

Effect of music based cognitive behavioral therapy on mathematics test anxiety and learning outcome: Evidence from a quasi-experimental study

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Abstract

Many learners experience mathematics test anxiety, which culminates in lower learning outcomes in the subject and ultimately undermines future career prospects, particularly in science, technology, engineering, and medicine, as well as the mental well-being of affected learners. Thus, the study aimed to assess the effectiveness of Music-Based Cognitive Behavioral Therapy (MB-CBT) in reducing test anxiety and enhancing learning outcomes in mathematics. The study adopted a quasi-experimental, non-equivalent control group design to examine a sample of 40 students with high mathematics test anxiety who were selected from one school via multistage sampling and assigned by intact classes to experimental and control groups. The experimental group of 20 randomly selected students received MB-CBT-based instruction for 8 weeks, while the control group comprised 20 randomly selected students who were conventionally taught over eight weeks as well. Analysis of covariance statistics was utilized for data analysis. Findings showed that the Music-Based Cognitive Behavioral Therapy intervention had a statistically significant effect on reducing mathematics test anxiety in students, thereby improving learning outcomes. The study shows that integrating music-imbued cognitive restructuring strategies into mathematics-related activities can serve as an effective instructional and psychological intervention for enhancing learning outcomes and reducing performance-related anxiety.

Keywords: Cognitive behavioral therapy, Learning outcomes, Mathematics learning, Mathematics test anxiety, Mathematics, Music-based cognitive-behavioral therapy.

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Contribution of this paper to the literature

This study contributes to the literature by examining the combined application of music and cognitive behavioral techniques in addressing mathematics test anxiety and learning outcomes within regular mathematics instruction. It therefore provides context-specific evidence regarding a school-based intervention that simultaneously addresses the emotional and cognitive barriers associated with mathematics learning.

1. Introduction

Mathematics plays a central role in scientific, technological, and economic development, and students' competence in the subject can shape their later educational and occupational opportunities. Learning outcomes in mathematics are not limited to computational accuracy; they also include conceptual understanding, problem-solving ability, motivation, and confidence in applying mathematical knowledge (Lin, Yin, Han, & Han, 2020; Mahajan & Singh, 2017; Radišić, 2023). Yet many students encounter psychological and emotional difficulties that prevent them from achieving these outcomes.

Mathematics test anxiety is one such difficulty. It involves fear, worry, tension, and physical discomfort that students may experience before or during a mathematics examination. These reactions can occupy the working-memory resources required for calculation, reasoning, and problem-solving, causing students to perform below their actual level of knowledge (Ashcraft & Krause, 2007). Mathematics test anxiety may also lead to avoidance, procrastination, reduced practice, poor concentration, and negative beliefs about mathematical ability (Devine, Fawcett, Szűcs, & Dowker, 2012; Pizzie & Kraemer, 2023). Anxiety and poor achievement can therefore become mutually reinforcing: anxiety weakens performance, and repeated poor performance heightens later anxiety.

Cognitive Behavioral Therapy has been used to manage anxiety by helping individuals recognize irrational beliefs, question negative thoughts, and develop more adaptive emotional and behavioral responses. Research suggests that cognitive behavioral interventions can reduce mathematics anxiety and improve achievement by changing fear-related beliefs and strengthening students' confidence in their mathematical ability (Bicer, Perihan, & Lee, 2020; Lovina & Chilota, 2021; Nikpour, Kargozar, & Ghribzadeh, 2021). Music may complement these strategies because it can support relaxation, emotional regulation, attention, memory, and engagement during learning (Gutiérrez & Camarena, 2015; Zaatar, Alhakim, Enayeh, & Tamer, 2024).

Music-Based Cognitive Behavioral Therapy brings together the cognitive restructuring and behavioral methods of Cognitive Behavioral Therapy and structured musical activities, including relaxation music, rhythm-supported rehearsal, singing, and positive self-statements set to simple melodies. Earlier studies have reported encouraging effects of music-based cognitive behavioral interventions on anxiety and test-taking behavior, although findings on academic achievement have been mixed (Agboeze et al., 2020; Puplampu, 2018; Ugwuanyi, Okeke, & Agboeze, 2021). Evidence on the specific use of this approach for mathematics test anxiety among secondary school students also remains limited.

Against this background, the study examined the effect of Music-Based Cognitive Behavioral Therapy on mathematics test anxiety and learning outcomes. It was guided by the following null hypotheses:

1. *There is no significant difference between students in the Music-Based Cognitive Behavioral Therapy group and those in the control group in their posttest mathematics achievement scores after controlling for pretest scores.*
2. *There is no significant difference between students in the Music-Based Cognitive Behavioral Therapy group and those in the control group in their posttest mathematics test-anxiety scores after controlling for pretest scores.*

2. Literature Review

2.1. Mathematics Test Anxiety and Learning Outcomes

Mathematics test anxiety and mathematics achievement influence one another. Anxiety may interfere with both the learning and demonstration of mathematical knowledge, while repeated poor performance can strengthen negative beliefs and increase later anxiety. Piccirilli et al. (2023), for example, found that higher mathematics-anxiety scores were associated with poorer performance, particularly among students who had difficulty acquiring new mathematical skills. Pizzie and Kraemer (2023) similarly noted that anxiety can reduce concentration, effort, practice, and willingness to participate in mathematics-related activities.

The working-memory explanation provides an important account of this relationship. Ashcraft and Krause (2007) argued that worry and intrusive thoughts use cognitive resources that would otherwise be available for calculation and problem-solving. As a result, a student with mathematics test anxiety may perform below his or her actual ability during an examination. Physical reactions, including a rapid heartbeat, sweating, disrupted sleep, and nausea, may further weaken concentration and encourage avoidance of mathematics-related tasks (Yusefzadeh, Amirzadeh Iranagh, & Nabilou, 2019).

2.2. Cognitive Behavioral Therapy and Music-Based Cognitive Behavioral Therapy

Cognitive Behavioral Therapy rests on the view that thoughts, emotions, and behavior are closely connected. Beliefs such as "I will fail mathematics" or "I cannot solve mathematical problems" can generate fear, avoidance, reduced effort, and poor performance. Cognitive behavioral interventions help learners identify these beliefs, examine whether they are accurate, replace them with more realistic alternatives, and practise more productive responses.

Available evidence indicates that Cognitive Behavioral Therapy can reduce mathematics anxiety and improve mathematics performance. In a meta-analysis, Bicer et al. (2020) found that cognitive behavioral interventions were effective in lowering students' mathematics anxiety. Lovina and Chilota (2021) also reported better mathematics learning outcomes and lower test anxiety after a cognitive behavioral intervention. Together, these findings suggest that work on students' negative beliefs can usefully complement conventional mathematics teaching.

Music offers an additional route to emotional regulation and engagement. It may lower physiological arousal, create a more supportive learning environment, improve concentration, and aid recall (Zaatar et al., 2024). When

used within a cognitive behavioral intervention, music can support relaxation, reinforce adaptive self-statements, sustain attention, and encourage participation.

MB-CBT, therefore, combines the emotional and cognitive benefits of music with cognitive restructuring and behavioral practice. Agboeze et al. (2020) and Ugwuanyi et al. (2021) found that music-based cognitive behavioral interventions reduced test-taking anxiety and related emotional difficulties among students. Puplampu (2018), however, reported that a music-based intervention improved learning, but that the improvement was not statistically significant. This mixed evidence suggests that music on its own may not always produce substantial academic gains and that combining it systematically with cognitive restructuring may be especially important.

The present study built on this evidence by embedding music-assisted relaxation, rhythm-supported rehearsal, positive self-statements, and guided cognitive restructuring directly within mathematics instruction. It then examined whether this combined approach improved mathematics achievement while also reducing mathematics test anxiety.

3. Method

3.1. Research Design

The research design for the study was a quasi-experimental research design.

3.2. Population and Sampling Technique

The population for this study was 600 senior secondary students in Port Harcourt LGA, Rivers State. A multistage sampling procedure was used to obtain the sample size. At the first stage of sampling, a simple random sampling technique, using balloting without replacement, was used to select one school from the population: Model Secondary School, GRA, Port Harcourt, Rivers State, Nigeria. At the second stage of sampling, a purposive sampling technique was employed to select only SS2 students with mathematics test anxiety. The Mathematics Anxiety Rating Scale (MARS-R) was administered to all 600 SS2 students to screen and select only those who had mathematics test anxiety, based on their scores on the MARS-R. At the third stage, a simple random sampling technique, using balloting, was used to assign 40 identified students with mathematics test anxiety, based on their high scores on the MARS-R, to experimental and control groups according to their class arms. That is, intact classes were used as the basis for assignment to the experimental and control groups. Thus, the final sample size was 40 students identified with mathematics test anxiety. Because intact classes, rather than individual random assignment, were used, the possibility of selection bias and pre-existing differences between the groups could not be completely eliminated. Analysis of covariance was therefore used to adjust the post-test outcomes for the corresponding pre-test scores. Nevertheless, the findings should be interpreted cautiously because unmeasured differences between the intact classes may have influenced the observed treatment effects.

3.3. Experimental Procedure and Data Collection

Following ethical approval and permission from the school authorities, written parental or guardian consent and student assent were obtained. Two intact classes were assigned to the experimental and control conditions. Teachers assigned to the experimental group were trained to implement the Music-Based Cognitive Behavioral Therapy lesson guide, while the control-group teacher taught the same mathematics topics using conventional instruction.

Before the intervention, both groups completed the Mathematics Achievement Test Form A and the Mathematics Anxiety Rating Scale-Revised. The intervention lasted eight weeks, with two 60-minute sessions each week. Both groups were taught the same Senior Secondary Two mathematics topics. In the experimental group, instruction incorporated music-assisted relaxation, rhythm-supported rehearsal, positive self-statements embedded in simple melodies, and guided cognitive restructuring. The control group received conventional explanation, demonstration, and practice without the music-based cognitive-behavioral components. Attendance, lesson implementation, and student engagement were monitored throughout the intervention. Following a one-week consolidation period, Mathematics Achievement Test Form B and the Mathematics Anxiety Rating Scale-Revised were administered as posttests under standardized classroom conditions.

3.4. Measures and Instruments for Data Collection

Two equivalent forms of the Mathematics Achievement Test (MAT), A and B, consisting of ten questions each, were used as instruments for data collection. Mathematics Achievement Test (A) was administered during the pretest assessment, while Mathematics Achievement Test (B) was administered after the treatment. The MAT, designed by a mathematics expert, was developed as a pretest and posttest instrument to assess performance and anxiety levels during testing. It was a 20-item multiple-choice assessment designed for Senior Secondary 2 students, covering approximation, sequences and series, quadratic equations, and simultaneous equations. It showed strong face validity because the questions clearly reflected typical SS2 mathematics tasks and followed standard examination formats, as confirmed by experts in measurement and evaluation and the school board. Its content validity was high, as the items were derived from a Table of Specifications and adequately represented all key curriculum areas. The test measured a range of cognitive skills—from recall to application and problem-solving—using a balanced distribution of questions across the four topics. The MAT, being an achievement-oriented cognitive instrument, was tested for internal consistency using the split-half method. The 20-item test was divided into odd and even halves, and a Guttman split-half coefficient of 0.78 was obtained. Both instruments were pilot-tested on a sample of 20 students who were not included in the study.

The second instrument was the MARS-R, developed by Plake and Parker (1982). It is a 24-item self-referencing scale designed to measure anxiety in mathematics. The scale was adopted because of its sound psychometric properties, strong reliability, and factorial validity, as demonstrated in previous studies. The MARS-R scale, containing 24 items, employed a structured scoring approach based on a five-point Likert scale. The total score for each respondent was calculated by adding the scores for all 24 items on the MARS-R. Those with scores of 70 or higher were classified as having high test anxiety. The MARS-R demonstrated a coefficient alpha reliability of 0.98 with the full-scale MARS. Additionally, the CBT-Music intervention program used in the study was developed based

on established principles of cognitive-behavioral therapy, ensuring its validity for addressing mathematics test anxiety.

3.5. Ethical Considerations

University of Port Harcourt approved this study through their institutional review board with ID No: UPH/CEREMAD/REC/MM118/078. The investigator adhered rigidly to the board's and the APA's ethical standards (APA, 2017).

3.6. Data Analysis

Data from the pre-tests and post-tests, along with records of attendance and engagement, were then collated and analyzed using appropriate statistical methods. Descriptive statistics, specifically the mean and standard deviation (SD), as well as Analysis of Covariance (ANCOVA), were employed to analyze the data. Statistical programs like SPSS version 25 were used to analyze the data.

4. Results and Discussion

4.1. Results

Hypothesis 1: There is no significant difference between the MB-CBT experimental group and the control group on post-test measures of mathematics performance.

Table 1a. Mean and standard deviation analysis showing the difference in post-test measures of mathematics learning outcome between the MB-CBT experimental group and the control group.

Treatment Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
MB-CBT	20	50.45	3.12	73.15	3.70	22.70
Control	20	52.55	13.00	57.25	5.62	4.70

Table 1b. ANCOVA analysis showing significant difference between MB-CBT experimental group and control group on post-test measures of mathematics learning outcome.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2536.040	2	1268.02	89.134	0.000	0.828
Intercept	456.355	1	456.355	32.079	0.000	0.464
PreAchievement	7.940	1	7.940	0.558	0.460	0.015
MB-CBT Trtmt	2344.820	1	2344.820	164.827	0.000	0.817
Error	526.360	37	14.226			
Total	173104.000	40				
Corrected Total	3062.400	39				

Table 1a shows that the students in the MB-CBT group demonstrated a greater improvement in mathematics achievement than those in the control group. The MB-CBT group increased from a pretest mean of 50.45 (SD = 3.12) to a posttest mean of 73.15 (SD = 3.70), representing a mean increase of 22.70 points. The control group increased from a pretest mean of 52.55 (SD = 13.00) to a posttest mean of 57.25 (SD = 5.62), representing a mean increase of 4.70 points. Although both groups improved, the increase observed in the MB-CBT group was substantially greater. This indicates that although both groups showed improvement from pretest to post-test, the MB-CBT group demonstrated a substantially greater increase in mathematics learning outcome. The relatively smaller standard deviation values within the MB-CBT group also suggest that the gains were more consistent across participants, whereas the control group exhibited wider variability in performance improvement. The foregoing implies that the students in the treatment group who were exposed to music-based cognitive behavioural therapy achieved better than those in control group. Furthermore, results in Table 1b showed the statistical effect of MB-CBT. After controlling for pretest mathematics-achievement scores, there was a statistically significant effect of treatment on posttest mathematics achievement, $F(1, 37) = 164.83, p < .001$, partial $\eta^2 = .817$. The effect size indicates that the treatment had a large effect on students' posttest mathematics achievement. The pretest achievement covariate was not statistically significant, $F(1, 37) = 0.56, p = .460$, partial $\eta^2 = .015$. Therefore, the null hypothesis was rejected. Students who received MB-CBT achieved significantly higher posttest mathematics scores than students who received conventional instruction after adjustment for their pretest scores.

Hypothesis 2: There is no significant difference between experimental group MB-CBT and control group on their post-test measures of Mathematics Test Anxiety performance.

Table 2a. Mean and standard deviation analysis showing the difference in post-test measures of mathematics anxiety between the MB-CBT experimental group and the control group.

Treatment Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
MB-CBT	20	100.85	5.82	53.25	8.94	-47.60
Control	20	95.95	13.00	95.85	12.51	-0.100

Table 2b. ANCOVA analysis showing significant difference between MB-CBT experimental group and control group on post-test measures of mathematics test anxiety.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18674.708	2	9337.354	80.136	0.000	0.812
Intercept	461.443	1	461.443	3.960	0.054	0.097
Pretest Anxiety	527.108	1	527.108	4.524	0.040	0.109
MB-CBT Trtmt	18527.411	1	18527.411	159.008	0.000	0.811
Error	4311.192	37	116.519			
Total	245294.000	40				
Corrected Total	22985.900	39				

Table 2a shows that mathematics test anxiety decreased substantially among students in the MB-CBT group. Their mean anxiety score decreased from 100.85 ($SD = 5.82$) at pretest to 53.25 ($SD = 8.94$) at posttest, representing a reduction of 47.60 points. In comparison, the control group recorded only a negligible decrease from 95.95 ($SD = 13.00$) at pretest to 95.85 ($SD = 12.51$) at posttest, representing a reduction of 0.10 points. These descriptive results indicate that students exposed to MB-CBT experienced a much greater reduction in mathematics test anxiety than those who received conventional instruction. Based on the table, it can be inferred that the MB-CBT intervention had a significantly positive effect on students' mathematics test anxiety. The treatment group showed a substantial reduction in post-test scores, along with a much larger reduction in anxiety compared to the control group.

MB-CBT as implemented in the experimental group positively influenced students' mathematics anxiety. The treatment group demonstrated a significant improvement in posttest scores, with a mean gain of -47.60 points. In contrast, the control group, which received no intervention, remained high in mathematics anxiety scores. These results indicate that MB-CBT has a pronounced impact on mathematics anxiety. Therefore, based on these results, MB-CBT has a significant positive effect on mathematics test anxiety.

Table 2b also shows the ANOVA result. After controlling for pretest mathematics test-anxiety scores, there was a statistically significant effect of treatment on posttest mathematics test anxiety, $F(1, 37) = 159.01, p < .001$, partial $\eta^2 = .811$. This represents a large treatment effect. Pretest mathematics test anxiety also made a statistically significant contribution to posttest anxiety, $F(1, 37) = 4.52, p = .040$, partial $\eta^2 = .109$. Therefore, the null hypothesis was rejected. Students who received MB-CBT had significantly lower posttest mathematics test-anxiety scores than students who received conventional instruction after controlling for their initial anxiety scores. This implies that the effectiveness of MB-CBT in reducing mathematics anxiety among secondary school students is statistically significant.

4.2. Discussion

Students who received MB-CBT made substantially greater gains in mathematics achievement than students taught through conventional methods. This result indicates that attention to the emotional and psychological aspects of learning, alongside subject content, can improve mathematics performance. The finding agrees with Lovina and Chilota (2021) who reported that a CBT-based intervention improved mathematics achievement while reducing test anxiety among students in the experimental group. Their work, like the present study, points to the value of cognitive restructuring in helping students question maladaptive beliefs, self-doubt, and fear related to mathematics.

The result is also consistent with the studies of Ugwuanyi et al. (2021) which showed that combining CBT with music reduced physics test anxiety and general test-taking anxiety among secondary school students. Although those studies focused on somewhat different outcomes, they support the view that music can strengthen a cognitive behavioral intervention by creating an emotional climate that encourages concentration, motivation, and active participation. In this sense, music may serve both as a means of emotional regulation and as a support for the cognitive work involved in learning.

The present finding differs, however, from that of Puplampu (2018) whose music-based intervention produced an improvement in students' subject-matter knowledge that was not statistically significant. Several differences may account for the contrasting results, including the characteristics of the samples, the research designs, and the instruments used. Baseline anxiety, age, academic context, and the absence of a structured cognitive-restructuring component may also have limited the effect observed in Puplampu's study. In the current intervention, music was paired deliberately with CBT techniques that challenged negative thoughts and irrational beliefs about mathematics. That combination may have increased the intervention's influence on both the emotional and cognitive processes involved in achievement.

The way music was used in the MB-CBT programme may also help to explain the observed gains. Musical activities sustained students' attention during mathematics lessons and created opportunities for interaction and peer bonding. These shared experiences may have strengthened students' sense of belonging, reduced fear of performance, and encouraged them to persist with difficult tasks. Music also supported relaxation, emotional regulation, and the internalization of CBT principles, enabling students to approach mathematics with greater confidence and less anxiety.

Beyond its effect on achievement, MB-CBT produced a substantial reduction in mathematics test anxiety, and this emotional improvement may have contributed to the better learning outcomes. Agboeze et al. (2020) similarly found that a CBT-music programme helped students manage their test-taking behavior. The present result also agrees with Ugwuanyi et al. (2021) who reported a significant reduction in test anxiety after a music-based CBT intervention. Taken together, these findings show that MB-CBT can address emotional barriers that interfere with students' performance in evaluative situations.

The result is not fully consistent with Trimmer, Tyo, and Naeem (2016) who observed reductions in anxiety and depression after MB-CBT but found that the differences were not statistically significant. The difference may be related to the outcomes examined. Trimmer et al. considered general anxiety and depression, whereas the current study focused specifically on mathematics test anxiety, a situational form of anxiety linked directly to academic evaluation. An intervention aimed at a clearly defined trigger may produce a stronger effect because it can address the particular thoughts and reactions that arise in that setting.

A further feature of the present intervention was the use of original music. Students contributed lyrics drawn from their own learning experiences, which may have made the sessions more personally meaningful and helped to sustain attention. Their participation in creating the music may also have deepened engagement with the cognitive behavioral techniques and strengthened the intervention's effect. The combination of lower test anxiety and higher mathematics performance therefore suggests that MB-CBT may offer a useful, holistic approach to students' emotional well-being and academic achievement.

5. Conclusion

The findings support Music-Based Cognitive Behavioral Therapy as a useful intervention for reducing mathematics test anxiety and improving learning outcomes among secondary school students. Compared with

students who received conventional instruction, those taught through MB-CBT reported markedly lower test anxiety and achieved higher mathematics scores. By embedding music-supported cognitive restructuring within mathematics lessons, the intervention addressed emotional and cognitive aspects of learning that traditional instruction may not always consider. The results are consistent with the central assumption of Cognitive Behavioral Therapy that maladaptive thoughts and emotional responses can hinder performance, while structured changes in thinking and behavior can support better outcomes. Music appeared to strengthen this process by providing a supportive atmosphere for concentration, engagement, and continued participation. Overall, the study adds to evidence that psychologically informed and multimodal teaching approaches can improve students' experiences and performance in mathematics.

6. Recommendations

The findings have practical implications for classroom teaching, school psychological services, assessment, and educational policy. Mathematics teachers may use carefully structured elements of music and cognitive restructuring to help students manage test anxiety and develop greater confidence in solving problems. Professional development in MB-CBT would enable teachers to apply these strategies consistently and appropriately during mathematics instruction.

For school counsellors and educational psychologists, MB-CBT offers a group-based intervention that can be implemented within the school environment. Its group format supports peer interaction, encourages emotional regulation, and makes it potentially suitable for both preventive and remedial programmes. Test developers should also recognize that anxiety can affect how students demonstrate what they know. Clear instructions, reasonable time demands, and assessment formats that avoid unnecessary pressure may help ensure that mathematics tests measure competence rather than anxiety-related performance difficulties. At the policy level, curriculum planners and other educational stakeholders should consider including CBT-informed and music-supported strategies in teacher training and school-based well-being programmes. Such an approach is consistent with models of education that give attention to both academic achievement and emotional health.

The results also point to several directions for further research. Future studies should examine whether the effects of MB-CBT differ by gender, prior achievement, or initial anxiety level, so that the students who benefit most can be identified. Researchers should also investigate the contribution of individual components, including the type of music, the length of exposure, and the intensity of cognitive restructuring. Randomized controlled trials would provide stronger evidence of causality and reduce the selection bias associated with quasi-experimental designs. Longitudinal research is equally important, as follow-up assessments conducted several months after the intervention would show whether the improvements in anxiety regulation and mathematics performance are sustained.

Qualitative studies could provide a fuller understanding of how students experience and interpret music-based therapy. Further work may also extend MB-CBT to other school subjects and educational levels, or compare it directly with alternative psychosocial and instructional interventions. Such studies would clarify the conditions under which MB-CBT is most effective and further establish its usefulness as an evidence-based approach to academic success and emotional well-being.

7. Limitations of the Study

The study has several limitations. First, the sample was relatively small, which limits statistical power and the extent to which the findings can be generalized. Second, the use of a quasi-experimental design and intact classes meant that participants were not assigned individually at random, leaving open the possibility of selection bias. Third, no long-term follow-up was conducted, so it is not known whether the gains were maintained after the intervention. Despite these limitations, the study provides useful evidence that Music-Based Cognitive Behavioral Therapy may reduce mathematics test anxiety and improve learning outcomes.

References

- Agboeze, M. U., Ugwuanyi, C. S., Okeke, C. I. O., Ugwu, G. C., Obikwelu, C. L., Obiozor, E. E., . . . Mbam, D. (2020). Efficacy of music-based cognitive behavior therapy on the management of test-taking behavior of children in basic science using a randomized trial group: Implication for community development. *Medicine*, 99(34), e21535. <https://doi.org/10.1097/md.00000000000021535>
- Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review*, 14(2), 243-248. <https://doi.org/10.3758/BF03194059>
- Bicer, A., Perihan, C., & Lee, Y. (2020). A meta-analysis: The effects of CBT as a clinic- & school-based treatment on students' mathematics anxiety. *International Electronic Journal of Mathematics Education*, 15(2), em0576. <https://doi.org/10.29333/iejme/7598>
- Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and Brain Functions*, 8, 33. <https://doi.org/10.1186/1744-9081-8-33>
- Gutiérrez, E. O. F., & Camarena, V. A. T. (2015). Music therapy in generalized anxiety disorder. *The Arts in Psychotherapy*, 44, 19-24. <https://doi.org/10.1016/j.aip.2015.02.003>
- Lin, W., Yin, H., Han, J., & Han, J. (2020). Teacher-student interaction and Chinese students' mathematics learning outcomes: The mediation of mathematics achievement emotions. *International Journal of Environmental Research and Public Health*, 17(13), 4742. <https://doi.org/10.3390/ijerph17134742>
- Lovina, N., & Chilota, O. (2021). Effect of cognitive behaviour therapy on mathematics test anxiety and achievement of secondary school students in Ogid Education Zone Anambra State. *Journal of Educational Research and Development*, 4(2), 83-96.
- Mahajan, M., & Singh, M. K. S. (2017). Importance and benefits of learning outcomes. *IOSR Journal of Humanities and Social Science*, 22(3), 65-67.
- Nikpour, G., Kargozar, A., & Ghribzadeh, S. (2021). The effectiveness of cognitive behavioral therapy (CBT) on students' test anxiety. *Journal of Depression and Anxiety Forecast*, 4(2), 1027.
- Piccirilli, M., Lanfalconi, G. A., Buratta, L., Ciotti, B., Lepri, A., Azzarelli, C., . . . Elisei, S. (2023). Assessment of math anxiety as a potential tool to identify students at risk of poor acquisition of new math skills: Longitudinal study of grade 9 Italian students. *Frontiers in Psychology*, 14, 1185677. <https://doi.org/10.3389/fpsyg.2023.1185677>
- Pizzie, R. G., & Kraemer, D. J. M. (2023). Strategies for remediating the impact of math anxiety on high school math performance. *npj Science of Learning*, 8, 44. <https://doi.org/10.1038/s41539-023-00188-5>
- Plake, B. S., & Parker, C. S. (1982). The development and validation of a revised version of the mathematics anxiety rating scale. *Educational and Psychological Measurement*, 42(2), 551-557. <https://doi.org/10.1177/001316448204200218>
- Puplampu, N. (2018). *Effects of instructional strategies based on the MUSIC model of academic motivation on undergraduate mathematics students' subject learning*. Doctoral Dissertation, The Florida State University.

- Radišić, J. (2023). Student mathematics learning outcomes. In A. Manizade, N. Buchholtz, & K. Beswick (Eds.), *The evolution of research on teaching mathematics: International perspectives in the digital era* (pp. 197–223). Cham, Switzerland: Springer.
- Trimmer, C., Tyo, R., & Naeem, F. (2016). Cognitive behavioural therapy-based music (CBT-Music) group for symptoms of anxiety and depression. *Canadian Journal of Community Mental Health, 35*(2), 83-87. <https://doi.org/10.7870/cjcmh-2016-029>
- Ugwuanyi, C. S., Okeke, C. I. O., & Agboeze, M. U. (2021). Management of test anxiety among pupils in basic science using music-based cognitive behavior therapy intervention: Implication for community development. *Journal of Rational-Emotive & Cognitive-Behavior Therapy, 39*(3), 285-305. <https://doi.org/10.1007/s10942-020-00371-2>
- Yusefzadeh, H., Amirzadeh Iranagh, J., & Nabilou, B. (2019). The effect of study preparation on test anxiety and performance: A quasi-experimental study. *Advances in Medical Education and Practice, 10*, 245-251. <https://doi.org/10.2147/amep.S192053>
- Zaatar, M. T., Alhakim, K., Enayeh, M., & Tamer, R. (2024). The transformative power of music: Insights into neuroplasticity, health, and disease. *Brain, Behavior, & Immunity - Health, 35*, 100716. <https://doi.org/10.1016/j.bbih.2023.100716>