



Effect of Problem-Based Learning on the Academic Performance and Interest in Welding and Fabrication among Nigeria Certificate in Education (NCE) Mechanical Technology Education Students in North-Eastern Nigeria

¹Yusuf Abdulkarim Kwami, ²Stephen Zira Kumazeghe, ¹Nasir Umar

²Department of Vocational and Technology Education,
Abubakar Tafawa Balewa University Bauchi.

²Department of Technology Education,
Modibbo Adama University Yola.

ABSTRACT

This study aims to investigate the effect of Problem-Based Learning (PBL) on students' academic performance and interest in welding and fabrication. Six null hypotheses were formulated based on the objective of the research. The study adopted a Quasi-Experimental Design (QED) and was conducted in the North-East region of Nigeria (NEN), targeting NCE I students of Mechanical Technology Education (MTE) in the area. The total population of NCE I students in the region was 438 during the 2023/2024 academic session. The sample for the study consisted of 31 students from Federal College of Education (Technical) Gombe, and 26 students from Federal College of Education (Technical) Potiskum, Yobe. The schools were selected using a simple random sampling technique. Data collection was conducted using two instruments: the Welding and Fabrication Performance Test (WEFAPERT) developed by the researcher, and the Welding and Fabrication Interest Inventory (WEFI) comprising 56 items measured on a five-point Likert scale. The instruments were validated by experts, and their reliability was determined using the test and re-test method and Cronbach Alpha coefficients, yielding reliability coefficients of 0.83 and 0.75, respectively. The study employed mean and standard deviation analysis, as well as independent and paired-sample t-tests, to test the null hypotheses at a significance level of 0.5. The results indicated that Problem-Based Learning positively influenced both academic performance and interest in welding and fabrication among NCE I students. Based on the findings, the study recommends the integration of Problem-Based Learning in tertiary institutions to enhance students' learning outcomes and foster a greater passion for welding and fabrication in technical education.

ARTICLE INFO

Article History

Received: December, 2022

Received in revised form: March, 2023

Accepted: April, 2023

Published online: June, 2023

KEYWORDS

Problem-Based Learning, Performance,
Interest Welding and Fabrication

INTRODUCTION

Without specific skill training, graduates, especially from technology, engineering and engineering-related field, may be incapable of acquiring skills and solving tasks and applying their knowledge in an actual workplace environment. Particularly, in this new technology era, the workplace contains more complicated and sophisticated high-tech machinery and computerized or digital systems, which create more complex and ill-structured problems (Pantzoz, Gumaelius, Buckley &

Pears, 2023).

It is therefore essential that engineering and vocational and technology education is about the development of individuals and that of the economy (Baba, & Umar, 2014). The graduates are guided through the right approach that will improve their performance and interests so that they can solve problems, with a wide range of skills, innovation, creativity, as well as good social skills and personal values, especially in welding and fabrication have wider applications in

Corresponding author: Yusuf Abdulkarim Kwami

✉ abdulkarimkwamiyusuf@gmail.com

Department of Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi

© 2023. Faculty of Tech. Education, ATBU Bauchi. All rights reserved



today's technological society, manufacturing technology sector and other industries such as construction/construction, oil and automobile industry. Almost every standards organization should have a maintenance department whose welding and fabrication departments are required. (Babalola, & Omolafe, 2022).

In response to these demands, colleges of education should have several steps to improve their teaching and learning system. Student Centred Learning (SCL) was introduced to replace the TLA through several learning methods and strategies. (Ekunola, Onojah, Talatu, & Bankole, 2022). These include methods such as Problem-Based Learning (PBL), case studies, practical activities, laboratory work, collaborative learning, computer-assisted learning, and group discussion (Hsu, & Liu, 2023). However, the study observed that there is much room for improvement in the current SCL implementation. The SCL implementation according to this study should be referred to the PBL approach, in the colleges of education, thus teaching and learning system should be more authentic and closer to the world of work (Rafiq, Triyono, & Djatmiko, 2023).

Welding and fabrication are one of the trade courses offered in the Colleges of Education among technical education students in Nigeria, (Okuta, Pindiga, & Bamidele, 2022) the trade course prepares the products for craftsmanship training as welders and fabricators. Welders are required to make, join and repair the metal parts for a massive range of machinery, equipment and structures while Fabricators are involved in the creation and repair of either light (water tanks, ducting, metal chains) or heavy metals (i.e. building structures, ships' hulls, bridges). The fabrication involves forming metal into different shapes mainly one of the four methods such as casting, forming, machining and welding. (Korkmaz, Waqar, Garcia-Collado, Gupta, & Krolczyk, 2022) As a fabricator you are likely to specialise in light metal fabrication - including ducts, water tanks, metal chairs, and aircraft parts or in heavy metal fabrication - including building structures, ships hulls, and bridges, thus it is required at small, medium and high scale production technology. (Behera & Behera, 2022).

This academic performance refers to excellence in all academic disciplines, in a

class as well as in extracurricular activities. (Katami, 2022). It includes excellence in sporting behaviour, confidence, communication skills, and others. Students' academic performance and Higher education institutions have been interested in graduation rates.

Investigation of factors related to the academic performance of university students is affected by different factors the way and manner the teacher prepares and delivers his lesson. Thus a methodological gap exists. Furthermore If we are interested in anything, it can be seen as vital to us, important to us, and the source of (mainly) positive sensations. Being involved, captivated, or totally preoccupied with an activity, item, or issue is how John Dewey originally defined interest. (Okoro, Onuabuobi, & Onuoha, 2022). According to Mangal (2007), interest is the central force that drives the whole machinery of the teaching-learning process. It means, with an interest, students will be more focused and easy to understand the material given by the teacher (Kerras, & Essayahi, 2022). Big interest will influence students' activity because the students' interest will be doing something that interests them, in this case, is an interest in learning. Additionally, interest aids in getting past learning plateaus that frequently occur or arrive early.

Problem-based learning (PBL) is an educational approach that focuses on the process of learning, rather than the acquisition of knowledge (Ali, Daud, Ba Hattab, Philip, Matoug-Elwerfelli, Anweigi, Du, 2022). It has been gaining popularity in recent years due to its efficacy in helping students develop critical thinking, problem-solving, and collaboration skills. Furthermore, evidence suggests that PBL can also improve student academic performance and increase student interest in a subject. The primary aim of PBL is to provide students with an opportunity to learn by solving relevant and complex problems. Students are expected to collaborate, apply their knowledge and skills, and find creative solutions (Simarmata, 2022). As such, PBL requires students to think critically, which can improve their cognitive abilities. Research suggests that PBL leads to better problem-solving skills, improved academic performance, and increased student engagement.

Corresponding author: Yusuf Abdulkarim Kwami

✉ abdulkarimkwamiyusuf@gmail.com

Department of Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi

© 2023. Faculty of Tech. Education, ATBU Bauchi. All rights reserved



In addition, PBL can increase student interest in a subject, which in turn can lead to better academic performance. By engaging students in the problem-solving process, PBL can help students to develop a better understanding of the material and bolster their interest in the subject (Setyani & Susilowati, 2022). Furthermore, it encourages students to think independently and discover new ways of approaching a problem. This can help to create a more positive attitude towards learning, which can further improve academic performance. All in all, PBL is a highly effective teaching method that can have a positive effect on student academic performance and interest (Setyani, & Susilowati, 2022). By providing students with an opportunity to solve relevant and complex problems, PBL encourages students to think critically and develop problem-solving and collaboration skills. This can lead to better academic performance and an increased interest in a subject.

Objectives of the Study

The study's primary goal is to ascertain the effect of problem-based learning (PBL) on Nigeria Certificate in Education (NCE) Mechanical Technology Education (MTE) students' performance and interest in Welding and Fabrication (W&F) in North-eastern Nigeria,

Hypotheses

The following null hypotheses were tested at 0.05 level of significant.

- H₀₁:** There is no significant difference in the mean performance of (NCE) MTE Students in the W&F course exposed to PBL and those exposed to the lecture method before the treatment.
- H₀₂:** There is no significant difference in the mean performance of the experimental group (exposed to PBL) NCE MTE Students in the W&F course at the pre-test and post-test.
- H₀₃:** There is no significant difference in the mean performance of the experimental group (exposed to PBL) and control group NCE MTE Students in the W&F course at the post-test.
- H₀₄:** There is no significant difference in the mean interest of (NCE) MTE Students in the W&F course exposed to PBL and those exposed to the lecture method

before the treatment.

- H₀₅:** There is no significant difference in the mean interest of the experimental group (exposed to PBL) NCE MTE Students in the W&F course at the pre-test and post-test.
- H₀₆:** There is no significant difference in the mean interest of the experimental group (exposed to PBL) and control group NCE MTE Students in the welding and Fabrication course at the post-test.

METHODOLOGY

The design of the study is Quasi-Experimental Design (QED), QEDs are so-called because they lack full laboratory control and laboratory isolation. They are the designs researchers use outside the laboratory settings. The area of the study is North East Nigeria (NEN) It consists of six states namely: Borno, Yobe, Bauchi, Adamawa, Gombe and Taraba. The target population are all NCE I students of MTE in NEN. The total number of students at NCE I is 438 students, as of the 2023/2024 academic session, NCE I was specifically selected, because the course TED 121 (Sheet Metal Welding and Fabrication) is taught NCE I level. While the Sample and Sampling Technique consists of 31 from Federal College of Education (Technical) Gombe Gombe state, and 26 from Federal College of Education (Technical) Potiskum, Yobe, a simple random sampling technique was used to select two schools which will be part of the study. The instrument for data collection was a test called Welding and Fabrication Performance Test (WEFAPERT), developed by the researcher based on the course content, the test has 35 items which covered, Safety precautions, Simple Sheet Metal Joints, Fabrication Process, Introduction to Gas Welding, Introduction to Arc Welding, Soft Soldering and Brazing, Bronze Welding, having an option A-E, While the second instrument was Welding and Fabrication Interest Inventory (WEFII), Which has 56 items, the items was measured on five-point Likert scale, Very Highly Interested (VHI), = 5, Highly Interested (HI) = 4, Interested (IN), =3, Not Interested (NI), =2, Not at All Interested (NAI), =1. The instrument was validated by experts. While the reliability of the first instrument was determined using the test and re-test method, the treatment for the study is

Corresponding author: Yusuf Abdulkarim Kwami

✉ abdulkarimkwamiyusuf@gmail.com

Department of Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi

© 2023. Faculty of Tech. Education, ATBU Bauchi. All rights reserved



called PBL: An instructional strategy that challenges students to "learn to learn," working cooperatively in groups to seek solutions to real-world problems. Through the following steps, Introducing the problem, Searching for facts and ideas, Brainstorming, Final briefing, Solving the problem, Address learning needs, the data collected were analysed using mean, standard deviation and an independent sample t-test to test the null hypotheses all at 0.5 level of significance because the consequences of rejecting a true null hypothesis were not severe.

RESULTS AND DISCUSSION

H₀₁: There is no significant difference in the

mean performance of (NCE) MTE Students in the W&F course exposed to PBL and those exposed to the lecture method before the treatment.

Table 1 presented the result of the independent-samples t-test conducted to compare the mean performance of (NCE) MTE Students in W&F for the experimental and control group at the pre-test administered before treatment. Based on the analysis, the result indicated that there was no significant difference in scores for the experimental group ($M = 3.29, SD = 1.07$) and control group ($M = 3.26, SD = .82; t(55) = .082, p = .935$, two-tailed).

Table 1: t-test of academic performance of experimental and control group at pre-test

	Group	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Diff.	Decision
Pre-test academic performance	Exper.	31	3.29	1.07	.082	55	.935	.021	Accepted
	control	26	3.26	.827					

H₀₂: There is no significant difference in the mean performance of the experimental group (exposed to PBL) NCE MTE Students in the W&F course at the pre-test and post-test.

Table 2 presented the result of the paired sample t-test conducted to compare the mean performance of (NCE) MTE Students in W&F in the experimental group at pre-test and post-tests. The result indicated that there was a

significant difference in scores for the experimental at pre-test ($M = 3.29, SD = 1.07$) and post-test ($M = 25.61, SD = 3.93; t(30) = -30.481, p = .000$, two-tailed). The effect size was found to be 0.969 using Eta Square, The mean increase in pos test score was 22.32 with a 95% confidence interval the eta squared statistic was (.90) indicating a very large effect size. Thus 90% of the variance in students' academic performance was explained by PBL.

Table 2: Paired sampled t-test of academic performance of experimental group at pre and post-test.

	Mean	N	SD	t	df	Sig. (2-tailed)	Mean diff.	Decision
Pre-test experimental	3.29	31	1.070	-30.481	30	.000	22.32	Rejected
Post-test experimental	25.61	31	3.93					

H₀₃: There is no significant difference in the mean performance of the experimental group (exposed to PBL) and control group NCE MTE Students in the W&F course at the post-test.

Table 3 presented the result of the independent-samples t-test conducted to compare the mean performance of (NCE) MTE Students in W&F for the experimental and control group at the post-test that was administered after the treatment. The result shows that there was significant difference in scores for experimental group ($M = 25.61, SD = 3.93$) and control group ($M = 14.65, SD = 4.62; t(55) = 9.66, p = .000$, two-tailed). The effect size was found to be 0.62 which is a moderate effect, thus 62% of the variance in students' academic performance was explained by PBL.



Table 3: t-test of academic performance of experimental and control group at post-test

	group	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Diff.	Decision
Post-test performance	Exper.	31	25.61	3.93	9.66	55	.000	10.95	Rejected
	control	26	14.65	4.62					

H₀₄: There is no significant difference in the mean interest of (NCE) MTE Students in the W&F course exposed to PBL and those exposed to the lecture method before the treatment.

Table 4 presented the result of the independent-samples t-test conducted to compare the mean interest of (NCE) MTE

Students in W&F for the experimental and control group at the pre-test that was administered before the treatment. There was no statistically significant difference in scores for the experimental group ($M = 1.87$, $SD = .67$) and control group ($M = 1.53$, $SD = .508$; $t(55) = 2.076$, $p = .073$, two-tailed).

Table 4: t-test of interest of experimental and control group at pre-test

	group	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Diff.	Decision
pre-test Interest	Exper.	31	1.87	.670	2.07	55	.073	.332	Accepted
	control	26	1.53	.508					

H₀₅: There is no significant difference in the mean interest of the experimental group (exposed to PBL) NCE MTE Students in the W&F course at the pre-test and post-test.

Table 5 presented the result of a paired sample t-test conducted to compare the mean interest of (NCE) MTE Students in W&F in the

experimental group at pre-test and post-tests. The result indicated that there was a significant difference in scores for the experimental at the pre-test ($M = 1.87$, $SD = .670$) and post-test ($M = 4.25$, $SD = .630$; $t(30) = -13.91$, $p = .000$, two-tailed). The effect size was found to be 0.86, thus 86% of the variance in students' interest was explained by PBL.

Table 5: paired sampled t-test of interest of the experimental group at pre and post-test

	Mean	N	SD	t	df	Sig. (2-tailed)	Mean diff.	Decision
Pair 1	Pre-test Exper, Interest	31	1.87	.670	-13.91	.000	-13.91	Rejected
	Post-test Exper, Interest	31	4.25	.630				

H₀₆: There is no significant difference in the mean interest of the experimental group (exposed to PBL) and control group NCE MTE Students in the welding and Fabrication course at the post-test.

Table 6 presented the result of the independent-samples t-test conducted to compare the mean interest of (NCE) MTE Students in W&F for the experimental and

control group at the post-test that was administered after the treatment. There was significant difference in scores for experimental group ($M = 4.25$, $SD = .630$) and control group ($M = 3.61$, $SD = .697$; $t(55) = 3.652$, $p = .001$, two-tailed). The effect size was 0.19, thus 19 % of the variance in students' interest was explained by PBL.



Table 6: t-test of interest of experimental and control group at post-test

	group	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Diff.	Decision
Post-test interest	Exper.	31	4.25	.630	3.652	55	.001	.642	Rejected
	control	26	3.61	.697					

DISCUSSION OF FINDINGS

Based on the findings of this study, it is believed that Problem-Based Learning (PBL) enables students to conduct research, integrate theory with practice, and utilize their knowledge and abilities to develop practical solutions (Smith, Maynard, Berry, Stephenson, Spiteri, Corrigan, & Smith, 2022). Additionally, the research gained support from Birdman, Wiek, and Lang (2022), who highlighted that PBL is an effective educational strategy that encourages active student engagement in solving meaningful problems. Therefore, PBL serves as a potent classroom approach, employing real-world problems to motivate students and enhance their interest in applying concepts and information, communicating effectively, and collaborating to deepen their understanding (Ruppert, Coleman, Pinter, Johnson, Rector, & Diaz, 2022).

Furthermore, studies by Lee and Hwang (2022) indicated that PBL enhances overall interest and engagement in lessons, while Basil, Umakalu, and Nwangwu (2022) revealed the positive effects of PBL on academic achievement. Yasin (2022) demonstrated that PBL instruction leads to a higher level of mathematics achievement compared to traditional teaching methods, and Ulger (2018) found that PBL fosters creative thinking and critical thinking disposition in students studying visual arts.

In the context of Biology education, Nneka (2019) discovered that students taught using problem-based-solving techniques outperformed those taught through conventional methods. Moreover, Carlos (2019) conducted research on university students and found that PBL significantly impacted their emotional intelligence growth. Similarly, Winarti, Waluya, and Rochmad (2019) investigated the impact of problem-based learning with performance assessment on students' mathematical problem-solving abilities, concluding that this approach effectively

improved problem-solving skills at different stages.

Conclusion

Based on the collection of studies and research on Problem-Based Learning (PBL), several significant conclusions can be drawn:

1. Effectiveness of PBL: The findings consistently support the effectiveness of Problem-Based Learning as an instructional method. PBL enables students to engage actively in the learning process by solving real-world problems, leading to improved academic performance and achievement across various subjects, such as mathematics, biology, and visual arts.
2. Holistic Learning: PBL facilitates a holistic approach to education by combining theoretical knowledge with practical application. Students are encouraged to conduct research, think critically, and apply their understanding to develop workable solutions, thereby fostering a deeper understanding of the subject matter.
3. Motivation and Engagement: PBL has a positive impact on students' motivation and engagement in the learning process. By presenting meaningful problems and real-world scenarios, students are intrinsically motivated to explore, investigate, and find solutions, leading to increased interest and active participation in their studies.
4. Emotional Intelligence Growth: One of the notable benefits of PBL is its impact on emotional intelligence development. The approach encourages collaborative problem-solving and effective communication, leading to improved emotional intelligence skills among students.



5. Relevance and Applicability: PBL enhances the relevance and applicability of knowledge. By solving authentic problems, students see the practical relevance of what they learn in the classroom, making the learning experience more meaningful and memorable.
6. Creativity and Critical Thinking: PBL fosters creative thinking and critical thinking disposition in students. By encouraging open-ended problem-solving and uncertainty, PBL promotes creativity and encourages students to think critically about various solutions.
7. Positive Impacts Across Different Educational Levels: The effectiveness of PBL is evident across different educational levels, from secondary school to university, making it a versatile and valuable instructional strategy for various age groups.

In conclusion, the collective evidence from the cited studies highlights the benefits of Problem-Based Learning, including improved academic performance, heightened interest and engagement, enhanced problem-solving skills, emotional intelligence growth, and the development of critical and creative thinking. PBL stands out as an effective and valuable approach to education that empowers students to become proactive learners, equipping them with the skills and knowledge necessary for success in real-world scenarios. As a result, educators and policymakers should consider integrating PBL into their teaching methodologies to enrich the learning experience and prepare students for future challenges.

References

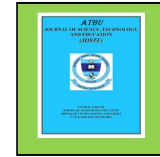
- Ali, K., Daud, A., Ba Hattab, R., Philip, N., Matoug-Elwerfelli, M., Anweigi, L., & Du, X. (2022). Development of self-regulation amongst dental students in problem-based learning curricula: A qualitative study. *European Journal of Dental Education*.
- Azamfirei, V., Granlund, A., & Lagrosen, Y. (2023). Lessons from adopting robotic in-line quality inspection in the Swedish manufacturing industry. *Procedia Computer Science*, 217, 386-394.
- Baba, M. M. & Umar, N. (2014) Roles of guidance and counselling in vocational and technology education (VTE) *Journal of Research in Education and Society*, 5 (2), 18-25
- Babalola, E. O., & Omolafe, E. V. (2022). The construction process of robotic devices to teach aspects of auto mechanics in Nigeria Basic Schools. *ASEAN Journal of Science and Engineering Education*, 2(1), 123-128.
- Basil, O., Umakalu, C., & Nwangwu, E. (2022). Effect of Google Classroom on Academic Achievement of Undergraduate Students in Computer Database Management System in Universities in South East Nigeria. *International Journal of Instructional Technology and Educational Studies*, 3(1), 9-15.
- Behera, A., & Behera, A. (2022). Additive Manufacturing Materials. *Advanced Materials: An Introduction to Modern Materials Science*, 667-700.
- Birdman, J., Wiek, A., & Lang, D. J. (2022). Developing key competencies in sustainability through project-based learning in graduate sustainability programs. *International Journal of Sustainability in Higher Education*, 23(5), 1139-1157.
- Carlos, L. (2019) Problem-Based Learning (PBL) in the development of emotional intelligence of university students. *Journal of Education and Training*. 5(6),102-107. <http://dx.doi.org/10.20511/pyr2019.v7n2.288>.
- Ekunola, G. T., Onojah, A. O., Talatu, A. F., & Bankole, M. O. (2022). Colleges of education lecturers' attitude towards the use of virtual classrooms for instruction. *Indonesian Journal of Multidisciplinary Research*, 2(1), 187-194.
- Hsu, K. C., & Liu, G. Z. (2023). The construction of a theory-based augmented reality-featured context-aware ubiquitous learning facilitation framework for oral communication

Corresponding author: Yusuf Abdulkarim Kwami

✉ abdulkarimkwamiyusuf@gmail.com

Department of Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi

© 2023. Faculty of Tech. Education, ATBU Bauchi. All rights reserved



- development. *Journal of Computer Assisted Learning*.
- Katami, N. A. (2022). Analysis of the impact of parent socio-economic background on secondary school students academic performance in Sokoto metropolis Nigeria. *Rima*, 1(2).
- Kerras, N., & Essayahi, M. L. B. (2022). Education and COVID-19: Learning Arabic language and perspectives. *Electronic Journal of E-learning*, 20(1), pp36-52.
- Korkmaz, M. E., Waqar, S., Garcia-Collado, A., Gupta, M. K., & Krolczyk, G. M. (2022). A technical overview of metallic parts in the hybrid additive manufacturing industry. *Journal of Materials Research and Technology*.
- Lee, H., & Hwang, Y. (2022). Technology-enhanced education through VR-making and metaverse-linking to foster teacher readiness and sustainable learning. *Sustainability*, 14(8), 4786.
- Nneka, R. N. (2019) Effect of problem based-solving technique on secondary school Students' Achievement in Biology. *International Journal of Scientific & Engineering Research* 10(3), 67-73
- Okoro, N. A. L., Onuabuobi, O. S., & Onuoha, E. C. (2022). Colour as an Instructional Strategy for Developing Language Skills for Functional Literacy among Children. *Zaria journal of Educational Studies (ZAJES)*, 22(1), 19-26.
- Okuta, S., Pindiga, M. Y., & Bamidele, O. A. (2022). Federal College of Education (Technical), Gombe. *The Nigerian Journal Research and Production Volume*, 25(1).
- Pantzos, P., Gumaelius, L., Buckley, J., & Pears, A. (2023). Engineering students' perceptions of the role of work industry-related activities on their motivation for studying and learning in higher education. *European Journal of Engineering Education*, 48(1), 91-109.
- Rafiq, A. A., Triyono, M. B., & Djatmiko, I. W. (2023). The integration of inquiry and problem-based learning and its impact on increasing vocational student involvement. *International Journal of Instruction*, 16(1), 659-684.
- Ruppert, N. B., Coleman, B., Pinter, H., Johnson, D. T., Rector, M., & Diaz, C. (2022). Culturally Sustaining Practices for Middle-Level Mathematics Teachers. *Education Sciences*, 12(12), 910.
- Setyani, N. S., & Susilowati, L. (2022). The Effect of E-Problem Based Learning on Students' Interest, Motivation and Achievement. *International Journal of Instruction*, 15(3).
- Setyani, N. S., & Susilowati, L. (2022). The Effect of E-Problem Based Learning on Students' Interest, Motivation and Achievement. *International Journal of Instruction*, 15(3).
- Simarmata, P. (2022). The Effect of Models Creative Problem Solving and Problem-Based Learning to Improvability Problem Solving Students. *JMEA: Journal of Mathematics Education and Application*, 1(1), 31-43.
- Smith, K., Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., ... & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM Education: Using Expert Wisdom and Research to Frame Educational Practice. *Education Sciences*, 12(10), 728.
- Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, 12(1), 56-62. Available at: <https://doi.org/10.7771/1541-5015.1649>.
- Winarti, E. R., Waluya, S. B., & Rochmad, K. (2019). The impact of problem-based learning using performance assessment on student's mathematical problem-solving ability. *5th ICMSE2018 Journal of Physics*: doi:10.1088/1742-6596/1321/3/032090.
- Yasin, A. (2022). *Effectiveness of Problem-Based Learning in Urban Middle Schools on Mathematics Achievement and School Climate*. St. John's University (New York).
- Zubairu, A. M. (2022). *Influence of Parental and Environmental Factors on the*

Corresponding author: Yusuf Abdulkarim Kwami

✉ abdulkarimkwamiyusuf@gmail.com

Department of Vocational and Technology Education, Abubakar Tafawa Balewa University, Bauchi

© 2023. Faculty of Tech. Education, ATBU Bauchi. All rights reserved



*Academic Performance of Business
Education Students (Doctoral
dissertation, Kwara State University
(Nigeria)).*