process		
3	Saul et al. (2011),	Competency-based Approach to support Learning Objectives in Learning, Education and Training	Used Bloom's taxonomies to create Competency	Classification of learning activities Taxonomies	a pre- and post-tests for assessing the course objectives.		Used EDMedia LMS
4	Sampson and Fytros (2008)	“Competence Models in Technology-Enhanced Competence-Based Learning (TECBL)”	Individual's characteristics	Individuals Competence Proficiency level	Context	Competence description	Competence measurement Scale
5	Quan and Yanning (2017)	“The Implication of Distance Learning in Competence-Based Maritime Education and Training (CBMET)”.	CBE Implementation Policy	CBE accreditation	Competency standards	Management procedures	Course development
6	Pearson (2015)	Competency-Based Education (CBE) Playbook Book	organization	Program development	Student success	Technology & infrastructure	Program management
			planning	designing	implementing	improving	achieving

## **Conceptual Framework**

The proposed conceptual framework is illustrated in Figure 4 below. It was developed by combining factors from the literature review and existing frameworks and models of CBE. The factors identified for integrating a comprehensive CBE program included: technology infrastructure, organization, competency standards, an interactive and user friendly LMS, instructional design, collaboration of learners, secure and reliable assignments, and analytics models. These factors are recommended for use with regard to five stages of the development process: planning, designing, implementing, improving, and achieving. These factors are briefly discussed below:

### ***Program Plan***

The planning aspect includes the organization of the process, the technology infrastructure and the program design and development. The role played by the organization consists of providing executive leadership, financial budgets, and accreditation of the program. For the *Technology infrastructure*, a content development studio, CBE online lab and server for hosting the LMS as well as provision of Internet connectivity to both staff and students are required. Regarding program development, the HEI staff must provide the breakdown and key components of the program curriculum.

### ***Program Design***

The program design requires the use of competency standards such as Bloom's Taxonomy. These together with an instructional design model which include systematic development of instructional specifications and analysis of learning needs and goals, and development of the design into learning content, are then uploaded in the Moodle LMS.

### ***Course Implementation***

The proposed framework is for an online Moodle LMS supported program. With this in mind, the course needs to be implemented in a way that makes it interactive and accessible to the learners. The learning activities should be implemented as re-usable components which are interactive in nature. There should also be a mechanism for grading the assessments and providing feedback to the learners.

### ***Course Review and Improvement***

The course and learning in Moodle can be improved using log data from the database and analysis using the Moodle Learning Analytics API. This will enable the course providers to put in place necessary interventions for the improvement of learning.

### ***Moodle Competency Framework***

This framework once created is attached to a learning activity. Learning plan templates are also used to enable the addition of competencies to single or cohorts of students. Students are then able to view and develop their competency via assigned activities.

### ***Activity Completion with Activity Competency***

A mechanism is put in place to ensure that learners complete their competency. The learners can then submit work as normal. The instructors grade the work as normal and the competency is achieved based on the criteria set up in the system.

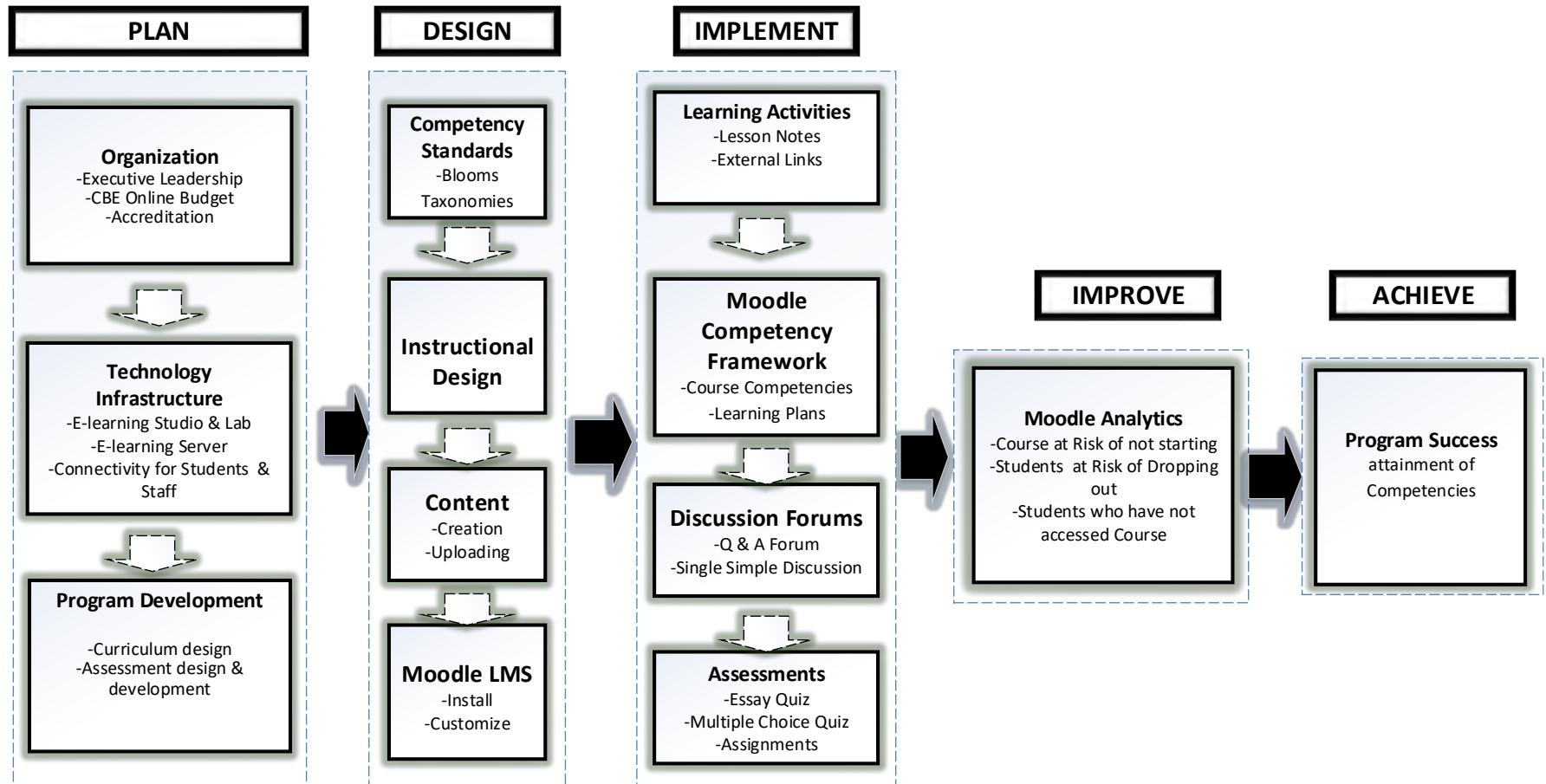


Figure 4: Proposed CBE Framework for Online Learning

## CONCLUSION

The purpose of this study was to create a CBE Framework that can be supported by Moodle LMS to successfully offer online Courses. After considering relevant literature on studies concerned with online support for CBE programs, five (5) factors that describe the stages of developing the program and a further thirteen (13) that are aligned to each of the five factors were identified. The five factors identified were: Planning; Design; Implementation; Improvement and Achieving. We can conclude that the model proposed in this study is suitable for implementing an Online CBE program using Moodle LMS. There is opportunity for the model which has been designed in the context of Kenya, to be considered as a typical representation of many situations facing HEIs in developing countries, and therefore the framework can be generalized to other countries. The model is presented to help those who are involved in the implementation of online CBE programs, to implement successful programs.

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