International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 20, Issue 10 (October, 2024), PP 25-30

The Impact of Design Thinking And Thinking Based Learning Strategies on the Academic Achievements of Technical College Students in Basic Electricity In North-Central, Nigeria

ABDULLAHI MUSA MOHAMMED, Dr. ENGR. HAUWA T. ABDULKAREEM., TIJJANI, S. ABDULRAHMAN & SHALUKO YOHANNA DOMA

Department of Electrical/Electronics Technology,
Niger State College of Education, Minna

ABSTRACT
This research examines how technical college students enrolled in foundational electrical courses perform academically when exposed to Discovery Teaching (DT) and Team-Based Learning (TBL). With intact class groups, a pre-test and post-test non-equivalent group strategy was used in a quasi-experimental study design. The population of the research consisted of 958 second-year students studying Basic Electricity (BE) at several technical institutes located in North-central Nigeria. A significance threshold of 0.05 was used to examine two queries and two null hypotheses that were developed to direct the investigation. The following tools were used to gather data: the Basic Electricity Skill Achievement Test (BESAT), the Basic Electricity Interest Inventory (BEII), lesson plans, and a training manual for both DT and TBL. Three experts validated the content and face validity of the materials. Using Cronbach's Alpha and Pearson's Product Moment Correlation, the reliability coefficients for BESAT and BEII were found to be 0.82 and 0.81, respectively. By giving these equipment directly to the patients, data were gathered. ANCOVA was used for testing hypotheses, and mean scores were calculated to answer the study questions. Among other things, the findings showed that students taught BE using the TBL technique had higher mean scores in skill and interest, whereas students taught BE using the DT strategy had higher scores for cognitive accomplishment. In order to improve students' cognitive abilities, general success, and interest in the subject matter, it is advised that technical college administrators encourage the integration of both DT and TBL teaching methodologies.

Key words: *interest, Technical College, students, basic electricity, Design thinking, Thinking-based learning.*

Date of Submission: 01-10-2024 Date of Acceptance: 10-10-2024

I. Introduction

A variety of techniques are used by teachers as part of their teaching approaches to create a stimulating and encouraging learning environment. These techniques also define the kinds of activities that take place throughout the teaching process in which teachers and students actively engage. Teaching, in the opinion of Duhu and Ibanga (2020), is a continual activity that aims to improve students by using effective pedagogical strategies. It is not a one-time event.

Hombly (2021) puts instructional techniques into two basic categories: student-centered approaches and teacher-centered approaches. Actively integrating students in their own learning process is the emphasis of student-centered techniques, which have been found to dramatically improve student engagement and academic achievement. Pusca and Northwood's (2018) research shows that these approaches promote more engagement and critical thinking, which in turn improves academic results.

The success of pupils in school topics is referred to as academic accomplishment, and it is usually measured by their results on different academic assessments and examinations. This idea goes beyond simple grades; it's a measure of the learning objectives that pupils have met. Academic accomplishment evaluates students' mastery of critical skills and information by showing how effectively they have met the learning goals specified in their courses and programs (Akinboro*et al*., 2019).

Furthermore, establishing a positive attitude toward learning and providing a dynamic educational setting are key parts of good teaching. Teachers may better meet the requirements and learning preferences of their students by using a variety of teaching approaches, which will improve their academic experience as a whole. For students to succeed in their academic endeavors and future employment, teaching strategies—especially those that prioritize student engagement—need to be continuously developed.

Active participation in the learning process is critical to students' academic performance in any topic,

including Basic Electricity (BE) (DeGone, 2021). A vital aspect of many technical college curriculum is Basic Electricity, especially when it comes to electrical trades. This course is the foundation of the curriculum for aspiring technicians and covers important subjects including electronics, static electricity, and current electricity (Jebba*et al*., 2020). It is impossible to exaggerate the significance of BE as students' success in other technical trade alternatives, such electrical installation and maintenance work (EIMW), depends on their ability in this subject.

Studies reveal that graduates of the EIMW profession often face difficulties, such as breaking electrical systems and electronic gadgets that are entrusted to them for maintenance (Akinpade*et al*., 2020). Concerns are raised about the efficiency of the teaching methodologies used at technical institutions as well as the suitability of their training in light of this concerning trend. Average scores dropped from 22% in 2021 to only 16.96% in 2023, according to a review of the National Business and Technical Examination Board (NABTEB) results for Electrical and Electronics trades from May/June 2021 to 2023 (Adewale, 2023). This indicates a concerning reduction in performance. The persistent underachievement and the apparent deficiency of graduates in critical technical abilities indicate that the technical college system has not effectively fulfilled the educational goals of BE.

Furthermore, Jebba*et al*. (2020) pointed out that the heavy dependence on conventional teaching techniques in electrical training is substantially to blame for students' struggles in displaying practical abilities as well as their general poor academic performance. These traditional methods often fall short of actively involving students, which impedes their capacity to apply theoretical information in real-world contexts. Innovative teaching methods that encourage more student engagement and the development of practical skills are desperately needed, since these modifications have the potential to both improve academic performance and prepare students for the demands of the electrical trade.

The unsatisfactory academic achievements of students, paired with the fast technical improvements in the sector, show the limitations of present teaching methodologies. This scenario emphasizes how urgently we need creative teaching strategies that improve student engagement and abilities while keeping up with modern developments. To equip students for these problems, behaviorist teaching approaches must give way to cognitive psychology-based ones. It is thus crucial to investigate instructional techniques like Design Thinking (DT) and Thinking-Based Learning (TBL) that cater to the unique learning demands of each student.

Design Thinking (DT) is a cutting-edge teaching approach that prioritizes problem-solving abilities and aims to provide students the skills necessary for learning in the twenty-first century and professional advancement. According to Shé *et al*. (2021), design theory (DT) is an approach for solving issues that have practical applications in a variety of domains, including research, teaching, and practice. According to Fabiano Pamato*et al*. (2021), DT is very useful for handling unclear and complicated problems. According to a review by Guaman-Quintanilla *et al*. (2018), DT is linked to critical abilities in learning environments, such as empathy, problem-solving, creativity, and teamwork. A five-step method that incorporates design, definition, ideation, prototyping, and testing into course creation is used to deploy DT techniques (Shé *et al*., 2021).

Moreover, Nor'ain*et al*. (2019) state that TBL techniques include the teaching of certain thinking skills into subject matter training. These tactics consist of four main parts: (i) assisting students in expressing how they think, (ii) involving them in critical thinking exercises, (iii) giving them chances to comprehend the different kinds of thinking involved, and (iv) tying together previously learned material with fresh insights discovered through investigation. Few research have been done to far to help EIMW teachers—especially those who teach BE—learn how to help students develop higher-order thinking abilities so that they may do better academically and interact with the material.

In the context of education, interest—which Duru *et al*. (2021) describe as a content-specific connection resulting from an individual's contact with their environment—is very important. It has a major impact on the general performance, self-efficacy, and involvement of students. The study's objective was to find out whether exposure to DT and TBL techniques would have an impact on the academic achievements of EIMW students in BE, given the departmental and institutional circumstances and the observed lackluster performance. Thus, the purpose of this study is to investigate how DT and TBL affect BE students' learning results at technical institutions in North-central Nigeria. It also looks at how gender interacts with students' interest in fundamental electrical after they see computer animation.

Research Questions

The research sought to address the following questions, aligned with its objectives:

1. How do the Design Thinking (DT) and Team-Based Learning (TBL) strategies affect students' skill acquisition in Basic Electricity (BE)?
2. What is the effect of DT and TBL strategies on students' interest in studying Basic Electricity?

Hypotheses

To guide the investigation, the following null hypotheses were proposed and will be tested at a 0.05 significance

level:

H_{O1}: There is no significant difference in the mean scores of students' skill achievement in Business Education when taught using Design Thinking versus Team-Based Learning strategies.

H_{O2}: There is no significant difference in the mean interest scores of students studying Basic Electricity when taught using Design Thinking compared to Team-Based Learning strategies.

II. Methodology

A pretest-posttest, non-equivalent control group strategy was used in the study's factorial research design. A factorial design entails include many independent variables or components in a research, according to Gall *et al*. (2017). The study, which focused on 958 NTC II Business Education (BE) students at 29 recognized technical institutions, was carried out in the North-Central geopolitical zone of Nigeria. Because the second year of the BE trade program comprises subjects including indicating instruments, magnetism, inductors, and transformers, NTC II students were chosen based on the structure of the NBTE curriculum for technical institutions.

A blend of basic random and purposeful sampling methods was used. Initially, a sample of 398 NTC II BE students was obtained by randomly selecting 12 technical institutions out of the 29 colleges in the North-Central zone. The strategy groups for Design Thinking (DT) and Team-Based Learning (TBL) included one technical college from each state, assigned at random. The DT group consisted of six colleges with 200 students, whereas the TBL group included six institutions with 198 pupils. To further classify pupils into ability categories, purposive selection was used: 49 students were categorized as high ability, 139 as medium ability, and 210 as poor ability.

The research used three tools, namely the Basic Electricity Interest Inventory (BEII), the Basic Electricity Skill Achievement Test (BESAT), and both. Four major subjects and associated sub-themes were covered in 10 lessons spread over ten weeks, with two sets of lesson plans created, one for each instructional technique (DT and TBL). The Niger State College of Education, Minna provided three specialists to verify these tools and lesson materials. Pearson's Product Moment Correlation (PPMC) yielded a reliability value of 0.82 when the BESAT was evaluated on a pilot sample of 32 NTC III EIMW students at Government Technical College, Malali, Kaduna State. Reliability for the BEII was determined using Cronbach's Alpha, yielding a score of 0.81.

The pretest was given to the DT and TBL experimental groups by the BE instructors. Following the course of therapy, the BESAT posttest results were gathered to evaluate skill achievement. In order to answer the study questions, data analysis used the mean and standard deviation. At a significance threshold of $p<0.05$, analysis of covariance (ANCOVA) was used to test the hypotheses.

III. Result

The results of data analysed in this study are as follows

Research Question 1

How do the Design Thinking (DT) and Team-Based Learning (TBL) strategies affect students' skill acquisition in Basic Electricity (BE)?

To address research question 1, the pre-test and post-test mean scores for both the DT and TBL groups were calculated. The findings are displayed in Table 1.

Table 1: Mean of Pre-test and Post-test Skill Achievement Scores of Students Taught BE Using DT and TBL Strategies

Groups	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
DT Strategy	200	25.12	3.45	72.45	1.52	47.33
TBL Strategy	198	21.90	2.61	79.32	1.89	57.42

The mean skill achievement scores of students who were taught Basic Electricity (BE) utilizing DT and TBL techniques are shown in Table 1. With a mean increase of 47.33, the students who were taught the DT technique had a pre-test mean score of 25.12 (SD = 3.45) and a post-test mean of 72.45 (SD = 1.52). In contrast, students who were taught the TBL approach had a mean score of 21.90 (SD = 2.61) before the exam and 79.32 (SD = 1.89) after it, resulting in a mean gain of 57.42.

This shows that while student learning improved as a result of both instructional techniques, students given the TBL approach showed a larger mean increase in skill attainment than students taught the DT strategy. Furthermore, the post-test findings' standard deviation indicates that the TBL group showed somewhat higher score variability than the DT group.

Research Question 2

Table 2: Mean of Pre-test and Post-test Scores of Students' Interest Taught BE Using DT and TBL Strategies

Groups	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
DT Strategy	200	33.85	1.75	66.80	1.05	32.95
TBL Strategy	198	33.60	1.10	77.15	0.88	43.55

The mean interest scores of students in Basic Electricity (BE) taught utilizing DT and TBL techniques are shown in Table 2 for both the pre- and post-tests. The students taught using the DT technique had a pre-test mean score of 33.85 (SD = 1.75) and a post-test mean of 66.80 (SD = 1.05), corresponding to a mean increase of 32.95. On the other hand, students who were instructed in the TBL technique had a mean score of 33.60 (SD = 1.10) before the exam and 77.15 (SD = 0.88) after it, representing a mean gain of 43.55.

The findings show that while students' interest in studying BE was favorably impacted by both DT and TBL procedures, students who were taught using the TBL approach had a larger rise in interest. Furthermore, the fact that the post-test standard deviations for both groups were reduced indicates that the students' interest levels were consistent after the intervention, and that the TBL technique produced somewhat more consistent outcomes for all students.

Hypothesis one

There is no significant difference in the mean scores of students' skill achievement in Basic Electricity when taught using Design Thinking and Team-Based Learning strategies.

Table 3: Analysis of Covariance for the Test of Significant Difference Between Students' Skills Achievement Mean Scores in BE When Taught Using PBL and PSM Strategies

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	952.43a	2	476.21	245.62	.000
Intercept	4260.78	1	4260.78	219.33	.000
Pretest	682.91	1	682.91	351.02	.000
Group	22.47	1	22.47	11.54	.001*
Error	824.34	398	2.07		
Total	2850.00	400			
Corrected Total	1776.77	399			

a. R Squared = .531 (Adjusted R Squared = .528)

For the purpose of determining the significance of the difference in the skill success scores of students taught Basic Electricity utilizing PBL in comparison to PSM, the F-calculated value is shown in the table 3. A precise p-value of 0.01 was found to coincide with an F-calculated value of 11.54. The null hypothesis, which states that there is no significant difference in students' skill attainment mean scores between the two teaching modalities, is rejected since the corresponding p-value is less than the significance threshold of 0.05. It is thus determined that while teaching Basic Electricity utilizing PBL and PSM techniques, there is a substantial difference in the mean scores of students' skills accomplishment.

Table 4: Analysis of Covariance for the Test of Significance Difference Between Students' Interest Mean Scores in BE When Taught Using IBL and CL Strategies

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1380.54a	2	690.27	611.34	.000
Intercept	3765.93	1	3765.93	333.68	.000
Pretest	2.41	1	2.41	2.14	.146
Group	1378.13	1	1378.13	122.14	.000*
Error	451.89	398	1.14		
Total	24240.00	400			
Corrected Total	1442.43	399			

a. R Squared = .970 (Adjusted R Squared = .969)

The F-calculated value, which was used to assess the significance of the variation in interest ratings between students given Business Education utilizing IBL and CL techniques, is shown in Table 4. The resultant F-calculated value was 122.14, and the associated p-value was 0.00. The null hypothesis, which proposed that there was no significant difference in students' interest mean scores in Business Education when taught using IBL vs CL techniques, is rejected since the p-value is less than the significance threshold of 0.05. The interest

mean scores of pupils taught using IBL and those taught using CL techniques vary significantly, according to this finding.

IV. Findings of the Study

Following data analysis and hypothesis testing, the following conclusions were reached:
1. The techniques of Team-Based Learning (TBL) and Design Thinking (DT) were both successful in raising students' skill accomplishment in Business Education (BE). However, the TBL technique proved to be more successful than the DT strategy in enhancing students' skill acquisition.
2. Students' interest in business education increased as a result of both the TBL and DT techniques. However, as compared to the DT approach, TBL had a stronger effect on students' interest levels.
3. When teaching DT vs TBL techniques, there was a substantial difference in the students' mean skill accomplishment scores in BE, with TBL producing better outcomes.
4. When teaching BE using DT and TBL methodologies, there was a substantial difference in the students' interest mean scores, with TBL having a more obvious positive impact.

V. Discussion of Findings

According to research on how DT and TBL methods affected students' skill development in business education, students who were taught using the TBL approach outperformed those who were taught using the DT strategy in terms of skill scores. This result implies that students who received instruction using TBL performed better while learning new skills. This is comparable with the findings of Sandika and Fitrihidayah (2018), whose research focused on increasing creative thinking and scientific attitudes in biology students using TBL. They found that TBL greatly enhanced attitudes and creative thinking. The study's findings confirm that the TBL model significantly improves students' practical and critical thinking abilities. This is probably because the model encourages collaboration, which guarantees that assignments are fully understood and facilitates problem-solving.

Furthermore, Chemeli (2019) emphasized that in terms of enhancing student achievements in a variety of topics, including technical and vocational courses, both DT and TBL tactics perform better than conventional teaching approaches. These results suggest that TBL may be a potent technique for enhancing students' skill development in technical disciplines like BE. The fact that there was a statistically significant difference in the skill accomplishment scores of students taught using DT vs TBL methodologies highlights the superior efficacy of TBL in fostering experiential learning and skill development. This is consistent with Adegunle's (2016) results, which showed that scaffolding approaches, as opposed to traditional methods, dramatically increased students' success.

The results showed that students who were taught using the TBL technique had higher mean interest scores in BE than students who were taught using DT. This suggests that TBL increased students' excitement for studying in addition to their academic success. Similar findings were made by Eze *et al*. (2016) in their investigation of meta-learning techniques, which markedly raised students' interest in and participation in building trade courses. Students' interest in BE was probably piqued by TBL's participatory style, which incorporates frequent feedback and group learning. According to Swartz and McGuinness (2019), TBL encourages cognitive practices that boost thinking effectiveness and encourage deeper involvement. TBL may thus pique students' attention more successfully than DT, resulting in learning that is both engaging and memorable.

VI. Conclusion

The research offers insightful information on how students' academic performance in Business Education (BE) at technical schools is affected by Design Thinking (DT) and Team-Based Learning (TBL) methodologies. The findings suggest that although students taught using the DT technique had superior cognitive performance, those taught with the TBL strategy had higher mean skill scores and exhibited more enthusiasm in the topic. Furthermore, low-ability children saw significant improvements in their cognitive and skill development as a result of using both DT and TBL tactics. Accordingly, the research finds that although both DT and TBL techniques improve students' cognitive and skill attainment, TBL is more successful at piqueing students' attention and helping them acquire new skills.

Recommendations

The conclusions lead to the following suggestions being made:
1. BE instructors should apply the TBL method to promote students' skill accomplishment and interest and the DT strategy to raise students' cognitive achievement.

2. To increase students' cognitive and skill accomplishments while piqueing their interest, the Science and Technical Schools Board shall support and educate BE instructors in the use of both DT and TBL methodologies.
3. Since DT and TBL techniques have been shown to improve students' cognitive and skill development as well as their participation in the learning process, technical college administrators need to encourage the use of these approaches while teaching BE.
4. In order to increase their cognitive capacity, acquisition of skills, and enthusiasm in the topic, students studying Electrical Installation and Maintenance Works should be exposed to learning via DT and TBL methodologies.

References

[1]. Adegunle, F. O. (2016). Effect of Scaffolding instructional method on students achievement and interest in metalwork technology in technical colleges in Lagos State. PhD Thesis Submitted to the Department of Vocational Teacher Education, University of Nigeria, Nsukka.

[2]. Adewale, M. S. (2023). Assessment of Provision and Utilization Of Facilities for Teaching and Learning of Motor Vehicle Mechanics in Technical Colleges in Niger State (Doctoral dissertation).

[3]. Akinpade, O. A., Alawode, O. D. & Usman, G. A. (2020). Assessment of Workshop Facilities for Effective Teaching - Learning Delivery in Industrial and Technology Education Department. Federal University of Technology, Minna. Journal of Information Education, Science and Technology, 6 (1), 62-67.

[4]. Akinboro, F. G., Adejumobi, L. A. & Makinde, V. (2019). Solar energy installation in Nigeria: Observations, prospect, problems and solution. Transnational Journal of Science and technology. 2(4), 73-84

[5]. Chemeli, J. (2019). Impact of the five key formative assessment strategies on learner's achievement in mathematics instruction in secondary schools: A case of Nandi County, Kenya. International Academic Journal of Social Sciences and Education, 2(1), 212-229.

[6]. DeGone, B. (2021). The Impact of Project-Based Learning on Students in High School Chemistry in Rural Maine. Electronic Theses and Dissertations. 3504. https://digitalcommons.library.umaine.edu/etd/3504.

[7]. Duhu, P.C. & Ibanga, I. J. (2020). Effects of Guided Discovery Method of Teaching on Students' Academic Achievement and Retention in Electrical Installation and Maintenance Work in Government Technical Colleges of Adamawa State. Journal of Information, Education, Science and Technology, 6 (2), 43-50.

[8]. Duru, P. T., Nwankwo, F., Motanya, C., Aliyu, M. & Rabiu, M. B. (2021). Effects of Science Process Skills on Achievement and Interest of Pre-service Biology Teacher's in College of Education, Minna Niger State, Nigeria. International Journal of Industrial Technology, Engineering, Science and Education, 2(1), 98-104.

[9]. Eze, T. I., Ezenwafor, J. I &Obidile I. J. (2016). "Effect of problem-based teaching methods on students' academic performance and retention in financial accouting in technical colleges in Anambra State". Schola Journal of Arts, Humanityand Social Science, 4 (6), 6343-639.

[10]. Fabiano Pamato, N., Marcos M., Francisco Antonio Pereira, F. & Carolina, (2021). Design Thinking as A Tool to The Teaching of Children, And Teachers In The 21st Century: An Integrative Review. International Journal for Innovation Education and Research, 9(11)131-146

[11]. Gall, M. D., Gall. J. P., & Borg, W. R. (2017). Educational Research: An Introduction (6th. ed). New York: Long Man Publishers.

[12]. Guaman-Quintanilla, S., Chiluiza, K., Everaert, P., & Valcke, M. (2018). Design Thinking In Higher Education: A Scoping Review. In 11th annual International Conference of Education, Research and Innovation 1(1), 2954–2963.

[13]. Hornby, A. (2021). Oxford learners dictionary of cueeent English 6th Ed. oxford; university press.

[14]. Jebba, A. M., Attahiru, A., & Abdullahi, M. M. (2020). Enhancing Psychosocial Environment on Academic Achievement in Basic Electricity in Government Technical Colleges in Niger State. Global Scientific Journal, 8 (10), 1321-1324.

[15]. Nor'ain, M. T., Zamzana, Z. &Ruslina, O.(2019). A Thinking-Based Learning Module for Enhancing 21st Century Skills. International Journal of Innovative Technology and Exploring Engineering , 8, (Issue-6S4), DOI: 10.35940/ijitee.F1080.0486S419

[16]. Pusca, D. & Northwood, D. O. (2018). Design Thinking and its Application to Problem Solving. Global Journal of Engineering Education, 20, (1) 48-53.

[17]. Sandika, B. &Fitrihidajati, H. (2018). Improving Creative Thinking Skills and Scientific Attitude Through Inquiry-Based Learning in Basic Biology Lecture Toward Students of Biology Education. Indonesian Journal of Biology Education. 4(1), 12-24.

[18]. Shé, C. N., Farrell, O., Brunton, J., & Costello, E. (2021). Integrating Design Thinking into Instructional Design: The Open Teach case study. Australasian Journal of Educational Technology, 4(12), 33-52

[19]. Swartz, R. J. & McGuinness C. (2019), "Developing and Assessing Thinking Skills Project Final Report Part 1," International Baccalaureate Organisation.