Effects of Problem-Based Learning on the Students' Retention of Pre-Service Technology Teachers in Foundry in North-West Nigeria

Adamu, Yusuf Sawaba[1], Professor Hassan Bello[2], Dr Muhammad Muhammad Inti[3] and Dr Ali Idris[4]

[1,2,3]Department of Vocational and Technology Education, Faculty of Technology Education,

Abubakar Tafawa Balewa University Bauchi, PMB 0248, Nigeria

[4]Department of Science and Technology Education, Faculty of Education,

Bayaro University Kano, PMB 3011, Kano State Nigeria

ABSTRACT

This research investigates effects of Problem-Based Learning (PBL) on the retention level of pre-service metalwork technology teachers in metal foundry in North-West Nigeria. Two objectives and two research questions guided the research. The study employs a quasi-experimental design with pre-test and post-test measures. The research was carried out in the North Western States of Nigeria, targeting a population of 522 pre-service metalwork technology teachers. Intact classes of the sampled institutions were used for the teaching. Simple random Sampling technique was used to select four institutions; two colleges of education and two polytechnics as samples for the study. All the institutions have the characteristics being sought for the study (similarity in operation and curriculum content).

Data was collected through teacher-made Performance Test using pre-test, post-test and post-posttest. The findings reveal a statistically significant difference in post post-test mean Students' retention between pre-service metalwork technology teachers exposed to problem-based learning and those instructed through traditional lecture methods. The study also revealed that there was no statistically significant difference in the mean retention level of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach in college of education and polytechnic. Therefore, the findings underscore the potential of problem-based learning to enhance Students' retention among pre-service metalwork technology teachers. Finally, the study suggests that the adoption of problem-based learning methods can significantly improve the Students' retention of pre-service metalwork technology teachers. Instructors are encouraged to explore and incorporate problem-based learning techniques into their teaching methodologies, creating dynamic and interactive classroom experiences.

Keywords: Problem-based learning, Students, Retention

INTRODUCTION

As global industries change and technology advances, personal success may necessitate the development of skills that were not previously required (Ma'aji, 2020). Traditional lecture method may no longer be able to

provide pre-service teachers with the required skills and experience for them to have good academic performance (Chia, 2021). Anastassis (2022) also observed that, in traditional lecture method, teachers are frequently transmitters of knowledge, while students are recipients, waiting for a teacher to issue orders, this approach has serious effects on students' interest and retention in metalwork technology.

The main objective of teaching metalwork Technology in colleges of education and polytechnics in Nigeria, is to develop human resources by producing competent metalwork technology graduates with knowledge and skills such as: problem solving skills, communication skills, teamwork, critical thinking skills and trade related competences like metal machining, sheet metalwork, forging, metal foundry among others (Sabo, 2021).

Sabo (2021) also analyzed that, the NCE minimum standard (2020, revised edition) curriculum slashed the student's graduation credit units from 118 credit units as it was in the NCE minimum standard (2012) to 94 credit units for the entire NCE (Technical) program which include; General and Pedagogical courses. The changes resulted in reduction of 16 credit units from 64 credit units as it was in the NCE (Technical) minimum standard of 2012 to 48 credit units for metalwork technology education. This represents 21% reduction in the trade curriculum contents of metalwork without corresponding credit units in the content. This reduction creates a gap between the traditional lecture method used in teaching metal foundry and the outcomes of students' academic performance (Sabo, 2021). In recent years, researchers in the field of higher education such as (Ornés and Lara 2020, Chia, 2021, Anastassis, 2022 and Rafiq, 2023) have become increasingly interested in modifying traditional lecture methods (teacher-centred) towards Problem-Based Learning approach (student-centered).

Statement of the Problem

Statistics have shown that, between 2016/2017 – 2018/2019 academic session, a total of 1,545 students sat for foundry examination in colleges of education and polytechnics in North-West Nigeria, 674 (41%) students passed the course, while 871 (59%) failed the course Similarly, Rafiq et al. (2023) also reported the low students' academic performance at the Department of Electronic Engineering, Cilacap State Polytechnic(Indonesia), between 2016/2017 and 2019/2020 academic year, and the learning method tends to be traditional lecture method. This situation has created a gap between the technical skills of pre-service metalwork technology teachers in the instructional process and the expected skills after graduation. Netekal et al. (2023) observed that, pre-service technology teachers are expected to have high quality grade to become good teachers and effectively solve the real-life complex problems with their acquired knowledge. In this regard, new approach in teaching is very important for the per-service teachers to improve students' academic retention.

Purpose of the Study

The main purpose of this study, is to determine the effect of Problem-Based learning on academic retention of pre-service metalwork technology teachers in metal foundry in North-West Nigeria. Specifically, the study intends to achieve the following objectives:

1. Determine the post-posttest mean difference in academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria.

2. Determine the mean difference in retention level of pre-service metalwork technology teachers of College of education and Polytechnics taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria.

Research Questions

The following research questions are formulated to guide the study:

1. What is the post-posttest mean difference in academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria?

2. What is the mean difference in retention level of pre-service metalwork technology teachers of College of education and Polytechnics taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria?

Hypotheses

The following null hypotheses will be tested at 0.05 level of significance in the study:

H_{O3}: There will be no significant difference between the academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in post-posttest.

H_{O4}: There is no significant difference in the retention level of pre-service metalwork technology teachers of college of education and polytechnic taught metal foundry using problem-based learning approach in North-Western Nigeria.

LITERATURE REVIEW

This chapter focuses on a review of related literature that provides direction for this research work. In reviewing the related literature for this study, journal publications, conference proceedings, research theses, magazines, and textbooks were used as reference materials. The review was organized under the following subheadings:

1.0 Theoretical Framework

1.1 Functional Context Theory

1.2 Situated Learning theory

1.3 Review of related empirical studies

A theoretical framework is an existing theory that allows a researcher to add depth to a data analysis by referencing theories advanced by people whose knowledge is much deeper and, in many cases, proven or unquestionable. The primary reason for creating a theoretical framework for a research work is to have a scholarly foundation for making sense of the meaning contained in data (Kivunja, 2018). This research work was based on two constructivism theories of learning; Functional Context Theory propounded by Thomas Stitch (1991) and Situated Learning theory by Lave (1988).
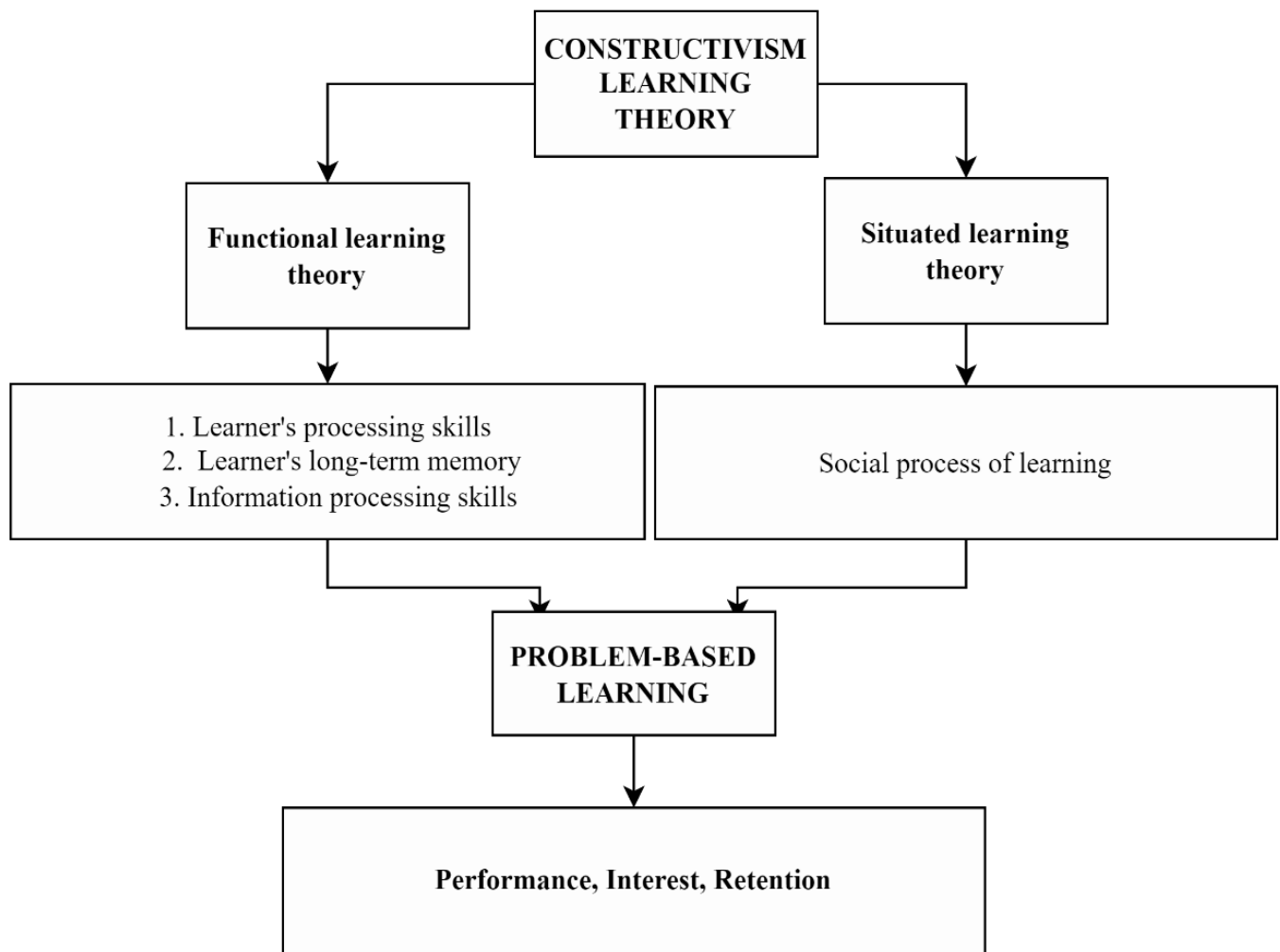
Figure 1: Theoretical Framework of the Study (Kearsley, 2013)

Tantut, et al. (2022) in their study aimed to compare the effects of Problem-Based Learning and Lecture-Based Learning on an undergraduate students' learning outcomes in nursing course. A Quasi-experimental was used for the study. The populatoin of the study included 161 students from two different classes of the course; as a control group (n = 88) and as an intervention group (n = 73). Both groups received lecture-based learning, which is common practice in lab and clinic, but the intervention group also receivedproblem-based learning approach. Secondary data analysis of students' learning outcomes was measured using students' learning progress in tests from lecture method (theory, paper, laboratory, and clinical), while students' satisfaction was measured using teaching method evaluation from students. The results indicates that, Students' learning outcomes (theory, laboratory, and clinical) in the problem-based learning group were significantly more than that of control group (p<0.001), whereas paper lesson outcomes were higher in control group as compared to that of an intervention group (t=6.43; p<0.001; 95% CI=1.46-2.76). There was more satisfaction with the PBL approach. There was no relationship between students' satisfaction and learning outcomes (p>0.05). However, students considered greater satisfaction in PBL compared to lecture-based learning. SPSS was used to analyze the data. The researchers concluded that, in problem-based learning, students contributed a lot to solving the problem and getting motivated, skills and knowledge they needed. This study was closely related to this study, which was to determine the effect of problem-based learning on students' academic performance as compared to traditional lecture method, but the study did not investigate student interest and retention. This leaves a gap for the researcher to consider student academic retention.

METHODOLOGY

The design for this study was Quasi-experimental research design that employed a pre-test, post-test and post-posttest. According to Sambo (2005) a study that involves teaching in an institutional arrangement is best done through quasi-experimental design. This design used intact classes. There was a pre-test, to both the control and the experimental groups that was conducted concurrently at the beginning of the study while, the post-test was conducted to experimental groups after the treatment. Quasi-experimental designs are mostly adopted for nonrandomized students to evaluate the effectiveness of a program and as substitutes for a true experimental design due to the subject selection process (Mustaffa, 2017).

Area of the Study

The study was carried out in North Western States of Nigeria. It is one of the six geopolitical zones in Nigeria. North Western Nigeria consists of the following states: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara. It is located at Latitude 11° North and Longitude 5.5° East. Its coordinates are 11° 00' 00" N and 5° 30' 00" E in DMS (Degrees Minutes Seconds) or 11.0 and 5.5 (in decimal degrees). The area was considered suitable for this study because it consists of Colleges of education and Polytechnics that offer Metalwork technology Program at NCE level.

Population of the Study

The population for this study comprised of all NCE II (Technical) students in all the Colleges of Education and Polytechnics that offer NCE (Technical) program. The population for this study comprises of 531 students.

Method of Data Collection

The data collected for this study was through pre-test, post-test and post-posttests on five constructs; Performance on practical foundry safety, Performance on practical Wood Pattern making, Performance on practical Sand molding, Performance on practical metal Melting and Pouring. The test items consist of fifty-two items measuring students' performance skills in metal foundry, The first 11 items measured students' performance skills in safety rules, the second 9 items measured performance skills on pattern making, the third 22 items measured performance skills sand on mould making and the fourth 10 items measured performance skills on metal melting, pouring and finishing. The Pre-test was conducted in the first week in both control and experimental schools while the post-test treatment was conducted in eight weeks in the experimental schools. This study has two research questions and two hypotheses. The research questions were answered by comparing the pretest and posttest of experimental and control groups. The null hypotheses developed in relation to the research questions were tested using inferential statistics. Analysis of Co-variance (ANCOVA) was used to analyses the hypotheses I and II at 0.05 level of significance. The Statistical Package for Social Sciences (SPSS) version 23.0 was also be used for the computation.

RESULTS AND DISCUSSION

Research question one

What is the post-posttest mean difference in academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria?

Table 1: Descriptive statistics of post-posttest mean difference in academic performance of pre-service metalwork technology Teachers taught using problem-based learning approach and those taught using traditional lecture method.

Variable	Group	N	Mean	S.D	Mean Diff.
Post-posttest	Experimental	171	3.42	.839	1.22
	Control	40	2.20	.405	
	Total	211			

Note: N= Number of Students SD= Standard Deviation, Mean Diff= Mean Difference

A descriptive statistic was performed to find out the difference between post-posttest mean difference in academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in North-Western Nigeria. The result in Table 1, revealed that there was a difference in the post-posttest mean academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach (M=3.42, SD=.839) and those taught using traditional lecture method (M=2.20, SD=.405). This indicated that, the post-posttest performance scores of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach was better than that of their counterparts taught using traditional lecture method

Research question two

What is the mean difference in retention level of pre-service metalwork technology teachers of college of education and polytechnic taught metal foundry using problem-based learning approach in North-Western Nigeria?

Table 2: Descriptive statistics of mean difference in retention level of pre-service metalwork technology teachers of college of education and polytechnic in North-Western Nigeria taught metal foundry using problem-based learning approach.

Variable	Group	N	Mean	S.D	Mean Diff.
Retention	College of Education	95	3.40	.880	0.02
	Polytechnic	76	3.42	.819	
	Total	171			

Note: N= Number of Students SD= Standard Deviation, Mean Diff= Mean Difference

A descriptive statistic was performed to find out the difference between mean retention scores of pre-service metalwork technology teachers of college of education and polytechnic in North-Western Nigeria taught metal foundry using problem-based learning approach. The result in Table 2, revealed that there was a difference in the retention scores of pre-service metalwork technology teachers taught metal foundry using problem-based learning approach in college of education (M=3.40, SD=.880) and that of those in polytechnic (M=3.42, SD=.819). This indicated that, pre-service metalwork technology teachers taught metal foundry using problem-based learning approach in polytechnic have better retention ability than their counterparts in college of education.

Hypotheses Testing

Hypotheses 1 to 2 of this study were tested using an independent sample t-test.

Test of hypothesis one

There is no significant difference between the academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method in post-posttest.

Table 3: Independent samples t-test for post-test scores of problem-based learning approach and traditional lecture method

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	Mean	SD	Sig. (2-tailed)
Post-posttest	Experimental	171	24.871	.000	8.951	3.42	.839	.000
	Control	40				2.20	.405	

The statistical evidence of independent-samples t-test presented in table 14 indicated that there was a statistically significant difference in post-posttest mean academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach (M=3.42, SD=.839) and those taught using traditional lecture method (M=2.20, SD=.405), t (209) = 8.951, *p* = .000. Null hypothesis three was therefore, rejected. This finding indicated problem-based learning approach had a significant effect on post-posttest academic performance of pre-service metalwork technology Teachers in metal foundry compared to those taught using traditional lecture method.

Test of hypothesis two

There is no significant difference in the retention level of pre-service metalwork technology teachers of college of education and polytechnic taught metal foundry using problem-based learning approach in North-Western Nigeria.

Table 4: Independent samples t-test for retention level of pre-service metalwork technology teachers of college of education and polytechnic taught metal foundry using problem-based learning approach

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	Mean	SD	Sig. (2-tailed)
Retention	College of Education	171	.433	.511	-.060	3.40	.880	.952
	Polytechnic	40				3.42	.819	

The statistical evidence presented the independent-samples t-test in table 4 indicated that there was no statistically significant difference in the mean retention level of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach in college of education (M=3.40, SD=.880) and polytechnic (M=3.42, SD=.819), t (169) = -.060, *p* = .952. Null hypothesis four was, therefore, accepted. This finding indicated that the retention ability of pre-service metalwork technology Teachers exposed to problem-based learning approach in polytechnic was not significantly better than that of their counterparts in college of education.

SUMMARY OF THE FINDINGS

1. The finding of research question three revealed that there was a difference in the post-posttest mean academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method. This is supported

by its corresponding hypothesis that there was a statistically significant difference in post-posttest mean academic performance of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach and those taught using traditional lecture method.

2. The result of research question four revealed that that there was a difference in the retention scores of pre-service metalwork technology teachers taught metal foundry using problem-based learning approach in college of education and that of those in polytechnic and this further confirmed by result of hypothesis four which indicated that there was no statistically significant difference in the mean retention level of pre-service metalwork technology Teachers taught metal foundry using problem-based learning approach in college of education and

CONCLUSION

This research provides valuable insights into the effects of problem-based learning on the academic performance of pre-service metalwork technology teachers in metal foundry in North-West Nigeria. The study revealed a significant difference in post-test mean academic performance between pre-service metalwork technology teachers exposed to problem-based learning and those taught using traditional lecture methods. The positive effect of problem-based learning on academic performance of pre-service metalwork technology teachers in metal foundry, as indicated by the findings, highlights the potential benefits of adopting problem-based learning methods in educational settings. This research emphasizing the importance of innovative teaching approaches to enhance the learning experience and outcomes for metalwork technology pre-service teachers, the positive outcomes of problem-based learning demonstrated in this study offer compelling evidence for its integration into the curriculum, fostering a more engaging and effective learning environment.

RECOMMENDATIONS

Based on the findings of this research, the following recommendations are proposed for consideration:

1. Educational institutions and teacher training programs in North-West Nigeria should to integrate problem-based learning methodologies into the curriculum for pre-service metalwork technology teachers. This approach has demonstrated a significant positive effect on academic performance, retention, and interest, highlighting its potential as an effective teaching strategy.
2. Teachers and educators involved in metalwork technology training should undergo professional development workshops and training sessions focused on implementing problem-based learning in their classrooms. This will equip them with the necessary skills and knowledge to effectively utilize problem-based learning methods, thereby enhancing the overall learning experience for pre-service teachers.

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