THE APPLICATION OF MUSICAL INTELLIGENCE-BASED MATHEMATICS LEARNING ON PLANE SHAPE DISCUSSION

Ismah[1*], Bayu Aji Eko Prasetyo[2]

[1,2,3]*Mathematics education, Faculty of Science Education, Universitas Muhammadiyah Jakarta*
KH. Ahmad Dahlan St., Cirendeu-Ciputat Tangerang Selatan, 15419, Indonesia

Corresponding author's e-mail: [1]* ismah.fr@gmail.com

Abstract. *In this study, Gardner's theory of multiple intelligences was used to conduct experimental research on several elementary school students at TPQ Al-Ikhwan Meruya Jakarta, Indonesia. The initial stage of this study was to classify the types of student intelligence using multiple intelligence instruments adopted from Shearer in 1997. Furthermore, learning strategies are applied to students according to the kind of intelligence. This study observed the differences in mathematics learning outcomes of students who have musical intelligence before and after the application of interactive learning media in the form of music containing a song with the title "Aku Bangun Datar" and the lyrics are examples of a two-dimensional figure with natural objects. The research method used was a quantitative quasi-experimental type with a pre-test-post-test design. Research data analysis using a statistical t-test for the difference in the mean of the two populations. The results of data analysis obtained a t value of -8,000, while the t table is -2.0686. The comparison between the t value and the t table is known that t is more significant than the t table, so the hypothesis is rejected. It means that there is a significant difference in students' knowledge about shapes before and after using music media.*

Keywords: math learning, musical intelligence, plane shapes

1. INTRODUCTION

Learning is a psychic or mental activity that produces changes in knowledge, understanding, skills, values, and attitudes through active interaction with the environment [1]. An effective learning process is needed to obtain optimal learning outcomes. An effective learning process occurs when students feel satisfied, challenged, and have fun following the learning process. Learning is related to brain work. Positive stimuli the brain receives will affect emotions and nerves work optimally [2]. Therefore, it is necessary to apply learning strategies to stimulate the brain's working system to run optimally.

Research on the development and application of learning strategies in methods, media, or teaching aids has been widely carried out. For example, Abdullah et al. (2014) improve STEM literacy using thinking strategies and visual representation [3], Wijaya (2020) uses VBA Learning Media to Improve Students' Mathematical Understanding Ability [4], and Ramadhani and Dahlya (2018) apply problem-based learning methods with Geogebra[5], Wijaya, et al., (2020) develop the dynamic Hawgent mathematic software as mathematics learning media for quadratic function material[6]. However, from various studies that have been carried out, the application or development of learning strategies ignores the type of intelligence possessed by students.

According to Gardner's theory, there are eight bits of intelligence: verbal-linguistic, logic-mathematical, spatial-visual, bodily-kinesthetic, musical, intrapersonal, interpersonal, and naturalist [7]. According to Gardner's theory, there are eight bits of intelligence: verbal-linguistic, logic-mathematical, spatial-visual, bodily-kinesthetic, musical, intrapersonal, interpersonal, and naturalist [7]. Gardner's theory provides the point that all children are intelligent, and logical intelligence is not the only intelligence possessed by children. Children are unique individuals, so teachers or educators must see the variation or uniqueness of each child so that the strategies used in learning effectively achieve learning objectives [8].

Learning media that can be applied have many variations, adjusted to the type of subject or material, achievement, and the kind of intelligence students possess. According to Gardner's theory, every child has eight bits of intelligence, one of which is musical intelligence. The learning media that are applied should follow the type of intelligence possessed by the students because the incompatibility of the application of the media to the kind of intelligence will hinder the knowledge and understanding of students and affect their achievement. These problems are more complex when applied to mathematics. Mathematics has an abstract nature, requiring memorization of some materials, such as the introduction of plane shapes and geometric shapes.

The results of research that has been carried out show that music influences students' cognitive abilities, such as spatial [9], [10]. Music can also improve students' mathematical skills [11], [12]. Other studies investigate the relationship between music training, intelligence, and executive function in adulthood [13]. The application of music will improve the performance of the human brain and body, as well as positively affect the hormone system [14]. The application of music in learning is expected to have a positive impact on the development of student knowledge. Students will feel comfortable when learning because music can affect students' emotions.

Based on the problems and the results of previous studies, research was conducted on the application of music media in learning mathematics based on the musical intelligence possessed by students in learning mathematics for early childhood on plane shape material. The music media applied consists of song lyrics that contain an introduction to plane shapes, as well as rhythms and tones that are designed simply because the target for this song is children so that all groups can play it. The song with the title "Aku Bangun Datar" ("I am a plane shape") is an interactive medium because the lyrics developed have an interaction between the songwriter and the listener. The songs developed include knowledge of plane shapes with objects that resemble plane shapes, such as doors that resemble rectangles, tiles that resemble squares, and so on. The song lyrics and musical notes are shown in Figure 1 below or can be seen on the YouTube link https://www.youtube.com/watch?v=rQtMn28J4IQ.

Figure 1. Lyrics and Notes of the Song "Aku Bangun Datar"

This study aimed to determine the effect of the application of musical intelligence-based media on students' knowledge of the plane shape material. Besides, students' interest in musical intelligence-based learning media, through the responses of students were seen descriptively.

2. RESEARCH METHODS

The method used in this research was quasi-experimental, namely, an experimental method that does not allow researchers to control the variables and experimental conditions fully. Instead, the research design used The One Group Pre-test-Post-test Design. In this design, the treatment effect was decided based on the difference between the pre-test and post-test without any comparison with the control group. The research design model can be seen in Table 1, as follows:

Table 1. Research Design Model

Pre-test	Treatment	Post-test
Y_1	X	Y_2

Where:
X = Treatment given
Y1 = Test results before treatment
Y2 = Test results after treatment

The research was conducted at TPQ Al-Ikhwan Meruya, West Jakarta, which lasted for one week from 2-9 June 2021, the research time was carried out for 35 minutes for each meeting.

2.1 Research Targets and Subjects

The targets in this study were teachers, parents, and students Music was used as a form of learning media. The song "Aku Bangun Datar" was developed to facilitate students with musical intelligence in learning mathematics. This media is relatively flexible and can be used at home or school so parents or teachers can accompany students in learning. Meanwhile, the research subjects were students aged five to seven years who are at level 1, totaling 24 people with the category of musical intelligence.

2.2 Research procedure

The research was conducted through the following procedures:

1. Measuring the intelligence of students.
2. Classifying students based on the type of intelligence they have.
3. Measuring the level of knowledge of students in the form of plane shapes (pre-test).
4. Introducing the music and the lyrics of the song "Aku Bangun Datar" to the participants on the first day.
5. Students are given the opportunity to sing together accompanied by music on the second and third days.
6. Students form 6 groups, each consisting of 3 people. Each group makes a different plane shape from cardboard, which the teacher on the fourth day determines.
7. Students sing together to the accompaniment of music while showing the plane shapes that have been made alternately, when singing the lyrics of the song "What shape am I?" on the fifth and sixth day.
8. Measuring the level of knowledge of students in the form of a plane shape (post-test)

2.3 Research Data and Instruments

The data used in this study were a knowledge test of plane shapes before being treated (pre-test) and a knowledge test of plane shapes after being treated (post-test). In addition, it is required data on the results of measuring the level of intelligence of students to determine the research subject. The instruments used to measure the musical intelligence of students are listed in Table 2, as follows:

Table 2. Questionnaire for Musical Intelligence

NO	STATEMENTS	Response				
		SS	S	N	TS	STS
1	Ananda is sensitive to tone (able to sing a song of the right pitch)					
2	Ananda can remember the melody of the song easily					
3	Ananda likes to sing					
4	Ananda can play a musical instrument well					
5	Ananda is able to move according to the rhythm of the song					
6	Ananda likes to hum while doing things/activities					
7	Ananda likes to beat the table rhythmically while studying					
8	Ananda is sensitive to recognize the types of sounds in the surrounding environment					
9	Ananda often moves body parts when listening to songs or music (for example: nodding his head, moving his feet, etc.)					
10	Ananda can sing a song after hearing it once or twice					

Note: SS= Strongly Agree; S=Agree; N=Neutral; TS=Disagree; STS=Strongly Disagree

The instrument used in this study has gone through the stages of expert validation and validation with statistical techniques through instrument testing.

2.4 Data Collection and Data Analysis Techniques

This research data was collected using the non-probability sampling technique. In this case, the selected research subjects are students with a type of musical intelligence based on the results of intelligence tests conducted at the beginning of the research. The collected data was analyzed using statistical inferential methods with the *t*-test for the difference between two paired population averages (paired *t*-test). The formulation of the paired t-student test is given as follows:

$$t = \frac{s_1{}^2 - s_2{}^2}{2s_1 s_2 \sqrt{\frac{1-r_{12}{}^2}{db}}}$$

Where:

t   = t test statistics
$s_1{}^2$ = first group variance (pre-test)
$s_2{}^2$ = second group variance (post-test)

db   = degrees of freedom (n-2), where n is the number of data

r_{12} = first and second group data correlation

3. RESULTS AND DISCUSSION

The results of the analysis obtained a description of the data as shown in Table 3 below:

Table 3. Data Description

Category	N	Minimum	Maximum	Average	Standard Deviation
pre-test	24	16	98	46.00	18.245
post-test	24	32	100	67.83	16.439

Based on Table 3, it can be seen that the number of data or research subjects is 24. The results of the pre-test knowledge measurement revealed that the lowest (minimum) value was 16, and the highest (maximum) value was 98. The post-test knowledge measurement results received the lowest (minimum) value of 32 and the highest (maximum) score of 100. The average value obtained based on the pre-test data is 46 with a standard deviation of 18.425, while the average post-test result is 67.83 with a standard deviation of 16.439. Based on the results of the data description, it is known that the average value of the results obtained from the post-test is greater than the average value of the results obtained from the pre-test. In comparison, the standard deviation value obtained from the post-test results is smaller than the standard deviation obtained from the pre-test results, so it can be concluded that the post-test data has the highest value compared to pre-test data with a narrower (homogeneous) data diversity. The graph of the difference between the students' pre-test and post-test results can be seen in Figure 2 below.
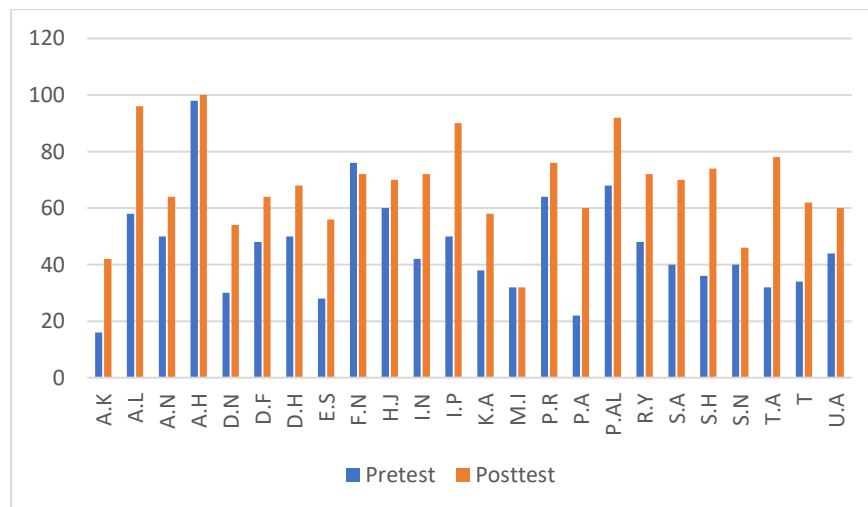

Figure 2. Recapitulation of Pre-test and Post-test Students' Knowledge Tests

The difference between the pre-test and post-test data from 24 students is visible in Figure 1. The blue chart is a visualization of the pre-test data, and the red chart is a visualization of the post-test data from each student, shown on the X-axis with initials. Furthermore, to find out the responses of the students who were the subjects of this study, a short interview was conducted to determine their interest in music media, which was applied in learning to increase their knowledge of plane shapes. The interviews' results showed that 91%, or 22 people, expressed interest in the used music media, while the remaining 9% or 2% expressed no interest, as seen in Figure 3. The reasons described by each participant varied. The results of the categories of student statements can be seen in Table 4 about the frequency of student reasons.
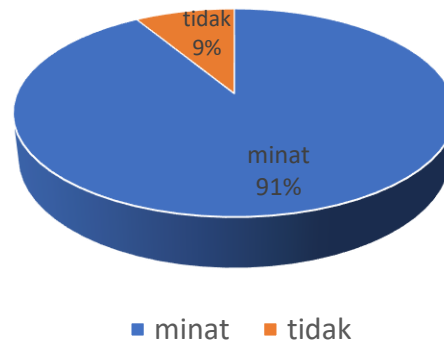
Figure 3. Pie Chart Percentage of Students' Interest in Learning Media

Table 4. Reasons for Students

No	Student Reason	Frequency
1	Learning is fun	11
2	Not bored	7
3	Easy to Memorize Plane shapes	4
4	Bored of singing the same song	2
	Total	24

The results of the acquisition of data descriptions are insufficient to represent differences in the data from the pre-test and post-test results of students' knowledge of plane shapes. Therefore, further analysis is needed using the paired t-test to test the hypothesis that there are differences in the average results of students' knowledge of plane shapes. They were based on the pre-test and post-test results by applying the music media of the song "Aku Bangun Datar." Before the data was analyzed, the assumption of normality and homogeneity of the data was tested as a requirement to use the parametric statistical method with the t-test. The results of normality and homogeneity tests can be seen in Table 5.

Table 5. Normality and Homogeneity Test

Group	Amount of data	Normality Test (Kolmogorov-Smirnov test)	Homogeneity Test (Levene's test)
Pre-test	24	0.16321 (sig. 0,220)	0,905 (sig. 0,081)
Post-test	24	0.10829 (sig. 0,401)	

Table 5 shows that the significance value obtained for the normality test with Kolmogorov-Smirnov's test for each group of pre-test and post-test is 0.220 and 0.401. These values are more significant than the error value (α) 0.05, so the hypothesis is accepted. It means that both groups of data come from the normally distributed population. The homogeneity test with Levene's test obtained a significance value of 0.081, which is greater than the error value (α) 0.05, so the hypothesis is accepted, which means that the two data groups are homogeneous. Because the assumptions of normality and homogeneity have been met, the data analysis using the t-test can be seen in Table 6 and Table 7, as follows:

Table 6. The Correlation of Pre-test and Post-test data

	Total Data (N)	Correlation	Significance
Pre-test and Post-test	24	0.707	0.000

Table 7. The Result of T-test

	t	Db	Significance (two-way)
Pre-test dan Post-test	-8.000	23	0.000

$t_{table} = t_{(0.05; 23)} = -2.0686$ (t_{table} at a significant level 0.05 and db = 23)

Based on the results of data analysis in Tables 6 and 7, the T-count is -8,000, and the t-table is -2.0686. Based on Table 6, the correlation value of the pre-test and post-test data is 0.707, or 70.7%. Based on the significance value obtained, 0.000 is smaller than the error tolerance value (α) of 0.05, so the correlation value is declared significant. Based on Table 7, it is known that t-count < t-table (-8.000 < -2.0686), so the

hypothesis is rejected. It means that there is a difference in the average knowledge of students about plane shapes before and after the application of music learning media based on musical intelligence. Therefore, in this case, it can be concluded that the music media that are applied in learning mathematics on plane shapes affect students' knowledge of plane shapes.

The research results obtained are in line with the results of previous studies that found the application of music in learning can optimize student learning outcomes because the music that contains elements of tone and rhythm will provide calm and comfort so that students can participate in education without pressure. [15]–[17].

4. CONCLUSIONS

The study results conclude that the application of music media with song lyrics containing learning materials can affect students' knowledge of the material given in learning. Especially for mathematics lessons, the use of plane shapes, interactive music media, and song lyrics can be a fun learning facility and make it easier for students to remember.

This study's response to students who feel bored singing the same song in every lesson is a drawback. Weaknesses in this study can be overcome by making varied song lyrics so that there will be innovations for other materials. Besides that, song lyrics are made interactive so that communication occurs between singers and those who listen. Students or teachers can sing, while listening is done by the students as well as answering the questions posed by the singer.

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REFERENCES

[1]   C. D. Lamichhane, "Understanding the Education Philosophy and Its Implications," *NCC J.*, vol. 3, no. 1, pp. 24–29, 2018, doi: 10.3126/nccj.v3i1.20245.
[2]   C. M. Tyng, H. U. Amin, M. N. M. Saad, and A. S. Malik, "The influences of emotion on learning and memory," *Front. Psychol.*, vol. 8, no. AUG, 2017, doi: 10.3389/fpsyg.2017.01454.
[3]   N. Abdullah, L. Halim, and E. Zakaria, "VStops: A thinking strategy and visual representation approach in mathematical word problem solving toward enhancing STEM literacy," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 10, no. 3, pp. 165–174, 2014, doi: 10.12973/eurasia.2014.1073a.
[4]   T. T. Wijaya, Z. Ying, L. Cunhua, and Zulfah, "Using Vba Learning Media To Improve Students' Mathematical Understanding Ability," *J. Educ.*, vol. 02, no. 02, pp. 245–254, 2020, [Online]. Available: https://www.jonedu.org/index.php/joe/article/view/314
[5]   R. Ramadhani and S. D. Narpila, "Problem based learning method with geogebra in mathematical learning," *Int. J. Eng. Technol.*, vol. 7, no. 3.2 Special Issue 2, pp. 774–777, 2018, doi: 10.14419/ijet.v7i3.2.18753.
[6]   T. Tanu Wijaya, Z. Ying, S. Chotimah, M. Bernard, Zulfah, and Astuti, "Hawgent dynamic mathematic software as mathematics learning media for teaching quadratic functions," *J. Phys. Conf. Ser.*, vol. 1592, no. 1, 2020, doi: 10.1088/1742-6596/1592/1/012079.
[7]   Howard Gardner, "Multiple Intelligences: The Theory in Practice , Multiple Intelligences: New Horizons," pp. 1–24, 1983.
[8]   A. Winarti, L. Yuanita, and M. Nur, "Journal of Technology and Science Education THE EFFECTIVENESS OF MULTIPLE INTELLIGENCES BASED INTELLIGENCES AND SCIENCE PROCESS SKILLS OF JUNIOR HIGH," vol. 9, no. 2, pp. 122–135, 2019.
[9]   V. D. Abrahan, F. Shifres, and N. Justel, "Cognitive benefits from a musical activity in older adults," *Front. Psychol.*, vol. 10, no. MAR, p. 652, 2019, doi: 10.3389/FPSYG.2019.00652/BIBTEX.
[10]   Arielle S. Dolegui, "The Impact of Listening to Music on Cognitive Performance - Inquiries Journal," *Inquiries journal*, 2013. http://www.inquiriesjournal.com/articles/1657/the-impact-of-listening-to-music-on-cognitive-performance (accessed May 11, 2022).
[11]   A. Chao-Fernández, D. Mato-Vázquez, and R. Chao-Fernández, "Influence of musical learning in the acquisition of mathematical skills in primary school," *Mathematics*, vol. 8, no. 11, pp. 1–13, 2020, doi: 10.3390/math8112003.
[12]   S. Holmes and S. Hallam, "The impact of participation in music on learning mathematics," *London Rev. Educ.*, vol. 15, no. 3, pp. 425–438, 2017, doi: 10.18546/LRE.15.3.07.

[13] A. Criscuolo, L. Bonetti, T. Särkämö, M. Kliuchko, and E. Brattico, "On the Association Between Musical Training, Intelligence and Executive Functions in Adulthood," *Front. Psychol.*, vol. 10, no. JULY, Jan. 2019, doi: 10.3389/FPSYG.2019.01704.

[14] B. Geethanjali, K. Adalarasu, and R. Rajsekaran, "Impact of Music on Brain Function during Mental Task using Electroencephalography," *World Acad. Sci. …*, vol. 6, no. 6, pp. 883–887, 2012, [Online]. Available: https://waset.org/journals/waset/v66/v66-164.pdf

[15] E. Prima, "Pengaruh Ritme Otak dan Musik dalam Proses Belajar," [The Effect of Brain Rhythm and Music in the Learning Process] *KOMUNIKA J. Dakwah dan Komun.*, vol. 12, no. 1, pp. 43–57, Jun. 2018, doi: 10.24090/KOMUNIKA.V12I1.1351.

[16] G. J. T. Garryn C. Ranuntu, "Peran lagu dalam pengajaran bahasa inggris tingkat dasar," [The role of songs in teaching basic English] *J. LPPM Bid. EkoSosBudKum*, vol. 4, no. 1, pp. 99–110, 2018.

[17] T. K. Aisyiyah *et al.*, "Pengaruh Musik Instrumental Dalam Pembelajaran Terhadap Pemahaman Konsep Matematika Siswa," [The Effect of Instrumental Music in Learning on Students' Understanding of Mathematical Concepts] pp. 1–9, 2016.