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Impact of Music on the Mathematical Foundation Knowledge of Preschoolers in Ibadan South West Local Government

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Abstract: *This study investigated the impact of music education on the mathematical foundation knowledge of preschoolers in Ibadan South West Local Government. Guided by guided by Cognitive Load Theory (Sweller, 1988), four specific purposes and four research questions, the study examined how integrating music into early childhood curricula could enhance cognitive abilities—such as memory, attention, and spatial-temporal reasoning—that underpin mathematical proficiency. Adopting a mixed-methods research design, the study employed a stratified random sampling technique to ensure representation from both public and private schools. From a total of 15 preschools (8 public and 7 private), a sample of 200 preschoolers and 30 early childhood educators was selected, with the educators chosen based on their involvement in teaching subjects that integrated music and mathematics.*

Data were collected using two primary instruments: a self-structured Teacher Questionnaire containing both closed-ended and open-ended questions, and a standardized Preschool Achievement Test (PAT) that assessed basic mathematical skills such as counting, number recognition, shapes, and patterns. In addition, a semi-structured Interview Guide was used to gather in-depth qualitative insights regarding the challenges and successes of integrating music into mathematics instruction. The instruments' validity was confirmed through expert review in early childhood education and educational measurement, while reliability was established via a pilot study—yielding a Cronbach's alpha of 0.78 for the questionnaire and a reliability coefficient of 0.82 for the PAT.

Quantitative data were analyzed using SPSS with descriptive statistics, Pearson's correlation, and regression analysis, whereas qualitative data were examined thematically to identify recurring patterns and themes. The findings underscored that the effective integration of music into preschool mathematics instruction enhanced both cognitive and mathematical skills and addressed educational inequities between public and private schools. Based on these findings, the study recommended that targeted professional development programmes be implemented for early childhood educators, that quality music resources be equitably distributed across schools, and that curriculum policies be reformed to

incorporate music-based pedagogical strategies. These recommendations were proposed as strategic interventions to bolster academic success in early childhood education.

Keywords: *Music Education, Mathematical Foundation, Early Childhood, Cognitive Development, Mixed Methods, Preschoolers, Ibadan, Music Pedagogy, Educational Equity, Spatial-Temporal Reasoning, Professional Development, Curriculum Reform.*

Introduction

Music education has emerged as a multifaceted tool in early childhood education, playing a critical role not only in language, cognitive, and socioemotional development but also in establishing a strong foundation for academic success in subjects like mathematics. Engaging preschoolers in music instruction within a safe and encouraging environment equips them with essential skills—such as memory, attention, and spatial-temporal reasoning—that are directly linked to mathematical proficiency (Holochwost et al., 2017). In this context, music becomes more than an art form; it is an integral component of cognitive development, enabling young learners to internalize abstract mathematical concepts through concrete, multisensory experiences.

Research consistently shows that music education enhances cognitive abilities that underpin mathematical skills. For instance, Shahab et al. (2021), Du and Leung (2021), and Jorritsma (2021) demonstrate that regular exposure to music fosters improvements in memory and attention, which are crucial for tasks such as number recognition and problem-solving. The rhythmic and structured nature of musical activities, such as singing, clapping, and playing instruments, helps develop spatial-temporal reasoning—a critical skill for understanding geometry and algebra (Ceylan et al., 2021). By engaging in these rhythmic exercises, children not only learn to recognize patterns and sequences but also develop the mental manipulation skills required to tackle arithmetic problems.

Moreover, the incorporation of diverse musical genres into the curriculum broadens the scope of learning by introducing children to a variety of patterns and structures that parallel mathematical operations. Multicultural music education, as highlighted by de Villiers (2021) and Shevock (2021), enriches the learning experience by exposing children to different cultural approaches to problem solving. This diversity challenges learners to consider alternative perspectives, thereby fostering creative and analytical thinking. Such an inclusive approach not only supports cognitive development but also promotes cultural awareness and sensitivity—a vital component of modern educational practices.

Despite these benefits, access to quality music education remains uneven, particularly in lower-income communities. Shaw and Auletto (2021) argue that children from disadvantaged backgrounds often have limited opportunities to engage in music instruction, which can exacerbate educational inequities and widen the achievement gap in mathematics. This disparity underscores the need for targeted interventions to ensure equitable access to high-quality music programs. Expanding music education in underserved areas could serve as a strategic intervention to boost both cognitive and mathematical skills, promoting overall academic success and social equity.

Beyond cognitive development, music education supports social and emotional growth. Incorporating varied musical genres and cultural traditions into the curriculum can challenge social norms and promote values such as tolerance, empathy, and social justice (Powell et al., 2017). When educators integrate music with other academic subjects, including mathematics, they create a dynamic and engaging learning environment that nurtures both academic and socioemotional development. Emotional and social support in the classroom, as documented by Hogenes et al. (2016), Allsup (2016), and Shively (2015), is essential for building the confidence and resilience required to confront complex mathematical challenges.

Furthermore, music education has been linked to the enhancement of executive function skills—such as working memory, attention, and cognitive flexibility—which are fundamental for academic success in mathematics. Empirical studies by Fautley (2017), Hess (2015), Benedict et al. (2015), and Laes and Schmidt (2016) indicate that preschoolers exposed to structured music training exhibit marked improvements in these executive functions. Although some studies (Dobrota & Ercegovac, 2016; Wong, Pan, & Shah, 2016) present mixed findings regarding a direct correlation between music education and mathematical ability, the preponderance of evidence supports the notion that the cognitive benefits derived from musical activities make mathematical concepts more approachable and engaging for young learners.

Teachers play a pivotal role in leveraging these benefits, yet they often face significant challenges. Limited training in integrating music with academic content, technology integration issues, and personal math anxiety can hinder effective instruction (Lavidas et al., 2022; Lavidas et al., 2023). To optimize the integration of music and mathematics, robust professional development is essential. Teachers must be equipped not only with musical skills but also with an in-depth understanding of how music can support mathematical concepts. In practice, utilizing techniques such as finger plays, rhymes, and songs that incorporate mathematical elements has proven effective in solidifying foundational knowledge. The use of tangible materials—like drums and xylophones—provides hands-on experiences that reinforce memory retention and pattern recognition (Malinović-Jovanović & Ristić, 2019; Wakabayashi et al., 2020; Nguyen et al., 2016; Mou et al., 2022).

Complementing instrumental music with literature and interactive games further enriches the learning environment. For example, pairing books like The Very Hungry Caterpillar with songs about shapes, patterns, and numbers creates an immersive, multidisciplinary experience that bridges abstract mathematical ideas with real-world contexts (Helenius, 2018; Stites et al., 2022; Maričić & Stamatović, 2017). Such integrative approaches not only stimulate curiosity but also make learning more engaging, thereby enhancing both cognitive and mathematical development.

Recent empirical studies support these integrative strategies. Salami and Owolabi (2022) investigated the use of songs and storytelling in teaching mathematics to preschoolers, revealing that the extent of musical integration in mathematics instruction was very low—an indication that current practices may not be fully capitalizing on music's potential. In contrast, Samsudin, Bakar, and Noor (2019) demonstrated that incorporating music and movement significantly attracted children's attention, improved their understanding, and enriched their emotional development. Similarly, Ngalim and Chiny (2018) found a positive relationship between the use of music in teaching and improved academic performance in mathematics, reinforcing the argument for enhanced music pedagogy in early education. Holmes and Hallam (2017) further substantiated these findings by showing that music instruction positively impacts spatial–temporal skills, which are critical for early mathematical learning.

In sum, the literature suggests that music education, when effectively integrated into early childhood curricula, offers substantial cognitive, social, and emotional benefits that collectively contribute to enhanced mathematical abilities. Addressing the challenges of resource limitations, inadequate teacher training, and uneven access to music programs is essential for maximizing these benefits and promoting educational equity. Future initiatives should focus on expanding professional development opportunities, incorporating a wider range of musical activities into the curriculum, and ensuring that all children, regardless of socio-economic background, have access to the cognitive and academic benefits of music education.

A key theoretical framework underpinning these educational strategies is Cognitive Load Theory (CLT), introduced by Sweller in 1988. CLT posits that the human brain has a limited capacity to process information, and that learning is most effective when instructional design minimizes extraneous cognitive load while maximizing germane load. In the context of early childhood education, music

serves as an intuitive tool that reduces the complexity of mathematical concepts. By aligning with the natural cognitive development stages of preschoolers, music simplifies the learning process, enabling children to focus on and internalize mathematical ideas more effectively. This theoretical perspective underscores the importance of integrating music education into the curriculum to enhance cognitive processing and facilitate a deeper understanding of mathematics.

Moreover, the impact of music on mathematical learning is not confined to cognitive development alone; it also extends to the broader socioemotional domain. Music education fosters a sense of community and belonging among students, encouraging collaboration and communication—skills that are essential for academic and personal success. By participating in group musical activities, children learn to work together, share ideas, and develop empathy, all of which contribute to a supportive and inclusive classroom atmosphere. This social cohesion, in turn, enhances their ability to engage with complex subjects like mathematics, creating a more dynamic and effective learning environment.

As educational institutions increasingly recognize the multifaceted benefits of music education, there is a growing movement to incorporate comprehensive music programs into early childhood curricula across the globe. Such initiatives are particularly relevant in regions where access to quality music education is limited, such as in Ibadan South West Local Government. By expanding these programs, educators can not only improve the mathematical abilities of preschoolers but also contribute to their overall cognitive and socioemotional development. This holistic approach promises to yield long-term academic benefits, laying a solid foundation for lifelong learning and success.

This indicates that high-quality music education offers a multifaceted approach to enhancing preschoolers' cognitive, mathematical, and socioemotional development. By reducing cognitive overload, fostering cultural awareness, and enhancing executive function skills, music serves as a bridge between abstract mathematical concepts and the tangible experiences of early childhood. The integration of diverse musical genres, multicultural perspectives, and interactive teaching methods enriches the learning environment, making mathematics more accessible and engaging for young learners. Furthermore, addressing the challenges of inequitable access to music education and providing robust professional development for educators are essential steps toward realizing the full potential of this educational approach. Ultimately, the strategic inclusion of music in early childhood education not only supports academic achievement but also promotes social justice, inclusivity, and a lifelong love of learning (Sweller, 1988; Holochwost et al. 2017; Shahab et al. 2021; Du and Leung, 2021; Jorritsma, 2021).

By fostering a nurturing and innovative educational environment where music and mathematics intersect, educators can empower young children with the tools they need to succeed academically and socially. This comprehensive integration of music into the curriculum not only enhances foundational mathematical knowledge but also cultivates creativity, resilience, and cultural competence—qualities that are essential in today's diverse and rapidly evolving world. In regions such as Ibadan South West Local Government, where educational disparities persist, the implementation of such integrative approaches could prove transformative, ultimately contributing to more equitable and effective early childhood education.

Statement of the Problem

The foundational years of education are crucial in shaping a child's future academic success, especially in mathematics. Research has shown that early childhood education plays a significant role in developing cognitive skills such as memory, attention, and problem-solving, which are essential for mathematical learning. However, despite the recognized importance of these early years, many preschool children continue to struggle with building a solid mathematical foundation. This challenge

is particularly evident in Ibadan South West Local Government, where access to innovative teaching methods and resources, including music education, remains limited.

Music, as an educational tool, has been linked to improvements in cognitive abilities, spatial-temporal reasoning, and mathematical performance. Studies have suggested that integrating music into early childhood education can enhance mathematical skills by improving memory, attention, and pattern recognition. However, in the context of Ibadan South West Local Government, there is limited empirical evidence on the extent to which music education impacts preschoolers' mathematical foundation knowledge. Moreover, the role of music genre classification, cultural diversity in music education, and teachers' ability to integrate music into mathematics lessons have not been fully explored.

Given these gaps, there is a need to investigate the impact of music on the mathematical foundation knowledge of preschoolers in Ibadan South West Local Government. Understanding this relationship can provide insights into how music education can be harnessed to enhance cognitive development and improve academic performance in mathematics. Therefore, this study seeks to examine the effectiveness of music education in fostering mathematical foundation knowledge among preschoolers and to explore the factors that may influence this relationship. The findings from this study can inform educational practices, guide curriculum development, and help improve the quality of early childhood education in the region.

Purpose of the study

The main purpose of this research is to investigate the impact of music on the mathematical foundation knowledge of preschoolers in Ibadan South West Local Government. Specifically, this study aims to:

explore the relationship between music and mathematical foundation knowledge of preschoolers in Ibadan South West Local Government.

examine the effectiveness of using music as a pedagogical tool to enhance mathematical foundation knowledge of preschoolers in Ibadan South West Local Government.

identify the challenges and limitations of using music to enhance mathematical foundation knowledge of preschoolers in Ibadan South West Local Government.

provide recommendations for music educators and policymakers on how to incorporate music into the curriculum to enhance mathematical foundation knowledge of preschoolers in Ibadan South West Local Government.

Research Questions

The research questions for this study are:

1. What is the relationship between music and mathematical foundation knowledge of preschoolers in Ibadan South West Local Government?

2. How effective is using music as a pedagogical tool in enhancing mathematical foundation knowledge of preschoolers in Ibadan South West Local Government?

3. What are the challenges and limitations of using music to enhance mathematical foundation knowledge of preschoolers in Ibadan South West Local Government?

4. What recommendations can be made for music educators and policymakers on how to incorporate music into the curriculum to enhance mathematical foundation knowledge of preschoolers in Ibadan South West Local Government?

Research Methodology

Research Design

The study adopted a mixed methods research design**,** which is appropriate for assessing the impact of music on the mathematical foundation knowledge of preschool children. A descriptive design allowed for the collection of data from a selected group of respondents to explore their current conditions and opinions, and analyze the relationship between music education and mathematics outcomes among preschoolers.

Population of the Study

The population for this study comprises all preschool children and early childhood educators in public and private schools in Ibadan South West Local Government**.** The total population includes approximately 1,500 preschoolers and 100 early childhood educators.

Sample and Sampling Techniques

The study employed a stratified random sampling technique to ensure that both public and private schools were represented in the sample. The stratified sampling method divides the population into subgroups (strata) based on school type (public or private) and then randomly selects participants from each stratum.

A total of 15 preschools were selected: 8 public schools and 7 private schools. The sample size consists of 200 preschoolers and 30 early childhood educators, with 10 to 15 children selected from each school. The educators were chosen based on their involvement in teaching subjects that integrate music and mathematics.

Research Instruments

The study employed two primary instruments for data collection:

Teacher Questionnaire: This self-structured questionnaire was used to gather information from early childhood educators about their use of music in teaching mathematics and their perceptions of its effectiveness in enhancing preschoolers' mathematical foundation knowledge. The questionnaire included both closed-ended and open-ended questions.

Preschool Achievement Test (PAT): A standardized test was developed to assess the mathematical foundation knowledge of the preschool children. The test focused on basic mathematical skills such as counting, number recognition, shapes, and patterns.

Interview Guide: For qualitative data, a semi-structured interview guide was designed to gather in-depth insights from selected teachers regarding the challenges and successes they have experienced while integrating music into their teaching.

Validity of the Instruments

To ensure the validity of the instruments, the questionnaire and achievement test were reviewed by experts in early childhood education and educational measurement and evaluation. Their feedback helped refine the content and structure of the instruments to align with the study’s objectives.

Reliability of the Instruments

The reliability of the instruments was established through a pilot test conducted in two schools outside the selected study area. The Cronbach's alpha coefficient for the teacher questionnaire was calculated at 0.78, indicating acceptable internal consistency. For the Preschool Achievement Test (PAT), the test-retest method was used, and a reliability coefficient of 0.82 was obtained, signifying high reliability.

Method of Data Analysis

The data collected from the study were analyzed using both quantitative and qualitative methods.

Quantitative Analysis: The data from the teacher questionnaire and PAT were coded and entered into the Statistical Package for Social Sciences (SPSS) software for analysis. Descriptive statistics, such as frequency and percentage were used to summarize the data. Inferential statistics, including Pearson's correlation and regression analysis, were employed to test the relationship between music education and preschoolers' mathematical foundation knowledge.

Qualitative Analysis: The interview data were analyzed thematically. Recurring themes and patterns were identified, and the responses were categorized to provide deeper insights into teachers' experiences with integrating music into mathematics lessons.

Results

This chapter presents the results of the study based on data collected through the teacher questionnaire, Preschool Achievement Test (PAT), and interviews with teachers. The data are presented in tabular form with corresponding interpretations and are followed by an explanatory analysis of the interview guide responses.

Results of the Teacher Questionnaire

The teacher questionnaire aimed to assess teachers' use of music in teaching mathematics and their perception of its effectiveness. Table1: presents the responses to key items from the questionnaire.

Table 1: Inferential Statistics Results of the Relationship between Music Education and Mathematical Foundation Knowledge

Statistic	value	p-value
Pearson's Correlation (r)	0.65	< 0.01
Regression Analysis		
R-squared	0.42	_
F-statistic	25.3	< 0.001
Beta (B) for Music Education	0.50	< 0.001
Standard Error	0.10	_
t-statistic	5.0	< 0.001

Interpretation: The Pearson's correlation coefficient ($r = 0.65$, $p < 0.01$) indicated a moderate to strong positive relationship between music education and the mathematical foundation knowledge of preschoolers in Ibadan South West Local Government. This suggests that an increase in music education is associated with improved mathematical skills. Further, regression analysis revealed that music education accounted for approximately 42% of the variance in preschoolers' mathematical performance ($R^2 = 0.42$, $F = 25.3$, $p < 0.001$). The significant beta coefficient ($B = 0.50$, $t = 5.0$, $p < 0.001$) confirms that music education is a significant predictor of mathematical foundation knowledge. These results

strongly support the hypothesis that integrating music into early childhood curricula can enhance mathematical skills among preschoolers.

Table 2: Teachers' Use of Music in Mathematics Lessons

Item	quency	centage (%)
Do you use music in teaching mathematics?		
Yes	22	73.3
No	8	26.7
Frequency of music use in math lessons		
Always	10	33.3
Sometimes	12	40.0
Rarely	6	20.0
Never	2	6.7
Effectiveness of music in enhancing math skills		
Very effective	18	60.0
Moderately effective	10	33.3
Not effective	2	6.7

Interpretation: From the data in Table 1, it is evident that the majority of teachers (73.3%) reported using music in their mathematics lessons. Most of them use music frequently, with 33.3% using it always and 40% using it sometimes. Additionally, 60% of the teachers found music to be very effective in enhancing mathematical skills among preschoolers, while 33.3% found it moderately effective. Only 6.7% believed music was not effective in improving math skills.

Table 3: Teachers' Perception of Challenges in Using Music for Math Lessons

Item	Frequency	Percentage (%)
Lack of resources (music materials)	15	50.0
Insufficient time in the curriculum to integrate music	12	40.0
Limited knowledge of how to use music for teaching math	8	26.7
Lack of training on the integration of music in teaching	10	33.3

Interpretation: Table 2 indicates that the most common challenge faced by teachers is the lack of resources, with 50% of the respondents highlighting this issue. Additionally, 40% mentioned insufficient time in the curriculum, and 33.3% reported that they had not received sufficient training on integrating music into mathematics lessons.

Results of the Preschool Achievement Test (PAT)

The PAT was designed to assess the preschoolers' foundational knowledge in mathematics, such as counting, number recognition, and shapes. Table 4.3 summarizes the results.

Table 4: Results of Preschool Achievement Test (PAT)

Performance Level	Public School (%)	Private School (%)	Overall (%)
High (80-100%)	15	45	30
Moderate (60-79%)	40	40	40
Low (Below 60%)	45	15	30

Interpretation: Table 3 shows that a higher percentage of preschoolers in private schools (45%) achieved high performance compared to those in public schools (15%). However, both public and private schools had a moderate performance rate of 40%. In public schools, 45% of the students performed at a low level, which was considerably higher than the 15% low performance rate in private schools. This indicates a performance gap between public and private preschools, with private schools performing better overall.

Interview Guide Analysis

The semi-structured interviews with selected teachers provided in-depth insights into their experiences and challenges in integrating music into mathematics lessons. Three major themes emerged from the analysis:

Positive Impact of Music on Engagement and Retention: Most teachers noted that incorporating music into their mathematics lessons had a noticeable effect on preschoolers' engagement and retention of mathematical concepts. One teacher remarked, "Children love to sing, and when we teach math through music, they remember numbers and patterns better. It makes the lesson more fun and interactive."

Challenges with Resources and Training: Teachers identified the lack of appropriate resources and insufficient training as significant barriers to effectively using music in teaching. One teacher said, "We don’t have enough materials, like instruments or recorded music, to integrate into our lessons. Also, I haven’t received any formal training on how to use music for teaching math."

Variability in Curriculum Flexibility: Some teachers mentioned that integrating music into mathematics was easier when the curriculum allowed for flexible lesson planning, while others found it challenging to fit music into an already packed schedule. As one teacher explained, "In my class, we have a little flexibility to include songs in lessons, but in other schools, there may not be enough time."

Discussion of Findings

Relationship between music and mathematical foundation knowledge of preschoolers

The study’s inferential statistics provided robust evidence supporting the positive relationship between music education and the mathematical foundation knowledge of preschoolers in Ibadan South West Local Government. Specifically, Pearson’s correlation analysis revealed a moderate to strong positive correlation ($r = 0.65$, $p < 0.01$), indicating that increased exposure to music education was associated with enhanced mathematical skills among the preschoolers. This finding was further substantiated by regression analysis, which demonstrated that music education accounted for 42% of the variance in mathematical performance ($R^2 = 0.42$, $F = 25.3$, $p < 0.001$). The significant beta coefficient ($B = 0.50$, $t = 5.0$, $p < 0.001$) confirmed that music education was a significant predictor of the preschoolers' mathematical foundation knowledge.

This finding is consistent with previous research. For example, Holmes and Hallam (2017) reported that music instruction significantly enhanced spatial–temporal reasoning, which is critical for mathematical performance in young learners. Similarly, Du and Leung (2021) found that engaging in music education

improved cognitive abilities such as memory and attention, which directly contribute to the acquisition of mathematical skills. These studies support the present findings, confirming that music education can be a significant predictor of enhanced mathematical foundation knowledge in preschoolers.

Teachers' Use of Music in Mathematics Lessons

The majority of teachers in this study reported using music in their mathematics lessons and perceived it as an effective tool to enhance preschoolers' mathematical skills. Specifically, 73.3% of teachers integrated music into their lessons, and 60% considered it very effective.

This finding aligns with research by Wang et al (2024), who found that integrating music in early childhood education can significantly enhance cognitive and academic outcomes. They argue that music helps children develop critical skills like memory, attention, and pattern recognition, which are essential in learning mathematics. Similarly, The Oxford Handbook of Early Childhood Learning and Development in Music (2024) concluded that music's rhythmic and repetitive nature supports young learners in understanding mathematical concepts such as counting and sequencing.

Challenges Faced by Teachers in Integrating Music into Lessons

The results showed that teachers faced several challenges when using music in their teaching. Lack of resources (50%) and insufficient time in the curriculum (40%) were the most significant barriers. Limited training on how to use music for teaching (33.3%) also emerged as a critical issue.

This finding is consistent with previous studies, such as Arasomwan & Daries(2024), who emphasized that many early childhood educators face challenges in accessing adequate teaching materials and resources. According to their study, budget constraints and a lack of institutional support often hinder the effective integration of innovative teaching strategies, including the use of music.

Similarly, Kirby et al (2022). argued that teachers need more professional development opportunities to learn how to integrate music into their lessons effectively. They found that teachers who had undergone specialized training were more confident and skilled in using music as a teaching tool. The lack of such training may explain why some teachers in this study felt ill-equipped to use music in their lessons.

Preschool Achievement Test (PAT) Results: Public vs. Private Schools

The study revealed a performance gap between preschoolers in public and private schools. Private school students performed better, with 45% achieving high scores compared to only 15% of public school students. Conversely, 45% of public school students performed at a low level compared to 15% of private school students.

This result is consistent with research by Schiman & Ressler (2024) and Daviet (2023) , who found that private schools generally provide better learning outcomes due to access to more resources, including better-trained teachers, learning materials, and extracurricular activities like music. These resources, which are often scarce in public schools, help foster a more supportive and stimulating learning environment.

Moreover, Daviet (2023) found that the quality of teacher training and professional development in private schools is often superior to that in public schools. Their study showed that private school teachers frequently receive more continuous professional development, which positively influences student achievement. This aligns with the present study's findings, where teachers in private schools reported having more resources and opportunities to integrate music into their lessons, potentially contributing to better student performance.

Impact of Music on Preschoolers' Engagement and Retention

Interviews with teachers highlighted that music positively impacted preschoolers' engagement and retention of mathematical concepts. Teachers reported that children enjoyed singing, which made it easier for them to remember numbers and patterns.

This finding supports the research of Daikoku (2023), who found that incorporating music into lessons improved both engagement and long-term retention in young children. Their study indicated that children who learned mathematical concepts through music retained the information longer than those who learned through traditional methods. They attributed this to the multisensory learning experience that music provides, which stimulates different areas of the brain.

Additionally, Souto (2023) noted that music helps in the development of memory and recall skills, which are crucial for mastering mathematical concepts. They argued that the rhythm and melody in songs create a structure that aids children in recalling sequences, such as counting and number patterns.

Conversely, Pušić et al (2023) pointed out that while music can enhance engagement and retention, its impact may vary based on the individual learning styles of students. Some children may respond more positively to music-based learning, while others might benefit from different teaching methods. This suggests that while music can be a valuable tool, it should be used in combination with other teaching strategies to meet diverse learning needs.

Summary of Findings

Inferential analysis showed a moderate to strong positive relationship between music education and mathematical foundation knowledge. Pearson's correlation ($r = 0.65$, $p < 0.01$) indicated that increased music education was associated with better mathematical skills. Regression analysis further revealed that music education accounted for 42% of the variance in mathematical performance ($R^2 = 0.42$, $F = 25.3$, $p < 0.001$) with a significant beta coefficient ($B = 0.50$, $t = 5.0$, $p < 0.001$), confirming that music education was a significant predictor of mathematical proficiency.

The majority of teachers use music in teaching mathematics, and they find it effective in improving preschoolers' foundational math skills.

The Preschool Achievement Test (PAT) results indicated that private school students performed better overall than public school students.

Teachers highlighted challenges such as lack of resources and insufficient training in using music for teaching mathematics.

The interviews revealed that music positively impacts student engagement and retention, but there is a need for more training and support to maximize its potential.

Conclusions

The study confirms that integrating music into mathematics lessons can enhance preschoolers' learning experiences, provided that resources and training are adequate. The performance gap between public and private school students highlights systemic inequalities that need addressing. While music is a valuable educational tool, it should be complemented by other teaching strategies to cater to diverse learning needs.

Recommendations

Educators should base training to emphasize how to utilize music to support various mathematical concepts and cater to different learning styles.

Schools should allocate resources to support the integration of music into lessons, including purchasing musical instruments and educational materials.

Policy Makers should help to **a**ddress the disparities between public and private schools by improving resource allocation and support for public schools.This will help to ensure that all schools have access to quality teaching materials and training can help bridge the performance gap.

Curriculum developers should develop policies that will encourage the integration of music and other creative arts into the early childhood education curriculum and ensure that these strategies are used consistently and effectively.

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