

Using Active Learning Strategies to Enhance Pre-Service Biology Teachers' Achievement and Self-Efficacy in a Mandatory Course

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Abstract

This study assessed the effect of Team-Based Learning Strategy (TBL) and 5E Learning Strategy (5ELS) on preservice biology teachers' achievement and self-efficacy in population education in southwestern Nigeria. A total of 401 pre-service teachers drawn from three intact classes of purposively selected three federal colleges of education in Southwest, Nigeria constituted the sample. Research instruments used were PEAT ($r=0.80$) and PESES ($r=0.82$). ANCOVA and Bonferroni post-hoc tests were used to analyse the collected data at 0.05 level of significance. There was significant effect of treatment on achievement ($F_{(2,378)}=12.26$; partial $\eta^2=0.06$). Self-efficacy was significant on pre-service biology teachers' achievement ($F_{(2,378)}=5.67$; partial $\eta^2=0.03$). Interaction effect of treatment and self-efficacy ($F_{(4,376)}=3.15$; partial $\eta^2=0.03$) on achievement was significant in the 5E group. The outcome of this study has proved that when students learn together as teams, they become active participants and are engaged with learning materials culminating in experiential and self-directed learning. Also, the higher the self-efficacy, the more successful students are at achieving tasks. Due to the effectiveness of these two strategies, it is recommended that lecturers handling the course adopt them in teaching.

Keywords: population education, active learning strategies, pre-service, prospective teachers, teacher-trainees, achievement, self-efficacy

Introduction

The approval of the current National Policy on Population for Development, Unity, Progress and Self-reliance by the Nigerian Government, on February 4, 1988 was part of the efforts geared towards solving population issues and associated problems. Population education is an educational scheme which creates an avenue to study population situation in the family, community, the nation and the world at large (Nigerian Educational Research and Development Council, 2004). The two main objectives for offering the course in Nigeria's colleges of education are to (i) identify the factors affecting population growth and (ii) list the problems associated with overpopulation and the remedies (Federal Republic of Nigeria, 2012). It is on record that this level of pre-service teachers is being prepared to teach at Basic level (six years of primary and three years of Junior Secondary education) of Nigeria's education system. This underscores their importance to the entire system of education. Put simply, these prospective teachers should be able to assist the nation in identifying and solving population issues/problems and communicate same to their would-be learners in related subjects as practicing teachers.

However, Pandey (2006) noted that in spite of the significance of population education and immense benefits to any society, it is commonly perceived in many countries that even the educated people have poor knowledge of the basic facts of population change and complex interrelationships with other population parameters. Also, available data have shown that pre-service biology teachers' achievement in population education as a compulsory course in Southwest colleges of education was below average (Asaaju, 2018).

While studies (Shkullaku, 2013; Tenaw, 2013) have established that enhanced self-efficacy could improve students' academic achievement, Ogunbameru and Uwameiye (2012) identified low self-efficacy as a factor responsible for performance deficiencies of pre-service teachers in Nigeria's colleges of education. In other words, there is a relationship between students' self-efficacy and academic achievement. Though self-efficacy has been investigated in science subjects (Kurbanoglu and Akin, 2010; Trujillo and Tanner, 2014), there are limited studies in biology in relation to self-efficacy (Trujillo and Tanner, 2014). Hence, this study focused on using active learning strategies to enhance pre-service biology teachers' self-efficacy for improved achievement in population education.

Self-efficacy and Academic Achievement

Self-efficacy is the degree of confidence in the expertise and proficiency an individual believes he or she has at performing or executing a task (Yalçinkaya, Boz and Erdur-Baker, 2012). Self-efficacy has become prominent and established in literature as one of the variables responsible for students' ability to learn and achieve academically (Koseoglu, 2015). It is a paramount attribute needed by pre-service teachers to solve the numerous problems in science (Ergul, 2009). From the submissions of these authors, self-efficacy is a crucial component of students' learning abilities and or disabilities. In other words, a learner's achievement or success at performing tasks is dependent on the self-belief (efficacy) in his or her ability.

However, self-efficacy has been linked to student achievement and motivation, and teachers' willingness to adopt innovative instructional strategies (Flores, 2015). It is expected that practicing science and would-be teachers should possess not just high but positive self-efficacy levels, and positive attitude to science in order to transfer effectively their understanding, dexterity and competencies to their learners (Turer and Kunt, 2015). There is a dearth of research in biology in relation to self-efficacy (Trujillo and Tanner, 2014). In light of the above submissions, it is imperative to assess the self-efficacy of pre-service biology teachers and its relationship with their achievement in population education.

Active Learning Strategies

Active learning is a means of searching for current information, organizing it in a purposeful manner and having the opportunity of explaining such information to others (Allen and Tanner, 2005). This type of learning has progressed to encapsulate a variety of instructional strategies involving a combination of intense interaction, in depth processing, elaboration of material, mapping out learning activities, probing, and social collaboration (Markant, Ruggeri, Gureckis and Xu kant, 2016). Adopting active learning strategies takes cognizance of the crucial nature of learning as a spectacle of the human brain, and anyone who undergoes the process of learning must be involved actively in making meaning, assessing previous experiences, and removing misconceptions (Miller and Tanner, 2015). Hence, Team-Based and 5E Learning strategies were adopted for this study because they possess the aforementioned attributes. More importantly, this researcher observed that available literature showed a dearth of research in determining the effect of the two strategies on teacher-trainees' achievement and self-efficacy especially in population education.

Active learning strategy and self-efficacy

In a study by Chan *et al.* (2015), a moderate, positive, but significant relationship was found to exist between active learning and self-efficacy of students at tertiary education just as collaborative learning contributed significantly to the development of self-efficacy among them. From the findings of Prince (2004), active learning strategy has the capacity to improve students' skills not only in academics, but also in interpersonal skills and self-efficacy. Zulhamri *et al.* (2014) described self-efficacy as a key determining factor that affects performance of individuals and their competencies in acquiring skills and knowledge.

Team-based and 5E learning strategies and academic achievement

Chad (2012) determined the impact of Team-Based Learning (TBL) strategy in a postgraduate marketing subject at an Australian university and concluded that TBL is an effective strategy which enables educators to offer students enhanced and stimulating learning experiences.

In another study, Emke, Butler and Larsen (2016) investigated the effect of TBL on long-term retention of knowledge in comparison to the traditional method. Students in both groups completed multiple-choice knowledge tests at four time points spanning two years. Test performance was compared at each time point to assess changes in knowledge retention as a function of time. Result showed that the performance of students in the TBL group was significantly higher than those in the traditional group.

Branson, Boss and Fowler (2016) compared the efficacy of TBL and traditional instruction in a nursing course with regard to the outcomes of academic performance of 221 undergraduate senior nursing students

using a quantitative, quasi-experimental post-test study. Results showed that TBL learners scored significantly higher when compared to those of lecture. Total scores indicated moderate to high levels of favourable experiences with TBL.

Similarly, Guzel (2016) compared the effect of 5E and traditional teaching on 62 11th grade students in a physics lesson. The quasi-experimental design was used at 0.05 level of significance. Students exposed to the 5E strategy had a better understanding of the concepts learned but the attitude scale showed that the differences between the groups were insignificant ($p>0.05$). On the other hand, Tuna and Kacar (2013) assessed the impact of 5E learning strategy on 10th grade elementary students' academic achievement in trigonometry. Outcome of the study showed that students in the 5E group scored higher than those in the control group in academic achievement.

Statement of the Problem

Nigeria's population is growing at a pace that requires sensitizing the people on the consequences of an unchecked population growth which informed the inclusion of population education in the curriculum of pre-service biology teachers in her colleges of education. However, available data have shown that students' performance in the course has been below average and this has been traced to the teaching method adopted by lecturers and students' low self-efficacy. Against this background, this study determined how two active learning strategies can be used to enhance students' performance and self-efficacy in the course.

Hypotheses

Three null hypotheses were formulated and tested at 0.05 level of significance.

Ho₁: There is no significant effect of treatment on pre-service biology teachers' achievement in population education

Ho₂: There is no significant effect of self-efficacy on pre-service biology teachers' achievement in population education

Ho₃: There is no significant interaction effect of treatment and self-efficacy on pre-service biology teachers' achievement in population education

Theoretical Framework

This study is anchored on the theory of positive social interdependence which occurs when the actions of an individual promote the attainment of consensus goals (Johnson, Johnson & Holubec, 1998). The basic assumption of this theory is structured to determine individuals' method of interacting with one another, and, in turn, determines learning outcomes (Johnson & Johnson, 2015). Science by nature is collaborative, and all careers in science to which undergraduates aspire will need that they acquire expertise in skills for them to work in teams and as teams (Miller & Tanner, 2015). This theory aligns with the attributes of TBL and 5E strategies by giving students the opportunity to work together in cohesion, sharing and discussing ideas, knowledge, and experiences with the aim of arriving at common solutions to problems. In essence, the success of one team-member is the success of the entire team-members and vice versa.

Methodology

The study adopted the pretest posttest control group quasi experimental design. Purposive sampling method was adopted to select three federal colleges of education in Southwest Nigeria using adequacy of learning facilities and uniformity in academic calendar as criteria. One intact class of second year students from each college was assigned randomly into three groups as follows:

Experimental Group 1 - Team-Based Learning Strategy (171)

Experimental Group 2 - 5E Learning Strategy (90)

Control Group - Conventional Strategy (140). In all, 401 second year pre-service biology teachers constituted the sample.

Team Formation

Formation of teams for those in the experimental (TBL and 5E) groups was done by the researcher and the research assistants using the class lists. This was to remove any form of bias and improve heterogeneity of the groups as giving liberty to students to choose their group members may lead to emergence of behaviours that are inimical to the essence of group formation and cohesion (Michaelsen and Black, 1994). Each team had between 5 and 7 members depending on the number of students in each intact class.

Research Instruments

Research instruments were Population Education Achievement Test (PEAT) and Population Self-Efficacy Scale (PESES). PEAT is a multiple-choice test consisting of 40 items designed and developed by the researcher to assess pre-service biology teachers' knowledge in population education. Item difficulty index was between 0.40 and 0.60 while the item discrimination index ranged between 0.35 and 0.65. Kuder Richardson-20 (KR-20) formula was used and a reliability coefficient of 0.80 obtained. PESES is a 20-item structured questionnaire. Ten of the items were adapted from the one originally developed by Schwarzer and Jerusalem (1995) while the remaining ten items were constructed by the researcher. Schwarzer and Jerusalem used a four-point scale of Exactly true, Moderately true, Hardly true, Not at all true and scored as 4, 3, 2, 1. This was modified to a four-point Strongly Agree, Agree, Disagree, and Strongly Disagree Likert scale. The positive statements were scored 4,3,2,1, respectively while scoring was done in a reverse order for the negative statements. Cronbach's Alpha was used to determine the reliability of the instrument and a value of 0.78 obtained.

Treatment

The study was undertaken within a period of ten weeks. The first week was used for the briefing and training of research assistants in the three colleges while the pretest was administered during the second week. Treatment was conducted during the following seven weeks while the posttest was administered in tenth week. For the TBL strategy, students in teams answered the questions generated from pre-class reading individually (Individual Readiness Assessment Test) and immediately after, as teams (Team Readiness Assessment Test). Immediate Feedback-Assessment Technique (IF-AT) was used to provide feedback. They moved on to apply acquired knowledge and shared experiences towards solving new problems while the teacher made clarifications on their conceptions or misconceptions if any and where necessary. Students and teacher reviewed the day's activities and teacher instructed students on areas of study for the next class. In the case of 5E learning strategy, the first phase, 'Engage' – teacher used questions to elicit students' prior learning/knowledge with a view to making clarifications or corrections, leading to the 'Explore' phase where students as teams proffered answers to questions/problems presented by the teacher and observed and recorded student-student interactions. The teacher explained difficult concepts and terminologies while students listened at the 'Explain' phase with a view to directing them to probable answers. At the 'Elaborate' phase, students applied new concepts to support explanations while the teacher directed them to alternative explanations using personal experiences. Assessment was done by the teacher at the 'Evaluate' phase to ascertain the extent of learning.

Analysis of data was carried out using Analysis of Covariance (ANCOVA) to decide group differences, with the pre-test scores as covariates. Bonferroni Post-hoc test was employed to find the magnitude of the differences in the various groups where there was significant effect. All the hypotheses were tested at 0.05 level of significance.

Results

Ho₁: There is no significant effect of treatment on pre-service biology teachers' achievement in population education

Table 1

Analysis of Covariance (ANCOVA) of Post-achievement by Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1510.967a	24	62.957	3.751	0.000	0.193
Intercept	9527.818	1	9527.818	567.687	0.000	0.602
Pre-Achievement	0.009	1	.009	0.001	0.982	0.000
Treatment	411.445	2	205.723	12.257	0.000*	0.061
Self-efficacy	190.319	2	95.159	5.670	0.004*	0.029
Treatment x Self-efficacy	211.628	4	52.907	3.152	0.014*	0.032
Error	6310.629	376	16.784			
Total	262261.000	401				
Corrected Total	7821.596	400				

* denotes significant difference at 0.05

Table 1 shows the effect of treatment was significant on participants’ achievement in population education ($F_{(2,378)} = 12.257$; $p < 0.05$, partial $\eta^2 = 0.061$). The effect size is 6.1%. This means that the treatment was the reason for the significant difference in the post-achievement scores of the participant. Consequently, hypothesis 1 was not accepted.

Ho₂: There is no significant effect of self-efficacy on pre-service biology teachers’ achievement in population education

Table 1 depicts a significant effect of self-efficacy on pre-service teachers’ achievement in population education ($F_{(2,378)} = 5.670$ $p < .05$; partial $\eta^2 = .029$). The effect size is 2.9% meaning that there is a significant difference in the mean post-achievement scores of pre-service biology teachers in population education by self-efficacy. Hence, hypothesis 2 was rejected.

Table 2: Bonferroni Post-hoc analysis of post-achievement by treatment and control groups

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Team Based Learning Strategy	5E Learning Strategy	-1.4632*	.53280	.019	-2.7444	-.1819
	Conventional Strategy	2.5083*	.46632	.000	1.3869	3.6296
5E Learning Strategy	Team Based Learning Strategy	1.4632*	.53280	.019	.1819	2.7444
	Conventional Strategy	3.9714*	.55277	.000	2.6422	5.3007
Conventional Strategy	Team Based Learning Strategy	-2.5083*	.46632	.000	-3.6296	-1.3869
	5E Learning Strategy	-3.9714*	.55277	.000	-5.3007	-2.6422

*denotes significant difference at 0.05

Table 2 reveals that the post-achievement mean scores in population education of pre-service biology in 5ELS group were significantly different from those in TBLS group and those exposed to the Conventional Strategy (CS).

Table 3

Bonferroni Post-hoc Analysis of Post-Achievement by Self-Efficacy

(I) efficacy	Self- (J) efficacy	Self-Mean Difference (IJ)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Low	Medium	-0.1898	.43165	1.000	-1.2278	.8482
	High	-1.1415	.85531	0.548	-3.1983	.9153
Medium	Low	0.1898	.43165	1.000	-.8482	1.2278
	High	-0.9517	.83348	0.763	-2.9560	1.0526
High	Low	1.1415	.85531	0.548	-.9153	3.1983
	Medium	0.9517	.83348	0.763	-1.0526	2.9560

Table 3 reveals that high self-efficacy pre-service teachers were not significantly different from their medium self-efficacy level counterparts and the low self-efficacy pre-service teachers in their post achievement to population education scores. Furthermore, the medium self-efficacy level was not significantly different from the low self-efficacy pre-service teachers.

Ho₃: There is no significant interaction effect of treatment and self-efficacy on pre-service biology teachers' achievement in population education.

Table 1 showed a significant two-way interaction effect of treatment and self-efficacy on pre-service teachers' achievement in the course ($F_{(4,376)} = 3.152$, $p < 0.05$; partial $\eta^2 = 0.032$). The effect size is 3.2%. Thus, hypothesis 3 was rejected.

Discussion of Findings

Findings showed that pre-service biology teachers in the 5E learning strategy performed better than their counterparts in Team Based Learning and Conventional strategies lending support to the findings from previous studies (Guzel, 2016; Tuna and Kacar, 2013) on the effectiveness of 5ELS at enhancing students' learning outcomes in science. For TBL, findings corroborated those of (Branson, Boss & Fowler, 2016; Emke, Butler & Larsen, 2016; Chad, 2012) who found that the academic performance of students exposed to TBLS improved more than those in the CS group. Results also aligned with the findings of Chan *et al.* (2015) and Prince (2004) that active learning strategies improved students' learning outcomes and self-efficacy. These affirmed the position of Fayombo (2013) that whoever was concerned about proffering solutions to students' underachievement and improving learning in education institutions should incorporate active learning strategies into their classroom practices.

Again, findings revealed significant effect of self-efficacy on pre-service biology teachers' achievement aligning with the finding of Li (2012) that self-efficacy had positive correlation with academic achievement. This also corroborated the description of self-efficacy by Zulhamri *et al.* (2014) as a key determining factor that affects performance of individuals and their competencies in acquiring skills and knowledge. It also showed that when students of different abilities are grouped together to execute tasks or carry out some activities, they not only learn from one another, they boost one another's self-efficacy.

Conclusion

The outcome of this study lends credence to studies conducted by other scholars that academic achievement and self-efficacy are intrinsically linked and exploring the impact of each on the other is a veritable means of helping students experience learning in the true sense of the word. If the self-efficacy of students is enhanced, it impacts greatly on their perspective of success as something achievable; failure is reduced. The more an individual believes that a task could be accomplished by him or her, the more efforts geared towards achieving such a task. In other words, even when tasks seem difficult to students, enhanced self-efficacy will primarily give an assurance that the task could be done before proceeding to finding means of getting it done.

The era of the teacher sweating it out to impart knowledge to a group of students in a structured and regimented classroom environment should be done with. More often than not, learning does not occur in such an environment as students merely watch but do not listen to what has become rhetoric. Some of the reasons being that attention is lost for some minutes into the teaching, students are neither involved nor engaged with learning materials directly aside taking notes churned out by the teacher which in most cases are left unread except for assessment purposes. Active learning strategies such as TBL and 5E are cooperative in nature and afford students the opportunity to interact with one another, engage with learning materials, ask questions and discuss among themselves, proffer solutions to problems with the teacher helping to facilitate learning which becomes experiential and self-directed. This makes knowledge concrete and permanent for immediate and future application to similar and or related tasks.

TBLS and 5ELS have shown to be effective at enhancing pre-service biology teachers' achievement and self-efficacy in the course under review. When students become active participants in the instructional process, there is the tendency for them to gain higher confidence at performing similar or related tasks subsequently. It affirmed the submissions of researchers that the quality of instruction and self-efficacy of learners are positively-associated. Putting it succinctly, learning strategies that increase the level of students' involvement and participation especially working as teams would boost their self-beliefs (efficacy) in their abilities to achieve success. Consequently, the higher their self-efficacy, the more they achieve and the more they are willing to work towards achieving greater success.

Recommendations

1. Teacher-educators handling population education in Nigeria's colleges of education should endeavour to expose pre-service biology teachers to active learning strategies that encourage team work, active involvement and participation.
2. To do the first recommendation however, lecturers need to be trained by their employers in the use of active learning strategies such as TBL and 5E as most of them were exposed only to the conventional method of teaching while in college or university; same method they have adopted over the years.
3. Self-efficacy is crucial to achieving either simple or difficult tasks; the more an individual believes in his or her ability to execute a task, the more effort exerted on that task especially among team members. Hence, teacher educators should endeavour to enhance their students' self-efficacy using active learning strategies where students of diverse abilities are grouped to provide consensus solutions to problems.

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