An Assessment of Resource availability for Problem Based Learning in a Ghanaian University setting

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Abstract

Purpose- The purpose of this study is to assess the differences pertaining to the resources presently accessible for Problem Based Learning (PBL) among six colleges of Kwame Nkrumah University of Science and Technology (KNUST) in Ghana.

Design/Methodology/Approach- Data for the study is the cross sectional type drawn from 1020 students. Poisson and Zero-Inflated Poisson (ZIP) models were implemented on the data to ascertain the variations regarding the extent of resources available for PBL across the colleges of the university.

Findings-The study outlines the specific resources accessible for PBL across college levels of KNUST. On aggregate, 25.7% reported that their respective colleges have sufficient resources, while 74.3% indicated otherwise. The ZIP model exhibited superiority over the Poisson model, when compared under a Vuong test. As per the ZIP model, none of the colleges appeared to differ significantly in terms of having sufficient resource for PBL.

Practical implications- Findings are applicable to informed decision making which targets achieving quality education through the use of PBL. Access to sufficient resources that meet the needs of colleges or compartments of a University is emphasized.

Originality/value- The application of Poisson and ZIP models to aggregated count data in PBL setting is novel.

Keywords: Resources, Universities, Education, Colleges

Paper type- Research paper

Introduction

With the pursuit to make university education an environment for higher order learning and creative thinking, many educationists have advocated for the introduction of educational strategy that integrates school learning with real-world phenomena. Largely, emphasis has been given to Problem Based Learning (PBL) in this regard. PBL is an approach to instructional delivery in education which is conceived as student-centered where learners are actively exposed to real world phenomena (Correnti and Marconi, 2014; Wilkerson and Gijselaers, 1996). In PBL, ill-structured problems serve as the first stimulus and structure for learning (Wilkerson and Gijselaers, 1996). The PBL strategy allows students to work in groups and a teacher facilitates the groups during a tutorial process (McPhee, 2002; Hmelo-Silver, 2004). Overton (2010) emphasized that PBL fail to work when tutorial consist of large group of students. Typically, PBL tutorial consists of a group of students, usually 8 to 10 and a teacher, who facilitates the lesson (Deo, 2013).

Today, PBL is considered to be an effective instructional strategy in education in that it allows long-term retention and skill development (Strobel, and van Barneveld, 2009). Research indicates that graduates from this form of education consistently achieve better and progress faster in their careers than graduates from comparable traditional classroom based education (Acs distance education, 2015). As a result, many universities particularly those in the developed part of the globe have incorporated PBL into their curriculum. Though universities in the developing parts of the world especially African countries happen to utilize programs that in part appear in the form of PBL, not much can be said about these universities. Literature in the setting of Ghanaian universities in particular is limited.

Implementing PBL in schools and universities is a challenging task that requires resources, enormous planning and organization (Wood, 2003; Azer, 2011). It also has implications for staffing and demands a different approach to timetabling, workload, and assessment (Wood, 2003). Infrastructural resources required in PBL include library, books, computer, internet, tutorial rooms, magazines, brochures, newspapers, television, telephones and study space (Wood, 2003; Mathews-Aydinli, 2007; Deo, 2013). These resources represent a massive source of information for learners and are accessed prior to and during tutorial sessions. When utilizing PBL, two main types of human resources are needed: first a “facilitator” who is well trained in PBL processes and has acquired competencies in facilitation and management of group dynamics and secondly, a “content expert” or “subject expert” who posses’ specialization in the concerned discipline (Deo, 2013). The tutor or facilitator guides the learning process and conducts a thorough debriefing at the conclusion of the learning experience (Savery, 2006).

Presently, universities in Ghana are utilizing PBL. At the Kwame Nkrumah University of Science and Technology (KNUST), PBL have been identified as one of the approaches essential to learning outcomes. The overwhelming number of students in recent years calls for urgent need to review the PBL environment of the university. Moreover, most administrative activities and application of programs like PBL are at the discretion of College administrators. However, there is absence of document describing the resources available or accessible for PBL at college levels. Given this exposition, the objective of the study is to assess the resources presently available for PBL at KNUST and most importantly investigate their distributions across the college levels. In

this study we defined PBL resource as the basic physical and organizational structures and facilities needed for the operation of PBL.

Literature Review

The origination of PBL has been accredited to the School of Medicine of McMaster University in Canada (Lee, and Kwan, 1997). Moreover, other institutions such as Michigan State University in the United States, Maastricht University in the Netherlands, and Newcastle University in Australia are also well recognized regarding the introduction of PBL (Barrows, 1996). The flaws of the traditional medical education led to the introduction of PBL. It is claimed that PBL foster several desirable learning outcomes: help students to construct an extensive and flexible knowledge base, become effective collaborators, acquire problem-solving skills, become intrinsically motivated to learn and develop self-directed learning (SDL) skills (Barrows, 1985, 1986; Norman and Schmidt, 1992). PBL was formerly conceptualized as a rigorous, structured approach to learning that is tailor-made for medical education and based on considerable experience and research (Barrows and Tamblyn, 1980). However, since its introduction several variants have been developed by different universities to suit their local needs. Moreover, today PBL is seen in use not only in medical domains but in a variety of academic disciplines such as biology (Szeberenyi, 2005), biochemistry (Osgood et al., 2005), chemistry (Barak and Dori, 2005) to mention few. Owing to this, the definition and conceptions of PBL has been considered in general terms rather than limiting it to the medical domain. Boud and Feletti, (1997) defined PBL as an approach to structuring the curriculum which involves confronting students with problems from practice which provide a stimulus for learning. According to Savery, (2006) PBL is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. Similarly, Correnti, et al., (2014) described PBL as a student-centered pedagogy which actively engage learners in real world problems. Hmelo-Silver (2004) also defined PBL as an instructional method in which students learn through facilitated problem solving that centers on a complex problem that does not have a single correct answer.

The process of facilitating PBL starts with the design or selection of ill-structured problems (Schmidt, 1983). This is recognized as a crucial factor to the success of learning in the PBL environment (Kukkamalla, et al., 2011; Savery, 2006). Hmelo-Silver and Barrows, (2006) explained ill-structured problems as complex problems that cannot be solved by a simple algorithm. The University of Delaware provides sample problems that fit into the disciplines of Biology, Chemistry/Biochemistry, Criminal Justice, and Physics available at http://www.udel.edu/inst/resources/. Also, Schmidt, (1983) presents a medical example of such problems in his paper. Research indicates that facilitators' industrial experiences and exposure to real-world phenomena leads to the design of credible problems (Tik, 2014). In PBL the tutor or facilitator guides the learning process and conducts a thorough debriefing at the conclusion of the learning experience (Savery, 2006). Deo, (2013) indicates that a typical PBL tutorial consists of a group of students, usually 8 to 10 and a teacher, who facilitates the lesson. According to Overton (2010) a PBL session with large number of students in a lecture theatre fail to work.

Once problems are designed and presented to students they are allowed to work in collaborative groups to discover what they need to learn in order to solve a problem (Hmelo-Silver, 2004). In this context, students must define the problem, identify and acquire the skills and knowledge needed to solve it, and work through to the solution. Schmidt, (1983) provided a step by step procedure which the study group need to follow while working through the problem. This is outlined as follows:
Step 1: Clarify terms and concepts not readily comprehensible
Step 2: Define the problem
Step 3: Analyse the problem
Step 4: Draw a systematic inventory of the explanations inferred from step 3.
Step 5: Formulate learning objectives
Step 6: Collect additional information outside the group
Step 7: Synthesize and test the newly acquired information

As study groups endeavor to go through the above steps they have to access information by utilizing several learning resources or materials. For instance, to formulate learning objectives, which happens to be Step 5, Wood (2003) indicated that students have to use triggers or trigger materials from the problem case or scenario. The author considered the following as examples of trigger materials:

- Paper based clinical scenarios
- Experimental or clinical laboratory data
- Photographs
- Video clips
- Newspaper articles
- All or part of an article from a scientific journal
- A real or simulated patient
- A family tree showing an inherited disorder

According to Overton, (2010) when utilizing PBL students need to have ready access to any relevant resources in the library, Internet, to mention few. The studies of Wood, (2003), Mathews-Aydinli, (2007), Azer, (2011) and Deo, (2013) largely focused on infrastructural and human resources. The authors suggested several infrastructural resources required in PBL and these include library, books, computer, internet, tutorial rooms, magazines, electronic materials, brochures, newspapers, television, telephones, over-head projectors, white boards, flip charts and study space (Wood, 2003; Mathews-Aydinli, 2007; Deo, 2013). Using PBL also has implications for staffing and demands a different approach to timetabling, workload, and assessment (Wood, 2003). Overton, (2010) acknowledges that the major resource implication for the use of PBL is time; time to develop and trial good problems, to train staff and to tutor the students. The author further indicated that PBL takes more staff time than traditional methods because the group sizes have to be restricted. Deo, (2013) claimed that two main types of human resources are needed when using PBL: first a “facilitator” who is well trained in PBL processes and has acquired competencies in facilitation and management of group dynamics and secondly, a “content expert” or “subject specialist” who posses’ specialization in the concerned discipline.

It is indicated that time and resource implications in PBL should not be underestimated when using PBL (Overton, 2010). However, most institutions often fall short in terms of resource

availability in PBL. For instance, Overton (2010) averred that many institutions may be short of space that helps PBL work well – flat seminar rooms with movable furniture. A recent study from the Malaysian setting based on the perception of students found insufficient levels of resources in PBL (Zin, 2013).

Materials and Methods

Survey Data

The analysis of the present study is based on data extracted from the KNUST-based Building Stronger University (BSU) phase two project. BSU is a programme under the Danish International Development Agency (DANIDA) to strengthen the research and educational capacities of universities in selected Danida priority countries. This project is a cross sectional survey of 1,145 participants who are workers and students of KNUST. The survey was conducted in the year 2014 with well structured questionnaires built from a proposed matrix for mapping PBL in selected Danida priority countries. The working survey participants were educational managers, teachers and Information Technology (IT) experts of the university.

In this study data on the student participants were mainly used. The student participants were 1020, representing 89.0% of the entire sample. Students were drawn from thirty three (33) programs (levels two hundred and three hundred and first year postgraduate) across the six colleges. These colleges are College of Science, College of Agriculture, College of Architecture, College of Health and Allied Sciences, College of Arts and College of Engineering. Since some colleges have large departments, probability –proportion-to-size method was used to select the programs among the six colleges. Anticipating a follow-up survey, second year and third year undergraduate and first year postgraduate students were considered as the target population. This will allow for follow-up survey and other research investigation of PBL at KNUST. The data collected were quantitative.

Ethical Issues

Permission was sought from all participants before any audio recordings and written information of any kind was administered. They were informed of the purpose of survey and what the information will be used for in the developmental agenda of KNUST.

Methodology of Data Analysis

Data analyses in this study were based on graphical and numerical approaches. Graphical procedures such as clustered and stacked bar charts were employed to perform descriptive analysis. Also, count regression analyses were conducted. In this context, the standard Poisson regression model and the Zero Inflated Poisson regression models were used. When applying these models, data was first aggregated into counts based on the responses of students from the various colleges. Our interest was in the frequency of individuals who think their colleges have sufficient resources for PBL and any response which opposed this was conceived as zero.

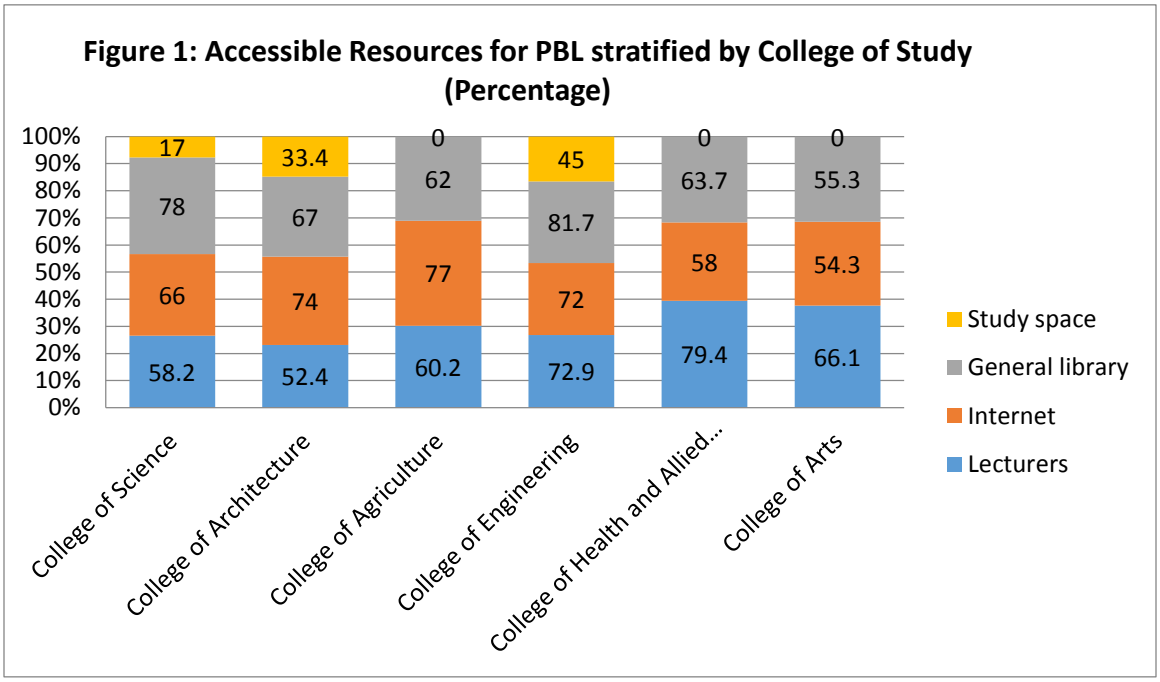
Consequently, students who indicated that their colleges have insufficient resources for PBL contributed to counts of zeros. The Poisson model assumes that data is equidispersed (Mouatassim and Ezzahid, 2012). However, this model produces inappropriate results in the case of over-dispersed data and data with too many zeros. The Zero-inflated models are able to incorporate over-dispersion and excess zeros (Zeileis, et al., 2008). In both models the aggregated responses from students about whether their colleges have sufficient resources for PBL was used as the outcome variable while college and level of study were considered explanatory variables. The Poisson and ZIP models are non-nested, for that reason the Vuong test was used to compare them. The test-statistic of the voug test is asymptotically distributed N(0,1) under the null hypothesis that the models are indistinguishable (Vuong, 1989). Data preparation and graphical procedures were computationally handled in Ms Excel and the count regression models were executed using R.

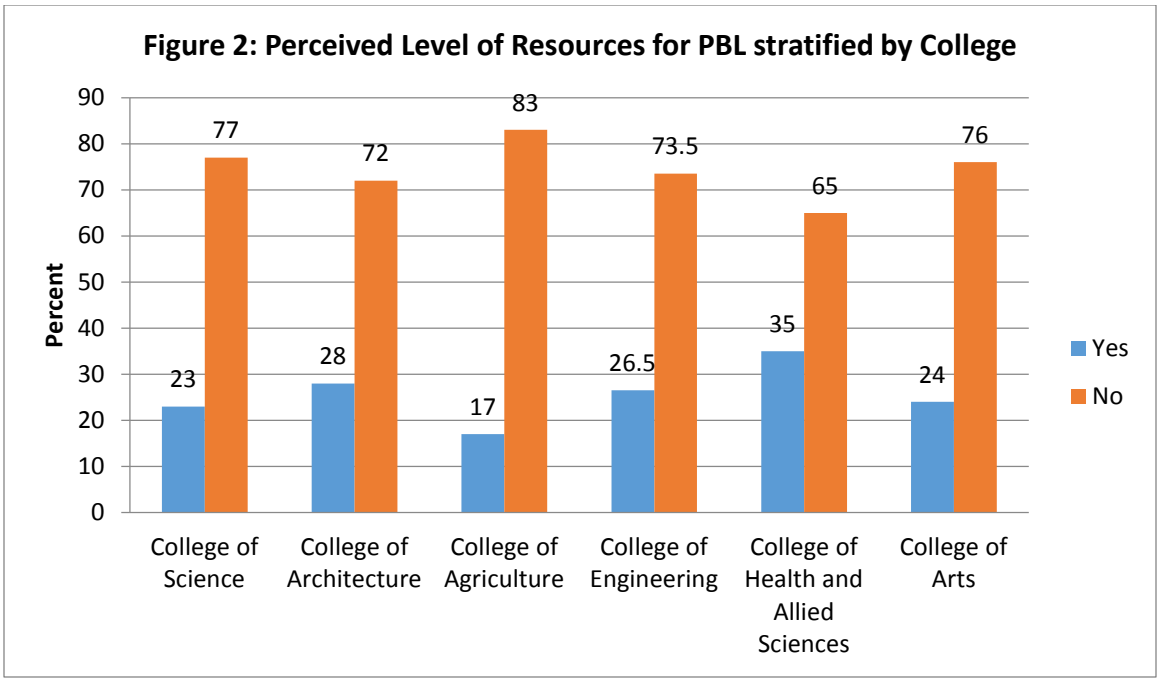
Findings

This section presents the results obtained by analyzing the data retrieved from the KNUST-based BSU Project. Totally, data on 1020 students from College of Science, College of Architecture, College of Agriculture, College of Engineering, College of Health and Allied Sciences, and College of Arts of the Kwame Nkrumah University of Science and technology (KNUST) was utilized. The students were asked to indicate the human and infrastructural resources presently available for PBL within their respective colleges. The responses from students in that respect are presented in Figure 1. From the figure the available infrastructural resources accessible for PBL are internet, general library and study space (Figure 1). Lecturers or teachers constitute the only human resource. Generally, more than half of the students from all the colleges indicated that they have access to internet, general library and lecturers in the PBL setting. From the figure, 17.0%, 33.4% and 45.0% of the students from College of Science, College of Architecture, and College of Engineering responded that they have access to study space. However, with the students from College of Agriculture, College of Health and Allied Sciences and College of Art no responses about having a study space for facilitating PBL were reported.

The students were asked to indicate whether the resources available in their respective colleges are sufficient for running PBL. Figure 2 presents the responses provided by students according to their individual colleges. Exactly, 35.0% of students from College of health and Allied Sciences indicated that their college has sufficient resources for PBL. This happens to be the highest, followed by 28.0% of students from College of Architecture. Conversely, on the whole, a large proportion of students from all the Colleges responded “no”, indicating majority of the students

disagree that their colleges have sufficient resources for PBL. On aggregate, 25.7% indicated that their various colleges have sufficient resources for PBL, while 74.3% responded otherwise (Figure 3). Thus, the aggregated responses across colleges consisted of counts of too many zeros, compared to the counting numbers. In this regard, it is convincing to study the underlying principles contributing to both components; counts and excess zeros. Poisson regression and Zero Inflated-Poisson (ZIP) regression analyses are performed using college of study and level of study as predictor variables (Table 1).





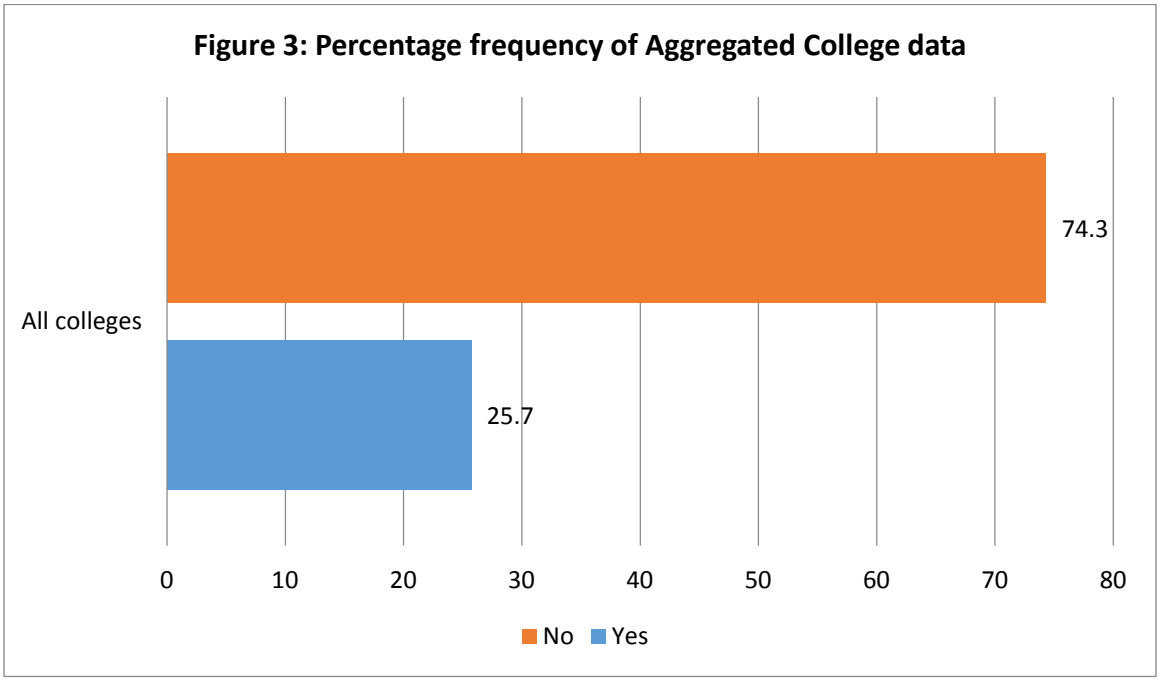


Table 1 shows the fit statistics of the standard Poisson regression and Zero Inflated-Poisson (ZIP) regression in explaining the aggregated number of perceived responses about the resources accessible for PBL within the colleges under study. From the log-likelihood test the standard

Poisson model corresponds to a p-value of 0.001. This indicates that the Poisson model is statistically significant at 5% level, compared to a null or intercept only model. Similarly, the ZIP model fits significantly better than the null model (p-value=0.000). Though both models appear to be significant, the Vuong test with test statistic of 2.137 and p-value of 0.015 suggests that the ZIP model is a significant improvement over the standard Poisson model. Therefore, the ZIP regression is used to model the data and subsequently presented in Table 2. In this model the count (Poisson) component rate ratios and 95% confidence interval (CI) for each of the categories of the covariates are presented. A second portion corresponding to the zero-inflated component of the model is expressed in logit coefficients.

INSERT TABLE 1 HERE

Following the ZIP model, the percentage of students from College of Architecture who hold the perception that their college has sufficient resources for PBL were 79.0% less than their counterparts from College of Science. For College of Agriculture the proportion of students who indicated that their college has sufficient resources for PBL were 87.0% less than College of Science. However, College of Engineering (7.0%), College of Health and Allied Sciences (38.0%) and College of Arts (1.0%) recorded proportions higher than that of College of science. Despite these variations p-values depict that none of the categories of the covariates (Colleges and Study levels) on the count component appeared to be significantly associated with the aggregated number of students who indicated that their colleges have sufficient human and infrastructural resources for PBL.

Of the zero-inflated component, College of Agriculture is significantly associated with the odds of the perceived insufficient resources for PBL. Students from College of Agriculture were 3 times more likely to indicate that their college has insufficient resources for PBL than those from college of Science.

However, the likelihood of students from College of Architecture responding that their college has insufficient support for PBL was decreased by 0.21. Correspondingly, the odds of students reporting that their college do not have sufficient resources for PBL were low for College of Engineering (OR=0.49), College of Health and Allied Sciences (OR=0.49) and College of Arts (OR=0.96), when compared to College of Science.

INSERT TABLE 2 HERE

Regarding the level of study, level 300 was associated with lower odds of zero counts (insufficiency) than level 200. Also, students at their postgraduate level were 0.59 times less likely to report that their college has insufficient resources for PBL compared to level.

Conclusion

In this paper, access to human and infrastructural resources in six Colleges of KNUST is considered as a crucial issue prior to seeing a complete implementation of PBL into the university's curriculum. The colleges considered are College of Science, College of Architecture, College of Agriculture, College of Engineering, College of Health and Allied Sciences, and College of Arts. The study shows that students in the aforementioned colleges have access to common PBL resources primarily internet, lecturers, and a general library. Additionally, students from College of Science, College of Architecture and College of Engineering have access to study space. These findings bear to agree with the studies of Wood, (2003), Mathews-Aydinli, (2007), Azer, (2011) and Deo, (2013). Collectively, 25.7% of the students indicated that their various colleges have sufficient resources for PBL, while 74.3% responded otherwise. When compared statistically, none of the colleges appeared to differ significantly in terms of having sufficient resources for PBL. The indication is that the colleges are perceived to be under-resourced. This is agrees with the study done in a Malaysian institution by Zin, (2013). Overton (2010) discusses resource implications in PBL and cautions that these implications should not be underestimated. The author emphasized that large group of students in tutorial meetings, inadequate study space and insufficient staff time; time to develop and trial good problems, to train staff and to tutor the students do not allow successful PBL environments. The present study justifies that the PBL environment of all the colleges of KNUST are under-resourced and this brings to light that students of the university may experience suboptimal learning outcomes. This underscores the importance of drafting policies for PBL resources based on the needs of each compartment or college with realistic themes such as ensuring sufficient resources. Recognizing these, KNUST and other institutions that share similar culture should assess their student/college to resource ratios, such as student to lecture ratio, student to computer ratio, student to study space ratio, time allocation, to mention few and these should meet the global standards in order to realize the intended learning outcomes of PBL. Moreover, KNUST should do more by introducing contemporary resources that can help students to learn and perform practical task in a modern academic environment.

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Table 1: Fit Statistics of Standard Poisson and ZIP Model for PBL Resources

		Poisson	Zero Inflated Poisson	Poisson and Zero Inflated Poisson
Log-likelihood	p-value	0.001	0.000	
Vuong Test	Test Statistic			3.064
	p-value			0.015

Level of Significance is 5%

Table 2: ZIP Regression Estimates for Aggregated Responses of Resources for PBL

Count model coefficients (Poisson with log link)				
Variables	**Rate Ratios (RR)**	**95% CI for Ratio Rate**		**p-value**
Intercept	1.04	0.50	5.63	0.361
College of Science				
College of Architecture	0.21	0.01	7.11	0.386
College of Agriculture	0.13	0.09	5.30	0.701
College of Engineering	1.07	0.21	5.72	0.882
College of Health and Allied Sciences	1.38	0.03	2.16	0.131
College of Arts	1.01	0.11	4.51	0.503
Level 200				
Level 300	0.67	0.02	3.86	0.299
Postgraduate	1.58	0.34	7.88	0.336
Zero-inflation model coefficients (binomial with logit link)				
	Odds Ratio (OR)	**95% CI for Odds Ratio**		**p-value**
Intercept	0.11	0.01	2.43	0.743
College of Science				
College of Architecture	0.30	0.13	3.35	0.441
College of Agriculture	1.03	0.39	6.02	0.024
College of Engineering	0.49	0.15	3.49	0.213
College of Health and Allied Sciences	0.29	0.06	3.08	0.116
College of Arts	0.96	0.09	4.41	0.344
Level 200				
Level 300	0.73	0.22	2.19	0.637
Postgraduate	0.41	0.23	1.97	0.804

Level of Significance is 5%; Reference categories: College of Science and Level 200