THE STUDENTS' MATHEMATICS SELF-REGULATED LEARNING AND MATHEMATICS ANXIETY BASED ON THE USE OF CHAT GPT, MUSIC, STUDY PROGRAM, AND ACADEMIC ACHIEVEMENT

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Article Info	ABSTRACT
	In the era of society 5.0, the reach of student learning resources is increasingly wider, with the internet and free AI-based search engines. The use of music during learning is a way for students to increase learning motivation. This research aims to find out: (1) Whether ChatGPT technology and music used during independent study have an impact on students' Mathematics Self-Regulated Learning (MSRL) and Mathematics Anxiety (MA); (2) Whether MSRL and MA have an association with the study program students choose; and (3) Whether MSRL and MA have an association with students' academic achievement. This research uses a correlational descriptive research method. The data collection technique uses a survey, implementing Google Forms. The respondents of this research were students at several universities in Indonesia. The research results show a significant difference in MSRL between students who use ChatGPT and students who do not use ChatGPT during independent learning. However, there was no significant difference in MSRL between students who listened to music and those who did not listen to music during independent learning. There was no significant difference in MA between students who used ChatGPT and those who did not use ChatGPT during independent study. There was no significant difference in MA between students who listened to music and those who did not listen to music during independent study. There is a significant association between MSRL and the origin of the student's Study Program, but there is no significant association between MA and the origin of the Study Program. There is no significant association between MSRL and Academic Achievement. There is no association between MA and students' Academic Achievement.
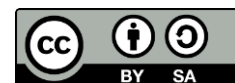
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1.   INTRODUCTION

The development of technology and information is moving very quickly and is affecting various fields, including education. Artificial intelligence (AI) technology is an innovation that is currently used to help solve the problem (Holmes et al., 2023; Sabzalieva & Valentini, 2023; Seo et al., 2021). The automation provided by AI has an impact on the efficiency of problem resolution times (He et al., 2021; OECD, 2023; Wijaya et al., 2024; Xu et al., 2021). AI automation technology in the education sector can be utilized in different learning settings. Students can have a personalized learning experience with the help of AI. This technology will provide opportunities for students to explore the concepts independently, thus fostering independence and motivation to learn. Thus, using technology in learning can improve the quality of student learning.

The use of technology in learning in Indonesia has experienced a very high acceleration during the COVID-19 pandemic. Since then, technology-based learning has become a basic necessity both in the classroom lecture process and in independent learning. Implementing various applications in lectures has a positive impact on student performance (Adıgüzel et al., 2023; Cardona et al., 2023; Darwanto et al., 2021; Rajan & Manyala, 2021; Umek et al., 2017). The AI technology that is trending in the educational world is ChatGPT. ChatGPT can help students explore a concept they are studying or will be studying. ChatGPT is a language model developed by OpenAI that is built using machine learning techniques on large amounts of text data on the internet. The application of ChatGPT in the educational world spreads via social media (Baidoo-Anu & Ansah, 2023). ChatGPT has very strong potential to improve teaching and learning processes (Baidoo-Anu & Ansah, 2023; El-Seoud et al., 2023).

Mathematics is very important for every student to learn, because in order to obtain prosperity in life in the future, every student must have good mathematical literacy. Mathematical literacy can be seen through students' mathematical learning performance during learning. Students' mathematics learning performance is influenced by students' Mathematics Self-Regulated Learning and Mathematics Anxiety (Al Mutawah et al., 2017; Cahyawati et al., 2023; Delima & Cahyawati, 2021; Villavicencio & Bernardo, 2016). Students with high levels of Mathematics Self-Regulated Learning have good learning achievements (Duru & Okeke, 2021; Paulino et al., 2016). Students' mathematical performance is influenced by the learning process in the classroom (Barroso et al., 2021; Kusuma & Dwipriyoko, 2021). Anxiety regarding mathematics becomes an obstacle for students in learning mathematics (Cahyawati et al., 2023; Gabriel et al., 2020; Kvedere, 2014). However, the learning process that involves listening to music during learning can reduce students' Mathematics Anxiety (Gan et al., 2016; Holmes & Hallam, 2017; Purnomo & Loekmono, 2021; Raja, 2017; Rodriguez et al., 2019; Sagge Jr & Palomo, 2014; Yuspitasari et al., 2020).

The higher a student's level of education, the higher his learning independence should be (Duru & Okeke, 2021; Effeney et al., 2013; Wolters & Hussain, 2015). Independent learning activities for Generation Z students are increasingly made easier by the wider internet access. Various AI-based search engines are available on the internet and are free. The use of music during independent learning activities is one way for most students to increase their motivation to learn (Gan et al., 2016; Sagge Jr & Palomo, 2014; Yamani et al., 2018). Currently, there are many internet-based music applications that offer song lists that are tailored to the age and activities of the listener. All the easy learning facilities currently available should be a supporting factor that can improve student learning achievement. If the student's performance during learning is good, it will provide good learning outcomes too. Therefore, there is a need for research that analyzes the relationship between technology and

music used by students when studying independently on student learning outcomes. The formulation of the problem in this research includes: (1) whether the ChatGPT technology and music used during independent learning have an impact on students' mathematics self-regulated learning and mathematics anxiety; (2) whether students' mathematics self-regulated learning and mathematics anxiety have an association with the study program students choose; and (3) whether students' mathematics self-regulated learning and mathematics anxiety have an association with students' learning achievement. This research aims to determine: (1) whether ChatGPT technology and music used during independent learning have an impact on students' Mathematics Self-Regulated Learning and Mathematics Anxiety; (2) whether Mathematics Self-Regulated Learning and Mathematics Anxiety have a relationship with the Study Program chosen by students; and (3) whether Mathematics Self-Regulated Learning and Mathematics Anxiety have a relationship with students' academic achievement. This research is new in the field of mathematics education because there have been no studies that analyze the relationship between the use of ChatGPT and music on students' mathematics self-regulated learning and mathematics anxiety. The results of this research will contribute to the field of mathematics education, especially in compiling independent learning materials using ChatGPT technology. Analysis of the association between the study program and learning achievement on students' mathematics self-regulated learning and mathematics anxiety is important because it will be taken into consideration by the lecturer in carrying out learning treatment based on the study program. The framework for the relationship between research variables can be seen in Figure 1.

To obtain a common perception of the terms used in this research, the author provides an operational definition of Mathematics Self-Regulated Learning (MSRL) as a student activity in managing their mathematics learning process so that they are able to achieve quality learning outcomes. Mathematics Anxiety (MA) in this research is a feeling of anxiety and tension, which can interfere with students in solving mathematics problems. MA is measured based on two indicators, namely affective anxiety and cognitive anxiety (Delima & Cahyawati, 2021). Meanwhile, MSRL measurement is based on 10 indicators, namely: (1) goal setting and planning; (2) organizing and transforming; (3) keeping records and monitoring; (4) environmental structuring; (5) seeking information; (6) rehearsing and memorizing; (7) reviewing records; (8) seeking social assistance; (9) self-consequence; (10) self-evaluation (Delima & Cahyawati, 2021). The Study Program chosen by the student (SP) is the study program that the student is currently pursuing at the higher education level. The student academic achievement referred to in this research is the Grade Point Average (GPA) obtained by students at the end of each semester.
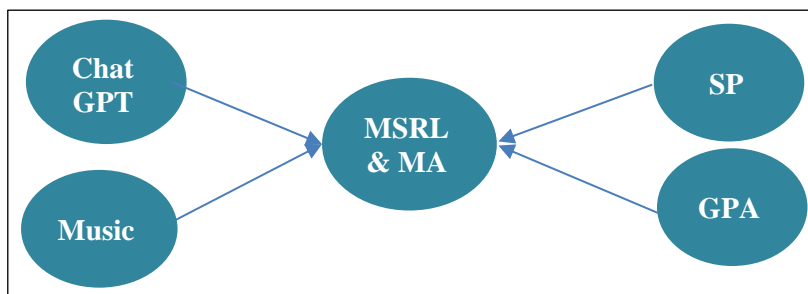

Figure 1. Research framework

2.   METHOD

This research is correlational descriptive research. The data collection technique uses a survey implementing Google Forms. The survey was conducted from September to October 2023. Respondents were students throughout Indonesia who are currently or have attended mathematics courses, with the distribution as follows (see Table 1).

Table 1. Number of students-based study program and gender

Study Program	Gender		Total
	Male	**Female**	
Statistics	14	9	23
Mathematics	9	12	21
Mathematics Education	5	20	25
Others	3	6	9
Total	31	47	78

The variables mathematics anxiety (MA) and mathematics self-regulated learning (MSRL) were measured using a Likert scale questionnaire, with the number of statement items being 11 items and 21 statement items respectively. Descriptions of indicators and questionnaire statement items are presented in Table 2.

Table 2. Indicators and items for MA and MSRL questionnaire statements

Variable	Indicator	Question Items
MA	Affective anxiety	1. I feel worried that I will get a low grade in the subject I am studying
		2. I feel nervous when the lecturer calls me to answer questions in front of the class
		3. I am worried that I will find questions that are difficult for me to solve while studying
		4. I am very worried that I did something wrong when solving the problem
		5. I am embarrassed to present and share my answers with other people
	Cognitive anxiety	6. I panic easily when faced with questions that I cannot answer
		7. Even though I have followed the recommended procedure to solve the problem, I am still unsure about my answer
		8. I feel uncomfortable when my friends ask me for answers to questions given by the lecturer
		9. I am worried that I may not be able to solve the questions quickly
		10. I am worried that I will not be able to understand the material given by the lecturer even if I listen attentively
		11. Sometimes I think that it would be easy for me if I didn't study this study program

Variable	Indicator	Question Items
MSRL	Goal setting and planning	1. I know the learning objectives of the study program I am currently choosing
		2. I set targets in completing college assignments in order to get maximum grades
		3. I have set a target study period for the study program I have currently chosen.
	Organizing and transforming	4. I prepare my study plan every semester
		5. I have prepared a study plan so that I can achieve the target study period that I have set
	Keeping records and monitoring	6. I re-read the course notes resulting from learning in class
		7. I enjoy doing practice questions related to the subjects studied
	Environment structuring	8. I try to come to class to attend lectures before time
		9. I always study in a place that I feel comfortable
		10. I like studying in a place that has a calm atmosphere
	Seeking information	11. I look for more than one reading source to support my course assignments
		12. I have at least one course notebook
	Rehearsing and memorizing	13. I record all lecture activities with the lecturer on the device I own
		14. I wrote down all the important things I received during lectures
	Reviewing records	15. I regularly check lecture material notes to see whether they are complete or not
		16. I feel the need to complete every practice question related to the material I have studied
	Seeking social assistance	17. I compare my lecture notes with those of my friends for confirmation
	Self-consequence	18. I prepare something to please myself as a reward for completing lecture assignments
		19. I am able to complete every assignment from the courses I am taking in the study program I am currently choosing
	Self-evaluation	20. I estimate for myself the grades that will be obtained for the results of the lecture assignments that I have completed
		21. I am able to follow well all the courses studied in the study program I am currently choosing.

Test the validity of the instrument using the Spearman correlation test (rho), while the reliability measure is determined based on the value of the Cronbach's alpha coefficient.

The validity and reliability coefficients for each statement in the questionnaire are presented in Table 3.

Table 3. Validity and reliability coefficient of MA and MSRL questionnaires

MA			MSRL				
Item	**Rho***	**Alpha****	**Item**	**Rho***	**Item**	**Rho***	**Alpha****
1	0.655	0.871	1	0.434	12	0.393	0.850
2	0.673		2	0.565	13	0.446	
3	0.740		3	0.489	14	0.628	
4	0.765		4	0.395	15	0.636	
5	0.728		5	0.652	16	0.465	
6	0.704		6	0.522	17	0.578	
7	0.664		7	0.518	18	0.449	
8	0.634		8	0.515	19	0.441	
9	0.669		9	0.464	20	0.233	
10	0.734		10	0.246	21	0.509	
11	0.299		11	0.567			
Rho_table (n = 78; $\alpha = 0.05$) = 0.223							

*) Spearman Correlation Coefficient
**) Cronbach's alpha coefficient

Table 3 shows that all statements have a rho value greater than the rho table, so it can be concluded that all statements are valid for use in analyzing research results. All statements have high reliability. Thus, each statement in the MA and MSRL instruments can be used as a research data collection tool (Budiastuti & Bandur, 2018; Cohen et al., 2017).

The survey results obtained were in the form of data on an ordinal scale, so data analysis used non-parametric statistics. Considering that the research data is on an ordinal scale, data categorization is carried out based on the following conditions (see Table 4).

Table 4. Distribution of students' MA and MSRL levels (Delima & Cahyawati, 2021)

Variable	Interval	Level
MA	$1.00 \leq MA < 2.35$	Low
	$2.35 \leq MA < 3.70$	Moderate
	$3.70 \leq MA \leq 5.00$	High
MRSL	$1.00 \leq MRSL < 2.35$	Low
	$2.35 \leq MRSL < 3.70$	Moderate
	$3.70 \leq MRSL \leq 5.00$	High

The hypothesis of this research is described as follows:

Hypothesis 1 : There is a significant difference between the MSRL of students who use ChatGPT and the MSRL of students who do not use ChatGPT during independent study.

Hypothesis 2 : There was a significant difference in students' MSRL between students who answered yes, uncertain, and did not listen to music during independent study.

Hypothesis 3 : There is a significant difference between the MA of students who use ChatGPT and the MA of students who do not use ChatGPT during independent study.

Hypothesis 4 : There was a significant difference in students' MA between students who answered yes, uncertain, and did not listen to music during independent study.

Hypothesis 5 : There is a significant association between MSRL and study program.

Hypothesis 6 : There is a significant association between MA and study program.

Hypothesis 7 : There is a significant association between MSRL and GPA.

Hypothesis 8 : There is a significant association between MA and GPA.

3. RESULT AND DISCUSSION

3.1. Results

The purpose of this research is to determine whether the use of ChatGPT and music during independent learning has an impact on students' MSRL. A description of the survey results in the form of data tabulation is presented in Table 5.

Table 5. Data tabulation students' MSRL

MSRL	Using Chat GPT		Total	Using Music			Total
	Yes	No		Yes	Uncertain	No	
Moderate	32	4	36	27	5	4	36
High	31	11	42	23	12	7	42
Total	63	15	78	50	17	11	78

Based on Table 5, because the respondents were taken from students at the tertiary level, there was not a single student who had a low MSRL. Table 5 also shows that the number of students who use ChatGPT is greater than students who do not use ChatGPT during the independent learning process at home. Likewise, the number of students who listen to music during independent study is greater than students who do not listen to music. The number of students with high MSRL is greater than students with medium MSRL. To test hypothesis 1, the Mann-Whitney U test was carried out, while to test hypothesis 2, the Kruskall-Wallis test was carried out (see Table 6).

Table 6. Hypothesis test for MSRL's data

MSRL	Mann-Whitney U Test	Kruskall-Wallis Test
Statistic	666.500	1.963
Asymp. Sig	0.014	0.375

Table 6 shows that there is a significant difference between the MSRL of students who use ChatGPT and the MSRL of students who do not use ChatGPT during independent study. In other words, the use of ChatGPT during independent learning has an impact on students' MSRL. Meanwhile, there was no significant difference in MSRL between groups of students who answered yes, uncertain, and did not listen to music during independent study. Next, tabulation of data on respondents who used ChatGPT and music during independent study on students' MA is presented in Table 7.

Table 7. Data tabulation students' MA

MA	Using Chat GPT		Total	Using Music			Total
	Yes	No		Yes	Uncertain	No	
Low	2	1	3	3	0	0	3
Moderate	35	9	44	31	8	5	44
High	26	5	31	16	9	6	31
Total	63	15	78	50	17	11	78

Table 7 shows that the majority of students have a medium MA level. The number of students with a medium MA level is not much different from the number of students with a high MA level. All students with a low MA level use music when studying independently. There was one student with a low MA level who never used ChatGPT when studying independently. To test hypothesis 3, the Mann-Whitney U test is carried out, while to test hypothesis 4, the Kruskall-Wallis test is carried out (see Table 8).

Table 8. Hypothesis test for MA's data

MSRL	Mann-Whitney U Test	Kruskall-Wallis Test
Statistic	447.000	4.872
Asymp. Sig	0.746	0.088

The results of hypothesis 3 testing in Table 8 show that there is no significant difference between the MA of students who use ChatGPT and the MA of students who do not use ChatGPT during independent study. Likewise, with the results of hypothesis 4 testing, it was found that there was no significant difference in MA between groups of students who answered yes, uncertain, and did not listen to music during independent study.

This research collects data from students' study programs with the aim of finding out whether there is an association between MSRL, MA and study programs. The results of grouping MSRL and MA data based on study program are presented in Table 9.

Table 9. Data tabulation Students' MSRL and MA based on study program

MSRL	Study Program*				Total	MA	Study Program*				Total
	S	M	ME	O			S	M	ME	O	
Low	0	0	0	0	0	Low	2	1	0	0	3
Medium	16	9	5	6	36	Medium	11	13	18	2	44
High	7	12	20	3	42	High	10	7	7	7	31
Total	23	21	25	9	78		23	21	25	9	78

*S: Statistics; M: Mathematics; ME: Mathematics Education; O: Others

Table 9 shows that students with a high MSRL level mostly come from mathematics education study programs, while the number of students with a high MA level mostly comes from statistics study programs. To find out whether there is an association between MSRL and MA on study programs (test hypothesis 5 and test hypothesis 6), a Chi-square test was carried out (see Table 10).

Table 10. Chi-square test based on study program

Chi-Square Test	Statistics	Asymp. Sig.
MSRL	13.569	0.004
MA	10.556	0.103

The Chi-square test results in Table 10 show that there is an association between MSRL and the origin of the student's study program, but there is no association between MA and the origin of the study program. Next, the distribution of students' MSRL and MA data based on GPA is presented in Table 11.

Table 11. Data tabulation Students' MSRL and MA based on GPA

MSRL	GPA*				Total	MA	GPA*				Total
	Cum	H	M	L			A	B	C	D	
Low	0	0	0	0	0	Low	2	0	1	0	3
Medium	19	13	4	0	36	Medium	26	14	4	0	44
High	22	16	4	0	42	High	13	15	3	0	31
Total	41	29	7	0	78		41	29	7	0	78

*Cum (Cum laude): 3.51 – 4.00; H (High): 3.01 – 3.50; M (Medium): 2.75 – 3.00; L(Low): < 2.75

Table 11 shows that students with a cum laude GPA most often have a high level of MSRL. Meanwhile, students with a cum laude GPA tend to have a medium MA level. To find out whether there is a significant association between MSRL and MA on GPA (hypothesis 7 and hypothesis 8), a Chi-square test was carried out and shows that there is no association between MSRL and MA on student GPA (see Table 12).

Table 12. Chi-square test based on GPA

Chi-Square Test	Statistics	Asymp. Sig.
MSRL	1.218	0.749
MA	6.640	0.355

3.2. Discussion

The research results showed that there was not a single student who had a low MSRL level, because the students who were respondents in this study were students at a higher education level. The number of students with high MSRL is greater than students with low MSRL. The profile of students in higher education has characteristics of self-regulated learning (SRL) at medium to high levels (Broadbent & Fuller-Tyszkiewicz, 2018; Virtanen, 2019). The use of ChatGPT during independent learning has an impact on students' MSRL. ChatGPT can assist students in solving problems during independent study (Chang et al., 2023). There is a significant difference between the MSRL of students who use ChatGPT and the MSRL scores of students who do not use ChatGPT during independent study. ChatGPT has been recommended as a learning medium that can improve student learning outcomes (Abdillah et al., 2023; Baidoo-Anu & Ansah, 2023; D et al., 2023; El-Seoud et al., 2023).

The use of music during independent study does not have a significant impact on students' MSRL. There is no significant difference between the MSRL of students who use

music and those who do not use music during independent study. Learning interventions using music during classroom learning for elementary school students were stated to have no impact on students' self-regulated learning (Zachariou et al., 2023). Students' self-regulated learning (SRL) in higher education can be improved by providing intervention in the form of motivation and a regular schedule for doing assignments (Sirazieva et al., 2018; Šteh & Šarić, 2020). The use of music in mathematics learning has an impact on increasing the spatial abilities of elementary school students (Holmes & Hallam, 2017; Rodriguez et al., 2019). Students' SRL in higher education is an important variable to improve (Cassidy, 2011; Sirazieva et al., 2018; Virtanen, 2019). Even though listening to music does not have an impact on students' MSRL, listening to music can influence students' dispositions and habits of mind (Sagge Jr & Palomo, 2014).

The use of ChatGPT does not have a significant impact on students' MA. AI technology is a technology that has not been widely used in mathematics learning, so the benefits of using AI in mathematics learning are still not felt by students in Indonesia. The majority of respondents in this study were students of mathematics, mathematics education, and statistics study programs so the MA of the majority of respondents was at a medium level. This makes it difficult for the respondent's MA to be influenced by any factor. The use of music during independent study does not have a significant impact on students' MA. There was no significant difference in MA between groups of students who answered yes, were unsure, and did not listen to music during learning. These results are in line with research from Raja (2017) which found that the use of music in mathematics learning in class did not have a significant effect on reducing student anxiety.

The majority of students with a high MSRL come from mathematics education study programs, while the majority of students with a high MA come from statistics study programs. There is a significant association between MSRL and the origin of the student's study program, but there is no significant association between MA and the origin of the study program. Students in higher education have enormous diversity because they come from various regions (Cassidy, 2011). Most students in higher education choose study programs based on the hope that they can get the job they dream of in the future. Learning at the higher education level has stimulated many improvements in students' SRL, so most students in higher education have very good SRL (Sirazieva et al., 2018; Virtanen, 2019). Thus, it is reasonable to say that there is a significant association between MSRL and the study program chosen by students.

The majority of students with a cum laude GPA have a high MSRL level. Meanwhile, students with cum laude GPAs tend to have a medium MA level. However, there was no significant association between either MSRL and GPA or MA and GPA of students. The correlation between SRL and study success tends to be weak, even in the case of students with moderate MSRL, there is no correlation between SRL and study success (Virtanen, 2019). Students with good SRL will have the ability to manage their learning strategies to obtain high learning outcomes. Student exam scores have a negative correlation with MA in the Research Design course. Apart from that, Math Anxiety also has a negative correlation with self-belief. The self-belief of higher education level students is correlated with success in learning calculus courses. Previous research provides data that MSRL and MA correlate with success in certain courses. This research places more emphasis on the GPA aspect, where GPA is the cumulative of all students' academic processes during their studies, so it is reasonable to say that neither MSRL nor MA is directly related to students' GPA.

4.   CONCLUSION

There is a significant difference in Mathematics Self-Regulated Learning between students who use ChatGPT and students who do not use ChatGPT during independent learning. However, there was no significant difference in Mathematics Self-Regulated Learning between students who listened to music and those who did not listen to music during independent learning. There was no significant difference in Mathematics Anxiety between students who used ChatGPT and those who did not use ChatGPT during independent study. There was no significant difference in Mathematics Anxiety between students who listened to music and those who did not listen to music during independent study. There is a significant association between Mathematics Self-Regulated Learning and the origin of the student's Study Program, but there is no significant association between Mathematics Anxiety and the origin of the Study Program. There is no significant association between Mathematics Self-Regulated Learning and Academic Achievement. There is no association between Mathematics Anxiety and students' Academic Achievement. Mathematics is a subject studied in almost all study programs. This research is limited to respondents from Mathematics, Mathematics Education and Statistics study programs. There needs to be further research that analyzes Mathematics Self-Regulated Learning and Mathematics Anxiety in students outside the Study Program.

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