



Impact of Professional Development on Mathematics Teachers' Content Knowledge

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Abstract

This study examined how professional development affected math instructors' subject-matter expertise. The study was done in Yenagoa Local Government Area of Bayelsa State. The research design used was survey-based, and the study's population consisted of 37 mathematics teachers from 35 secondary schools. For the study, the whole population was involved. The Mathematics Teachers' Subject Content and Pedagogical Knowledge Questionnaire (MTSCPQ) was the tool used to collect the data. Cronbach-Alpha was used for trial testing, and a reliability value of 0.76 was obtained. The research questions were addressed using descriptive statistics, specifically mean and standard deviation. It was discovered that subject content and pedagogical content knowledge are significantly impacted by professional development. Based on the findings, recommendations were made, including the need for annual refresher courses for all teachers and mandatory training for all newly hired teachers.

Keywords: Professional Development, Content Knowledge, Pedagogical Content Knowledge, Mathematics Teachers

Introduction

Mathematics is very important to all disciplines and all spheres of life because of the numerous contributions it provides, amongst which is technological developments. The importance of mathematics as a tool in the pursuit of technological advance cannot be overstated (Adu et al., 2014). Since mathematics has so many applications and helps the mind grow, it is evident in every aspect of human activity. But even with its broad applicability, a lot of students still struggle with the material. This is attributed to a number of variables (Kwateng, 2019). Teaching mathematics and teachers' subject-matter expertise appear to be the most important of these numerous aspects. Currently, there has been a significant growth in research in the fields of mathematics teaching and mathematics teacher professional development. It is necessary to gain a deeper understanding of the fundamentals of mathematics teacher education as well as the professional development environments that support teachers' professional growth. Furthermore, studies on mathematics instruction and teacher preparation have implications for classrooms, schools, and larger institutional contexts in the context of education (Zehetmeier et al., 2021).

Professional development is essential in enhancing the subject content knowledge of a teacher (Alfred et al., 2023), mathematics teachers are inclusive. It can have a significant impact on their ability to effectively teach mathematics, keep up with the latest educational trends, and improve student outcomes. Professional development influences the subject content knowledge of mathematics teachers through, deepening understanding of mathematics concepts which often includes workshops, seminars, and courses that delve into specific mathematical concepts, theories, and principles, exposure to updated curriculum and pedagogy which keeps teachers updated on the latest curriculum standards, instructional strategies, and pedagogical approaches in mathematics education, as well as integration of technology which often includes training on integrating technology into mathematics instruction, and improvement of instructional strategies where teachers gain insights into various instructional methods and strategies that are effective in teaching mathematics (Badasie & Schulze, 2019). In addition, professional development also influences mathematics teacher's subject content knowledge through enhanced problem-solving skills which often focuses on improving problem-solving skills and collaboration and peer learning which often includes collaborative activities, such as group discussions and peer-to-peer learning as well as feedback and assessment practices, building confidence and passion for mathematics and alignment with educational goals and standards which ensures that

teachers align their subject content knowledge with educational goals, standards, and objectives set by education boards and institutions.

It has been determined that professional development for educators is essential to raising the calibre of educators as well as their pedagogical content understanding and practices. Professional development has essentially been accepted as a legislative approach to help all students meet high academic requirements and increase the number of highly qualified instructors (Askew, 2019). Venuste and Jean (2022) specifically presented evidence that pupils outperformed their peers on mathematics examinations in classrooms where teachers had received professional development in working with unique populations. Additionally, on evaluations of mathematics, pupils fared better than their peers whose teachers had undergone professional development in higher-order thinking skills.

Yang et al. (2018) state that coherence, active learning, adequate duration, group engagement, an emphasis on content knowledge, and a reform approach rather than a traditional one are the characteristics of professional development that make it most effective. To promote educational transformation, teacher professional development is essential (Tay et al., 2017). We contend that action research, which is influenced by pertinent theories like contextual learning and socio-constructivist learning, could support practitioners' professional development in any field. According to Wright (2017), professional development is defined as the process of enhancing instructors' knowledge, abilities, attitudes, and beliefs in the subjects of science and mathematics. By engaging in professional development opportunities, teachers can enhance their comprehension of students, the subject matter, and the teaching process. Enhancing student accomplishment is the goal of professional development. Professional development needs to result in better student outcomes and teacher learning in order to be effective. Effective professional development, according to Norton (2019), comprises three structural and three fundamental elements. Focusing on subject matter expertise, providing chances for active learning, and ensuring coherence with other learning activities are essential components of successful professional development. The type of professional development activity, group involvement, and activity duration are structural elements that influence teacher learning. Adler and Venkat (2014) emphasized learning principles that would adequately facilitate the development of teachers in their profession, in such areas as understanding their students, the content to be taught, and competency in the teaching. The principle is such that it emphasises teachers come into the classroom biased with preconceptions that are of negative influence. The new paradigm gives equal opportunities to all teachers to develop their potential to have access to realities which will impact on their abilities to inculcate knowledge to the students.

Statement of Problem

Teachers are seen as "learning specialists" in a field rich in knowledge. Teachers are anticipated to evaluate and incorporate new, relevant information into their core professional practices. Additionally, they are required to periodically update their knowledge to improve their teaching and adapt to students' changing needs. By exploring the knowledge that contributes to effective teaching and learning, we aim to enhance teacher quality, which is crucial for boosting student achievement. The primary goal of examining teacher knowledge is to improve student outcomes. Therefore, this study examines the content knowledge of mathematics teachers and the impact of professional development on their practice.

Objectives of the study

This study seeks to find out the impact of professional development on subject content knowledge of mathematics teachers. Specifically, the study opts to:

1. determine the impact of professional development on the subject content knowledge of mathematics teachers.
2. determine the impact of professional development on the pedagogical content knowledge of mathematics teachers.

Research Questions

The following research questions guided this study:

1. What impact does professional development have on the subject content knowledge of mathematics teachers?
2. What impact does professional development have on the pedagogical content knowledge of mathematics teachers?

Methodology

In order to investigate teachers' perceptions of professional development's effects on the subject and the pedagogical content knowledge of mathematics instructors, this study employed a survey research design. The Yenagoa Local Government Area in Bayelsa State served as the study's location. Thirty-seven (37) mathematics teachers from thirty-five (35) schools in the Yenagoa Education Zone make up the study's population. Since the whole population was utilized, no sample was taken. The Mathematics Teachers' Subject Content and Pedagogical Knowledge Questionnaire (MTSCPQ) was the tool used to collect the data. The purpose of the tool is to assess mathematics teachers' subject and pedagogical content understanding. The instrument consists of two sections A and B. The participant's personal information is found in Section A. Section B collects data on how pedagogical content and subject content knowledge of mathematics teachers affect professional development. Two professionals validated the instrument. One measurement and evaluation specialist and one mathematics educator. Using Cronbach-alpha was used for trial testing, and a reliability value of 0.76 was obtained. In order to address the study issues, the acquired data were analyzed using the descriptive statistics of mean and standard deviation. Mean and standard deviation were used in answering the research questions.

Results

Research Question 1: What impact does professional development have on the subject content knowledge of mathematics teachers?

Table 1: Mean and standard deviations of the subject content knowledge of mathematics teachers (N=37)

S/N	Items	Mean	SD	Remark
1	I always define and go over basic concepts in my math classes.	2.57	.50	HI
2	It is crucial to recognize the characteristics of comparable triangles in geometry	2.54	.51	HI
3	It's critical to distinguish between statistics and probability in statistics	2.65	.48	HI
4	Students must understand the difference between a sample and a population in statistics.	2.41	.50	LI
5	Occasionally, I give students examples of difficult arithmetic problems and help them answer them	2.59	.50	HI
6	I always tie my arithmetic lessons to the real-world experiences of my students.	2.43	.50	LI
7	I always use concrete objects to address students' misconceptions in mathematics	2.62	.50	HI
8	The use of appropriate techniques eases up understanding of mathematics concepts	2.24	.44	LI
	Subject content	2.51	0.49	HI

Table 1 demonstrates that teachers have a substantial impact on items 1, 2, 3, 5, and 7 with mean score ratings ranging from 2.54 to 2.62. While items 4, 6, and 8 (with mean score ratings ranging from 2.24 to 2.43) demonstrate no impact. Mathematics teachers' total mean subject content knowledge score is 2.51, indicating that professional development has a positive effect on subject material knowledge.

Research Question 2: What impact does professional development have on the pedagogical knowledge of mathematics teachers?

Table 2: Mean and standard deviations of the pedagogical content knowledge of mathematics teachers (N=37)

S/N	Items	Mean	SD	Remark
1	When computation becomes complex, I occasionally bring in a spreadsheet	2.54	.51	HI
2	Teaching probability with dice helps students understand it better	2.59	.50	HI
3	I use a variety of mathematics apps to help students solve problems	2.54	.50	HI
4	I use teacher-student strategies to teach only more advanced concepts	2.54	.51	HI
5	I use student feedback to create an introduction for my next class	2.68	.48	HI
6	I occasionally take students to the mathematics lab to use computers to compute complex concepts	2.51	.51	HI
7	I use Geogebra to solve complex problems in geometry and algebra	2.54	.56	HI
8	I always remind students to use math software to plot graphs for easy understanding	2.49	.51	LI
	Pedagogy content	2.55	.51	HI

Table 2 reveals that teachers exhibit high impact in items 1 through 7, with mean score ratings ranging from 2.51 to 2.68. Conversely, teachers show low impact in only item 8, with mean score ratings of 2.49. The mean score of pedagogy content knowledge among mathematics teachers is 2.55, indicating that there is a positive impact between mathematics teachers' pedagogy content knowledge and professional development.

Discussion

The study found that professional development significantly affects teachers' subject content and pedagogical content knowledge from their perspective. This implies that the professional development of teachers showed a positive effect on the subject content knowledge of mathematics teachers. It also showed a positive effect on the pedagogical content knowledge of mathematics teachers. These results are consistent with Robin et al. (2017), Ezeugwu and Diri (2014), as well as Alfred et al. (2023) whose studies found that professional development improved mathematics instructors' subject and pedagogical topic knowledge. These results suggest that in order to ensure effective instruction and higher student achievement in mathematics, professional development for teachers is crucial. Additional research by Oleson (2010) revealed that teacher practices changed as a result of professional development, becoming more student-centered. Additionally, it improved teachers' self-efficacy in the recommended strategy.

Conclusion

The impact of professional development on mathematics instructors' subject-matter expertise was examined in this study. This study demonstrates the beneficial effects of professional development on math instructors' topics and pedagogical content understanding. These results suggest that in order to support effective teaching and raise students' mathematics performance, professional development for teachers is crucial. It also demonstrates how professional development has aided in exposing mathematics teachers to a variety of contemporary techniques and trends for recognizing and resolving students' prior knowledge, preconceptions, and misconceptions before introducing new concepts to them. Additionally, it gives teachers a forum to engage with recently introduced teaching aids and technologies in order to enhance their pedagogical content knowledge and enhance their instruction in the classroom. The best opportunities for teachers to expand their curricular knowledge are provided by professional development, which also helps instructors' topic and pedagogical content knowledge to grow. Teachers can become more knowledgeable about contemporary approaches to structuring curriculum for instruction and conveying information in a way that makes sense to students through professional development opportunities.

Recommendations

The findings proffered the following recommendations:

1. Teachers should participate in the planning of professional development programmes.
2. There should be compulsory training for all newly recruited teachers and refresher courses for all teachers annually.
3. Teachers should be well motivated to participate.

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