British Journal of Education, Learning and Development Psychology

ISSN 2682-6704 • Volume 9, Issue 2, 2026 • pp. 63–80

RESEARCH ARTICLE Received: 16 May 2026, Accepted: 4 Jun 2026, Published: 27 Aug 2026

Investigating Mathematics Teachers' Competencies in Applying Project-Based Learning on Students' Achievement in Secondary Schools in Bamenda III Subdivision of the North West Region, Cameroon

Monique Abongkeyung Newen

Higher Technical Teachers Training College, University of Bamenda, Cameroon.

Email: abongmon@yahoo.co.uk

Abstract

Many studies have focused on exploring innovative instructional strategies with little or no attention given to the competencies possessed by teachers in utilising these strategies. This study investigated Mathematics teachers' competencies in applying project-based learning on students' achievement in Secondary schools in Bamenda III subdivision of the North West Region, Cameroon. The design of the study was descriptive survey research. The population of the study comprised all the mathematics teachers in Bamenda III subdivision, numbering two hundred and thirty-six (236). The sample size was 96. The instrument used for data collection was a structured questionnaire designed by the researcher. The reliability was established using Cronbach's alpha, giving a coefficient of 0.78. Data collected by the researcher were analyzed using mean and standard deviation to answer the research questions, while the t-test was used to test the hypotheses at 0.05 level of significance. The results of the study indicated that mathematics teachers did not differ significantly in their possession of the cognitive structures that support their behavior in applying PBL. From the findings, the following recommendations were made. Mathematics teachers should build up their capacities to be able to give out their best to keep up with the changing times.

Keywords: Project-Based Learning, Mathematics teachers, Competencies, Mathematics achievement.

How to Cite: Monique Abongkeyung Newen (2026), Investigating Mathematics Teachers' Competencies in Applying Project-Based Learning on Students' Achievement in Secondary Schools in Bamenda III Subdivision of the North West Region, Cameroon. British Journal of Education, Learning and Development Psychology 9(2), 63-80. DOI: 10.52589/BJELDP-G4R95TLT

INTRODUCTION

In this era of globalisation and digitalisation, the tendency to get students to succeed and excel in mathematics is paramount. Many students in secondary schools give up mathematics due to factors that researchers have sought to identify. Factors can be categorized into teachers' factors and students' factors, which affect students' achievement in mathematics. Teacher-related factors, such as poor teaching strategies, a lack of experienced teachers, and inadequate instructional materials, are the most prominent causes of students' failure in mathematics. On the part of the students, factors like students' lack of interest, poor attitudes like poor study habits, and insufficient practising of the concepts, amongst others, feature most. Researchers have explored some strategies to ameliorate students' achievement in mathematics. Odo (2017) investigated the efficacy of first principles of instruction in improving students' achievement, interest, and retention in number and numeration. The results indicated that the First Principles of Instruction were more effective than the traditional method in terms of achievement, interest, and retention. In another study, Omoroh and Adiri (2019) investigated the effect of concept mapping and lecture instructional approaches on students' mathematics achievement. The findings revealed that students taught geometry using concept mapping had a higher mean achievement score than those taught using a lecture instructional approach. With the modern trends of digitalisation, some studies like that of Filiz (2025) investigated the use of digital tools in mathematics teaching: Bibliometric approach. The results indicated that research on the use of digital tools in mathematics teaching has had a tremendous surge in recent years. It has been found that interest in digital tools has grown particularly after 2006, and this growth has been enhanced after 2014. Due to the COVID19 pandemic, the use of digital tools in education has become a necessity, and this has caused studies after 2020 to grow significantly. Bani-Hamad and Abdullah (2019) carried out a study on the effect of project-based learning to improve the 21st-century skills among Emirati secondary students. The findings from the study indicated that a project-based learning approach has a significant effect on the improvement of 21st-century skills (4Cs) among Emirati secondary-level students who participated in the Think Science National Competition 2019. Most of the studies have delved into the efficacy of instructional strategies, with very few taking into consideration the competencies possessed by teachers in utilising these strategies. Li, QI, and Li (2025) explored the conceptualization of mathematics teachers' professional competence in project-based learning contexts. This work focused on the conceptualisation of teachers' competence without considering how to check if the teachers actually possess the competencies.

Statement of the Problem

Given the poor achievement of students in mathematics, teachers and researchers have sought to identify the causes of the problem and discovered that instructional strategies are the root cause of the failure of most students. As such, many innovative instructional strategies like Competency-Based Approach, digital learning platforms, and Project-Based Learning have been discovered and exploited in the teaching and learning of mathematics. Despite the application of the innovative strategies, the mathematics achievement of students in both internal and external examinations has not improved significantly. The researcher observed that some basic elements of these instructional strategies have not been duly considered. It is not just enough to advocate for an innovative instructional strategy, but to consider whether the teachers are competent enough to accommodate such strategies. Also, most studies have focused on exploring innovative instructional strategies with little or no attention given to the competencies possessed by teachers in utilising these strategies. Given the most innovative of these strategies, which is Project-Based Learning and has been reported to be effective in some areas, yet the achievement of students in mathematics has not significantly improved, this study sought to investigate if the teachers in Bamenda III subdivision are competent enough to utilise this strategy. No study has been done on investigating mathematics teachers' competencies in utilising PBL on students' mathematics achievement in Bamenda III Subdivision.

REVIEW OF LITERATURE

With the fast evolution taking place in the world, more innovative teaching approaches spring up to make the teaching-learning process more productive. Rosen (2017) observed that with changes in the world, it is necessary to reshape how and what to teach in the educative process to meet the needs and be abreast with the growing demands of society. This has significantly changed learning over the last decade due, in part, to the technological revolution. According to (The Partnership for 21st-Century Learning, 2015), several ways to acquire knowledge, skills, and understanding in classrooms exist, which make use of instructional approaches and strategies aligned with 21st -century skills development, which are the capacity to collaborate, create, critically think, and communicate interactively, as well as independently. Soulé and Warrick. (2015) reported that although creativity, critical thinking, communication, and collaboration are not novel to education, they are compulsory prerequisite skills in the 21st -century work environment. It poses some issues, therefore, for the 21st -century mathematics classrooms to enable students to create their thinking and apply their knowledge in various ways. Students learn by doing hands-on activities, projects, and problem-based learning, collaboration within groups, and using technology for productivity, communication, and creativity. National Council of Teachers of Mathematics (2000) reiterated that mathematics instruction, like others, must emphasize mathematical processes such as critical and logical thinking, reasoning, communication, making connections, and problem-solving. In Cameroon, mathematics is one of the main priorities in terms of time allocation per class. The Ministry of Basic Education mandated a 50- minute time allocation every day in the Basic Education Curriculum and 40 minutes for five days in the secondary school curriculum. Additionally, mathematics is one of the compulsory subjects included in the ordinary level Cameroon General Certificate of Education program, and most of the combinations for technical and tertiary subjects require mathematics. Also, teacher trainees for the primary and secondary schools are given a lot of training on how to teach mathematics and perform mathematical operations for their students' data. However, given the consideration that the Cameroon education system is dedicated to Mathematics, there are still issues, concerns, and difficulties in teaching and learning the subject.

Despite the utilisation of innovative instructional strategies like the Competence-Based Approach, project-based learning, and even the most cherished digital learning to accommodate the demands of the 21st century, the report from classroom teachers and examination bodies like the Cameroon G.C.E. continues to indicate a poor achievement of students in mathematics. This is due to the fact that students view it as a problem area due to its complexity and abstractness. It is worth checking whether these instructional strategies in themselves have elements that do not meet the expectations of the mathematics program, rather than advocating for new strategies every day.

One of the elements that the researcher has observed as problematic to be investigated is the competencies of teachers in utilising the instructional strategies, the most innovative of which is Project-Based Learning (PBL).

According to Teacher Academy (2023), PBL always starts with a driving question that aims at looking for solutions, usually to some real issue. After exploring a topic actively, collecting information, and gaining new insights, each student or group of students will probably come up with different solutions to answer the same question.

In PBL, the product(s) that students create have the goal of solving something problematic that they care about (because the teacher somehow succeeds in making the topic relevant and meaningful for them).

Normally, in PBL, students are expected to create a product and to learn not because the teacher told them to do so, but because they have accepted the challenge of addressing a problematic driving question. If learners are made to feel that they can do something to solve that issue, they will probably try and solve it… and learn a lot by going through the process! Viro, Lehtonen, Joutsenlahti & Tahvanainen (2020) posited that in order to thrive in today's uncertain environment, there is a need to master 21st-century skills as well as knowledge of key subjects. Project-based learning (PBL) has been recommended as an important instructional strategy to prepare students for their future work and life. As teachers play an important role in classroom instructional practice, understanding their perspectives on PBL is essential in order to provide them with support for its successful implementation. Larmer, Mergendoller, and Boss (2015) argued that the objective of PBL is to assist students in developing not only their knowledge and understanding of subjects but also success skills (i.e., 21st century skills). They emphasised that during the project, students are required to apply their knowledge of subjects to practice. As a result, students promote their deep learning of subjects through understanding and the use of several skills, such as critical thinking, problem solving, collaboration, and self-management. This calls for an investigation to find out if students' achievement in mathematics is influenced by PBL, especially in terms of teachers' competencies. Gumus (2022) observed that teachers' personal and professional characteristics are critical for students' learning, harmonious communication skills, and adaptation to the requirements of the age in which one lives, starting with self-adaptation.

Furthermore, expectations about teacher competencies have been important in every period of world history. The proficiency criteria created with different motivations have also been determinant regarding teachers' social status, responsibilities, and areas of authority. Societies' values, priorities, goals, and economic structure have been among the determining factors in perspectives on teachers and what is expected from education in every period of history. Teachers' competencies are often understood as integrative and complex constructs, including knowledge, skills, and dispositions to act in professional situations (Korthagen, 2004). The researcher further indicated that, in a theoretical and descriptive sense, competencies are cognitive structures that support certain teacher behaviours, and in an operational sense, competencies cover a variety of skills, allowing a teacher to act in complicated and changing professional situations and find solutions to them.

Competence as a concept in educational research originated from Weinert (2001), who viewed competence as a multi-dimensional construct consisting of cognitive and affective-motivational perspectives. The cognitive perspectives of teacher competence are concerned with teachers' professional knowledge, which Shulman (1986) indicated can be differentiated into content knowledge (CK, namely domain-specific subject-matter knowledge), pedagogical content knowledge (PCK, i.e., knowledge of instructional strategies and representations, and knowledge of students' (mis)conceptions), and general pedagogical knowledge (GPK, including broad principles and strategies of classroom management and organization). In mathematics education, teachers' professional knowledge is made up solely of mathematics content knowledge (MCK) and mathematics pedagogical content knowledge (MPCK), although Neubrand (2018) reported that different ways of conceptualising it exist. Consider the case whereby Shulman(1987) viewed teachers' knowledge as having seven categories, which were reshaped and compressed into one basic category of knowledge, the mathematics knowledge for teaching, only covering categories related to CK and PCK (Ball et al., 2008). Moreover, theoretically and empirically, it is difficult to differentiate between MCK and MPCK, so that there is little agreement about the components of MPCK (Depaepe et al., 2013). The other perspectives to be considered are the affective–motivational.

On the other hand, the affective-motivational perspectives of teacher competence include beliefs and affective traits (e.g., motivation), as well as metacognitive abilities (e.g., self-regulation), which creates a link between cognitive abilities and teaching practice (Döhrmann et al., 2012). Belief is difficult to conceptualize just as the concept of knowledge, since they are determined by a variety of factors and are influenced by individual interpretation and social construction (Richardson, 1996). Teachers' belief systems have multiple dimensions, embodying aspects of students' abilities, the purpose of mathematics education, and the teacher's role (Thompson, 1992). Three critical aspects of teacher beliefs were identified by Hoy, Davis and Pape as follows : (a) beliefs about the role of teachers or their abilities, namely teachers' self-efficacy (Tschannen-Moran, Hoy & Hoy, 1998), (b) epistemological beliefs (Hofer & Pintrich, 1997; e.g., beliefs about the nature of mathematical knowledge and the knowing of mathematics), and (c) beliefs about teaching and learning (in mathematics education as beliefs about mathematics teaching and learning; Liljedahl, Rösken & Rolka, 2021). From a philosophical view, Ernest (1989) stratified epistemological beliefs about mathematics into three aspects: "the instrumentalist view of mathematics as a set of unrelated but utilitarian rules and facts … the Platonist view of mathematics as a static but unified body of certain knowledge … and the problem-solving view of mathematics as a dynamic, continually expanding field of human creation and invention, a cultural product". From the perspective of learning theories, both epistemological beliefs and beliefs about teaching and learning can be classified into transmissive- oriented beliefs, where teachers tend to convey knowledge to students, and constructivist-oriented beliefs, where teachers prefer to apply a learner-oriented strategy (VossKleickmann, Kunter & Hachfeld, 2013). The instrumentalist and Platonist views correspond to transmissive-oriented beliefs, whereas the problem-solving view corresponds to constructivist-oriented beliefs (Beswick, 2005). Defined in this way, teacher competence is regarded as the sum of personal dispositions (cognition and affect-motivation) associated with latent abilities or skills required for teaching performance (Klieme, Hartig & Rauch, 2008). To understand the level and depth of teacher competence and its impact on teaching performance, many scholars and research institutes have developed the conceptual frameworks of teacher competence, which were validated in large-scale empirical studies. For instance, in an international comparative teacher education and development study–learning to teach mathematics (TEDS-M), and the cognitively activating instruction and the development of students' mathematical literacy

(COACTIV) research program, mathematics teachers' competence was conceptualized as the integration of professional knowledge, beliefs, motivation, and self-regulation (Döhrmann, Kaiser & Blömeke, 2012). Given the context of project-based learning, there is a need to investigate teachers' competencies on students' achievement in mathematics.

According to Yang and Kaiser (2022), researchers in China have been devoted to exploring teacher competence in project-based learning contexts, because instructional quality and student achievement are anchored on teacher competence. Some particular competence is needed for teachers to meet demands and challenges for project-based learning contexts in practice. For this reason, Zhang and Yang (2021) proposed a theoretical framework including seven teaching competencies in project-based learning contexts for the purpose of designing and implementing the national curriculum. Working on a holistic model of competence (Le Deist & Winterton, 2005), a conceptual model and an assessment scale of teacher competence with three facets (cognitive competence, professional competence, and social competence) were structured by Wan and Gao (2023). Similarly, based on role analysis and needs assessment, Ye, Sang & Wang (2021) identified four components of teacher competence using empirical results from grounded theory, including learning competence, design competence, collaborative problem-solving competence, and assessment and feedback competence.

THEORETICAL REVIEW

A fundamental characteristic of project-based learning is its potential to absorb students in collaborative and inquiry-based learning to create records or look for solutions to real-world problems (Kokotsaki, et al, 2016). Given the holistic construct of teacher competence, the outcomes of teacher education, and the features related to project-based learning, a theoretical framework of teacher competence for teaching mathematical modeling proposed by Wess,et al. (2021) was considered appropriate for this study.

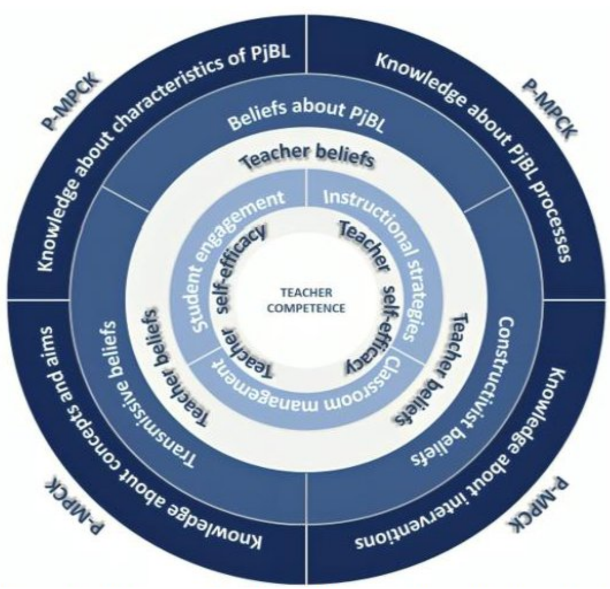

Figure 1: The conceptual model of mathematics teachers' competence in PBL contexts (Source: Li, Qi & Li, 2025)

Derived from the modeling framework, the conceptual model of math teachers' professional competence in project-based learning contexts (Figure 1) is presented in three facets: teacher beliefs, teacher self-efficacy, and P-MPCK. Teacher beliefs consist of three dimensions: beliefs about project-based learning (BFP), constructivist beliefs (CBF), and transmissive beliefs (TBF). BFP refers to the extent to which teachers agree with the practical values of PBL to students' achievement and development (Condliffe, et al, 2017), and the goal/value of project-based learning in mathematics education (Yunita,et al, 2021). CBF measures the extent to which teachers agree with a learner-oriented strategy (Voss ,et al, 2013). Instead, TBF emphasizes "the skill mastery with correct performance and conceptual understanding with unified knowledge" (Ernest, 1989) and measures the extent to which teachers agree with a teacher-oriented strategy (Voss,et al, 2013). Teacher self-efficacy is divided into three dimensions: self-efficacy for instructional strategies (SEI), self-efficacy for classroom management (SEC), and self-efficacy for student engagement (SES). SEC represents the extent to which mathematics teachers believe their abilities to deal with disruptive behavior in class and create a classroom environment suitable for project-based learning. SES represents the extent to which mathematics teachers believe their ability to create project-based learning tasks to evoke students' learning interest and help students learn mathematics through project-based learning. P-MPCK refers to the knowledge and/or ability to carry out project-based learning in math. Similar to the cognitive facets in the modeling framework (Borromeo Ferri, 2018), PMPCK could be specified into four dimensions:

1. The theoretical dimension provides a background for Project based learning in mathematics education, including conceptual knowledge of Project based learning (Ministry of Education, 2022; Thomas, 2000, e.g., theoretical foundation and curriculum demand) and the values and educational aims related to Project based learning (Herro, et al, 2021; Kokotsaki et al., 2016; e.g., enhancing students' collaborative problem solving skills), namely, knowledge about concepts and aims (KCA).

2. The task dimension refers to the ability to analyze and create project-based learning tasks; thereby, it includes knowledge about the characteristics and evaluation criteria of project-based learning tasks (Markham,et al, 2003; e.g., challenging questions, sustained inquiry, and public product), namely, knowledge about characteristics of project-based learning (KCH).

3. The diagnostic dimension represents the ability to identify phases in Project based learning lessons (Fisher,et al, 2020; e.g., entry, inquiry, and presentation phase) and to diagnose students' difficulties and misconceptions with their causes (Thomas, 2000; e.g., the challenges in generating meaningful scientific questions and conducting systematic inquiry activities), namely, knowledge about Project based learning processes (KDG).

4. The instruction dimension focuses on interventions when implementing project-based learning lessons, which contain different intervention measures along with corresponding effects on students' thinking and behavior (Thomas, 2000; e.g., providing scaffolds for learning or suggestions on teamwork), namely, knowledge about interventions (KIT). To attain these ends, the educational system experiences continuous changes.

Changes in many areas, such as new forms of communication, the transformations in the classroom and the school, the diversity of educational resources, the flexibility of curricula, management styles, learner profiles, and parent profiles, have led to discussions on how to develop and update

ISSN 2682-6704 • Volume 9, Issue 2, 2026 • pp. 63–80

teachers' skills. What makes a good teacher? What makes learning meaningful and relevant? Which learning methods and principles are critical for an employable generation to achieve the economic level wanted by society? What constitutes the main motivation for today's teacher competencies? What knowledge and skills teachers have and should have, and in which educational atmosphere they will use their knowledge and skills are fundamental questions. Therefore, teachers can be said to be faced with an unusual proficiency scale, both for the healthy functioning of education and for the ability to manage the skills students are expected to have in the future.

Objectives of the Study

The main objective of the study is to investigate Mathematics teachers' competencies in applying Project-Based Learning on students' mathematics achievement in Secondary schools in Bamenda III subdivision of Bamenda. Specifically, the study sought to investigate if teachers possess:

1. The cognitive structures that support teachers' behavior in applying PBL
2. The affective-motivational perspectives required when applying PBL
3. The variety of skills that allow teachers to find solutions to complicated and changing professional situations

Research Questions

The main research question was what are mathematics teachers' competencies in applying PBL to students' mathematics achievement? The specific research questions were

1. Do teachers possess the cognitive structures that support teachers' behavior in applying PBL?
2. Do teachers possess the affective-motivational perspectives required when applying PBL?
3. Do teachers possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL?

Research Hypotheses

The following hypotheses were formulated at the 0.05 level of significance to guide the study:

H_{o1}: Teachers do not significantly possess the cognitive structures that support their behavior in applying PBL.

H_{o2}: Teachers do not significantly possess the affective-motivational perspectives required when applying PBL.

H_{o3}: Teachers do not significantly possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL.

METHODOLOGY

The design of the study was descriptive survey research in which a questionnaire was used to collect data. The study was carried out in Bamenda III subdivision of the North West region of Cameroon. The population of the study comprised all the mathematics teachers in Bamenda III subdivision, numbering two hundred and thirty-eight (238). Two private and two government schools were randomly selected by balloting, and the mathematics teachers of the sampled schools constituted the sample, which numbered 96. The instrument used for data collection was a structured questionnaire designed by the researcher. The questionnaire was made up of twenty (20) items arranged in three clusters to answer the three research questions. The questionnaire had four sections as follows: Section A was on personal information of the respondents. Section B gathered information on the cognitive structures that support teachers' behavior in applying PBL. Section C sought information on the affective-motivational perspectives required when applying PBL. Section D sought information on a variety of skills that allow teachers to find solutions to complicated and changing professional situations when applying PBL. The f*ace* validity was carried out by one expert in mathematics education and one in measurement and evaluation. The reliability was established using Cronbach's alpha, and the coefficient is 0.78. Data collected by the researcher were analyzed using mean and standard deviation to answer the research questions, while the t-test was used to test the hypotheses at 0.05 level of significance.

RESULTS

The researcher investigated the participants' responses regarding whether mathematics teachers possess the cognitive structures that support teachers' behavior in applying PBL. Based on the participants' (n = 96) responses, Table 1 presents the results of Survey A for six attributes that were listed as best describing cognitive structures that support teachers' behavior in applying PBL. The researcher first examined teachers' views regarding the motivation to gain and master mathematics knowledge when applying PBL. Overall, teachers indicated that they were motivated to gain and master mathematics knowledge when applying PBL (53% agreed that they are motivated to gain and master mathematics knowledge when applying PBL). A small number of participants (43% disagreed with the fact that they are not motivated to gain and master mathematics knowledge when applying PBL. In terms of motivation to be creative and innovative, a majority considered that there was no motivation to be creative and innovative when applying PBL (55.2%). Some participants (65%) thought that they possessed the critical thinking necessary in utilising PBL, and some (58%) considered that they possess decision making potentials necessary in utilising PBL. However, most of the participants (71%) thought that they lacked ICT literacy, and (64%) indicated that they do not develop collaboration when applying PBL. Overall, mathematics teachers indicated that they did not have the cognitive structures that support teachers' behavior in applying PBL. However, the teachers were more concerned with gaining mastery of knowledge, critical thinking, and decision-making.

ISSN 2682-6704 • Volume 9, Issue 2, 2026 • pp. 63–80

Research Question One: Do teachers possess the cognitive structures that support teachers' behavior in applying PBL?

Table 1: Cognitive Structures that Support Teachers' Behavior in applying PBL

	Cognitive Structures	Agree f (%)	Disagree f (%)	Do not know f (%)
1	Motivated to Gaining and Mastery mathematics Knowledge	51(53.12)	42(43.8)	3(3.13)
2	Motivated to Creativity and innovation	41(42.7)	53(55.2)	2(2.1)
3	Critical Thinking	62(64.6)	33(34.4)	1(1.04)
4	Decision making	56(58.3)	36(37.5)	4(4.2)
5	Information and communication technologies literacy	24(25)	68(70.8)	4(4.2)
6	Development of Collaboration/teamwork	34(35.4)	61(63.5)	3(3.13)

Note: n= 96; non respondents = 0

Based on the participants' (n = 96) responses, Table 2 presents the results of Survey A for five attributes that were listed as best describing meta-cognitive abilities required when applying PBL. The researcher first examined teachers' views regarding self-regulation when applying PBL. Overall, teachers indicated that they possessed self-regulation when applying PBL (51% agreed that they have self-regulation when applying PBL). A small number of participants (48% disagreed with the fact that they do not have self-regulation when applying PBL. In terms of organizing and scheduling, a majority considered that they could define the subject and plan time resources when applying PBL (55.2%). Some participants (53%) thought that they were committed and careful in utilising PBL, and some (44%) considered that there was good flow, positive spirit, and productive environment in utilising PBL. However, most of the participants (63%) thought that they did not connect theory to practice when applying PBL. Overall, mathematics teachers indicated that they have self-regulation, organizing, and scheduling when applying PBL. However, the teachers did not have a good flow, positive spirit, and productive environment, and could not connect theory and practice when utilising PBL.

$H_{o1:}$ Teachers do not significantly possess the cognitive structures that support their behavior in applying PBL.

Table 2: t-test analysis of the mean possession of the cognitive structures that support teachers' behavior in applying PBL.

Status	N	Mean	Std. Deviation	Df	t-cal	Sig. (2-tailed)
Teachers possessing	45	2.57	.17	237	-0.751	0.42
Teachers not possessing	51	2.62	.17			

The result of the study, as presented in Table 2, shows the t-test analysis of the significant difference between the mean ratings of teachers who possess or do not possess the cognitive structures that support their behavior in applying PBL.

Result shows that a t-value of -0.751 with degree of freedom of 237 and a probability value of 0.42 was obtained. Since the probability value of 0.42 is greater than the 0.05 level of significance for testing the null hypothesis. It means that the result is not significant. The null hypothesis, which stated that teachers do not significantly possess the cognitive structures that support their behavior in applying PBL, is therefore accepted. The inference drawn is that mathematics teachers did not differ significantly in their possession of the cognitive structures that support their behavior in applying PBL.

Research Question Two: Do teachers possess the affective-motivational perspectives required when applying PBL?

Table 3: Meta-cognitive abilities required when applying PBL

	Meta-cognitive abilities	**Agree f (%)**	**Disagree f (%)**	**Do not know f (%)**
7	Self regulation	49 (51)	46 (47.9)	1(1.04)
8	Organising and scheduling (defining the subject and planning time resource)	53(55.2)	40(41.7)	3(3.13)
9	Perseverance (commitment and carefulness)	51 (53.13)	43(44.8)	2(2.1)
10	Pleasant atmosphere (good flow, positive spirit, and productive environment)	42(43.8)	52(54.2)	2(2.1)
11	Connection between theory and practice(proximity of practicality, connection to everyday life, contextuality, usefulness, application)	35(36.5)	60(62.5)	1(1.04)

Note: n= 96; non respondents = 0

Table 3 shows teachers' responses to five affective traits required when applying PBL. Overall, PBL was considered suitable for implementation in mathematics education. Only a small number of participants (24%) thought that PBL was unsuitable for mathematics. In terms of suitable applications, a majority considered PBL to be suitable for revising mathematics content (85%) and for learning new content (84%). Some participants (23%) thought that PBL could be used only for learning less important things. However, most of the participants (68%) thought that mathematics plays a less important role as a supportive tool in a project consisting of other study subjects. Overall, most teachers shared a similar opinion on the suitable applications for implementing PBL in mathematics. However, they believed that PBL is suitable for using for any mathematics learning.

ISSN 2682-6704 • Volume 9, Issue 2, 2026 • pp. 63–80

H_{o2}: Teachers do not significantly possess the affective-motivational perspectives required when applying PBL.

Table 4: t-test analysis of the mean possession of the affective-motivational perspectives required when applying PBL.

Status	N	Mean	Std. Deviation	Df	t-cal	Sig. (2-tailed)
Teachers possessing	50	2.71	.17	248	-0.642	0.31
Teachers not possessing	46	2.32	.17			

The result of the study, as presented in Table 4, shows the t-test analysis of the significant difference between the mean ratings of teachers who possess or do not possess the cognitive structures that support their behavior in applying PBL.

Result shows that a t-value of -0.642 with degree of freedom of 248 and a probability value of 0.31 was obtained. Since the probability value of 0.31 is greater than 0.05 level of significance for testing the null hypothesis. It means that the result is not significant. The null hypothesis, which stated that teachers do not significantly possess the affective-motivational perspectives required when applying PBL, is therefore accepted. The inference drawn is that mathematics teachers did not differ significantly in their possession of the affective-motivational perspectives required when applying PBL.

Table 5: Affective Traits and Beliefs

	Affective Traits and Beliefs	Agree f (%)	Disagree f (%)	Do not know f (%)
12	PBL is NOT suitable for mathematics education.	23(23.96)	71(73.96)	2(2.1)
13	PBL is suitable for revising mathematics content.	82(85.4)	11(47.9)	3(3.13)
14	PBL is suitable for learning new content.	81(84.4)	14(14.6)	1(1.04)
15	PBL can ONLY be used for learning less important things.	22(22.9%)	72(75%)	2(2.1%)
16	Mathematics is a supportive tool for projects in other study subjects	65(67.7%)	29(30.2%)	2(2.1%)

Note: n= 96; non respondents = 0

Table 6 shows teachers' responses to four skills that allow teachers to find solutions to complicated and changing professional situations when applying PBL.

https://doi.org/10.52589/BJELDP-G4R95TLT

Overall, teachers did not have the skills that allow them to find solutions to complicated and changing professional situations when applying PBL. A small number of participants (45%) experienced growth of responsibility. In terms of the development of problem-solving skills, a majority (52%) considered possessing learning of communication and career skills. Some participants (35%) possessed developed data collection skills. Overall, most teachers shared a similar opinion on the skills that allow teachers to find solutions to complicated and changing professional situations when applying PBL. However, they were of the opinion that they did not possess the skills expected of them to find solutions to complicated and changing professional situations when applying PBL.

Research Question Three: Do teachers possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL?

Table 6: Skills that allow teachers to find solutions to complicated and changing professional situations when applying PBL

	Skills	Agree f (%)	Disagree f (%)	Do not know f (%)
17	Growth of responsibility.	43(44.8)	50(52.1)	3(3.13)
18	Development of problem-solving skills.	45(46.9)	49(51.04)	2(2.08)
19	Learning of communication and career skills.	50(52.08)	45(46.9)	1(1.04)
20	Development of data collection skills.	34(35.42)	52(54.17)	0(0)

H_{o3}: Teachers do not significantly possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL.

Table 7: t-test analysis of the mean possession of the variety of skills that allow teachers to find solutions to complicated and changing professional situations when applying PBL.

Status	N	Mean	Std. Deviation	Df	t-cal	Sig. (2-tailed)
Teachers possessing	39	2.14	.19	235	-0.724	0.56
Teachers not possessing	49	2.62	.17			

The result of the study, as presented in Table 4, shows the t-test analysis of the significant difference between the mean ratings of teachers who possess or do not possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL. The result shows that a t-value of -0.724 with degrees of freedom of 235 and a probability value of 0.56 was obtained. Since the probability value of 0.56 is greater than 0.05 level of significance for testing the null hypothesis. It means that the result is not significant. The null hypothesis, which stated that teachers do not significantly possess the variety of skills that allow them to find solutions to complicated and changing professional situations when applying

PBL, is therefore accepted. The inference drawn is that mathematics teachers did not differ significantly in their possession of the variety of skills that allow them to find solutions to complicated and changing professional situations when applying PBL.

Discussion of Findings

The findings from research question one revealed that mathematics teachers have self-regulation, organizing, and scheduling when applying PBL. However, the teachers did not have a good flow, positive spirit, and productive environment, and could not connect theory and practice when utilising PBL. Another finding is that mathematics teachers did not differ significantly in their possession of the cognitive structures that support their behavior in applying PBL. These findings align with the observation of Rosen (2017) that with changes in the world, it is necessary to reshape how and what to teach in the educative process to meet the needs and be abreast with the growing demands of society. The teachers lacked good flow, positive spirit, and productive environment, and were not able to connect theory and practice when utilising PBL, which might have led to students not being able to utilise PBL, and so they achieve poorly in mathematics. This calls for teachers to be more involved in the teaching-learning process to enable students to achieve success in their academic pursuits.

The results from research question two indicated that mathematics teachers were of the opinion that PBL is suitable for using for any mathematics learning. They did not differ significantly in their possession of the affective-motivational perspectives required when applying PBL. This finding agrees with the work of Yang and Kaiser (2022), who reported that researchers in China have been devoted to exploring teacher competence in project-based learning contexts, because instructional quality and student achievement are anchored on teacher competence. And that some particular competence is needed for teachers to meet demands and challenges for project-based learning contexts in practice.

The results from research question three revealed that teachers did not possess the skills expected of them to find solutions to complicated and changing professional situations when applying PBL. A teacher not possessing the skills is an indicator that they cannot deliver the concepts to the students appropriately. Teachers are required to build up their capacities in order to meet the needs of the students and the changing times.

CONCLUSION

This study sought to investigate the competencies of mathematics teachers in utilizing PBL on students' achievement in mathematics. Mathematics teachers' competencies were considered in terms of the cognitive structures, affective motivational perspectives, and the skills they possess. Mathematics teachers. The teacher's lack of good flow, positive spirit, and productive environment, and not being able to connect between theory and practice when utilising PBL, could be attributed to a lack of motivation from the administration and the teachers' conservative attitude to adapt to the changing world. Teachers did not differ significantly in their possession of the affective-motivational perspectives required when applying PBL. There is a need for teachers to be more proactive and resourceful so as to give out the best to the students for better achievement. It is a major issue to learn that teachers did not possess the skills expected of them to find solutions to complicated and changing professional situations when applying PBL. With this scenario, the students are likely to register poor achievement in the subject.

RECOMMENDATIONS

From the findings of the study, the following recommendations were made:

1. Mathematics teachers should build up their capacities to be able to give out their best to keep up with the changing times. To achieve these ends, the Ministry of Education and the mathematics teachers' association should offer refresher courses to teachers to equip them with the skills and values required to function in the 21st-century classroom.

2. Teacher training institutions also have the duty to equip teacher trainees with the skills required in implementing innovative instructional strategies like PBL.

3. Motivations and incentives should be given to teachers to enable get the resources that are needed in implementing the desired instructional strategies.

REFERENCES

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? Journal of Teacher Education, 59(5), 389-407. https://doi.org/10.1177/0022487108324554

Bani-Hamad, A.M.H. & Abdullah, A.H. (2019). The effect of project-based learning to improve the 21st-century skills among Emirati secondary students. *International Journal of Academic Research in Business and Social Sciences, 9*(12), 560-573.

Beswick, K. (2005). The beliefs/practice connection in broadly defined contexts. Mathematics Education Research Journal, 17, 39-68. https://doi.org/10.1007 /BF03217415

Borromeo Ferri, R. (2018). Learning how to teach mathematical modeling in school and teacher education. Springer. https://doi.org/10.1007/978-3-319- 68072-9

Condliffe, B., Quint, J., Visher, M. G., Bangser, M. R., Drohojowska, S., Saco, L., & Nelson, E. (2017). Project-based learning: A literature review. MDRC

Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagogical content knowledge: A systematic review of the way in which the concept has pervaded mathematics educational research. Teaching and Teacher Education, 34, 12-25. https://doi.org/10.1016/j.tate.2013.03.001

Döhrmann, M., Kaiser, G., & Blömeke, S. (2012). The conceptualization of mathematics competencies in the international teacher education study, TEDS-M. ZDM Mathematics Education, 44(3), 325-340. https://doi.org/10.1007/s11858-012-0432-z

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), Mathematics teaching: The state of the art (pp. 249-253). Falmer.

Fisher, D., Kusumah, Y. S., & Dahlan, J. A., 2020. Project-based learning in mathematics: A literature review. Journal of Physics: Conference Series, 1657(1), Article 012032. https://doi.org/10.1088/1742- 6596/1657/1/012032

Filiz, A. (2025). The use of digital tools in mathematics teaching: Bibliometric approach. International Electronic Journal of Mathematics Education, 20(4), em0844. https://doi.org/10.29333/iejme/16637

Gümüs, A. (2022). Twenty-first-century teacher competencies and trends in teacher training. Y. Alpaydın and C. Demirli (eds.), Educational Theory in the 21st Century, Maarif Global Education Series, https://doi.org/10.1007/978-981-16-9640-4_11.

Herro, D., Quigley, C., & Abimbade, O. (2021). Assessing elementary students' collaborative problem-solving in makerspace activities. Information and Learning Sciences, 122(11/12), 774-794. https://doi.org/10.1108/ILS-08-2020-0176

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. Review of Educational Research, 67(1), 88-140. https://doi.org/10.3102/00346543067001088

Hoy, A. W., Davis, H., & Pape, S. J. (2006). Teacher knowledge and beliefs. In P. A. Alexander, & P. H. Winne (Eds.), Handbook of educational psychology (pp. 715-737). Lawrence Erlbaum Associates Publishers.

Klieme, E., Hartig, J., & Rauch, D. (2008). The concept of competence in educational contexts. In J. Hartig, E. Klieme, & D. Leutner (Eds.), Assessment of competencies in educational contexts (pp. 3-22).

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267-277. https://doi.org/10.1177/ 1365480216659733

Korthagen, F.A.J.(2004). In Search of the Essence of a Good Teacher: Towards a More Holistic Approach in Teacher Education. Teach. Teach. Educ. 2004, 20, 77–97. [CrossRef]

Larmer, J., Mergendoller, J., and Boss, S. (2015). Setting the standard for project-based learning: A proven approach to rigorous classroom instruction. Alexandria, VA: ASCD.

Le Deist, F. D., & Winterton, J. (2005). What is competence? Human Resource Development International, 8(1), 27-46. https://doi.org/10.1080/ 1367886042000338227

Liljedahl, P., Rösken, B., & Rolka, K. (2021). Changes to preservice elementary teachers' beliefs about mathematics and the teaching and learning of mathematics: How and why? Journal of Adult Learning, Knowledge and Innovation, 4(1), 20-30. https://doi.org/10.1556/2059.03.2019.09

Li, S.; Qi, C. & Li, R. (2025).The conceptualisation of mathematics teachers' professional competence in project-based learning contexts. *Eurasia Journal of Mathematics, Science and Technology Education, 21*(7), em2660 ISSN:1305-8223 (online) https://doi.org/10.29333/ejmste/16562

Markham, T., Larmer, J., & Ravitz, J (2003). Project-based learning handbook: A guide to standards-focused project-based learning for middle and high school teachers (2nd ed.). Buck Institute for Education.

Ministry of Education. (2022). Mathematics Curriculum Standards for Compulsory Education. Retrieved August 20, 2024, from http://www.moe.gov.cn/srcsite/A26/s8001/202204/t20220420_619921.html

National Council of Teachers of Mathematics. Principles and standards for school mathematics. Reston, VA: NCTM. 2000.

Neubrand, M. (2018). Conceptualizations of professional knowledge for teachers of mathematics. ZDM Mathematics Education, 50, 601-612. https://doi.org /10.1007/s11858-017-0906-0

Odo, I.O. (2017). Efficacy of First principles of instruction in improving students' achievement, Interest, and retention in number and numeration in Nsukka education zone of Enugu state. *An unpublished Ph.D Thesis, University of Nigeria, Nsukka.*

Omoroh, P & Adiri, I.E. (2019). Effect of concept mapping and lecture instructional approaches on students' mathematics achievement. Abacis (Mathematics Education Series), 44(1), 231-235

Rosen, A. (2017). "A technology revolution isn't coming to classrooms, it's here". Internet: https://www.huffingtonpost.com/amy-rosen/atechnology-revolution-is-here_b_9857182.html.

Soulé, H. & Warrick, T. (2015). "Defining 21st-century readiness for all students: What we know and how to get there". *Psychology of Aesthetics, Creativity, and the Arts. 9*(2), 178–186. Available: https://doi.org/10.1037/aca0000017 [Jan. 29, 2020].

The Partnership for 21st-Century Learning. (2015). P21 framework definitions. Partnership for 21st-century Learning.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14. https://doi.org/10.3102/ 0013189X015002004

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, 57(1), 1-23. https://doi.org/10.17763/haer. 57.1.j463w79r56455411

Thomas, J. W. (2000). A review of research on project-based learning. Autodesk.

Thompson, A. (1992). Teacher's beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics (pp. 127-146). IAP.

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. Teaching and Teacher Education, 17(7), 783-805. https://doi.org/10.1016/S0742-051X(01)00036-1

Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. Review of Educational Research, 68(2), 202-248. https://doi.org/10.3102/00346543068002202

Toom, A.; Pyhältö, K.; Pietarinen, J.; Soini, T. Professional Agency for Learning as a Key for Developing Teachers' Competencies? Educ. Sci. 2021, 11, 324. https:// doi.org/10.3390/educsci11070324

Viro, E., Lehtonen, D., Joutsenlahti, J., & Tahvanainen, V. (2020). Teachers' perspectives on project-based learning in mathematics and science. *European Journal of Science and Mathematics Education, 8*(1), 12-31. https://doi.org/10.30935/scimath/9544

Voss, T., Kleickmann, T., Kunter, M., & Hachfeld, A. (2013). Mathematics teachers' beliefs. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), Cognitive activation in the mathematics classroom and professional competence of teachers: Results from the COACTIV project (pp. 249- 271). Springer. https://doi.org/10.1007/978-1- 4614-5149-5_12

Wess, R., Klock, H., Siller, H. S., & Greefrath, G. (2021). Measuring professional competence for the teaching of mathematical modeling: A test instrument. In G. Kaiser, G. A. Stillman, M. S. Biembengut, W. Blum, H. Doerr, P. Galbraith, T. Ikeda, M. Niss, & J. Xie (Eds.), International perspectives on the teaching and learning of mathematical modeling (pp. 249-260). Springer. https://doi.org/10.1007/978-3-030-78071-5_3

Weinert, F. E. (2001). Concept of competence: A conceptual clarification. In D. S. Rychen & L. H. Salganik (Eds.), Defining and selecting key competencies (pp. 45-65). Hogrefe & Huber Publishers.

Wan, H., & Gao, X. Y. (2023). Project-based learning teachers: Role cognitions and competence elements. Teacher Education Research, 35(2), 63-68. https://doi.org/10.13445/j.cnki.t.e.r.2023.02.001

Yang, X., & Kaiser, G. (2022). The impact of mathematics teachers' professional competence on instructional quality and students' mathematics learning outcomes. Current Opinion in Behavioral Sciences, 48, Article 101225. https://doi.org/10.1016/j.cobeha. 2022.101225.

Ye, B. X., Sang, G. Y., & Wang, X. Y. (2021). Teacher competence in project-based learning: Framework construction based on mixed surveys. Journal of Shanghai Educational Research, 10, 23-29. https://doi.org/10.16194/j.cnki.31-1059/g4.2021. 10.006.

Yunita, Y., Juandi, D., Kusumah, Y. S., & Suhendra, S. (2021). The effectiveness of the project-based learning (PBL) model in students' mathematical ability: A systematic literature review. Journal of Physics: Conference Series, 1882(1), Article 012080. http://doi.org/10.1088/1742-6596/1882/1/01208 0

Zhang, W. L., & Yang, X. Q. (2021). The structure and connotation of teacher competence for project-based teaching based on the national curriculum. Educational Information Technology, Z2, 3-7.