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**PBL Framework For African Higher Education: A Case Study In UENR**

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**Abstract**

The traditional teaching and learning methods pose several challenges in Higher Education in Ghana and Africa at large. Some of the challenges are related to low creativity and poor problem-solving ability due to the use of the traditional pedagogical approach. Since the introduction of Problem Based Learning in 1960 at McMaster University in Canada many educational reforms have been achieved by aiding students to work through the diverse and complex problems that arise in the industry by developing their problem-solving ability and creativity. PBL is widely regarded in the developed countries as a successful and innovative tool for training students to be problem-solvers at the end of their study. We propose a PBL framework for training graduates to help produce the right manpower for the country. This study considers the behavior of both lecturers and students in UENR and the Infrastructure for teaching and learning. The framework inculcates the essential characteristics of the Aalborg PBL model to achieve the intended purpose. The model shares some similarities with the Aalborg PBL model in the formation or organization of groups, assessment methods, and theoretical principles of problem analysis in engineering. The framework applies an enhanced method in the integration of knowledge and practice, collaboration, and group work; these are influenced by our upbringing, early childhood education history and traditional believes.

**Keywords:** Problem Based-Learning, Framework, Infrastructure, Knowledge, Pedagogical

**Type of Contribution:** PBL Research

**1.0 Introduction**

Recent advances in the area of physical and applied sciences job market require confident persons that can comprehend the needs of the institution. Graduates who are capable of processing issues to understand a problem and applying their knowledge to solve the problem or real-world problems effectively are required nowadays in most firms. One new method that equips students to be self-confident and use the knowledge gained to solve real-world problems is PBL (Wee, 2004 & Jonasseh et. al, 2006).

In 1960 the PBL model was introduced by McMaster University, several other PBL models have emerged to improve the standard of learning in our institutions. Most of the PBL models are just an improvement of the 1960 McMaster University some of which including Australia (Yadav et. Al, 2011), Denmark (Barrows & Tamblyn, 1980), Iran (Dehkordi & Heydarnejad, 2008) and Singapore (Wee, 2004). Problem-Based Learning (PBL) model is self-learning concepts that follow constructivist and a collaborative learning theoretical principle that shares the same operational structures as Student-Centered Learning (SCL) method.

PBL is a very challenging learning approach that builds students in several areas like developing a team spirit in working together towards understanding a problem and sharing ideas to possibly solving the problem (DeGoeli, 1997). This method aid students to acquire concepts and principles from each other through solving a real-world problem. Real-world problems bring the students into contact with the environment helping them translate the theoretical concepts and principles into operation to first analyze the problem and proceed to solve it. In solving the problem, the concepts and principles when putting into implementation become procedural knowledge.

Several works conducted by research on learning methods have pointed out that PBL is a good tool in achieving deep-content learning which is an intended learning outcome (Hmelo-Silver, 2004). Evidence provided in the literature suggests that students who engage in deep-content enhance their understanding of the course and it improves their performance in the future conceptualization of advanced problems. To make students acquire deep-content learning in a course then the problem to be solved should be properly structured to push students to achieve deep-content knowledge. A deep-content knowledge broadens the student’s thinking ability in the use of in-depth concepts, principles, and procedures (Gijbels et. al, 2005). The conventional face-to-face equally has advantages but certainly not in terms of reaching the highest level of the bloom’s taxonomy in application and synthesis. Several studies have shown the massive achievement of the conventional face-to-face learning method in the acquisition of concepts and principal knowledge (Gijbels et. Al, 2005 & Hung, 2006).

In a wider context, it is believed that PBL demonstrates a more effective knowledge of application or procedure than conventional learning approaches. In (Norman & Schmidt, 2000 & Dehkordi & Heydarejad, 2008) study was conducted with two separate groups. The first group was taught using the conventional teaching approach while the PBL learning method was applied to the second group. During the assessment of the two groups, group two demonstrated higher cognitive levels of application and evaluation while group one established knowledge in lower cognitive levels.

In this study, we propose a PBL framework for training creative and problem-solving graduates to help produce the right manpower to engineer a real-world solution in the country. This framework considers the behavior of both staff and students in UENR and Infrastructure for teaching and learning. The framework adopts the essential characteristics of the Aalborg PBL model to achieve the intended purpose. The model shares some similarities with the Aalborg PBL model in the formation or organization of groups, assessment methods, and theoretical principles of problem analysis in engineering. The proposal applies an enhanced method in the integration of knowledge and practice, collaboration, and group work; these are influenced by our upbringing, early childhood education history and traditional believes.

**2.0 Proposed PBL Framework**

Studies conducted by (Segalas et. al, 2009) concluded that PBL achieves better learning outcomes from a field of study through active participatory work through groups and group community projects. We noted from literature and our experience from teaching for several years that group work and presentation is not an automatic basis for all-inclusive learning. However, in PBL, the problem to be solved is presented and students are organized in smaller groups to work hand-in-hand to solve the problem. The students are required to engage with each other to come out with opinions, ideas, and ways to develop solutions and alternatives solutions to the problem. Students evaluate and analyze the problem before them depending on the different social contexts and setting mostly derived by where and how they relate the problem to society. The student is allowed to share their personal experiences and link it with the problem at hand to help conceptualize ideas to formulate solutions in a collaborative learning environment.

The PBL concepts allow students to relate with most things like the environment, objects, and people's concern to have the first-hand experience and help them make sense out of the problem posed by the facilitator. At each stage, feedback is collected through several means, for example through ideas and contributions from stakeholders or the facilitator to drive their path towards coming out with an innovative solution or prototype. The feedback receives is to aid the group to:

1. decide collectively to change their direction towards the solution to the problem
2. decide to change the direction in the conceptualization and understanding of the problem
3. decide to proceed but rather change their responses towards the building their solution.

Following the study from (DeGoeji, 1997), PBL consist of; the problem to be solved, organizing the students into smaller groups, the facilitator, developed learning objectives that will be centered around a goal-oriented study, self -directed time for learning by groups, mapping of concepts and evaluation by groups. In the traditional face-to-face learning approach students are on the receiving side whiles the tutor/teacher delivers concepts from the beginning of the teaching process to the end mostly with little or no involvement of the students, this usually takes place in a typical classroom. With the traditional face-to-face learning, approach teaching takes place in an ordered procedure mostly believed to be on an incremental basis, from basic/introductory gradually to the intermediate concepts/theories through to advanced principles of the course of study. The pedagogical approach of the face-to-face learning method is believed to be the best in terms of the development of the mental faculty of students. Whilst in PBL the problem is presented to the students before they learn the basic knowledge of the course. In this way, as the problem unfolds in progressive stages students are simulated to seek advanced knowledge in various forms in their efforts to evaluate and solve the problem. The main aim of this approach is to help students build the knowledge within a collaborative group-centered environment and supported by a facilitator’s direction.

**2.1 Process of the PBL framework**

The first stage is achieved by developing a set of good, well explained, and clear learning outcomes. The development is done by the facilitators with the help of the curricula. The assessment module is inherited completely from the Aalborg PBL module with little modification to fit our environment. The learning outcomes gives a clear and elaborate definition of problem definition boundaries. The pivot of the learning process rests on the wigs of the problem definition, hence the proposed PBL module puts a lot in to make sure the problem defined covers the entire scope of the developed learning outcomes. The Aalborg problem definition module is incorporated with some support from the local industries of interest, to fine-tune the problem into real-world problems that our country is faced with presently and in the nearby future.

Groups are formed after the problem definition stage. The group formation is well-explained in section 3.3. The course facilitator or facilitators divide the class into groups, sometimes using prior knowledge of the class history or previous group history as a guide.

After the first three stages, students are introduced to PBL. Students are first introduced to PBL by the PBL center in a preparatory course. The facilitators also take time to explain the application of the PBL teaching and learning method to students. This broadens students' knowledge of the concepts of PBL and how it can be implemented in the course to achieve the learning outcomes of the course. A detailed explanation of this stage is below in section 3.4. The next stage is that the groups formed in stage 3 set into work and become research groups. The groups work with support from industries concerned, the facilitator, and some major stakeholders like the head of industries facing the problem at stake and lecturers handling similar courses.

Identify Outcomes and Design mode of Assessment

Develop the problem

Introduce PBL & Introduce motivation

Group Research

Group Students

Produce Results

Assess Project

**Figure 1: Proposed PBL Framework for Higher Educational Learning in UENR**

The final stage before the assessment of student work is the outcome of the group research stage. After an intensive research student collective put together their various ideas, suggestion, and knowledge gained to develop the product and draft their report. The groups put together their research outputs, solutions, and products for assessment. The final stage is reached when students are done with their various research works and manufacturing of products if need be. The final stage which is the assessment module is inherited from the Aalborg University PBL method. Little modification is allowed in some cases where stakeholders and industry are made to be a major decider of students' performance.

**3.0 Stages of the Proposed PBL Module**

The stages of the proposed PBL method are presented below and the mode of operation is explained for easy understanding and implementation.

**3.1 Identify Learning Outcomes and Design Assessment Methods**

The learning outcomes are the first items to check. These are taken from the curriculum of the programme of study. The learning outcomes clearly defines what the facilitator expects the students to acquire or gain by the end of the course (Sheldon & Fesenmaier, 2015). This can be achieved by designing clear and simple assessment methods to progressively measure the knowledge gained by the student at each stage. The Aalborg assessment method is adopted and used in the Africa context for a more robust measurement.

**3.2 Develop the Problem**

Engineering is an applied science that is focused on addressing large-scale pressing challenges that society faces world-wide. Hence the development of a problem should be mainly geared toward solving real-world problems that engineering industries are currently faced with that are aligned with the expected learning outcomes of the course (Andersson & Clausen, 2018). The initial problems should be local and more country centered. Stakeholders from relevant engineering industries and the Ghana Institution of Engineers (GhIE) should be consulted to define the problem. The problem is presented to students to train their thinking faculty to become effective problem-solvers delivering real-world products and services that are beneficial to society, especially in the developing world. This way the university builds a sense of ownership and responsibility as well as confidence in students to face the job market after completion.

**3.3 Proposed Grouping of Students**

To achieve all-inclusive learning in the African setting, a lot of measures have to be put in place to make students responsible for seeking knowledge through self-direction and group collaboration. We propose to carefully organize the groups into smaller numbers considering the following characteristics;

1. Background of the students (taking into consideration which regions they are coming from, their culture and educational history)
2. Age of the student (Age in Africa signifies a lot during decision making and relationships)
3. Religious background and beliefs

Whiles in the Western part of the world most things are taken on a lighter side they make a great deal of meaning in Ghana and Africa at large. In some parts of Africa, children are always wrong no matter the case and the elderly are always right. Children from this background will always appear to be very timid, tight-lipped, and reserved until they are pushed to the corner, they will always be quiet. From this narrative, it is very clear that if care is not taken in the grouping and such a student from a very traditional Africa home with these traits is put in a group with people who are extroverts this student will never contribute to the group and will not raise any concern even if the group is on the wrong track and he/she knows. Adding to African tradition is our educational history. Our early-childhood development schools are mostly filled with teachers who have no proper training in education, these teachers are a serious contributing factor to some kids being very reserved and timid. Some kids are very innovative, out-spoken, and instrumental types who always want to do things by themselves in their early development stages. When they try to do things on their own and they are forcefully stopped on several occasions or speak out and the teacher shuts them up and even in some situations rain them with negative and demoralizing statements on some occasions will make the kid turn to be quiet and dull. This affects the kid’s development and can transform him/her to be timid in life. Early Childhood development stages need special care and hence needs professionals with skills to handle such stages.

The religious background and beliefs of people in Africa are some time needs some critical consideration. The group must be properly constituted to aid harmony. Some Religions taboo certain foods and attitudes, and members of the group must respect the religious beliefs of others to create a conducive environment for collaborative learning.

Age is very important in Africa, so when forming a group, a blend of the ages will be very useful in achieving the objective of the PBL method. When the grouping is done properly and well little facilitation is needed to direct students to the construction and reconstruction of knowledge for real-life problem-solving (Baker, 2000a & Baker, 2000b).

**3.4 Introduce PBL and Motivate the Students**

This stage introduces students to the modern learning approach adopted by most developed parts of the world today. The local task force in UENR on the Erasmus + project titled “Enhancing Entrepreneurship, Innovation, and Sustainability in Higher Education in Africa” (EEISHEA) have been trained on the implementation of PBL in higher education. Based on the proposal of the EEISHEA, the University is putting plans in place to establish a PBL center to train students on how PBL works and the role of the student.

This research proposes to explain PBL with “learning by doing”, where we start with a very simple example to make students understand the basic concept of the learning method. With our upbringing in Africa and early childhood education through to the tertiary, students get so used to the conventional face-to-face teaching and learning methods hence a smooth transition is necessary to make students cope. The straightforward task for students to present to different actors in new learning environments could cause frustration and kill the interest of students (Gijbels et. Al 2005).

After the center trains the students, the course facilitator also takes students through the concepts of the PBL and how it can be implemented in the course to achieve the learning outcomes of the course. This is meant to educate the student on the knowledge he/she is supposed to acquire or gain by the end of the course and efficient ways to acquire the needed knowledge.

A pretest was conducted with “Level 200” Computer Science Students in a course titled “COMP 205: Systems Analysis and Design”, the outcome of the training was very impressive.

**3.5 Conducting Group Research**

The organized groups start with a brainstorming session when groups define the problem with the help of the facilitator and major stakeholders and try to explain what they understand about the problem (background knowledge), what additional knowledge they need to learn more about (topics to research), and how they look for data (databases, interviews, etc.) (Onyon, 2012).

The groups are expected to meet and share ideas to write the problem as a statement and in some cases research questions. When they are stack, they result in asking the facilitator in some instance whereas in other instances they fall on to the main stakeholders from the industry for help. This activity carried out by the group is to come out with good research questions to aid in their work/project, without a good problem statement/research question the research process can be unguided.

 To achieve the needed result within a record time, students are required to divide the project into several tasks and decide upon group roles and assign responsibility for researching topics necessary for them to fully understand the problem at hand. An initial hypothesis is developed to “test” the solution. This process continues until they are done with the final product.

**3.6 Produce Results**

After collective research, the group fashion products and presentations that put together their research, solutions, and learning. The style of the final/summative assessment is completely decided by the students. This step is treated as a research fair for groups to showcase their research and products. Students gather resources to advance contextual facts that inform their understanding, and then they collaboratively present their findings, including all alternative viable solutions, as research posters to the class, facilitator, and major stakeholders for assessment.

**3.7 Assessment Methods and Implementation**

The facilitator in this PBL is to direct the students thinking and reasoning faculty by actively posing questions and suggestions that will aid students to think out of the box and search for additional knowledge to better understand the problem at hand at each stage of the problem-solving process. During these interactions with the students, the facilitator monitors and evaluates group and individual progress. Each group is evaluated based on the context of the problem discussion meeting. At each stage of the group’s work, evaluation takes place by the facilitator with the help of some major stakeholders in situations where the problem is taking from an industry (Gijbels et.al, 2005 & Urden, 2004).

In PBL students acquire much more knowledge and understanding of the course than the course content. The learning process includes the following; how to work with others, how to solve problems in a group, how to present their ideas clearly to an audience, and how to learn from their own mistakes. The assessment should capture some salient points like what they learned and how they came to learn it (Albanese & Mitchell, 1993).

The areas that our proposal emphasis in the assessment include content mastery, collaboration/participation, and presentation style, meeting deadlines, and some elements specifics depending on the project and course of study.

For this assessment method to be more efficient lecturers and students should be motivated to play their roles more efficiently.

Students should be motivated by taking them to the industry or industries to interact with the environment and the people/workers to have a first-hand experience of the problem.

The promotion criteria in UENR and Ghanaian institutions consider only the following; Promotion of Knowledge, Community Service, and Teaching. Lecturers should be motivated to adopt this new method to train our students to be citizens who can act in unknown contexts and adapt to a changing environment. Hence to encourage lecturers to change from the conventional face-to-face teaching methods to fully embrace the PBL method. Some kind of motivation should be given to the lecturer to encourage them to stick to this teaching and learning method. The only way to sustain the use of PBL is motivation from both the angle of the lecturer and the student. Figure 1 presents the framework of the PBL learning method proposed for UENR.

**4.0 Stages of Knowledge Acquisition and Development Using PBL Model**

Figure 2 below illustrates the process of educational development stages that students pass through when trained using the proposed PBL model. The framework developed encourages facilitators to design a real-world well-structured problem. Group researching makes students share ideas and gain a better understanding of the problem and subject understanding. Students equally develop meta-cognitive knowledge and a good understanding of scientific principles and concepts. Team working skills is an important component required in every workplace during the process each student in the group develops this teamwork skills as well as build some good personal qualities necessary for life.

Higher cognitive knowledge of the application is gained by a combination of a good understanding of scientific principles and concepts, meta-cognitive skills, and a deep sense of problem understanding and evaluation. Teamwork skills coupled with personal skills and a higher cognitive knowledge of applications prepares students for employment and life.

Employability, Citizenship, life, etc.

Problem Analysis & Subject Understanding

Concepts and Principles

Meta-Cognitive Knowledge

Research

Problem

**Figure 2: Knowledge and Skills Acquisition Model Using the PBL Learning Method**

**5.0 Conclusion**

Based on the African setting and our educational background it will be very challenging to implement the PBL modes as it appears in most parts of the world like Denmark, Australia, and Canada. Some adjustments will be very beneficial for the successful implementation and sustainability of the PBL module.

Africa is one of the biggest continents and endowed with natural resources that need the right manpower with the requisite knowledge in the industries to help solve real-world problems that they encountered daily. The conventional learning approaches turn out students with a lower cognitive level of knowledge.

An enhanced PBL framework is proposed that will help train graduates to be creative and problem-solving to augment manpower deficit in the country. This framework takes into consideration the means to harness the behavior of both staff and students in running an efficient learning system. The framework adopts the essential characteristics of the Aalborg PBL model with some modifications to aid it to achieve the intended purpose.

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