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Relationship between Teachers' Self-Reported Implementation of Innovative Teaching Methods and their Perceptions of Student Academic Performance in 3D geometry in Public Day Secondary Schools in Musanze District, Rwanda

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Abstract

Purpose: This study examined the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in three-dimensional (3D) geometry in public day secondary schools in Musanze District, Rwanda. The study focused on determining whether greater implementation of innovative instructional practices was associated with more favorable teacher perceptions of students' academic performance in 3D geometry.

Methodology: The study employed a quantitative research approach and a correlational research design. The study involved 50 mathematics teachers from six selected public day secondary schools in Musanze District using a census approach. Data were collected using the Teachers' Instructional Practices and Perceptions Questionnaire (TIPPQ), which measured teachers' implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry. Data were analyzed using descriptive statistics and Pearson Product-Moment Correlation Analysis.

Findings: The findings revealed a strong, positive, and statistically significant relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry, $r(48) = .748$, $p < .001$. The coefficient of determination showed that approximately 56.0% of the variance in teachers' perceptions of student academic performance was associated with the implementation of innovative teaching methods. The results indicate that teachers who reported greater implementation of inquiry-based learning, guided discovery, collaborative learning, and technology-supported instruction also reported more favorable perceptions of students' performance in 3D geometry.

Unique Contribution to Theory, Practice and Policy: The study contributes contextual evidence to Constructivist Learning Theory and the Technological Pedagogical Content Knowledge (TPACK) Framework by demonstrating the relevance of innovative, learner-centered, and technology-supported instructional practices in 3D geometry. In practice, mathematics teachers should strengthen the consistent use of inquiry-based learning, guided discovery, collaborative activities, and digital visualization tools such as GeoGebra and SketchUp. School leaders and education policymakers should provide appropriate instructional resources and targeted professional development to support teachers in effectively implementing innovative methods for 3D geometry instruction.

Keywords: *Innovative Teaching Methods, Teacher Implementation, Academic Performance, Three-Dimensional Geometry, Mathematics Education, Secondary Schools, Rwanda*

1. Introduction

Mathematics plays a fundamental role in the development of logical reasoning, critical thinking, problem-solving abilities, and analytical skills that are essential for academic achievement and participation in science, technology, engineering, and mathematics (STEM) disciplines. Mathematics education is therefore an important component of secondary education because it equips learners with competencies that can be applied in further education, employment, technological development, and everyday decision-making. However, mathematics remains a challenging subject for many learners, particularly when instruction involves abstract concepts that require learners to construct mental representations and apply mathematical reasoning. One area that presents particular challenges is geometry, where learners are expected to visualize shapes, understand relationships among geometric elements, and apply mathematical principles to unfamiliar situations. Spatial thinking is especially important for success in mathematics and STEM-related disciplines, and evidence indicates that spatial skills can be developed through appropriate educational interventions (Uttal et al., 2013).

Three-dimensional geometry is among the areas of mathematics that require substantial spatial reasoning and visualization. Unlike two-dimensional geometry, three-dimensional geometry requires learners to reason about objects involving length, width, and height and to mentally interpret relationships that may not be immediately visible from conventional diagrams. Learners may experience difficulties when they are required to visualize three-dimensional objects, identify their properties, interpret different views, and solve problems involving spatial relationships. These demands make the instructional approaches used by mathematics teachers particularly important. When learners are provided with opportunities to interact with geometric representations, manipulate objects, investigate relationships, and receive appropriate guidance, they may develop stronger conceptual and spatial understanding. Research on spatial thinking demonstrates that spatial skills are closely connected to achievement in STEM fields and can be enhanced through training and educational experiences (Uttal et al., 2013).

To address the challenges associated with mathematics learning, educational systems have increasingly promoted innovative teaching methods that emphasize active participation, inquiry, collaboration, problem solving, guided discovery, and technology-supported learning. Innovative approaches seek to change the traditional role of the teacher from being primarily a transmitter of information to becoming a facilitator of learners' active construction of knowledge. Such approaches may provide learners with opportunities to explore mathematical relationships, discuss alternative solutions, apply concepts to practical situations, and use technological tools to visualize abstract ideas. Evidence from research on inquiry-based learning indicates that student-centered inquiry approaches can contribute positively to academic achievement by encouraging learners to participate actively in the learning process. A meta-analysis by Kaçar et al. (2021), for example, found that inquiry-based learning significantly increased academic achievement, with particularly meaningful effects reported at the secondary school level.

The successful implementation of innovative teaching methods, however, depends largely on teachers' knowledge, skills, confidence, and willingness to change their classroom practices. The availability of innovative instructional approaches does not automatically result in their effective classroom implementation. Teachers must understand how particular methods can be aligned with curriculum objectives, learning content, learner characteristics, available resources, and assessment requirements. This is particularly important in mathematics because innovative methods may require teachers to reorganize classroom interactions, provide learning resources, facilitate group activities, guide inquiry, and integrate technological tools into mathematical tasks. In Rwanda, evidence from mathematics education research has shown that teachers' transition from teacher-centered to learner-centered pedagogy has been an important component of curriculum reform. Uworwabayeho (2009), in a case study involving secondary mathematics teachers in Rwanda, found that teachers became more aware of the need for pedagogical change and became more flexible in accepting learner autonomy.

At the international level, innovative approaches to geometry instruction have increasingly incorporated technology to support visualization and conceptual understanding. Digital tools can provide dynamic representations that enable learners to manipulate geometric objects and observe relationships that may be difficult to demonstrate using static diagrams. Such technologies may be particularly useful in three-dimensional geometry because they can allow learners to examine geometric objects from different perspectives and interact with mathematical representations. In Rwanda, Uwurukundo et al. (2022) investigated the effect of GeoGebra software on secondary school students' achievement in three-dimensional geometry. The study involved 87 students from four secondary schools and found that students who learned geometry using GeoGebra achieved significantly higher scores than students who learned without the software. The researchers concluded that GeoGebra could support the teaching and learning of geometry concepts in Rwandan secondary schools.

In Africa, mathematics education continues to face challenges related to teaching resources, teacher preparation, classroom conditions, and the adoption of learner-centered instructional practices. These challenges are particularly important in geometry because learners require opportunities to develop spatial reasoning and mathematical visualization. The adoption of innovative teaching methods has consequently become an important area of educational reform. However, the effectiveness of innovative approaches depends not only on the availability of instructional resources but also on teachers' ability and willingness to integrate these approaches into regular classroom instruction. Consequently, research examining teachers' implementation of innovative teaching methods can contribute to understanding how pedagogical reforms are translated into classroom practice.

In Rwanda, mathematics education has undergone significant pedagogical changes associated with curriculum reform and efforts to strengthen competency-based and learner-centered instruction. The transition from traditional teacher-centered approaches toward approaches that emphasize learner participation, problem solving, critical thinking, and practical application has increased expectations for mathematics teachers. Uworwabayeho (2009) documented this transition in the Rwandan context and highlighted the challenges associated with changing deeply established classroom practices. The study showed that the movement toward learner-centered mathematics teaching involved changes in classroom interaction and teachers' acceptance of greater learner autonomy. More recent evidence indicates that Rwanda has continued to invest in teacher professional development and the use of innovative teaching resources in mathematics and science education. Nkundabakura et al. (2023) examined the use of modernized tools and innovative teaching methods among 959 upper-primary and lower-secondary mathematics and science teachers from 10 districts in Rwanda. The study used classroom observations to assess teachers' implementation of modernized resources and innovative teaching approaches after professional development. The findings indicated that secondary school teachers used resources provided through the Rwanda Quality Basic Education for Human Capital Development project at an average rate of 65.5%, while the reported use of modernized tools was also substantial. The researchers concluded that continued use of modernized tools and innovative teaching methods could contribute to improving mathematics and science teaching and learning.

The Rwandan evidence also demonstrates that teacher professional development is an important component of strengthening instructional practices. Nkundabakura et al. (2024) examined the effectiveness of continuous professional development training on mathematics and science teachers' pedagogical content knowledge in Rwanda. The study provides evidence of continued efforts to strengthen teachers' pedagogical knowledge and improve the quality of mathematics and science teaching through professional development. These developments demonstrate that innovative teaching methods are not only a theoretical recommendation but are increasingly incorporated into teacher development and classroom practice in Rwanda. Recent research has also provided more specific evidence concerning the teaching and learning of three-dimensional geometry in Rwanda. Uwurukundo et al. (2024) investigated the use of GeoGebra in teaching and learning three-dimensional geometry among secondary school students and examined teachers' and students' attitudes toward the technology. The study involved Senior Five students from Kicukiro and Musanze Districts and reported significantly better performance among students who used GeoGebra compared with those who received traditional geometry instruction. The study also reported improvements in teachers' and students' attitudes toward the use of GeoGebra in three-dimensional geometry. This evidence is particularly relevant to the present study because it demonstrates that innovative and technology-supported approaches are already being examined within the same geographical context and mathematical content area.

Despite these developments, an important research gap remains. Existing Rwandan studies have largely examined the effectiveness of particular technologies, such as GeoGebra, the implementation of modernized teaching resources, teacher professional development, or teachers' pedagogical knowledge. For example, Uwurukundo et al. (2022) examined the effect of GeoGebra on students' achievement in three-dimensional geometry, while Nkundabakura et al. (2023) examined the use of modernized tools and innovative methods among mathematics and science teachers across ten districts. Although these studies provide valuable evidence, limited attention has been given to the broader relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of students' academic performance specifically in three-dimensional geometry.

The gap is particularly relevant in public day secondary schools in Musanze District. Although previous research has included schools from Musanze District, including research on GeoGebra and three-dimensional geometry, there remains limited evidence examining teachers' perceptions of students' academic performance in relation to the extent to which teachers report implementing innovative instructional approaches. The present study therefore moves beyond examining whether a single technology improves students' test scores and instead examines whether teachers who report greater implementation of innovative teaching methods also report more favorable perceptions of students' academic performance in three-dimensional geometry. This distinction is important because teachers' perceptions represent their professional judgments about students' learning, participation, understanding, and performance rather than direct measurement of students' examination scores.

The present study addresses this gap by examining the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in three-dimensional geometry in public day secondary schools in Musanze District, Rwanda. By focusing on teachers as the respondents and examining innovative teaching implementation as a measurable construct, the study contributes evidence concerning the relationship between classroom pedagogy and perceived student outcomes. The findings may be useful to mathematics teachers, school leaders, teacher educators, curriculum developers, and education policymakers in identifying areas where innovative teaching practices can be strengthened to support the teaching and learning of three-dimensional geometry. The study therefore seeks to establish whether the extent to which mathematics teachers report implementing innovative teaching methods is significantly related to their perceptions of students' academic performance in three-dimensional geometry. In doing so, the study contributes to the growing body of research on innovative mathematics instruction in Rwanda and provides localized evidence from public day secondary schools in Musanze District.

2. Purpose and Objectives of the Study

The purpose of this study was to examine the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in three-dimensional geometry in public day secondary schools in Musanze District, Rwanda. The study sought to determine the extent to which teachers implement innovative teaching methods and establish whether the implementation of these methods is significantly related to teachers' perceptions of students' academic performance in three-dimensional geometry.

3. Theoretical Framework

This study was guided by Constructivist Learning Theory and the Technological Pedagogical Content Knowledge (TPACK) Framework. The two theoretical perspectives were considered appropriate because the study examines teachers’ self-reported implementation of innovative teaching methods and their perceptions of students’ academic performance in three-dimensional geometry. Constructivist Learning Theory provides a basis for understanding how active, learner-centered instructional approaches support the construction of mathematical knowledge, while the TPACK Framework explains the knowledge teachers require to integrate appropriate pedagogical strategies and technological resources into mathematics instruction.

Constructivist Learning Theory

Constructivist Learning Theory is associated with the work of Piaget (1973) and Vygotsky (1978) and is based on the view that learners actively construct knowledge through interaction with their environment, prior experiences, teachers, peers, and learning resources. Piaget (1973) emphasized learning as an active process in which learners develop understanding through interaction with their environment and the construction of cognitive structures. Similarly, Vygotsky (1978) emphasized the social nature of learning and the importance of interaction, language, collaboration, and guidance in the development of knowledge. The theory therefore views learners as active participants in the learning process rather than passive recipients of information and supports instructional approaches that provide opportunities for exploration, interaction, inquiry, and problem solving.

Constructivist Learning Theory is particularly relevant to mathematics education because mathematical knowledge develops through active engagement with concepts, relationships, representations, and problems. This is especially important in three-dimensional geometry, where learners are required to visualize geometric objects, interpret spatial relationships, construct mental representations, and apply mathematical reasoning to solve problems. Innovative teaching methods such as inquiry-based learning, guided discovery, collaborative learning, problem-solving activities, and practical learning provide opportunities for learners to explore mathematical concepts and develop understanding through active participation. In this context, teachers act as facilitators who organize learning experiences, provide guidance, and support learners as they construct mathematical meaning. The theory therefore provides a strong foundation for examining teachers’ implementation of innovative teaching methods because greater use of learner-centered approaches reflects greater opportunities for students to engage actively with three-dimensional geometry.

Constructivist Learning Theory emphasizes that learners actively construct knowledge through exploration, interaction, collaboration, and problem solving (Piaget, 1973; Vygotsky, 1978). In three-dimensional geometry, innovative teaching methods may provide learners with opportunities to interact with mathematical concepts and develop their understanding. Therefore, the theory provides a basis for examining whether teachers' implementation of innovative teaching methods is associated with their perceptions of students' academic performance in three-dimensional geometry.

Technological Pedagogical Content Knowledge (TPACK) Framework

The Technological Pedagogical Content Knowledge (TPACK) Framework was developed by Mishra and Koehler (2006) from Shulman's concept of pedagogical content knowledge. The framework explains that effective teaching with technology requires an understanding of the complex interaction among content knowledge, pedagogical knowledge, and technological knowledge. Content knowledge concerns what teachers know about the subject they teach, pedagogical knowledge concerns how teaching and learning are organized, and technological knowledge concerns teachers' understanding of technologies that can support instruction. Mishra and Koehler (2006) argue that effective technology integration cannot be achieved by considering these forms of knowledge separately because meaningful teaching with technology depends on their interaction within particular learning contexts.

The TPACK Framework is particularly relevant to innovative mathematics instruction because teachers are increasingly expected to combine appropriate pedagogical approaches with technological resources to support learners' understanding. This is especially applicable to three-dimensional geometry, where learners may experience difficulties understanding abstract spatial relationships through conventional explanations and static diagrams. Teachers may use dynamic geometry software, interactive visualizations, digital representations, demonstrations, and collaborative activities to make geometric concepts more accessible and meaningful. However, effective implementation requires teachers to understand both the mathematical content and the pedagogical purpose of the technology being used. In the Rwandan context, Uworwabayeho (2009) found that the use of Geometer's Sketchpad challenged mathematics teachers' existing classroom practices and encouraged reflection on teaching and learning, including a movement toward learner-centered pedagogy.

The TPACK Framework is also relevant to teachers' perceptions of students' academic performance because the effective integration of content, pedagogy, and technology may create learning experiences that support students' understanding of complex mathematical concepts. In three-dimensional geometry, teachers who appropriately combine mathematical content knowledge with innovative pedagogical approaches and suitable technological resources may provide learners with greater opportunities to visualize geometric objects, explore spatial relationships, solve problems, and communicate mathematical reasoning. These classroom experiences may influence teachers' perceptions of students' academic performance. Therefore, the TPACK Framework provides a suitable theoretical explanation for the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of students' academic performance in three-dimensional geometry (Mishra & Koehler, 2006).

4. Methods

The study adopted a quantitative research approach and a correlational research design to examine the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in three-dimensional geometry in public day secondary schools in Musanze District, Rwanda. The study involved 50 mathematics teachers from six selected public day secondary schools in Musanze District. Given the relatively small number of mathematics teachers in the selected schools, the study used a census approach, whereby all identified mathematics teachers were included in the study.

Data were collected using the Teachers' Instructional Practices and Perceptions Questionnaire (TIPPQ) as the main research instrument. The questionnaire measured teachers' self-reported implementation of innovative teaching methods, including inquiry-based learning, guided discovery, collaborative learning, and the use of digital tools such as GeoGebra and SketchUp. It also measured teachers' perceptions of students' academic performance in three-dimensional geometry, including perceived understanding, engagement, problem-solving ability, visualization, and overall performance. The questionnaire consisted of structured items measured using a five-point Likert scale. Before the main data collection, the instrument was reviewed by experts to establish content validity and was piloted to assess clarity and reliability. Reliability was assessed using Cronbach's alpha, with a coefficient of 0.70 or above considered acceptable.

Data were coded and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including means and standard deviations, were used to summarize teachers' responses on the two study variables. Pearson Product-Moment Correlation Analysis was used to determine the strength, direction, and statistical significance of the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in three-dimensional geometry. Statistical significance was tested at the 0.05 level. Because the study employed a correlational design, the findings were interpreted in terms of association rather than causation

5. Results

This section presents the findings on the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry. The results are presented using descriptive statistics and Pearson Product-Moment Correlation Analysis based on responses from 50 mathematics teachers.

Descriptive Statistics of Baseline Teacher Constructs

The study sought to determine the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry. Data for this objective were collected using teachers' questionnaires and analyzed using descriptive statistics and Pearson Product-Moment Correlation Analysis. To provide an overview of the two study variables, means and standard deviations were computed using SPSS version 27. The results are presented in Table 1.

Table 1. Descriptive Statistical Indices for Teacher Instructional Practices and Performance Perceptions (n = 50)

Statistical Parameter	Self-Reported Implementation of Innovative Methods	Perceptions of Student Performance in 3D Geometry
Mean (M)	3.125	3.242
Standard Error of Mean (SE_M)	0.08	0.078
Median	3.1	3.2
Standard Deviation (SD)	0.563	0.554
Sample Variance (σ^2)	0.317	0.307

Note. All indices are computed from continuous composite variable transformations mapped across standard 5-point Likert matrices.

The results presented in Table 1 show that teachers' self-reported implementation of innovative teaching methods had a mean score of 3.125, a median score of 3.1, a standard deviation of 0.563, and a sample variance of 0.317. The standard error of the mean was 0.080. These statistics summarize teachers' responses regarding the implementation of innovative teaching methods in the teaching of 3D geometry. The findings further indicate that teachers' perceptions of students' academic performance in 3D geometry had a mean score of 3.242, a median score of 3.2, a standard deviation of 0.554, and a sample variance of 0.307. The standard error of the mean was 0.078. These values summarize teachers' responses concerning students' academic performance in 3D geometry.

A comparison of the two variables shows that the mean score for teachers' perceptions of students' academic performance (M = 3.242) was slightly higher than the mean score for the self-reported implementation of innovative teaching methods (M = 3.125). Similarly, the median score for perceptions of student performance (3.2) was slightly higher than the median score for implementation of innovative teaching methods (3.1). The standard deviations for the two variables were relatively close, at 0.563 and 0.554, respectively. Likewise, the sample variances were similar, with values of 0.317 for self-reported implementation of innovative teaching methods and 0.307 for perceptions of students' academic performance.

Pearson Product-Moment Correlation Analysis

To determine the relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry, a two-tailed Pearson Product-Moment Correlation Analysis was conducted. The analysis examined the strength, direction, and statistical significance of the linear relationship between the two variables. The results are presented in Table 2.

Table 2. Pearson Correlation Matrix for Innovative Teaching Methods and Perceived Student Performance (n = 50)

Composite Scale Measure	1	2
1. Innovative Teaching Methods	—	.748**
Sig. (2-tailed)		< .001
Sum of Squares & Cross-products	15.531	19.572
Covariance	0.317	0.399
2. Perceptions of Student Performance	.748**	—
Sig. (2-tailed)	< .001	
Sum of Squares & Cross-products	19.572	15.019
Covariance	0.399	0.307

Note**:** Correlation is statistically significant at the 0.01 level (2-tailed) based on a sample size of n = 50 teachers.

The inferential findings presented in Table 2 revealed a strong, positive, and highly statistically significant linear relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of students' academic performance in 3D geometry, $r(48) = .748$, $p < .001$. The findings therefore confirm a strong positive association between teachers' implementation of innovative instructional practices and their perceptions regarding students' understanding and achievement in 3D geometry. Since the significance value was less than the significance level of .05, the null hypothesis (H_{03}), which stated that there is no statistically significant relationship between teachers' implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry, was rejected. To further determine the practical significance of the relationship, the coefficient of determination ($R^2 = r^2$) was calculated as follows: $R^2 = (0.748)^2 = 0.5595$

The coefficient of determination indicates that approximately 56.0% of the total variance observed in teachers' perceptions of students' academic performance in 3D geometry was explained by teachers' implementation of innovative teaching methods. This implies that the intensity and consistency with which teachers implemented innovative instructional approaches substantially influenced how they evaluated students' conceptual understanding, visualization abilities, classroom participation, problem-solving skills, and overall geometry performance. The positive direction of the correlation coefficient further establishes that as teachers increasingly integrated technology-supported instruction, inquiry-based learning, guided discovery activities, and collaborative classroom practices into geometry lessons, their perceptions regarding students' academic achievement improved correspondingly.

The findings were strongly corroborated by the qualitative findings obtained during teacher interviews, particularly under the theme relating to conceptual and spatial visualization in geometry instruction. Teachers consistently emphasized that shifting from traditional lecture-based instruction to interactive visualization approaches significantly improved students' understanding of abstract geometric concepts. For example, one teacher explained that "students understand geometric solids more easily because they can visualize shapes," highlighting the role of visual learning tools in strengthening students' conceptual understanding. Another teacher directly linked technology integration with improved mathematical mastery by stating that "students used GeoGebra to rotate geometric solids and understand volume." These qualitative responses provide practical classroom evidence supporting the strong positive correlation observed in the statistical analysis and demonstrate how innovative instructional approaches enhanced students' spatial reasoning and geometry learning experiences.

6. Discussion of Findings

The findings of the study established a positive relationship between teachers' self-reported implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry in public day secondary schools in Musanze District, Rwanda. This finding directly addresses the main focus of the study by showing that differences in the extent to which mathematics teachers reported implementing innovative teaching methods were associated with differences in how they perceived students' academic performance in 3D geometry. The finding suggests that the implementation of inquiry-based learning, guided discovery, collaborative learning, and technology-supported instruction may provide students with opportunities to actively engage with three-dimensional geometric concepts. Such approaches can support students in visualizing geometric objects, understanding spatial relationships, applying mathematical concepts, and solving geometry problems.

The finding is consistent with Uwurukundo et al. (2022), who examined the use of GeoGebra in teaching three-dimensional geometry in Rwandan secondary schools and found positive outcomes associated with technology-supported instruction. This previous evidence supports the present finding that innovative teaching approaches are relevant to the teaching and learning of 3D geometry. However, while Uwurukundo et al. focused on the use of a specific technological tool, the present study examined teachers' broader implementation of innovative teaching methods and its relationship with their perceptions of student academic performance in 3D geometry. Similarly, Nkundabakura et al. (2023) examined the use of modernized tools and innovative teaching methods among mathematics and science teachers in Rwanda. Their findings support the importance of teachers' implementation of innovative instructional practices in mathematics education. Therefore, the present study adds contextual evidence by specifically examining this relationship in the teaching of 3D geometry in public day secondary schools in Musanze District.

The finding is further supported by Uworwabayeho (2009), whose study of mathematics teachers in Rwanda highlighted the movement toward learner-centered teaching and greater acceptance of learner autonomy. This is relevant to the present study because innovative teaching methods require teachers to provide learners with greater opportunities to participate in mathematical activities. In 3D geometry, such participation is important because students need to visualize geometric solids, explore spatial relationships, discuss mathematical ideas, and apply concepts to problems. The finding also aligns with Constructivist Learning Theory, which emphasizes active construction of knowledge through exploration, interaction, collaboration, inquiry, and problem solving. It further relates to the TPACK Framework, which emphasizes the integration of content, pedagogy, and technology in effective teaching. Together, these perspectives help explain why teachers' implementation of innovative methods may be associated with their perceptions of students' performance in 3D geometry.

7. Implications

The findings imply that mathematics teachers should consistently use innovative teaching methods such as inquiry-based learning, guided discovery, collaborative activities, and technology-supported visualization when teaching 3D geometry. School heads should provide functional ICT facilities and appropriate geometry software, including GeoGebra and SketchUp, and ensure that these resources are effectively integrated into classroom instruction. Teacher professional development should focus on practical skills for designing innovative 3D geometry activities and combining technology with appropriate mathematics pedagogy. Education policymakers and curriculum developers should provide practical guidance and resources that support innovative approaches to teaching spatial and three-dimensional concepts. These measures can strengthen teachers' capacity to help students visualize geometric objects, understand spatial relationships, and apply mathematical concepts. Future research should compare teachers' perceptions of student performance with students' actual achievement in 3D geometry to determine whether the observed relationship is reflected in measured performance.

8. Conclusion

This study examined the relationship between teachers' implementation of innovative teaching methods and their perceptions of student academic performance in 3D geometry in public day secondary schools in Musanze District, Rwanda. The study concludes that innovative, learner-centered, collaborative, and technology-supported approaches can support effective teaching and learning of 3D geometry. Strengthening teachers' capacity and providing appropriate instructional resources are therefore important for improving 3D geometry instruction. Overall, continued support for innovative mathematics teaching can enhance students' engagement, understanding, and learning of three-dimensional geometry.

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