

The Mediating Role of Math Anxiety to the Relationship of Music Exposure and Math Fluency Among Junior High School Students

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ABSTRACT

This study examined the mediating role of Math Anxiety in the relationship between Music Exposure and Math Fluency among junior high school students. The researchers aimed to determine whether engagement with music could influence students' anxiety toward mathematics and whether this change in anxiety could affect their math fluency. Structural Equation Modeling (SEM) was used to analyze both the direct and indirect relationships among the variables. Data were collected from 118 respondents using standardized questionnaires to measure Music Exposure significantly reduced Math Anxiety among students, suggesting that music may help create a more relaxed emotional state when dealing with mathematics-related tasks. However, despite this reduction in anxiety, Music exposure did not show a significant direct effect on Math Fluency. In addition, the indirect effect of Music Exposure on Math Fluency through Math Anxiety was not significant, indicating that although music can reduce anxiety, this change does not necessarily translate into improved mathematical performance. The proposed model explained only a small portion of the variance in Math Fluency ($R^2 = 0.136$), suggesting that other factors may have a stronger influence on students' performance in mathematics. Variables such as attention, motivation, prior knowledge, and cognitive ability may play more important roles in determining students' math fluency. Overall, the findings highlight that music may function more as an emotional support tool that helps reduce anxiety in learning environments rather than as a direct method for improving mathematical fluency.

Keywords: Music Exposure, Math Anxiety, Math Fluency, Mediation, Structural Equation Modeling

INTRODUCTION

Introduce the problem

Mathematics is a key school subject that helps build important skills like logical thinking, solving everyday problems, and making smart decisions, which people use in real life—such as figuring out money matters or understanding simple data from the world around them. Even though it's so useful, many students, especially in the Philippines, have a hard time getting good at it. As shown in a report from the 2022 PISA (OECD, 2023), which pointed out that teenagers in the Philippines often score low on worldwide math tests—which unfortunately had similar results with the previous PISA in 2018 (OECD, 2019)—because of things like not enough learning tools, money problems at home, and ways society views school subjects. This struggle usually comes from math anxiety, which is just a strong feeling of nervousness or stress that gets in the way of doing math well, leading to things like a racing mind, mistakes in simple calculations, and a loop of feeling bad about it over time (Khasawneh et al., 2021). For many, this worry often happens in junior high school, when students start dealing with tougher ideas like basic shapes and numbers patterns, making them feel overwhelmed and leading to problems like skipping homework or losing interest in class (Weir, 2023).

Substantial evidence demonstrates that engagement with music, whether through listening or playing, exerts a positive influence on task performance, enhancing concentration and cognitive efficiency. For instance, empirical studies have established that music improves students' mathematical performance and abilities, such as accelerating problem Many studies show that engaging with music, whether by listening or playing, has a positive effect on task performance by improving focus and mental efficiency. For example, research has found that music helps students perform better in math, speeding up problem-solving and improving memory for

numbers, as shown in studies by Milman and Paz-Baruch (2025) and Raja (2020). This may be because music makes learning more enjoyable and helps the brain process math concepts more smoothly. In addition, other studies suggest that music helps reduce test anxiety, whether students simply listen or take part in musical activities, which promotes calmness and clearer thinking (Galal et al., 2021). For instance, a student who listens to favorite music before a test may feel less nervous, make fewer mistakes, and score higher. However, it is still unclear whether these benefits in math skills happen directly by improving thinking ability or indirectly by lowering math anxiety. To better understand this, the present study uses Structural Equation Modeling (SEM), a reliable method of analysis, to find out whether math anxiety acts as a link between music exposure and math fluency. This is especially relevant in faith-based schools, where education values both intellectual and emotional growth. This study aims to determine whether math anxiety mediates the relationship between music exposure and math fluency among junior high school students in a faith-based setting. By examining this connection, the research seeks to uncover how music can serve as an indirect tool for improving mathematical performance through the reduction of anxiety. The expected results of this study may offer useful ideas and guidance to improve math learning and support greater student achievement in such settings.

Research Questions

1. Does music exposure have a negative and direct influence on math anxiety?
2. Does math anxiety have a negative and direct influence on math fluency?
3. Does music exposure have a direct relationship with math fluency?
4. Does math anxiety mediate the relationship between music exposure and math fluency?

Research Hypothesis

H₁: Music exposure has a significantly positive impact on math fluency.

H₂: Music exposure has a significantly negative impact on math anxiety.

H₃: Math anxiety has a significantly negative impact on math fluency.

H₄: Math anxiety would emerge as a significant mediator between music exposure and math fluency.

LITERATURE REVIEW

Music Exposure's Influence on Math Anxiety

Milman and Paz-Baruch (2025) explored the effect of preferred background music on the mathematical performance of adolescents with mathematics difficulties, finding that listening to self-selected music improved accuracy and reduced anxiety during mathematical tasks. The study highlighted that personalized music conditions can enhance focus and emotional regulation, suggesting that music exposure may serve as a supportive tool for improving math fluency and engagement in students with learning challenges.

Akin (2023) conducted a meta-analysis titled *Let Me Make Mathematics and Music Together: A Meta-Analysis of the Causal Role of Music Interventions on Mathematics Achievement*, which revealed that music interventions have a significant positive effect on students' mathematics achievement. The study emphasized that rhythm and melody-based activities enhance cognitive processes such as pattern recognition and working memory, contributing to improved mathematical performance.

Yuspitasari et al. (2020) investigated the effect of classical Mozart music on students' anxiety before examinations, revealing that exposure to Mozart's compositions significantly reduced anxiety levels among students. The study concluded that classical music can create a calming atmosphere that helps learners manage stress and improve emotional readiness before tests.

This systematic review (Ishak et al., 2022) examined randomized and quasi-experimental studies of music therapy for adolescents / young adults with anxiety disorders. While methodological limitations remain, the review found consistent evidence that music-based interventions reduce anxiety symptoms, supporting the theoretical link between music exposure and affective outcomes (such as math anxiety) that your study proposes. This supports the current study's assumption that music exposure can lower students' math anxiety through similar emotional mechanisms aligning with the Arousal-Mood perspective.

Zaatar et al. (2023) reviewed numerous studies on how music affects emotion, focus, and learning. They found that listening to calming personally chosen music lowers stress indicators like heart rate and cortisol levels, while boosting attention and emotional stability during tasks. Overall, the review concluded that music help regulate mood and arousal, promoting better focus, reduced anxiety, and improved learning readiness.

1.4.3 Math Anxiety's Influence on Math Fluency

A study examining the relationship between math anxiety and performance among Grade 9 students found a negative correlation where higher anxiety levels led to lower math achievements (Alcover, 2024). With the Debilitating Anxiety Model and self-efficacy theory, the study highlights the reduction of anxiety as a key factor for improving math performance. These findings are relevant to exploring the indirect relationship between music exposure and math fluency by lowering anxiety, suggesting its potential role as a mediator in students' learning outcomes.

Different components of math anxiety—such as fear of judgement and interest in studying math—can produce effects on students' math performance. Some students with high anxiety levels still reach the required competence if they also have strong interest in math, despite having fears of evaluation (Piccirilli & Lanfanoli, 2025). This emphasizes the idea that math anxiety is not just a simple and uniform barrier and that internal attitudes—such as interest or preferences—and possibly external factors might affect its negative impact. Music exposure may help with components of anxiety, thus the enhancement of math fluency even in students who are math-anxious.

Math anxiety, defined as feelings of fear and mental confusion that weaken short-term memory and math calculations, is affected by complicating influences such as natural tendencies, past poor results, and surrounding factors like school systems, family support, and society's preconceived ideas (Rada & Lucietto, 2022). Among middle school students, this anxiety can interfere with the connection between listening to music—which may improve skills with shapes and spaces, as well as with numbers—and math skills by disrupting thinking processes and reducing potential benefits from helpful activities (Rada & Lucietto, 2022; Lucietto et al., 2020). Dealing with these factors through encouraging help programs could lessen anxiety and boost math results, highlighting the need for research on how these influences work in different groups of people.

Barroso et al. (2021) conducted a meta-analysis of 262 studies involving over 100,000 participants and found only a small negative association ($r = -0.20$) between math anxiety and math achievement, suggesting that anxiety's impairing effects may be overstated and not a strong mediator in all contexts, such as between external stimuli like music exposure and fluency outcomes in junior high students. This challenges the notion of math anxiety as a pervasive barrier, indicating that general cognitive abilities and prior knowledge may play larger roles in performance.

Sammallahti et al. (2023) reviewed 37 studies on interventions aimed at reducing math anxiety in elementary to secondary students. They found that most methods—like relaxation, mindfulness, and music-based activities—successfully lowered students' reported anxiety, but only slightly improved math performance, often without statistical significance. The researchers noted that while these activities help students feel calmer and more confident, they don't necessarily strengthen the cognitive skills, such as working memory or quick recall, that are key to math fluency.

Codding et al. (2023) conducted a meta-analysis of over 40 intervention studies focused on enhancing math fluency and accuracy among school-age students. The review found that direct, skill-based interventions—such as timed practice, self-monitoring, and feedback—had the largest effects on math fluency, while emotional or

motivational supports alone produced smaller gains. The proponents emphasized that fluency growth depends primarily on consistent practice and automatic retrieval, not solely on changes in affective states like anxiety or motivation.

De Vries (2022) explored the effects of various math fact fluency assessments on math anxiety among fourth-grade students in a central Iowa elementary school. Fifteen students participated over an eight-week period and were divided into three groups: control, experimental, and mixed-strategy, with five students in each. The control group took timed tests twice a week, the experimental group participated in one math fact interview weekly, and the mixed-strategy group completed both a timed test and an interview once a week. A math anxiety survey was administered before and after the treatments to compare changes within and between groups. Results showed a significant difference in the experimental group's scores, while no significant changes were observed in the control or mixed-strategy groups. Additionally, comparisons between all three groups showed no significant differences overall.

Sala and Gobet (2020) conducted a multilevel meta-analysis on the cognitive and academic benefits of music training with children, concluding that once design quality is controlled for, the overall effect of music training on academic outcomes (including mathematics) is essentially null.

Music Exposure's Influence on Math Fluency

Wafiq (2025) examined the impact of music education on mathematical skills and cognitive development, revealing a positive correlation between musical experience and mathematical performance. The study emphasized that musical training enhances pattern recognition and analytical reasoning abilities, which are critical components of mathematical problem-solving. This suggests that integrating music education into the curriculum may contribute to the development of cognitive skills that underpin success in mathematics.

Sriram (2023) investigated the effect of music on math performance among secondary school students finding that those who listened to music—particularly instrumental or inspirational genres—performed better in math tasks compared to those who did not. This study supports the idea that music exposure can create a conducive learning environment that enhances cognitive functions such as attention and memory, thereby improving mathematical problem-solving abilities. The findings align with other research advocating for the use of music as a supportive tool in academic settings.

Orpella et al. (2025) investigated the effects of music explicitly advertised to support focus—particularly “work flow” music—on mood and cognitive processing speed. Their findings show that such music positively influences emotional state and enhances processing speed without impairing accuracy, suggesting that genre-neutral, purpose-designed music can serve as an effective cognitive aid.

Galal et al. (2021) examined how music interventions affected test anxiety among pharmacy students. Participants were divided into groups that either listened to relaxing music (passive intervention) or actively engaged with music (such as rhythmic participation). Results revealed that both types of music interventions significantly reduced test anxiety levels before exams. The researchers concluded that music serves as an effective, low-cost strategy to reduce academic stress and anxiety, helping students improve focus and emotional regulation during testing situations.

An action-research (Insorio, 2025) involved 100 Grade 7 students in the Philippines and used a “math dance and song” intervention to reduce math anxiety and promote engagement. Using Wilcoxon Signed-Rank and Rosenthal's correlation coefficient, the study found that after the intervention, students reported significantly lower math anxiety and higher behavioural, cognitive, emotional, and social engagement. This study supports the theoretical link between music-based activities and affective outcomes in mathematics learning.

This experimental study (Lee & Deweese, 2022) randomly assigned 25 high-school students to complete an ACT-style math test either with background music, without music, or based on their preference. It found no significant difference in test scores between the music and silence conditions ($p > 0.9$) but did observe that students who habitually listened to music while studying/testtaking completed their tests significantly faster. The finding supports the idea that background music does not automatically improve math test performance.

A large-scale study by Whiteford et al. (2025) found no evidence that musical training enhances neural processing or cognitive performance. Involving more than 260 participants, the study failed to replicate earlier findings that suggested musicians have stronger neural responses to sound. Results showed that neither years of musical training nor age of onset had any measurable effect on auditory neural encoding or sound tracking, contradicting smaller past studies that reported positive outcomes. These findings indicate that music exposure does not significantly influence neural or cognitive skills related to abilities such as math fluency. A meta-analysis (Wang et al, 2024) synthesized 23 studies (49 effect sizes) of interventions integrating music into mathematics learning, finding a meaningful positive effect on mathematical performance and identifying moderators such as intervention method, grade level, music genre, and publication year. This suggests that music-math integration may confer measurable benefits when carefully targeted, supporting the rationale for exploring music exposure in relation to math-fluency.

Theoretical Framework

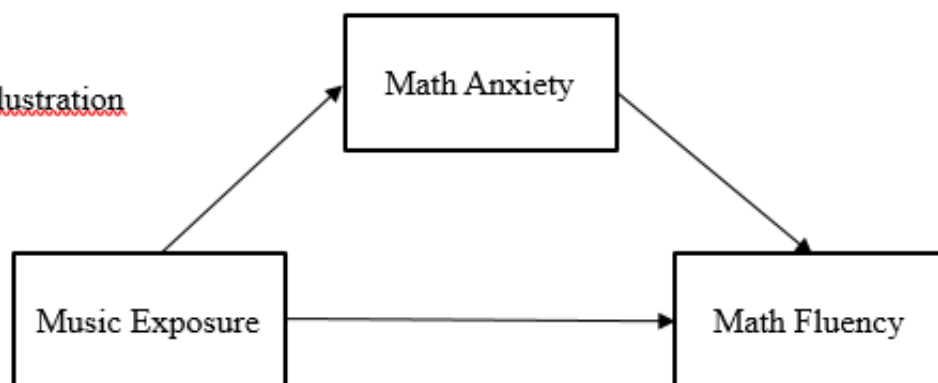
This study draws on three complementary theories to explain the relationships among Music Exposure (ME), Math Anxiety (MA), and Math Fluency (MF): Tobias’ Deficit Theory (1983), Wine’s Debilitating Anxiety Model (1980) (Samante & Alave, 2021). And the Arousal Mood Theory (Thompson et al., 2001) (sometimes used to interpret “Mozart-effect” type findings). Each theory guides our variables and hypotheses as follows.

Tobias’ Deficit Theory (1983) proposes that when students struggle to master a subject—such as lacking fluency or understanding in math—they start to feel incompetent, which can lead to anxiety. In this study, it means students with weaker math skills are more likely to feel anxious about math. That anxiety, in turn, can cause them to avoid math tasks, worsening their fluency over time. In short, Tobias’ theory views math anxiety as both a result of earlier learning gaps and a cause of ongoing performance issues, supporting its role as a key factor connected to math fluency. Wine’s model explains that anxiety takes up working memory and attention, making it harder to think clearly and perform complex tasks, In this study, the Debilitating Anxiety Model (1980) suggests that students with higher math anxiety struggle more with the mental focus and speed needed for fluent arithmetic, leading to lower math fluency scores. This theory supports the idea that math anxiety directly lowers performance—and that easing anxiety could help students do better by freeing up their cognitive resources.

The Arousal–Mood Theory (Thompson et al., 2001) suggests that music can change a person’s alertness and emotional state—either calming them or boosting focus—and these shifts can temporarily affect thinking and performance. In this study, music exposure is thought to influence mood and arousal, helping to reduce math anxiety or improve attention, which could then enhance math fluency. In short, this theory explains how music might lower anxiety and support better engagement and performance in math tasks.

Conceptual Framework

Figure 1
 Conceptual Illustration



The relationship among Music Exposure, Math Anxiety, and Math Fluency can be understood through a mediational framework. Music Exposure serves as the activating factor that may influence students' emotional and cognitive states. Specifically, engagement with music can shape levels of Math Anxiety, either reducing or reinforcing it depending on the nature of the exposure. Math Anxiety, in turn, mediates this relationship, acting as the bridge that links Music Exposure to students' Math Fluency. In this framework, lower anxiety may enhance fluency by promoting focus and confidence while higher anxiety may hinder performance, making Math Fluency a direct outcome of how Music Exposure affects students' emotional responses towards mathematics.

MATERIALS & METHODS

Sampling Method

The target population of this study consists of junior high school students in a faith-based school. A combination of convenience sampling and purposive sampling were employed in the study. All Grade 9 students in the institution (n = 81) were included as respondents through convenience sampling, due to pre-existing math fluency data. However, because the number did not meet the sufficient sample size for a simplistic Structural Equation Modeling (SEM) (Wolf et al., 2015; Van et al., 2020), the researchers purposively selected one Grade 10 and Grade 8 class to be included in the study. Rules of Thumb was used to determine the sample size (Wilson Van Voorhis & Morgan, 2007), ensuring an adequate number of respondents for analysis (n = 118) while maintaining relevance of the sample to the objectives of the study.

Data Collection

Data were collected through questionnaires and a timed math fluency test. Music exposure and math anxiety were measured using structured questionnaires, respectively with the use of the MusEQ development scale (Vanstone et al., 2016) and the MARS 30-item mathematics anxiety instrument (Suinn & Winston, 2003). Math fluency was assessed using the Ekwasion Math Fluency Test, consisting of one-minute subtests on motor skills and basic operations. All instruments were administered in classrooms under standardized instructions and conditions.

Variable Measurement

Responses for music exposure and math anxiety were measured using a 5-point Likert scale questionnaire. Table 1 shows the interpretation of responses.

Table #1 5-point Likert scale Interpretation Table

Scale	Range	Verbal Interpretation
5	4.21 – 5.00	Strongly Agree / Very High
4	3.41 – 4.20	Agree / High
3	2.61 – 3.40	Neutral / Moderate
2	1.81 – 2.60	Disagree / Low
1	1.00 – 1.80	Strongly Disagree / Very Low

Math fluency was measured through the Ekwasion Math Fluency Test, consisting a six-part test on motor skills and basic operations, with scores computed based on the number of correct responses within one minute (speed) and the proportion of correct answers relative to total attempts (accuracy).

Validity and Reliability of Research Instrument

The measurement model was evaluated based on internal consistency reliability, convergent validity, and discriminant validity for the latent constructs *Music Exposure* and *Math Anxiety*. Meanwhile, *Math Fluency* was

excluded from this analysis as it represents an observed variable. Discriminant validity was evaluated using the **Heterotrait-Monotrait (HTMT)** ration of correlations (Henseler et al., 2015).

Data Analysis

Structural Equation Modeling (SEM) was employed in this study because it allows simultaneous testing of multiple relationships among observed and latent variables within a single model. SEM enables researchers to estimate complex cause-effect relationship models involving multiple constructs simultaneously (Hair et al., 2021).

Unlike traditional regression, SEM can estimate both direct and indirect effects, making it ideal for mediation analysis such as examining whether Math Anxiety mediates the link between Music Exposure and Math Fluency. This approach provides a more comprehensive understanding of complex psychological constructs by accounting for measurement error and testing the overall model fit rather than individual paths alone.

RESULTS AND DISCUSSION

Validity and Reliability

Reliability and Convergent Validity

Table #2 presents the internal consistency and convergent validity indices of the constructs. The results reveal that the Cronbach’s alpha (α) values of 0.900 for *Music Exposure* and 0.925 for *Math Anxiety* exceed the recommended threshold of 0.70 (Hair et al., 2021), indicating strong internal consistency.

Similarly, the composite reliability (ρ_C) and Dijkstra–Henseler’s rho_A (ρ_A) values for both constructs were above 0.70, confirming adequate construct reliability. The Average Variance Extracted (AVE) values of 0.505 and 0.503 also surpassed the 0.50 criterion (Fornell & Larcker, 1981), indicating that more than half of the variance in the indicators was explained by their corresponding constructs. Collectively, these indices demonstrate satisfactory reliability and convergent validity for the measurement model.

Table #2

<i>Reliability</i>				
Constructs	Alpha	rhoC	AVE	rhoA
Music Exposure	0.9	0.916	0.505	0.917
Math Anxiety	0.925	0.935	0.503	0.932

Threshold: Alpha, rhoC, and rhoA > 0.7, AVE > 0.5

Discriminant Validity

As shown in Table #3, the HTMT value between *Music Exposure* and *Math Anxiety* was 0.557, which is below the conservative threshold of 0.85. This indicates that the two constructs are empirically distinct from one another, thus supporting discriminant validity.

Table #3

HTMT

Construct	Music Exposure	Math Anxiety
Music Exposure	—	0.557
Math Anxiety		—

HTMT < 0.85

Structural Model Assessment

Table #4 Hypothesis Testing

Effects	Relations	Beta	T Statistics	p-values	Decision
	Direct				
H1	ME → MF	0.076	0.338	0.735	Not Sig.
H2	ME → MA	-0.54	7.392	< 0.001	Sig.
H3	MA → MF	-0.322	0.982	0.326	Not Sig.
	Mediation				
H4	ME → MA → MF	-0.174	0.91	0.363	Not Sig.
Math Fluency, $R^2 = 0.136$					

Effect of Music Exposure on Math Fluency

The relationship between Music Exposure and Math Fluency was positive but not significant ($\beta = 0.076$, $t = 0.338$, $p = 0.735$). This suggests that exposure to music does not directly improve students' mathematical fluency. Similar results were found by Lee & Dewese (2022), who observed no significant difference in test scores between who listened to music and those who did not. Sala & Gobet (2020) also reported when research design quality is controlled, music training has little to no direct effect on academic performance.

However, some studies suggest that music might still help learning under specific conditions. Milman and Paz-Baruch (2025) found that self-selected background music improved focus and accuracy for students with math difficulties. Wang et al. (2024) also reported that the positive effect of music on math outcomes depends on the type of activity and the learner's background. These findings imply that music exposure alone is not enough to improve fluency but may work better when paired with targeted math practice or when it enhances attention and motivation.

Effect of Music Exposure to Math Anxiety

A significant negative relationship was observed between Music Exposure and Math Anxiety ($\beta = -0.540$, $t = 7.392$, $p < .001$), supporting the hypothesis that higher exposure to music is associated with lower math anxiety. Thus, students who are more frequently exposed to music may experience less anxiety toward mathematics-related tasks. Galal et al. (2021) found similar results, showing that both listening to and performing music reduced students' test anxiety. Insorio (2025) also demonstrated that using songs and dance in math classes lowered Math Anxiety while increasing students' engagement. These findings suggest that music can serve as an effective tool in the classroom.

Recent studies further explain this effect. Ishak et al. (2022) showed that music therapy helps lower stress and anxiety among young people, while Wang et al. (2024) emphasized that music integration in school improves motivation and confidence. Likewise, Whiteford et al. (2025) noted that music can regulate mood and physiological arousal, reducing stress before challenging tasks. Altogether, these studies support the conclusion that music exposure significantly helps reduce math anxiety.

Effect of Math Anxiety on Math Fluency

The path from Math Anxiety to Math Fluency was negative but not significant ($\beta = -0.322$, $t = 0.982$, $p = 0.326$). Although the direction of the relationship aligns with the theoretical expectation that higher anxiety leads to poorer performance, the effect was statistically insignificant. This suggests that math anxiety, while potentially influential, may not have been a dominant factor affecting fluency in this sample—possibly due to compensatory factors such as confidence, familiarity with mathematical tasks, or general academic ability. Barroso et al. (2021) found that although anxiety and math performance are generally related, the connection is weak and may depend

on the type of math task. Sammallahti et al. (2023) also reported that anxiety-reduction programs improve emotions but not always performance outcomes.

This finding may be because math fluency tasks rely on automatic skills rather than complex problem-solving, which are less affected by anxiety. Coddling et al. (2023) noted that targeted practice, not emotional change alone, most strongly predicts fluency gains. Zaatari et al. (2023) and Wang et al. (2024) also highlighted that motivation, attention, and prior knowledge play larger roles than anxiety in timed math tasks. Thus, while Math Anxiety influences feelings toward math, it may not always have a direct and measurable impact on fluency.

Indirect Effect (ME → MA → MF)

The mediating effect of Math Anxiety on the relationship between Music Exposure and Math Fluency was not significant ($\beta = -0.174$, $t = 0.910$, $p = 0.363$). Although Music Exposure significantly reduced Math Anxiety (H2), this reduction did not significantly translate into higher Math Fluency. The absence of mediation suggests that while music may help alleviate anxiety, it does not necessarily enhance mathematical performance indirectly through anxiety reduction alone. Other potential mediators—such as concentration, motivation, or cognitive flexibility—may play a more prominent role. This result supports earlier research showing that relieving anxiety alone does not automatically improve math performance (Sammallahti et al., 2023; Barroso et al., 2021). Music may help students feel more relaxed but not necessarily faster or more accurate in solving math problems.

Studies by Zaatari et al. (2023) and Wang et al. (2024) suggest that combining emotional support like music with cognitive training leads to stronger academic effects. Likewise, Milman and Paz-Baruch (2025) and Whiteford et al. (2025) indicate that while music improves mood and focus, additional practice or teaching strategies are needed for it to affect performance. Therefore, the current findings show that Math Anxiety did not significantly mediate the link between Music Exposure and Math Fluency, implying that other variables such as motivation and attention may play stronger roles.

Summary

The findings of this study reveal that Music Exposure significantly decreases Math Anxiety but does not have a direct or indirect effect on Math Fluency. This means that students who regularly engage with or listen to music tend to experience less emotional stress and nervousness toward mathematics, supporting results from Galal et al. (2021) and Insorio (2025) who both reported that music activities reduce anxiety and improve student engagement.

However, this emotional benefit did not translate into measurable improvements in students' Math Fluency, aligning with studies such as Lee and Dewese (2022) and Whiteford et al. (2025) that found no significant difference in math performance between those exposed to music and those who were not.

The statistical model ($R^2 = 0.136$) indicates that Music Exposure and Math Anxiety together explained only a small portion of the variance in Math Fluency. This suggests that other factors—such as cognitive ability, motivation, or familiarity with math concepts—may have stronger influences on fluency performance.

As Barroso et al. (2021) and Coddling et al. (2023) noted, Math Fluency is heavily shaped by repeated practice and procedural automaticity, which are not directly altered by changes in emotion alone. Additionally, while music effectively reduces anxiety, studies like Sammallahti et al. (2023) show that emotional relief does not always lead to higher academic achievement unless accompanied by targeted instructional strategies.

Overall, the results suggest that music serves better as an emotional support tool than a direct enhancer of mathematical ability. It can create a positive and calm learning atmosphere that helps students approach math tasks with greater confidence and less fear, consistent with Arousal-Mood Theory (Thompson et al., 2001) and recent evidence on music's role in emotional regulation (Ishak et al., 2022; Zaatari et al., 2023; Wang et al., 2024). Future studies may expand this line of inquiry by including additional variables—such as attention, working memory, or motivation—and exploring how different types of music genres or learning settings can optimize both emotional and cognitive outcomes.

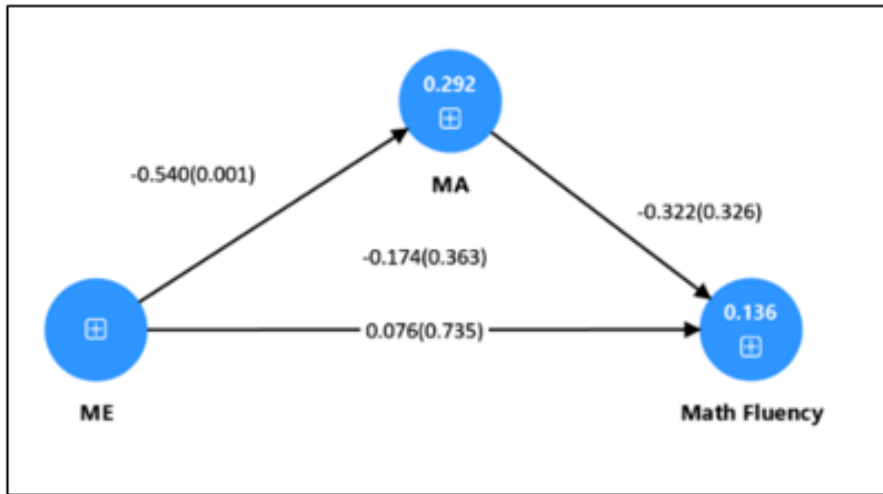


Figure 2 Mediating Effect of Math Anxiety on the Relationship between Music Exposure and Math Fluency

CONCLUSION

The findings of this study demonstrated that Music Exposure reduces Math Anxiety significantly, but did not significantly improve Math Fluency both directly and indirectly. This indicates that frequent engagement with music can help students manage anxiety toward mathematics-related tasks, but such emotional benefits may not necessarily translate into improved mathematical performance. The lack of a significant mediation role for Math Anxiety would indicate that other variables—such as, motivation focus or general cognitive abilities—might be more involved in accounting for the link between music and math outcomes.

Despite the limited predictive power of the model ($R^2=0.136$), the findings contribute to the growing body of research exploring the cognitive and emotional effects of music academically. The study reinforces that Music Exposure can serve as an effective tool for reducing stress and creating a more positive learning environment, even if its direct influence on Math Fluency remains minimal.

Future research may benefit from incorporating additional variables such as attention, working memory, or learning motivation to better understand how music interacts with students' academic performance. Expanding the sample size, including diverse educational settings, and differentiating between types of genres of music may also yield deeper insights. Lastly, by integrating music as a supportive classroom element, educators may foster emotionally balanced learners who approach mathematics with greater confidence and reduced anxiety.

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