

Research Article

Students' Satisfaction of Blended Problem-Based Learning: An Academic Experience at Kwame Nkrumah University of Science and Technology

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Implementation of problem-based learning has been a challenge in most African institutions of higher learning including Kwame Nkrumah University of Science and Technology (KNUST) due to deficiencies in the secondary education system. This article seeks to investigate the effect of blended problem-based learning (BPBL) practices on students' satisfaction at KNUST during the Enhancing Entrepreneurship, Innovation and Sustainability in Higher Education in Africa (EEISHEA) 2019–2022 project. In line with this objective, a survey instrument was prepared and validated and a multistage sampling technique with an effective sample size of 1,304 students (621 female and 883 males), 71 lecturers, and 16 technicians across the six colleges of KNUST were obtained. The generalized linear models, simple and multiple logistic regression, were estimated from the data to compare effect of teacher-centered and BPBL paradigms on students' satisfaction. To prevent overfitting, a cross-validation was performed on the fitted models. Receiver operating curve and area under curve were employed to ascertain the predictive power of the models. Results indicate about 67.35% of students posited that lecturers have incorporated some problem-based learning (PBL) elements into their course delivery. About 72.13% of respondents submitted that the integration of the PBL ignited their self-directed and collaborative learning and improved learner's problem-solving skills. Furthermore, the fitted models suggest that BPBL, gender, level of program, and college influence students' satisfaction. The odds of satisfaction of an individual in the BPBL group is 7.4 times higher than respondents in the traditional group with a confidence interval for the odds ratio (OR), (OR 7.4, 95% CI: 4.31–13.16).

1. Introduction

Satisfaction of a process is an important characteristic one considers when it comes to decision-making in any form of service provided. Douglas et al. [1] viewed students as customers and sought their views on a number of aspects of teaching, assessment, and support provided by their university. They identified teaching ability, subject expertise of staff and information technology (IT) facilities as most important while the least important were decoration in lecture facility, vending machines, and decoration in tutorial rooms. Satisfaction could be viewed from different perspectives; teacher and student.

Ho and Au [2] defined teaching satisfaction based on Locke [3] concept of job satisfaction—"the pleasurable

emotional state resulting from the appraisal of one's job as achieving or facilitating one's job values" and was echoed by Ho [4], Ma and MacMillan [5]. Teaching satisfaction is a function of perceived relation between what one wants from one's job and one considering teaching as offering or entailing. This is the product resulting from attitudinal construct and affective responses of lecturers.

Yi [6] presented satisfaction as a postconsumption evaluation of a product/service that occurs at the end of a psychological process. Although a general definition guides satisfaction research, Yi [6] concluded that a precise definition remains an important topic. Alves and Raposo [7] indicated that the measurement of satisfaction depends on consumer and social behavior theory. Each strand of these

behavior theories has its own dimensions which focus on students' satisfaction of the process.

Problem-based learning (PBL) has been described as a successful teaching and learning strategy because it engages students in deep rather than surface learning and focuses on the student rather than the teacher [8–10]. Ravitz [11] in a PBL meta-analyses stated that studies should avoid emphasizing a false dichotomy between PBL and traditional instruction acknowledged in a meta-analysis paper that PBL itself can take different forms, including variations in the levels of PBL in a course curriculum. As indicated by Ravitz [11], the definitions of PBL frequently indicate the teacher as facilitator using some PBL strategies and may do away with lecturing [8]. The original intentions for PBL which was to equip learners with self-directed learning skills to aid lifelong learning in their future world of work may not be appropriate to learners who expect some level of information in their studies [12]. Vernon and Blake [13] found out that clinical performance ratings for medical students significantly favored medical students. As indicated by Ravitz [11] who cited [14, 15] that although PBL students felt disadvantaged in preparations for the standard tests, they were more likely to be accepted into their choice of residencies and felt more prepared for problem-solving, information gathering, self-directed learning, and self-evaluation techniques and skills to their world of work. As argued strongly by Walker and Leary [16], although PBL, with its different forms, generally gives an evenly expected outcomes in the science, medical and engineering, a better outcome present itself in teacher education, business, and other disciplines. It has long been acknowledged that PBL may be successful if complemented by the blended-learning approaches [17–22].

Students admitted into Kwame Nkrumah University of Science and Technology (KNUST) had predominantly undergone traditional instruction and this presents a contextual challenge of using purely PBL for instruction. The blended-PBL (BPBL) within this article is incorporating some level of variations of PBL into traditional instruction. These variations include activities to aid youth development outcomes of the 21st century skills, getting into college and staying in [1, 12, 23–26]. What is not clear is whether the learners will be satisfied.

Various implementation strategies of teaching method exist and each had touted its superiority with respect to level of students' satisfaction over the other in a course delivery. In this research we will not get into the implementation strategies. Douglas et al. [1] found that the most important aspects of students' satisfaction were those associated with the teaching and learning. As argued strongly by Rowley [27, 28] that feedbacks are essential in the total quality management of the teaching process at the university. In his article, he identified four main reasons for collecting feedbacks, one of which is vital in this paper; to provide students with an opportunity to express their level of satisfaction with their academic experience. Here the experience refers to the teaching method, a BPBL or traditional (only lecture based). The levels of satisfaction or dissatisfaction strongly affect the student's success or failure of learning. Douglas et al. [1] research on measuring student satisfaction at a UK university concluded that

students identified 10 most important variables necessary for satisfaction of the learner with the top 5 being; teaching ability of staff, subject expertise of staff, information technology facilities, lectures, and supplementary lecture materials. Kilgour et al. [29] identified seven factors influencing the satisfaction level of students in healthcare using PBL; the facilitator role, tutorial structure, individual student factors, case authenticity, increased feedback, group harmony, and resource availability. Sembiring et al. [30] in a study of level of satisfaction in the learning process of students in PBL at the University of Sumatra Utara, Indonesia, used five dimensions of service characteristics namely; physical evidence, reliability, responsiveness, assurance, and concern through importance performance analysis and concluded that quality of service was low among students. In each of these studies, factors that determine level of satisfaction are situational specific. It is worth mentioning that determinants of level of satisfaction of the student does not automatically develop employable skills required for the job market [31, 32]. PBL processes tend to improve the skills and competences required for a 21st century graduate (see [33, 34] for details). As stated by Clausen and Andersson [35] skills alone are not sufficient for the employers of graduates but the flexibility of the graduate's ability to apply them under the different situations on the job market [36]. Some of the attributes required of graduates' employability are discussed by Bosman and Dredge [33], Cavanagh et al. [37], and Yorke and Knight [38]. Based on the main thrust of each of these aforementioned articles it suffices to submit that determinants of level of satisfaction may not necessarily have any association with employability skills.

Most African countries are having the challenge of introducing a new pedagogical approach to their instruction due to the fear of students' riots even though they may be affinity toward a new learning approach. Consequently, this research may aid other universities faced with the challenge fear of incorporating innovative pedagogy to gather a scientific basis for introduction. KNUST, Ghana has conducted training workshop for her faculty to incorporate some elements of PBL in their course delivery. This paradigm shift by lectures from teacher to student-centered learning has naturally raised concerns within the university community. These are; students' workload, ability to complete the treatise for a particular course, limitation of resources (both human and infrastructure), and receptiveness of the students. This may result in student's unrest and hence has created some level of uneasiness on the part of faculty to incorporate PBL in their teaching. Efforts by most institutions to attain appreciable level of acceptability of her cliental through services provided are paramount. Receptiveness of students to a new approach of course delivery is profoundly accentuated through the satisfaction of the student thereby improving on student retention, attraction, and funding of the institution.

In Ghana, there are plethoras of universities and the choice to attend a particular university by parents and students depends on how well students are trained to acquire 21st century skills—which build satisfaction and good image of the institution. These have strong impact on the retention

TABLE 1: Test of independence between teaching method and attributes for a 21st century graduate.

Variable	Paired attribute	χ^2 (p-Value)
Method of teaching (TL or blend)	QL1: improves my confidence level	8.324 (0.004)
	QL2: promotes collaborative learning	9.213 (0.002)
	QL3: encourages my active participation	11.024 (0.001)
	QL4: helps me develop ICT skills for my carrier	7.546 (0.006)
	QL5: helps me develop professional skills in the program	15.236 (0.0001)
	QL6: improve my self-regulated learning	16.024 (0.0001)
	QL7: improve my knowledge level of course	18.913 (0.001)

Source: field survey (2022).

of current students and the attraction of potential students. The goal of the present research is to answer the following questions;

- (1) Is there association between method of teaching and attributes of a 21st century graduates?
- (2) What are the key factors that determine students' satisfaction?
- (3) What is the effect of the key factors on students' satisfaction?

2. Materials and Methods

To achieve the objectives a cross-sectional survey of students randomly drawn from Colleges of Science (CoS), Agriculture and Natural Resources (CANR), Architecture and Built Environment (CABE), Health and Allied Sciences CoHAS, Arts and Social Science (CASS), and College of Engineering (COE). The survey questionnaire was validated and administered. A multistage sampling technique was used to obtain and effective sample size and exploratory analyses were performed. The following research hypotheses:

- (i) attributes needed for 21st century graduate have association with the method of teaching;
- (ii) blended-PBL influence students' satisfaction at KNUST;
- (iii) resource is a determinant of students' satisfaction at KNUST;
- (iv) college of a student has an effect on students' satisfaction at KNUST;
- (v) level of program is a determinant of students' satisfaction at KNUST;
- (vi) key factors identified have effect on students' satisfaction at KNUST;

were investigated to achieve our aim.

2.1. Variables. Satisfaction: response to this question was Likert scale and was reclassified into binary and was coded Strongly Agree and Agree = 1 and Somewhat Agree and Disagree = 0. The internal reliability and consistency for satisfaction were good with Cronbach's $\alpha = 0.85$. Respondents

were also required to state the college they are and was coded as; (CABE = 0, CASS = 1, CANR = 2, COS = 3, COS = 4, and CoHAS = 5). For the question on the level of program responses were coded: 100 or 200 = 0, 300 or 400 = 1, Masters = 2, Ph.D. = 3, gender (Male = 1 Female = 0), and resource level is good (Strongly agree = 2, Agree = 1, Disagree = 0), had an experience of PBL method of teaching (Yes = 1, No = 2) and age of the student. Bosman and Dredge [33], Cavanagh et al. [37], Yorke and Knight [38], Dolmans et al. [39], Norman and Schmidt [40], Savery and Duffy [41], and Yew and Schmidt [42] identified some attributes required from a 21st century graduate. These are reclassified into seven in this paper; confidence level, collaborative learning, ICT skill, professional skills, self-regulated learning, and knowledge level of course. Survey participants were asked whether the method of teaching (BPBL or traditional) improves these seven areas per individual's future carrier (Table 1), QL1-QL7, and each response item was coded (Yes = 1, No = 0).

We investigated the association between method of teaching (traditional and blended) and some generic attributes for 21st century graduate (Table 1). The effect of key factors on students' satisfaction was examined by using a generalized linear model (GLM). Since Hypotheses I-IV examined the relationship between students' satisfaction and other variables a pairwise χ^2 test was performed and GLMs (Tables 2 and 3) were fitted to the data to establish the effect of key factors on the satisfaction of students. Validation for the fitted GLM was done using the deviance analysis (Table 4). To prevent overfitting, a cross-validation was performed on the fitted model. The predictive power of the fitted models was investigated using area under curve result on Figure 1. In the following sections we present results, discussions, limitations, and conclusion.

3. Results and Discussion

3.1. Results. Distribution of respondents with their corresponding percentages is indicated in Table 5. Survey responses show 995 (64%) were satisfied with the teaching method and 509 (34%) were not. Data retrieved from the survey indicates that there were 621 (41%) females and 883 (59%) males across the six colleges of the university. Level of program distribution reflects fewer Ph.D. (54,4%) and Masters (95,6%) students as compared to level 100 and 200 ($n = 522$, 35%) and level 300

TABLE 2: Multiple logistic regression for students' satisfaction.

	Estimate	Standard error	Z values	p^* -Value	Odds ratio	95% Confidence interval of OR	
(Intercept) gender:							
Female	4.739	1.617	2.93	0.003	114.313	5.268	3083.043
Male	1.926	0.433	4.447	<0.001	6.849	3.040	16.667
Age level:							
(100 and 200)	0.953	0.712	1.338	0.090	2.593	0.642	10.475
300 and 400	1.470	0.534	2.753	0.006	4.35	1.581	13.054
500	1.934	0.447	4.326	<0.001	6.919	2.949	17.178
600	2.293	0.644	3.563	<0.001	9.905	2.938	37.485
College: (CABE)							
COS	2.101	0.45	4.671	<0.001	8.197	3.484	20.408
CoHAS	3.008	0.653	4.609	<0.001	20.408	6.024	76.923
COE	2.491	0.777	3.207	0.001	12.048	2.976	66.667
CANR	0.902	1.608	0.561	0.575	2.465	0.149	85.21
CASS	-0.025	0.01	-2.504	0.012	0.975	0.955	0.994
Resources: (DNA)							
SA	0.416	0.678	0.613	0.540	1.515	0.398	5.714
A	1.451	0.687	2.111	0.035	4.267	1.129	16.859

Source: field survey (2022); p^* -value for probability significance level of 0.05.

TABLE 3: Simple logistic regression for students' satisfaction.

	Estimate	Standard error	Z values	p^* -Value	Odds ratio	95% Confidence interval of OR	
Intercept	0.806	0.152	5.317	<0.001	2.238	1.671	3.031
PBL (TA)							
Blend	2.001	0.289	7.092	<0.001	7.407	4.310	13.158

Source: field survey (2022).

TABLE 4: Residual deviance for fitted models.

	Residual Df.	Residual dev.	Diff Df.	Diff dev.	p -Value*
Null	1,503	1417.98			
Model 2	1,502	1359.54	1	58.44	<0.001
Model 1	1,491	1217.09	12	200.89	<0.001

Source: field survey (2022).

and 400 ($n = 833$, 55%) students in the university setup. The distribution of sample fairly represents the colleges with CABE ($n = 288$, 19%), COS ($n = 301$, 20%), CoHASS ($n = 223$, 15%), COE ($n = 311$, 21%) CANR ($n = 108$, 7%), and CASS ($n = 273$, 18%). The average age of respondents was 23.2 (S.D = 3.8) years.

Pearson's test of independence, odds ratio are reported with a corresponding test at 5% level and its associated 95% confidence interval (CI). All analyses were performed using R software.

3.2. Hypothesis I. Attributes needed for a 21st century graduate must have associated with the method of teaching.

A pairwise comparisons test, using Pearson's χ^2 tests of independence, was conducted between the method of

teaching and some generic attributes expected of a 21st-century graduate and results indicate that they are significant with a degree of freedom (df) 1, Table 1.

3.3. Hypotheses II-IV. The pairwise test of independence (Table 6) between students' satisfaction and each of the predictor variables, level of program, college, method of teaching, resources, and gender were conducted to identify the key factors that affect students' satisfaction and results indicate that they were statistically significant. Further analyses among predictor variables show that level of program and the variables, college ($\chi^2 = 21.93$, $df = 15$, p -value = 0.11), and gender ($\chi^2 = 6.822$, $df = 3$, p -value = 0.078) were not independent. College was not independent with the variables PBL

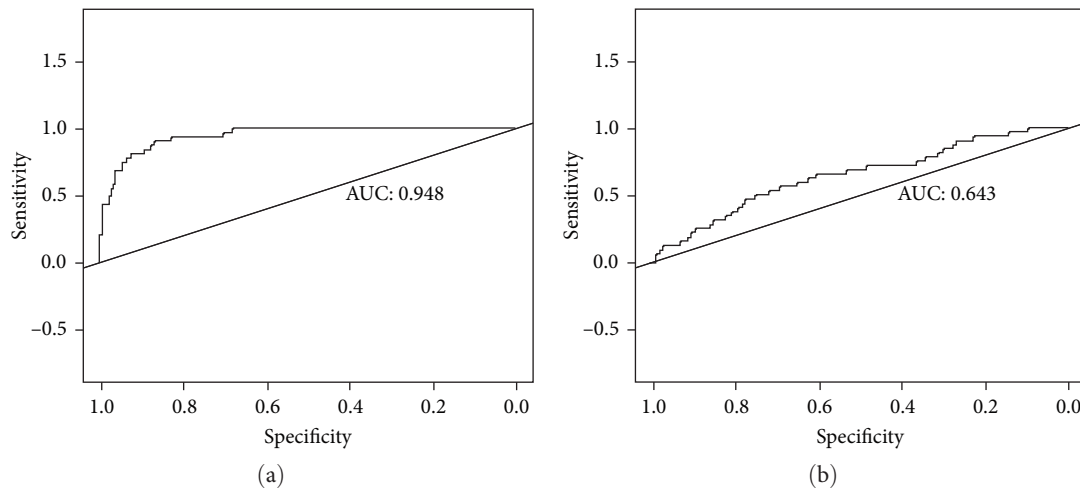


FIGURE 1: Predictive power of Model 1 (a) and Model 2 (b). Source: Field Survey (2022).

TABLE 5: Distribution of respondents.

Variable	Level	Number	(%)
Satisfaction	Yes	995	66
	No	509	34
Blended-PBL	Yes	1,013	67
	No	491	33
Gender	Female	621	41
	Male	883	59
Level	100 and 200	522	35
	300 and 400	833	55
	500	95	6
	600	54	4
College	CABE	288	19
	COS	301	20
	CoHAS	223	15
	COE	311	21
	CANR	108	7
	CASS	273	18
Resources	A	698	46
	DNA	421	28
	SA	385	26

Source: field survey (2022).

TABLE 6: Pairwise test of independence of variables.

Paired variables	χ^2 value	Df	<i>p</i> -Value*
Satisfaction:			
Level	79.624	3	<0.001
College	72.694	5	<0.001
PBL	54.686	1	<0.001
Resources	45.785	2	<0.001
Gender	21.107	1	<0.001
Level:			
College	21.93	15	0.11
PBL	67.348	3	<0.001
Resources	27.747	6	<0.001
Gender	6.822	3	0.078
College:			
PBL	8.809	5	0.117
Resources	11.507	10	0.320
Gender	7.848	5	0.165
PBL:			
Resources	25.113	2	<0.001
Gender	5.45	1	0.020
Resources:			
Gender	0.648	2	0.723

Source: field survey (2022).

($\chi^2 = 8.807$, $df = 5$, p -value = 0.117), resources ($\chi^2 = 11.507$, $df = 10$, p -value = 0.320), and gender ($\chi^2 = 7.848$, $df = 5$, p -value = 0.165). Resources not independent with the variable gender ($\chi^2 = 0.648$, $df = 2$, p -value = 0.723).

We conducted a simple and multiple logistic regression analysis to investigate the effect of BPBL on students' satisfaction. To investigate hypothesis VI, which will eventually aid in achieving the third objective, two models were considered and predictor variables were entered hierarchically. Model 1 (Table 2) has gender, level of program, college, and resources. Model 2 has the BPBL as the only predictor for the likelihood of students' satisfaction (Table 3 displays results). The pairwise results (Table 6) suggest the model

with a BPBL predictor should not contain resources and gender.

In Model 1, all predictor variables were statistically significant but age. Male group (OR = 6.849, CI = 3.04–16.67) has positive effect of students' satisfaction with respect to female group. Using level 100 and 200 as a baseline, level of program was statistically significant at its levels with positive effect on students' satisfaction for levels 300 and 400 (OR = 4.35, CI = 1.54–13.05), masters (OR = 6.92, CI = 2.95–17.18), and Ph.D. (OR = 9.91, CI = 2.94–37.49) students, if all other variables were held constant. This implies the higher the level of student the more likely the student will be satisfied. Colleges

of science (OR=8.2, CI=3.48–20.41), Health and Allied Sciences (OR=20.41, CI=6.02–76.92), and college of engineering (12.05, CI=2.98–66.67) have a positive effect and college of Arts and Social Science (OR=0.98, CI=0.96–0.99) has a negative effect on students' satisfaction with respect to Architecture and Built Environment (baseline) given that all other variables held constant. Students in colleges of science were about eight times more likely to be satisfied compared to students in the baseline group. Similarly, students from college of health and allied sciences are 20 times more likely to be satisfied. Further students from college of engineering are 12 times more likely to be satisfied compared to students in college of architecture and built environment. There is no difference in students' satisfaction for colleges of agriculture and natural resource and architecture and built environment. Students in college of architecture and built environment are more satisfied than students in college of art and social sciences. There is no difference between students who were satisfied in the strongly agreed group and do not agree group. Further, respondents who agree that KNUST has enough resource were four times more likely to be satisfied compared to the respondents who do not agree. A male student is about seven times more likely to be satisfied compared to a female.

A simple logistic regression with BPBL (OR=7.41, CI=4.3–1416) as a predictor suggests a positive effect on students' satisfaction. The models validation table, residual deviance analysis (Table 4 display results), indicates data fitted well and have a high-predictive power of 94.8% (Figure 1) for Model 2. Thus, randomly selected individual from students who is satisfied has a test value larger than that for a randomly chosen individual from students who are unsatisfied 94.8% of the times.

4. Discussion

To our knowledge, this is the first study that has investigated factors and their effects on students' satisfaction and examined association between methods of teaching and some generic attributes that a 21st century graduate must possess. These generic attributes required for future professional life of the student is primus to most students and measures adopted to advance this agenda will be welcomed.

Is there association between method of teaching and attributes of a 21st century graduates?

From the results for Hypothesis I that test association between method of teaching and seven attributes, it was observed that each generic skills required is associated with the teaching method which is consistent with work done by Sheldon and Fesenmaier [34]. These results do not take into account other confounding variables adjusted for in the analysis. Further no classification is done with respect to level (graduate or undergraduate) that teaching method plays a role.

What are the key factors that determine students' satisfaction?

Results for Hypotheses II–V suggest that all identified variables determine the students' satisfaction. A pairwise analysis indicates that level of programme and the college of a student is not associated, this is not surprising since most programs in the colleges have the same number of years. The level of program is highly associated with BPBL is as a result of the curricula of the programs at KNUST. Mostly, much emphasis is placed on the knowledge level of learning for students at the first 2 years (levels 100 and 200) as compared to those in the third year (level 300) or thereafter. Students at levels 300, 400, and graduate school are more likely to be exposed to the experiential learning through internships, deep learning and formulating, and solving ill-structure problems.

What is the effect of the key factors on students' satisfaction?

While this study identified level of program, college, and gender of the student as significant variables in the Model 1, further analysis needs to be done on the role resources, adjusted for, play in the level of students' satisfaction at KNUST. Results by Hyun et al. [43] seem to suggest that not all the classrooms need to be remodeled for students' active engagement and other resources could be brought to help student achieve the necessary satisfaction. Model 2 indicates students were satisfied with the BPBL introduces on learning.

5. Conclusions

Notwithstanding the limitations of this study, results show that method of teaching has positive impact on students' satisfaction. Further, for each level of the program, a student has a positive relationship with students' satisfaction for the BPBL with their delivery considering level 100 and 200 as baseline. This study also suggests that students in all colleges except college of art and social sciences have positive effect on students' satisfaction.

Data Availability

The dataset used in the study is available upon request from the corresponding author.

Additional Points

Limitations. This study has some limitations. First students' perception of satisfaction may not be linked to students learning outcome hence further research in this direction will enrich the existing knowledge in this area. Second, these results cannot be globalized since the survey questions were given during in-class sessions and peer influence in answering the questions cannot be controlled. Third, though students were given the opportunity to read on PBL and know its elements, understanding the methods of teaching may be a challenge to some of them.

Disclosure

This paper with the title “Students’ Satisfaction of Blended Problem Based Learning” was presented in the International Conference on Higher Education in Africa (EESHEA) [44].

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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