Konselor
Volume 11 Number 02 2022, pp 63-74
ISSN: Print 1412-9760 – Online 2541-5948
DOI: https://doi.org/10.24036/02022112121279-0-00
Received May 12th, 2022; Revised June 20th , 2022; Accepted July 5th, 2022

KONSELOR
http://ejournal.unp.ac.id/index.php/konselor

Impact of problem-based laboratory experience on behavioral skills outcome of telecommunication students in polytechnics

Chinyere Theresa Ogbuanya[1]
[1]Senior fellow, School of Education Studies, Faculty of Education, University of the Free State, Bloemfontein, South Africa
*Corresponding author, e-mail: chinyere.ogbuanya@unn.edu.ng.

Abstract

The study determined the impact of problem-based laboratory experience on the behavioral skills outcome of telecommunication students in Polytechnics in North Central Nigeria. Quasi-experimental research design was used for the study. The sample for this study comprised 282 telecommunications students in 12 polytechnics in North Central Nigeria. A questionnaire titled "Behavioural and Skills Outcomes Scale. The coefficient of internal consistency was established using Cronbach alpha and was found to be 0.73. Data collected were analyzed using Analysis of Variance, t-test and analysis of co-variance with SPSS version 22. A significant main effect of treatment was observed on the overall behavioral skills. There was non- significant effect of gender but a significant interaction between treatment conditions and gender was found out. There was no significant difference in the behavioral skills outcome based on gender, age, residence, location, religion and ethnicity. It was recommended that technical teachers should use problem bases laboratory experience in teaching and learning telecommunication in Polytechnics as well as emphasize and assess behavioural skills outcome.

Keywords: Problem-based learning, telecommunication, behavioural skills, Polytechnics

How to Cite: Ogbuanya, T.C. (2022). Impact of problem-based laboratory experience on behavioral skills outcome of telecommunication students in polytechnics. *Konselor*, *11*(2): pp. 63-74, DOI:https://doi.org/10.24036/02022112121279-0-00

Introduction

Telecommunication has transformed the world. It is the wheel that is moving technological development in the world today. According to Raman (2015), telecommunication involves the exchange of information between two communication entities using technology. It is the transmission of signs, signals, sounds, words, writing, and messages via signals, wire, radio and optics. According to Wheen (2011), it is the science of communicating over a long-distance using telephone or radio technology. This means that telecommunication has to do with exchange of information over a long distance. It makes use of other media like radio, optics and wires. To achieve communication through these media demands a great deal of skill, knowledge and attitude. These media are communication systems and such have input, process and output signals with complex circuitry. These circuits are made up of fragile sensitive components or devices as such are liable to develop fault from time to time. Technicians and technologists trained in Polytechnics are meant to maintain electronic communication systems. Such manpower can only be produced with appropriate teaching and learning method that is activity based and student centered. One teaching and learning method that can actively involve students is problem-based learning.

Problem-based learning enables students to seek for new knowledge and skill. According to Overton (2010), problem-based learning involves problems that are meant for the curriculum objectives. They have to be real and engaging. They also need to place the group in a professional role. As scientists, problem-based learning requires students to develop a problem-solving strategy that require the student to acquire new knowledge and also require the students to make judgments, approximations and deal with omitted or excess information. According to Pepper (2009), Problem based learning (PBL) is a teaching and learning strategy which is used to engage students in deep learning. It is a strategy used to align courses work with the real-life

professional work that students are expected to engage in on graduation. To McKenzie and Brown (2017), PBL is a teaching method used to develop skills like team working, listening and self-directed learning. It allows the use of research and reasoning to progress and complete the task in a professionalized way. PBL is an instructional learner-centered strategy that strengthens learners to carry-out research, fuse theory and practice, and apply knowledge and skills to develop a real solution to problems (Orji 2015, Orji, 2021, Orji & Ogbuanya, 2018, Orji & Ogbuanya 2022). Since this type of learning involves the blending of theory and practice and application of knowledge to real life problem, it usually requires laboratory experience, hand on experience, critical thinking among others.

Problem based laboratory experience entails carrying-out laboratory work in small groups to develop necessary skills for life long experiences. For Orji (2021) problem-based experience (PBLE) can be viewed as a student-centered teaching strategy in which students learn about particular contents or tasks by solving open-ended problems. It also involves learners working in small groups and focuses on the learner's reflection and reasoning to construct their own learning experiences (Peters & Amador, 2006; Azer, 2011). To Schmidt, Rotgans, & Yew (2011) problem-based laboratory experience can be viewed as the type of learning based on identified issues within a scenario in the laboratory to increase knowledge and understanding. PBLE in this case does not focus on problem solving with a defined solution, but it allows for the development of desirable skills, attributes and experiences from finding solutions to undefined problems. This includes, knowledge acquisition, skills outcomes, enhanced communication and interpersonal skills that promote further learning and other behavioural outcomes among group members.

Behaviour could be seen to mean overt attitude. They are dispositions that are explicit and can easily be seen in an individual. According to Ossorio (2006), behaviours are observable and measurable actions of individuals or organisms. To Haug et al. (2009), behaviour is a range of observable physical and emotional actions that people engage in; biologically, socially, intellectually, and so on and are influenced by their culture, attitudes, emotion among other factors. The product of such of behaviour is known as behavioural outcome. Behviour outcomes are observable and desirable changes in an individual' actions (Bergner, 2011). The expression of some of these behaviour outcomes led individuals to acquire and perfect in certain skills.

Skills can simply be seen as the ability to do something well. It is a kind of ability to perform a task. Hence, behavioral skills outcome are observable and desirable physical and emotional actions that lead an individual to perform a task very well. Gupta (2007) defined behavourial skill outcomes as competencies, values, motivations and beliefs people need in order to be successful in a job or task. That means that behavioral skill outcomes are soft skill required for performance of task and success on the job that are of importance to the student as well as graduates. Rothwell (2012) explained that there are core skills outcomes required for tasks accomplishment. Unfortunately, teachers generally do not pay much attention to behavioral skills. It also possible that telecom students graduate without adequate behavioral skill since these skills are often not measured to determine their presence or not. This probably may be because they are not easily measurable with tests, yet they are the basic and fundamental skill on which other skill thrive better.

Behavioral skills could be acquired by telecommunication students engaged in problem-based laboratory experience. Experiences gained from this exposure can be employed in resolving specific problems or challenges practically or in theoretical terms. According to Haug et al. (2009), behavioral skills include; social skills, emotional skills, intellectual or cognitive skills, communication skills, interpersonal skills, problem solving skills, self-confidence and time management skills. In this study, the impact of PBL on behavioral skills such as communication skill, interpersonal skills and problem-solving skills were considered.

Communication is a means of exchange of information between one person and another. Good communication skill is highly required in all context of life. Baldwin, & Schultz, (1983) defined communication skills as the ability to communicate in socially acceptable way, which involves the speaker's interaction with others, the audience perception about the speaker in terms of vocal presentation, message control, command of language, physical appearance and so on. Accordingly, Pratt and Richards (2014) asserted that clearly written communication and verbal communication, and active listening are skills that may enhance academic performance. Osborn and Pearson (2014) supported this assertion by noting that oral and written communication skills are the prerequisite for students' academics, personal, and professional success. It is also a prerequisite for acquisition of interpersonal skill.

Student need interpersonal skills that will further enhance their classroom interaction and sociability. Students' interpersonal skills involves the inter relationship among students in the class. This is quite an important skill required in a problem-solving laboratory. To Weimer (2002), Interpersonal skills are affective attributes that enable an individual to interact with other people. These skills determine the ability to recognize and connect with others. According to Wood (2009), people especially telecommunication

students need to have effective interpersonal skills to enable them understand themselves and others' behaviours, cope with circumstances, and control any situation(s) they find themselves in. In reality without both interpersonal and problem-solving skills students may end up not achieving much in laboratory experience.

Problem solving skills enable students solve problems confronting them in class and in the world of work. The Programme of International Students' Assessment (PISA) (2012) defined problem-solving skills as an individual's abilities to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious. Such skills according to PISA include the willingness to engage in a task, one's potential as a constructive and reflective individual, critical and analytic thinking, creativity, self-confidence, motivation, curiosity and perseverance. According to Adeyemi (2008) problem-solving involves a systematic application of acquired knowledge to overcome any obstacle perceived by an individual as a problem. Ifamuyiwa and Ajilogba (2012) pointed out that, problem solving skills helps in finding solutions to identified problems by carrying out sets of action. Adesoji (2008) strongly believed that problem solving involves initiating, usually on the basis of hunches or feelings, interactions with the environment to clarify the nature of a problem and potential solutions, so that the problem-solver can learn more about the nature of the problem and the effectiveness of their strategies, modify their behaviour and launch a further round of experimental interactions with the environment.

In problem solving, emphasis is laid on thinking skills, which is integrating knowledge, skills and behaviours. According to Osuolale (2014), good teachers and well-equipped schools can enhance students' overall problem-solving skills such as critical thinking, analytical thinking, creativity, common sense, motivation and curiosity in addition to their competence in regular curricular subjects. Telecommunication students exposed to problem-based laboratory experience may acquire these behavioral skills their gender notwithstanding.

Males and females tend to learn and acquire skills differently. Gender is the role male and female students play in the acquisition of skills. It differentiates the way they interact and behave in groups settings. According to Okeke (2003), the study of gender is not just mere identification of male and female sexes. Gender concerns the analysis of the relationship of males and females including the division of labour, tasks, access to resources among other societal considerations. Mlambo (2011) perceived gender as a cultural construct that distinguishes the roles, behaviour, mental and emotional characteristics between males and females as developed by a society. This means that gender differences are defined by the society based on its norms and values. This societal definition prescript activity for male and female students which they in turn brings to school. This however might likely affect their behavioral skill development ability. However, Study by Akiri and Ugborugbo (2008) reported that there was a significant relationship between gender and student's performance in chemistry laboratory. Also, Olagunju and Abiona (2008) revealed that male students were more effective in science laboratory activities than their female counterparts, while Khurshid and Zahur (2013) discovered that females are more careful in laboratory activities than the males. Gender therefore, is a factor for consideration in this study as well as other demographic variables such as ethnicity, age, religion, residence and location.

Studies have reported possible relationship between ethnicity and learning outcome. Ethnic heterogeneity provide platform for students interaction in a rich and diverse environment, and also gives opportunity to learn from each other's cultural differences and practices (Khan & Sobani, 2012). It improves interpersonal dynamics and learning processes while promoting interethnic cooperation (Singaram et al, 2008). In another study, Duda et al, (2019) found that ethnicity did not significantly affect the skills performed by students during engagement in science-based activities (students' science process skill) and that the learning model used by the teacher to convey the learning task content which is integrated with the learning materials does not relate with ethnicity toward students' science process skill. Similarly, ethnicity does not predict perceived student adjustment and support in group learning environment (Beneroso & Erans, 2021). In contracts, Cartwright (2015) identified ethnicity as a factor that had caused disempowerment in terms of peers' work adjustment in group learning environments, just like location.

Location is a pertinent variable that define individual learning environment. Just as it informs curriculum development and teaching methods, it stands the chances of influencing learning outcome. De Witte and Rogge (2016) who found that PBL does not contribute to students' knowledge and skills outcome though it fosters learning motivation, further concluded that controlling for location as a source of heterogeneity does not alter the results. However, to determine whether the effectiveness of PBL would be impacted by other factors, Chen and Yang (2019) affirmed that learning location significantly related to the variability in student academic achievement. Location contributes to situated experiences which in turn can support students'

learning. This agrees with the view that location foster learning as it allows engagement in blended spaces of educational interest and further blend the real world with virtual elements (Georgiou & Kyza, 2017). Location as well as students' residence might be a factor in their behavioral skill development when exposed to PBL experience.

The major focus of learners' residence is to provide students with a primary learning environment that helps support their academic success. This implies that issues around learners' residence could significantly influence their behavioral outcome especially in a problem-based learning situation. Peter et al, (2018) who view learners residence as (on-campus and off-campus/school residence) deduced that living in on-campus residence in the first year of university had positive effects on retention to the second year and persistence to graduation, with benefits particularly pronounced for international students. In like manner, Pike (2002) affirmed that living on campus directly associated with significantly higher levels of openness to diversity than living off campus. Similarly, Stassen (2003) found that learners residence positively influence their learning outcome around their retention and first semester GPA among others. This may also depend on the age of the student.

Age is a construct that define the length of time that a person has lived or a thing has existed. Theoretically, learning is age based. Thus, variation in age amid learning groups stands the chance of influencing their behavioral learning outcome even in a problem-based learning atmosphere. According to De-Koning, et al, (2012) age negatively correlations academic achievement, indicating that younger students perform better than older students in term of academic achievement. Prensky (2002) and Lajoie et al., (2014) sarcastically argued that PBL support the utilizing of technology for their learning process thereby reducing boredom in learning. However, Fidan and Tuncel (2019) demonstrated that the early age students studying in middle and junior high schools have more difficulty in science course. Similarly, for early-age students, long-term PBL activities can be boring (Donnelly, 2005) and can made learner feel incompetent during the learning process (Dolmans et al., 2005; Hung, 2011). Beside age, religion has been implicated to influence behavioural skills outcome in learning situations.

Religion is the belief in and worship of a supernatural being, especially a personal God or gods. Religion is belief driven. Students bring beliefs about learning to a new learning situation which may hamper their behavioral learning outcome especially in a problem-based learning environment (Hmelo-Silver, 2004). In teams of the unexpected, learners often seek comfort in their religion which generating words like "MY GOD WILL HELP ME". According to Bamuhair et al, (2015) religion elicit/provide a comfort zone for coping with stress and stressor in a problem-based learning process. In the teaching of Hebrew course, Harding (2001) defends PBL on the basis that it stimulates student motivation and promotes deep learning.

Problem based learning is being perceived to be a student-centered learning. Students involved in this type of learning acquire skills that could enhance the transfer of such skills to the world of work. Such skills if obtained by telecommunication students will go a long way in enabling students achieve maximally in school as well as in the world of work. Hence, the present study intents to investigate the impact of problem-based laboratory experience on behavioural skills outcome among telecommunication students in polytechnics in North central states. Primarily, the study investigated the impact of problem-based laboratory experiences on behavioural skills outcomes of telecommunication students in polytechnics in North-central states of Nigeria. Specifically, the study tested the following null hypotheses at 0.05 level of significance:

1. There is no significant main effect of problem-based laboratory experiences on behavioural skills outcomes of telecommunication students in polytechnics.

2. There is no significant interaction effect of treatment conditions (PBL and Lecture) and gender on behavioural skills outcomes of telecommunication students in polytechnics.

3. If there is a significant difference in the behavioural skills outcomes of telecommunication students based on gender, age, residence, location, religion, and ethnicity when exposed to problem-based laboratory experiences.

Method

Design of the Study

The design of the study was quasi-experimental research design, specifically, pre-test, and post-test non-equivalent control group design. This design was considered suitable to conduct this study because intact classes (non-randomized groups) were to two different groups in order to determine the behavioral outcome of telecommunication students engaged in problem-based laboratory experience.

Area of the Study

The area of this study was the North Central Zone of Nigeria. The zone comprises six States. The States include: Benue, Nassarawa, Niger, Kogi, Kwara and Plateau. There are12 polytechnics in the zone. People of the area have diverse cultures and traditions, languages, and religions among others. The economic activities of the people majorly include farming, trading, skill occupations and artisanship. As a zone that is often face ethnic and religious crisis, behavioural skills need not be left to chance. Deliberate effort should be made not only to teach and assess cognitive and psychomotor skill but also behavioural skills. Blend of technical and behavioural skills will go a long way in helping the telecommunication graduates to function in North Central zone of Nigeria.

Sample and Sampling Techniques

The sample for this study 'comprised 282 telecommunication Polytechnic students. Simple random sampling technique was used to choose six Polytechnics for the study. The total number of telecommunication students in the six chosen Polytechnics was 282. This made up of 175 males and 107 females.

Instrument for Data Collection

The instrument titled "Rubrics for Assessing Behavioural and Skills Outcomes of Telecommunication Students Engaged in Problem-Based Laboratory Experience (RABSOTSEPLE) was divided into five clusters. Cluster I assessed communication skills of telecommunication students. Cluster II assessed interpersonal skills of telecommunication students. Cluster III assessed self-confidence skills outcome of telecommunication student. Furthermore, cluster IV was assessed time management skills among telecommunication students while cluster V assessed problem solving skills among the telecommunication students.

Validation of the Instrument

To ensure the face validity of the instrument, copies of the instrument were given to two experts in the Department of Industrial Technical Education (electrical electronic technology option), Faculty of Vocational and Technical education, and one expert in Federal Polytechnic Nasarawa. The experts were asked to check the items in terms of clarity and appropriateness for the study. Their suggestions and corrections incorporated into the final draft of the instrument.

Reliability of the Instrument

To ensure the reliability of the instrument, 20 copies of the instrument were trial tested on 20 telecommunication students engaged in problem-based laboratory experience in Federal Polytechnic Bida, which was not part of sample for the study but share similar characteristics with those involved in the study. The internal consistency of the instrument was ascertained using Cronbach alpha method of estimating reliability. The reason for using Cronbach alpha was because the items were not dichotomously scored. The reliability coefficients obtained for each cluster were: Cluster I on Communication skills 0.72, cluster II Interpersonal skills 0.73 and Cluster III on Problem- solving skills 0.87. Overall reliability of 0.73 was obtained for the instrument. A reliability coefficient value of 0.73 and above was considered high. The inter-rater reliability was employed to determine relationship between two raters using the rubrics to rate 20 students on their behavioral skills. Product moment correlation was employed to determine the coefficient which was found to be 0.77.

Experimental Procedures

The initial observation and ratings were done on both experimental and control group before the commencement of the treatment. This pre-test provided the base line data to compare students in both groups. The students' normal telecommunication laboratories were used all through. Each formal laboratory session followed the same pattern:

- Each class was divided into groups of five students in each group one of them chairing the proceedings and another acting as the scribe. The roles were changed for each problem. The students predominantly conducted the class session while the teacher guided their activities.
- The teacher summarized the problem and solution of the previous lesson and the brief them on the new problem for the day.
- The briefing takes the form of the student being given a written problem or scenario.
- The leader of the group read out the problem and group identified the main content of the problem, equipment and facilities required in solving the problem. The group identified their own step by step approach on how to arrive at the expected outcome. The facilitator was present to ensure that each group remained focused and the correct sets of laboratory experiences were learnt.
- At the end of every problem the group presented their work to the entire class.

- The experimental group and control group were thought 16 lessons each. Each lesson lasted for 2 hours of two lessons per week. The treatment lasted for 2 months

Method of Data Collection

The researcher together with 12 research assistants who were properly briefed used the rubrics to assess the students during laboratory exercises. The researcher and the research assistants rated the students using the rubrics on the degree of behavioral skills exhibited by the students during laboratory exercises. Eventually, 275 students participated consisting of 173 males and 102 females.

Method of Data Analysis

Data was analyzed ANOVA ANCOVA statistics with SPSS version 22. Mean and If the mean gain score of the experimental group greater than that of the control group, it means that the treatment has a better effect and vice versa. ANCOVA statistic was used to test all the hypotheses at .05 level of significance. If the probability value (p) is less than or equal to the 0.05 alpha value at which it is tested, it means that there is a significant effect of the treatment. On the other hand, if (p) value is greater than the 0 .05 alpha value, it means that there is no significant effect of the treatment.

Results

Table 1: Participant demographics

Variables	Treatment group N (%)	Control group N (%)	χ^2	Significance
Gender				
Male	89 (32.4%)	77 (28.0%)	.919	.338
Female	52 (18.9%)	57 (20.7%)		
Age[a]	20.67±2.26[b]	20.53±1.69[b]	.600	.549*
Residence				
Campus hostel	84 (30.5%)	72 (26.2%)	.956	.328
Off-campus	57 (20.7%)	62 (22.5%)		
Location				
Urban	62 (22.5%)	49 (17.8%)	1.565	.211
Rural	79 (28.7%)	85 (30.9%)		
Religion				
Christianity	46 (16.7%)	57 (20.7%)	2.882	0.90
Islam	95 (34.5%)	77 (28.0%)		
Ethnicity				
Hausa	61 (22.2%)	68 (24.7%)	1.689	.637
Igbo	32 (11.6%)	27 (9.8%)		
Yoruba	29 (10.5%)	22 (8.0%)		
Others	19 (6.9%)	17 (6.2%)		

*t-test results for age, b = mean and standard deviation in years, χ^2 = Chi-Squared.

Table 1 showed that the mean age of the treatment group was 20.67 ± 2.26 years, while that of the control group was 20.53±1.69years, with no significant difference, t=.600, P =.549. Among the 275 participants who took part in the study, those in the treatment group comprised 89 (32.4%) male and 52 (18.9%) female participants, while the control group comprised 77 (28.0%) male and 57 (20.7%) female participants, with no significant difference, χ^2 =.919, P =.338. In addition, among the treatment participants, 84 (30.5%) live on campus and 57 (28.75) live off-campus, while 72 (26.2%) and 62 (22.5%) of the control group participants live on campus and off-campus respectively. Other demographic details like location, religion and ethnicity are shown in Table 1.

Table 2. ANOVA comparison for treatment and control groups at pre-test (Time 1), and Post-test (Time 2).

Time	Behavioral Skills	Group	*N*	*M±SD*	95% CI	*f(1,273)*	*p*
Pre-test	Communication	Treatment	141	5.79±1.85	5.487 – 6.102	.484	.487
		Control	134	5.66±1.16	5.466 – 5.863		
	Interpersonal	Treatment	141	6.57±2.14	6.218 – 6.931	1.098	.296
		Control	134	6.81±1.44	6.560 – 7.052		
	Problem-solving	Treatment	141	6.27±1.64	5.667 – 6.542	.067	.797
		Control	134	6.22±1.26	6.009 – 6.439		
	OVERALL	Treatment	141	33.55±5.19	32.68 – 34.41	.152	.697
		Control	134	33.75±2.99	33.24 – 34.26		
Post-test	Communication	Treatment	141	13.65±2.15	13.29 – 14.00	1521.8	< .001
		Control	134	5.50±1.13	5.307 – 5.693		
	Interpersonal	Treatment	141	12.73±2.46	12.32 – 13.14	520.4	< .001
		Control	134	7.08±1.50	6.825 – 7.339		
		Control	134	7.40±1.81	7.085 – 7.706		
	Problem-solving	Treatment	141	12.55±2.65	12.10 – 12.99	523.5	< .001
		Control	134	6.51±1.55	6.242 – 6.773		
	OVERALL	Treatment	141	76.57±6.24	75.53 – 77.61	4541.4	< .001
		Control	134	34.79±3.63	34.17 – 35.41		

N=number of participants; M=mean; SD=standard deviation; CI=confidence interval

Table 2 shows the effect of problem-based laboratory experience on the behavioral skills among telecommunication students. At Time 1 (pre-test), the result showed that there were no baseline differences between participants in the treatment group as shown: communication skills (M = 5.79; SD = 1.85); interpersonal skills (M = 6.57; SD = 2.14); problem-solving skills (M = 6.27 SD = 1.64); and those in the control group, communication skills (M =5.66; SD = 1.16); interpersonal skills (M = 6.81; SD = 1.44);; problem-solving skills (M = 6.22; SD = 1.26); Overall (M = 33.75; SD = 5.19; CI = 32.68 – 34.41) (M = 33.75; SD = 2.99; CI = 33.24 – 34.26); f (1,273) = .152, p = .697. In addition, a significant main effect of treatment was observed on the overall behavioral skills at time 2 (post-test) (M = 76.57; SD = 6.24; CI = 75.53 – 77.61) when comparison with the control condition (M = 34.79; SD = 3.63; CI = 34.17 – 35.41), f (1,273) = 4541.4, p <.001, η_p^2 = .964. This shows that the treatment condition caused a significant increase in behavioral skills outcome among telecommunication students. These results presented provided an empirical support for the hypothesised effect of problem-based laboratory experiences on behavioral skills outcomes among telecommunication students in polytechnics.

Table 3. Interaction effect of problem-based laboratory experiences and gender on behavioural skills outcomes.

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	120435.824[a]	4	30108.956	1208.922	.000
Intercept	10773.163	1	10773.163	432.559	.000
Behavioral Skills	.102	1	.102	.004	.949
Groups	110023.776	1	110023.776	4417.628	.000
Gender	3.946	1	3.946	.158	.691
Groups * Gender	**427.278**	**1**	**427.278**	**17.156**	**.000***
Error	6724.518	270	24.906		
Total	996181.000	275			
Corrected Total	127160.342	274			

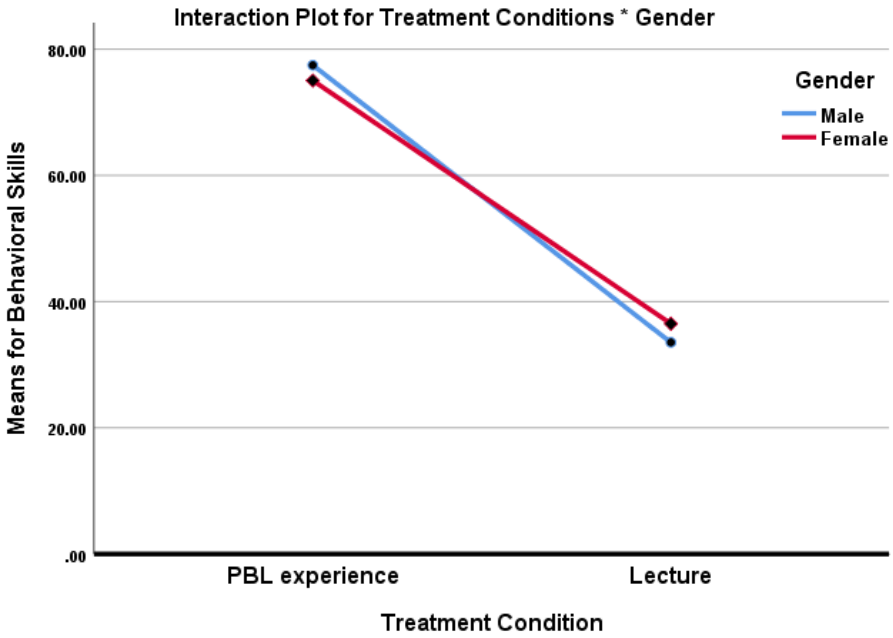

Figure 1: Interaction effect of Treatment groups and gender on behavioural skills outcomes

A 2 × 2 ANOVA was conducted to evaluate the effects of two treatment conditions and gender on behavioral skills outcome of telecommunication students. The means and standard deviations for behavioral skills outcome are presented in Table 2. The overall post-test (time 2) result indicated a significant main effect, $F(2,273) = 4541.4$, $p < .001$, $\eta_p^2 = .964$, a non-significant effect for gender, $F(1, 273) = .158$, $p = .691$, and a significant interaction between treatment conditions and gender, $F(2, 273) = 17.156$, $p < .001$. Because the interaction between the treatment conditions and gender was significant, choice was made to ignore the main effect and instead examined the treatment condition simple main effects, that is, the differences among treatment conditions for men and women separately. Therefore, the graph in figure 1 above showed that behavioural skills outcomes are higher for male telecommunication students when exposed to problem-based laboratory experiences. On the other hand, behavioural skills outcomes are higher for female telecommunication students when the lecture is used.

Table 4. Behavioral Skills scores across the control variables among telecommunication students.

Control Variables	N	M±SD	95%CI	*f(1,272)*	Significance
Gender					
Male	166	57.10±22.48	53.65 – 60.54		
Female	109	54.87±20.06	51.06 – 58.68	.701	.403
Age					
18 – 20 years	178	55.65±22.38	52.34 – 58.96		
21 – 23 years	58	55.90±20.43	50.53 – 61.27		
24 & Above	39	59.28±19.38	53.00 – 58.77	.462	.631
Residence					
Campus hostel	156	57.30±22.47	53.75 – 60.86		
Off-campus	119	54.79±20.27	51.11 – 58.47	.917	.339
Location					
Urban	111	57.92±22.73	53.64 – 62.19		
Rural	164	55.06±20.69	51.87 – 58.25	1.166	.281
Religion					
Christianity	103	53.12±22.58	48.70 – 57.53		
Islam	172	58.07±20.74	54.95 – 61.19	3.436	.065
Ethnicity					
Hausa	129	54.34±22.49	50.42 – 58.26		

Control Variables	N	M±SD	95%CI	*f(1,272)*	Significance
Igbo	59	57.61±21.43	52.03 – 63.19		
Yoruba	51	58.88±20.62	53.08 – 64.68		
Others	36	56.86±19.69	50.20 – 63.52	.677	.567

N: number of participants; M: mean; SD: standard deviation; CI: confidence interval.

Table 4 shows the behavioral skills scores of the telecommunication students in respect of control variables assessed in the study. Using t-test or one-way ANOVA statistics where appropriate, the data was broken down to show the association between behavioral skills outcome scores and the following control variables: gender, age, residence, location, and ethnicity. The results showed that there is no significant difference in the behavioral skills scores based on gender ($F(1,272) = .701$, $p = .403$); age ($F(1,272) = .462$, $p = .631$); residence ($F(1,272) = .917$, $p = .339$); location ($F(1,272) = 1.166$, $p = .281$); religion ($F(1,272) = 3.436$, $p = .065$); and ethnicity ($F(1,272) = .677$, $p = .567$) and among telecommunication students exposed to problem-based laboratory experience.

Discussion

The purpose of this study was to determine the impact of problem-based laboratory experience on the behavioral skills outcome of telecommunication students in Polytechnics. The findings revealed a significant main effect of treatment on the overall behavioral skills. In other words the treatment condition (PBL) caused a significant increase in the behavioral skills outcome (Communication skill, Interpersonal skill and Problem solving skill) among telecommunication students in Polytechnics. The above findings appear to support the view of Lunenburg (2010), during interactions in problem based situation, people are confronted with issues and matters that require them to assume certain roles and perform certain tasks to generate desirable outcomes such as communication skills. In the same vein, Harding (2001) defended PBL on the basis that it stimulates student motivation and promotes deep learning.

In addition, the study outcome also indicated a significant interaction between treatment conditions and gender. This finding is in line with Sinnes (2006) who averred that both males and females have similar approach to scientific inquiry and derive equal benefits. This aligns with the report that gender is an independent factor that influences the outcomes of PBL (Khan & Sobani, 2012). In the same vein, Nistor (2013) opined that there is no significant gender differences in behavioral leaning outcomes because males were more stable in attitudes, while females performed well in engagement. On the contrary, Das Carlo et al (2003) found out that females were more productive and had significantly higher scores on motivation, cohesion, interaction, and elaboration when compare to their male counterpart in a problem-based learning atmosphere.

The findings from the results presented in Table 4 revealed that there was no significant difference in the behavioral skills scores based on gender, residence, location, religion and ethnicity and among telecommunication students exposed to problem-based laboratory experience. Pike (2002) affirmed that living on campus directly associated with significantly higher levels of openness to diversity than living off campus which negates the findings of this study. Similarly, Stassen (2003) found that learners residence positively influence their learning outcome around their retention and first semester GPA among others. Similarly, De Witte, & Rogge, (2016) found that PBL does not contribute to students' knowledge and skills outcome though it fosters learning motivation, further concluded that controlling for location as a source of heterogeneity does not alter the results. However, to determine whether the effectiveness of PBL would be impacted by other factors, Chen and Yang (2019) affirmed that learning location significantly related to the variability in student academic achievement.

Conclusion

The need for appropriate and adequate learning outcomes at all education levels is crucial in this contemporary world more than ever before. Educators are often tasked with developing courses and curricula that teach learners how to perform certain procedures by given instructions to learners. This instruction must be designed to provide an optimal, uniform learning experience for all learners. Instructions are often structured or modeled to present the abstract knowledge to learners. The use of model in teaching is usually discipline-specific as representation of a reality to learners. This study found out that students taught with PBLE improved more in their behavioural skills outcomes more among than those who taught with lecture/demonstration method. The study therefore concludes that PBLE is effective in improving behavioural skill outcome of Polytechnic Telecom students. The gender effect was found to be significant which favours the males in PBLE more than the females. It is therefore concluded that PBLE is more effective in improving behavioural skills outcome of males more than the females in Telecommunication in Polytechnics.

References

Akiri, A. A. & Ugborugbo, N. M., (2008). An examination of gender's influence on teachers' productivity in secondary schools. journal of social sciences. DOI: 10.1080/09718923.2008.11892650

Adesoji, F. A. (2008). Students ' ability levels and effectiveness of problem-solving instructional strategy. Journal of Social Sciences, 17(1), 5–18.

Adeyemi, B. A. (2008). Effects of cooperative learning and problem-solving strategies on Junior secondary school students ' achievement in social studies. Electronic Journal of Research in Educational Psychology, 16(3), 691–708

Azer, S. A. (2011). Training Students to Learn in a Problem-Based Learning Programme. Medical Education, 45, 510. https://doi.org/10.1111/j.1365-2923.2011.03952.x

Baldwin, I. T., & Schultz, J. C. (1983). Rapid changes in tree leaf chemistry induced by damage: evidence for communication between plants. *Science*, *221*(4607), 277-279.

Bergner, R. (2013). An integrative framework for psychopathology and Psychotherapy. New Ideas in Psychology, 22, 127-141.

Bamuhair, S. S., Al Farhan, A. I., Althubaiti, A., Agha, S., ur Rahman, S., & Ibrahim, N. O. (2015). Sources of stress and coping strategies among undergraduate medical students enrolled in a problem-based learning curriculum. *depression*, *20*, 33. http://dx.doi.org/10.1155/2015/575139

Beneroso, D., & Erans, M. (2021). Team-based learning: an ethnicity-focused study on the perceptions of teamwork abilities of engineering students. *European Journal of Engineering Education*, *46*(5), 678-689.

Cartwright, N. 2015. "Pedagogy & Inequality: A Case-Study of Team-Based Learning & Race." 8th equality, diversity and Inclusion international Conference (EDI 2015).

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71-81. https://doi.org/10.1016/j.edurev.2018.11.001

Das Carlo, M., Swadi, H., & Mpofu, D. (2003). Medical student perceptions of factors affecting productivity of problem-based learning tutorial groups: does culture influence the outcome?. *Teaching and learning in medicine*, *15*(1), 59-64.

De Koning, B. B., Loyens, S. M., Rikers, R. M., Smeets, G., & van der Molen, H. T. (2012). Generation Psy: Student characteristics and academic achievement in a three-year problem-based learning bachelor program. *Learning and Individual differences*, *22*(3), 313-323.

De Witte, K., & Rogge, N. (2016). Problem-based learning in secondary education: evaluation by an experiment. *Education Economics*, *24*(1), 58-82. https://doi.org/10.1080/09645292.2014.966061

Dolmans, D. H., De Grave, W., Wolfhagen, I. H., & Van Der Vleuten, C. P. (2005). Problem-based learning: Future challenges for educational practice and research. *Medical education*, *39*(7), 732-741.

Donnelly, R. (2005). Using technology to support project and problem-based learning.

Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, *12*(1), 1207-1222.

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, *142*, 103635.

Georgiou, Y., & Kyza, E. A. (2017, October). A design-based approach to augmented reality location-based activities: Investigating immersion in relation to student learning. In *Proceedings of the 16th World Conference on Mobile and Contextual Learning* (pp. 1-8).https://doi.org/10.1145/3136907.3136926.

Gupta, A.(2007). Determinants of revenu efforts in developing countries.IMF Working Papoer. 1- 39. https://doi.org/10.5089/9781451867480.001

Harding, J. E. (2001). Problem-based Learning in Biblical Studies: Reflections from Classroom Experience. *Teaching Theology & Religion*, *4*(2), 89-97.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational psychology review*, *16*(3), 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Ifamuyiwa, A. S., & Ajilogba, S. I. (2012). A Problem Solving Model as a Strategy for Improving Secondary School Students ' achievement and Retention in Further Mathematics. Journal of Science and Technology, 2(2) 33-47

Khurshid, F., & Zahur, B. (2013). Comparison of teachers' awareness and utilization of innovative teaching strategies in private and public sector secondary schools. Elixir Psychology 45, 12242-12245. Retrieved on March 10, 2013 from www.elixirpublishers.com

Khan, M. A. A., & Sobani, Z. A. (2012). Influence of gender and ethnicity on problem-based learning. *Journal of Pakistan Medical Students*, *2*(3), 122-125.

Lajoie, S. P., Hmelo-Silver, C. E., Wiseman, J. G., Chan, L. K., Lu, J., Khurana, C., ... & Kazemitabar, M. (2014). Using online digital tools and video to support international problem-based learning. *Interdisciplinary Journal of Problem-Based Learning*, *8*(2), 60-75.

McKenzie, B. & Brown, A. (2017), Exploring a Problem-Based Learning Approach in Pharmaceutics. *Pharmacy 5*, 53. https://doi.org/10.3390/pharmacy5030053

Mlambo V. (2011) An analysis of some factors affecting student academic performance in an introductory biochemistry course at the University of the West Indies *Era Educational Research Association* 2(3) 293-301

Nistor, N. (2013). Stability of attitudes and participation in online university courses: Gender and location effects. *Computers & Education*, *68*, 284-292. https://doi.org/10.1016/j.compedu.2013.05.016

Okeke, E. C. (2003): Gender and Sexuality Education: Bridging the Gap in Human Resource Development. *Journal of Curriculum Organization of Nigeria* 10(1), 117-120.

Olagunju, A. M and Abiona, O. F (2008) Production and utilization of resources in biology education. A case study of South West Nigeria secondary schools. *international Journal of African & African American studies3(4)234-248*

Orji, C. T., (2015). *Effect of problem based instructional strategy on achievement of students in electronic work in technical colleges in Enugu State*. Master's Thesis, University of Nigeria, Nsukka.

Orji, C. T., & Ogbuanya, T. C. (2018). Effectiveness of Problem-based and Lecture-based Learning Environments on Students' Achievements in Electronic Works in Technical Colleges in Nigeria. *International Journal of Electrical Engineering Education*, 55(4): pp. 334-353, DOI: 10.1177/0020720918773983.

Orji, C. T., & Ogbuanya, T. C. (2022). Mediating roles of ability beliefs and intrinsic motivation in PBL and engagement in practical skills relations among electrical/electronic education undergraduate. *Innovations in Education and Teaching International*, *59*(3), 326-336.

Orji, C. T. (2021). Efficacy of Problem-Based Learning on Engagement and Practical Skills Acquisition among Electrical. *Electronic Technology Education Students in Universities in South-East Nigeria. (Doctoral Thesis, University of Nigeria, Nsukka).*

Osuolale, O.J. (2014). Problems of teaching and learning science in Junior Secondary Schools in Nasarawa State, Nigeria. *Journal of Education and Practice*, 5, (34).

Osborn C. & Pearson J. (2014) Why Communication is Important: A Rationale for the Centrality of the Study of Communication. Journal of the Association for Communication Administration Pp1-15

Ossorio, P. G. (2006). The behavior of persons. The collected works of Peter G. Ossorio (Vol. V). Ann Arbor, MI: Descriptive Psychology Press.

Overton, T. (2010). Problem based learning: An introduction. UK physical science centre.

Prensky, M. (2002). The motivation of gameplay: The real twenty-first century learning revolution. *On the horizon*.

Peters, C. B. & Amador J. A. L. M. (2006) The Practice of Problem-Based Learning: A Guide to Implementing PBL in the College Classroom 1st Edition

Peters, J., Wakabayashi, P., Weppler, G., D'ALESSIO, M. A. Y. A., & Mudge, R. (2018). More Than a Place to Eat and Sleep: The Value of Living and Learning in Residence. *Journal of College & University Student Housing*, *45*(1).

Pike, G. R. (2002). The differential effects of on-and off-campus living arrangements on students' openness to diversity. *NASPA journal*, *39*(4), 283-299. https://doi.org/10.2202/1949-6605.1179

Pratt, J. Y. & Richard E. A (2014). Communicating cross-culturally: What teachers should know. The Internet TESL Journal, 12(2).

Pepper, C. (2009). Problem based learning in science. Issues in Educational Research, 19(2), 128.

Programme for International Students Assessement [PISA], (2012). Results : Creative Problem Solving: Students's skills in tackling real-life problems, 5. OECD

Raman K (2015) Basic Concepts in Telecommunications Systems. J. Telecomm System Manage 3: e116

Rothwell, J. (2012). "The Hidden STEM Economy," (Washington DC: Brookings Institution).

Schmidt, H., Rotgans, J., & Yew, E. (2011). history: from those who wrote it. *Medical Education*, *45*, 792-806.

Singaram, V. S., Dolmans, D. H. J. M., Lachman, N., & Van der Vleuten, C. P. M. (2008). Perceptions of problem-based learning (PBL) group effectiveness in a socially- culturally diverse medical student population. *Education for Health*, *21*(2), 116.

Stassen, M. L. (2003). Student outcomes: The impact of varying living-learning community models. *Research in higher education*, *44*(5), 581-613. https://doi.org/10.1023/A:1025495309569

Weimer, M. (2002). Learner-centered teaching. San Francisco: Jossey-Bass.

Wheen, A. (2011) Dot-Dash to Dot.Com: How Modern Telecommunications Evolved from the Telegraph to the Internet. Springer.

Wood, D. F. (2003). ABC of learning and teaching in medicine: Problem based learning. BMJ: British Medical Journal, 326(7384), 328.