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The Influence of Digital Literacy and Learning Styles on Students' Mathematics Learning Outcomes

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Abstract

The aim of this research is to determine whether or not there is an influence of digital literacy on students' mathematics learning outcomes, whether or not there is an influence of learning styles on students' mathematics learning outcomes, and whether or not there is an influence of digital literacy and learning styles on students' mathematics learning outcomes. This research is quantitative research with an ex post facto type. This research was conducted at MTsN 3 Medan. Data collection methods use questionnaires and documentation. The analysis techniques used are descriptive analysis, data analysis prerequisite tests, and hypothesis testing. The research results show that there is an influence of digital literacy on students' mathematics learning outcomes, as evidenced by (Sig.) 0.005 < 0.05. There is an influence of learning style on students' mathematics learning outcomes, as evidenced by (Sig.) 0.005 < 0.05. There is a significant influence between digital literacy and learning style on mathematics learning outcomes, with a Sig value of < 0.05. This is proven by the results of multiple regression analysis with a Sig value of digital literacy of 0.037 and a Sig value of learning style of 0.035 < 0.05. Digital literacy and learning styles contribute to student mathematics learning outcomes by 42.5%.

1. Introduction

Recent developments show that many students prefer to complete assignments on the internet rather than with books. Students do not need to read unnecessary literature because the internet offers cheap and easy services. This may be fun for students because they are busy with a lot of schoolwork to complete, which allows them to complete it quickly without spending a lot of time (Efendi & Hanif, 2022). This shows that digital literacy occupies a major position in current educational needs and is one measure of success in the fields of Indonesian education and culture.

Digital literacy is the skill to collaborate, communicate, and understand digital technology to create, engage, and share knowledge (Setiani & Barokah, 2021). An attitude or potential that a person has for utilizing digital facilities and tools to manage, access, and combine digital resources properly and correctly is the definition of digital literacy (Zahroh & Sholeh, 2022). "Digital literacy" is an objective understanding of all the learned knowledge of an individual and society as a whole, as well as the ability to read, write, and communicate using digital media. One component of digital literacy is the ability to use digital technology for independent learning activities, both inside and outside the classroom. Digital literacy includes media literacy and the ability to use learning media. A person's ability to select, organize, and use available digital materials in an appropriate and intelligent way to meet their needs is known as media literacy (Nawaf et al., 2023).

Digital literacy is important to apply to mathematics learning because it provides opportunities for students to interact, communicate, understand mathematics, practice, and compete. With digital literacy skills, students can master various information and mathematical knowledge intelligently and healthily

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(Muliawanti & Kusuma, 2019). Developing digital literacy in learning materials not only gives students experience in digital technology culture but also supports students in expanding their knowledge and being critical in participating in learning. In today's technological developments, sources of knowledge and information are very easy to access. Printed textbooks can be supplemented with alternative sources of information in various formats and modes, such as video, audio, or animation. Digital literacy can help students understand the world through sources of history, geography, mathematics, religion, or science using digital technology (Muliawanti & Kusuma, 2019). Utilization of digital media in the form of gadgets, laptops, computers, and other digital tools allows humans to communicate or obtain information quickly (Putri & Suripah, 2021).

According to Giovanni & Komariah (2019), students who pursue digital literacy independently can improve their learning outcomes because they can independently search for learning material if the questions asked by the teacher are difficult. Another study that is consistent with these findings is that digital literacy contributes significantly to increasing academic achievement. Average academic achievement is positively correlated with students' digital literacy (Wulandari et al., 2022). The results of this research are supported by the conclusion that digital literacy influences mathematics learning outcomes (Bastiwi & Pramesthi, 2022).

Learning outcomes are the final and most important acquisition in the learning process at school. Student learning outcomes can reflect the results of general examinations, Midterm Exam, Final Semester Exam, and national examinations (Efendi & Hanif, 2022). The changes experienced by students—not only changes in knowledge but also changes in skills, attitudes, and understanding and appreciation of students who learn—are called learning outcomes (Achdiyat & Andriyani, 2016). Each student's mathematics learning achievement during learning does not only depend on the teacher's learning efforts. Learning outcomes also depend on students' learning efforts. Teachers who do well in class will result in student learning outcomes decreasing if students' learning activities are lazy. On the other hand, if the teacher's teaching activities are ineffective and the students' learning activities are good, then the results can be high or even very high. Based on initial observations, it shows that students are more dependent on teachers and less interested in carrying out learning activities, resulting in low student learning outcomes. Internal and external factors are two of the many factors that influence student learning outcomes in class. Internal factors come from within the student, while external factors come from outside the student (Sidabutar, 2018). Good learning results reflect a good learning style, because knowing and understanding a good learning style will help students learn so that the results are optimal (Suyono, 2018).

"Learning style" is a term that refers to how relaxed, comfortable, and safe a person is when learning, both temporally and sensoryly. Often, each person has a different way of understanding and absorbing the same lessons. There are fast, medium, and slow, and therefore students often have to use different methods to understand the lessons. This is what is called a learning modality or learning style (Anggelina et al., 2023; Irawati et al., 2021). According to Hamzah B. Uno, learning style is how well a person understands and absorbs lessons. Learning styles include ways of describing how someone learns or how each person focuses on the learning process. With this explanation, it can be said that learning style is determined by how each person concentrates, absorbs new information, and stores it in their brain (Ratu, 2023). VAK learning consists of three styles (visual, auditory, and kinesthetic) (Kadir et al., 2020).

The visual learning style is learning by seeing, so the eyes have a very important role. An auditory learning style is a learning method that uses hearing to obtain information. Kinesthetic learning style is a learning method where students obtain information through experience, movement, and touch. Each student uses one of these three learning styles. They are more likely to use one of these learning styles (Irawati et al., 2021). When students understand their learning styles, they can easily process learning materials and store them in long-term memory, improving their learning outcomes. An individual's learning style usually depends on how they think, process, and understand the information they prefer. Learning styles play an important role in the learning process, as they improve students' understanding of the material. Students usually use auditive, visual, and kinesthetic learning styles when participating in daily learning activities.

Research results Anggelina et al. (2023) show that teachers' teaching styles and students' learning styles have a significant influence on student learning outcomes. In line with what was expressed by (Irawati et al., 2021; Riyani & Utomo, 2022), learning outcomes are influenced by learning style.

The results of research Anggelina et al. (2023) on the Influence of Teacher Teaching Styles and Student Learning Styles on Student Learning Outcomes: A Case Study of SMK Negeri 1 Kinali show that teacher

teaching styles and student learning styles have a significant influence on the learning outcomes of class XI TJKT students in the KK1 subject (Network Planning and Addressing) at SMK Negeri 1 Kinali. Meanwhile, research Irawati et al. (2021) on the influence of learning style on science learning outcomes found that learning outcomes are influenced by learning style.

As shown by the findings of interviews conducted with students, one of the reasons why students have poor mathematics learning outcomes is the perception that mathematics is difficult, lack of interest in reading or literacy, students tend to learn not because of interest or curiosity to learn the material but only because of compulsion, lack of self-confidence in dealing with mathematics, this is also caused by students choosing the wrong learning style. The importance of digital literacy in the current era requires research to be conducted to find out the influence of digital literacy and students' learning styles. Based on the problems mentioned above, the researcher is interested in conducting research with the title: "The Influence of Digital Literacy and Learning Styles on Student Mathematics Learning Outcomes". The objectives of this research are as follows: 1. To find out whether or not there is an influence of digital literacy on student results. students' mathematics learning; 2. Knowing whether or not there is an influence of learning styles on students' mathematics learning outcomes; and 3. Knowing whether or not there is an influence of digital literacy and learning styles on students' mathematics learning outcomes.

2. Methods

Quantitative methods were used in this research. Quantitative research is defined as systematic research into phenomena by collecting data that can be measured using mathematical, statistical, or computational techniques (Abdullah et al., 2023). Ex post facto research is the type used, as quoted from Ibrahim et al. (2018). According to Sukardi, this is a type of research where the independent variable is observed before the dependent variable is observed. The aim of this research is to find out how the dependent variable, mathematics learning outcomes (Y), is influenced by the independent variables, namely digital literacy (X_1) and learning style (X_2).

All class IX students at MTsN 3 Medan ware the population in this study, consisting of IX 1–IX 7, for a total of 224 students. All class IX students ware considered by researchers to have the same character or interests. Determining the number of research samples used the probability sampling method, namely cluster random sampling. (Ismail, 2018) states that cluster random sampling is a sampling method where the population is divided into several different groups and is called a cluster. Classes IX 1 and IX 3 ware the samples of this research.

Questionnaires and documentation ware data collection methods used by researchers. In this research, the instrument used was a non-test, namely a questionnaire. The non-test instrument consists of 10 digital literacy questionnaire statements and 15 learning style questionnaire statements. With five answer options available, a Likert scale questionnaire is used to determine scores or values for the list of questions asked by researchers to respondents. Question answers are categorized as strongly disagree (STS) with a score of 1, disagree (TS) with a score of 2, or unsure. (R) gets a score of 3, agree (S) gets a score of 4, and strongly agree (SS) gets a score of 5. If the question tends to be negative, then strongly disagree (STS) gets a score of 5, and so on. The instrument tests used are the validity test and the reliability test. Data on student learning outcomes is collected through documentation methods.

In this research, the following analysis techniques will be used: descriptive analysis, data analysis prerequisite tests, and hypothesis testing. Analysis prerequisite tests are carried out to determine whether the data collected meets the requirements for analysis. Several conditions that must be met include normality, linearity, multicollinearity, heteroscedasticity, and autocorrelation tests. Several proposed hypotheses were tested through hypothesis testing. This includes simple linear regression analysis and multiple linear regression.

3. Results & Discussions

3.1. Testing Research Instruments

This research began by distributing digital literacy and learning style questionnaires to test the instrument. The aim of this trial is to test the validity and reliability so that the measurement results can be accounted

for. The trial of this instrument was carried out at MTsN 3 Medan in class VIII 3 with 28 students. After all the data is collected, the next step is to analyze the instrument data. Data analysis carried out includes:

3.1.1. Validity Test

r_{table} (0.374) was found based on the results of the validity analysis of 20 digital literacy questionnaire statements (X_1) and 21 learning style questionnaire statements (X_2) with N (64). The correlation results determine the validity of the questionnaire. If $r_{count} > r_{table}$, the instrument is said to be valid, but if $r_{count} < r_{table}$, then the instrument is invalid. If the probability (Sig.) < 0.05, the instrument is said to be valid, and if the probability (Sig.) > 0.05, then the instrument is said to be invalid. According to the results of the validity test using SPSS 25, obtained from the 20 statement items of the digital literacy instrument, there were 10 valid statement items and 10 invalid items. For the digital literacy variable, 10 statement items were used for data collection. Next, the researcher looked at the validity test results of the 21 statement items of the learning style instrument, where 15 statement items were declared valid and 6 statement items were invalid. These 15 statement items were used for data collection.

3.1.2. Reliability Test

The research tool is declared reliable if the analysis results show Cronbach Alpha > 0.6. The results of the reliability test of the instruments for the two variables, namely the digital literacy and learning style variables with SPSS 25, which have been tested, obtained reliability results as shown in the following table:

Table 1. Reliability Test Results for Independent Variables

Variable	Alpha	Coefficient	Information
Digital Literacy (X_1)	0.695	0.6	Reliable
Learning Style (X_2)	0.747	0.6	Reliable

3.2. Descriptive Analysis

In this research, there are two independent variables, namely digital literacy (X_1) and learning style (X_2), and one dependent variable, namely mathematics learning outcomes (Y), in class IX MTsN 3 Medan students. The results of the descriptive analysis seen from the questionnaire data obtained after the research can be concluded as follows: 25% of students have high digital literacy with a total of 16 students, 51.56% of students have moderate digital literacy with a total of 33 students, and students who have moderate digital literacy are 51.56% with a total of 33 students. low digital at 23.44% with a total of 165 students. Based on the results of the digital literacy trend data, it can be seen that the digital literacy of class IX MTsN 3 Medan students for the 2023/2024 academic year is classified as moderate.

Based on the results of the learning style questionnaire, looking at the type of learning style, it is known that 28 students have a visual learning style with a percentage of 44%, which is included in the medium category. 20 students have an auditory learning style with a percentage of 31%, which is included in the medium category. Furthermore, 16 students have a kinesthetic learning style with a percentage of 31%, which is included in the medium category.

The mathematics learning outcomes of class IX MTsN 3 Medan students have high learning outcomes of 28.13% with a total of 18 students, medium learning outcomes of 56.25% with a total of 36 students, and low learning outcomes of 15.63% with a total of 10 students. Based on trend data on learning outcomes, it can be concluded that the learning outcomes of class IX MTsN 3 Medan students are classified as moderate for the 2023/2024 academic year.

3.3. Data Analysis Prerequisite Test

The collected data is tested to meet the analysis requirements.

3.3.1. Normality Test

From the test results with SPSS 25, the Asymp value was obtained. Sig. (2-tailed) more than 0.05, namely 0.200. Therefore, it can be concluded that each variable examined in this study meets the prerequisites and has a normal distribution. By fulfilling this test, analysis can be carried out using parametric statistics.

3.3.2. Linearity Test

The results of the linearity test using SPSS 25 can be seen in the following table:

Table 2. Linearity Test Results

Variable	F	Sig.	Information
$X_1 - Y$	1.144	0.347> 0.05	Linear
$X_2 - Y$	0.911	0.580 > 0.05	Linear

The result is that the linearity test shows results > 0.05. This shows that there is a linear relationship between digital literacy, learning styles, and mathematics learning outcomes.

3.3.3. Multicollinearity Test

The results of the multicollinearity test using SPSS 25 are shown in the following table:

Table 3. Multicollinearity Test Results

Variable	VIF	Tolerance	Conclusion
Digital Literacy	1.111	0.900	Multicollinearity Free
Learning Style	1.111	0.900	Multicollinearity Free

The results of the multicollinearity test are based on the following decision-making principles: if the tolerance > 0.10 indicates that there are no symptoms of multicollinearity among the independent variables, and vice versa, If VIF < 10, then there are no symptoms of multicollinearity between the independent variables, and vice versa. So the conclusion that can be drawn from the test results with SPSS 25 on the variables (digital literacy) and (learning style) is that there are no symptoms of multicollinearity between the independent variables because the tolerance value (0.900)> 0.10 and the VIF value (1.111) < 10.

3.3.4. Heteroscedasticity Test

The results of the heteroscedasticity test using SPSS 25 are shown in the following table:

Table 4. Heteroscedasticity Test Results

Variable	*Sig.*	Conclusion
Digital Literacy	0.516	Heteroscedasticity Free
Learning Style	0.646	Heteroscedasticity Free

Based on the table above, the significance values of the digital literacy and learning style variables are 0.516 and 0.646, respectively, where the significance value obtained is greater than 0.05. So it can be concluded that this regression model is good because there are no symptoms of heteroscedasticity.

3.3.5. Autocorrelation Test

The Durbin-Watson test can be used to find out whether there is autocorrelation in the regression. This is done by comparing the DW value (d_{count}) with the value (d_{table}). Based on testing with SPSS 25, the autocorrelation test results show a Durbin-Watson value of 2.331. Based on the DW table for k = 2 (number of independent variables) and n = 64, the dl value = 1.5315, the du value = 1.6601 and the 4-du value = 4-1.6601 = 2.3399. Because 1.6601 < 2.331 < 2.3399, it can be concluded that there is no autocorrelation.

3.4. Hypothesis testing

Several hypotheses proposed in this research were tested through hypothesis testing. The first and second hypotheses were tested using simple linear regression analysis, and the third hypothesis was tested using multiple linear regression analysis because there are two independent variables. The following is an explanation of hypothesis testing.

3.4.1. Correlation Test

From the results of correlation testing using SPSS 25, it shows that the correlation between digital literacy and learning outcomes is seen at a probability (Sig.) of 0.005 < 0.05, so Ho is rejected. In conclusion, there is a significant relationship between digital literacy and learning outcomes. The correlation between learning styles and learning outcomes can be seen at a probability (Sig.) of 0.005 < 0.05, so Ho is rejected. In conclusion, there is a significant relationship between learning styles and learning outcomes. The correlation between digital literacy and learning style can be seen at a probability (Sig.) of 0.000 < 0.05, so Ho is rejected. In conclusion, there is a significant relationship between digital literacy and there is a significant relationship between learning style and learning outcomes.

3.4.2. Simple Linear Regression Test

A simple linear regression analysis technique was used to determine the influence of digital literacy on students' mathematics learning outcomes and the influence of learning style on students' mathematics learning outcomes. The results of the digital literacy test on mathematics learning outcomes using SPSS 25 are shown in the following table:

Table 5. Results of Simple Regression Analysis (X_1-Y)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	77.035	2.435		31.636	.000
	Digital Literacy	.181	.063	.343	2.880	.005

a. Dependent Variable: Mathematics Learning Outcomes

According to the table above, the value (Sig.) is 0.005 < 0.05, so it can be concluded that Ho is rejected and Ha is accepted, which shows that digital literacy influences the mathematics learning outcomes of class IX MTsN 3 Medan students in the 2023/2024 academic year. Apart from that, from the table, it is known that the a value is 77.035 and the b value is 0.181, which shows that mathematics learning outcomes will increase by 0.181 with every additional 1% of digital literacy. Therefore, the regression equation is Y = 77.035 + 0.181X.

Table 6. Digital Literacy R Square Value Test Results

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.343[a]	.118	.104	1.867

a. Predictors: (Constant), Digital Literacy

(Source: SPSS 25 Output)

The table shows that the R square is 0.118, which means that the influence of digital literacy on students' mathematics learning outcomes is 11.8%, and other variables not studied influence 88.2% of students' mathematics learning outcomes.

The results of the learning style test on mathematics learning outcomes using SPSS 25 are shown in the following table:

Table 7. Results of Simple Regression Analysis (X_2-Y)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	77.929	2.109		36.954	.000
	Learning Style	.107	.037	.346	2.904	.005

a. Dependent Variable: Mathematics Learning Outcomes
(Source: SPSS 25 Output)

The table above shows that the value (Sig.) is 0.005 < 0.05, so it can be concluded that Ho is rejected and Ha is accepted, which shows that learning style influences the mathematics learning outcomes of class IX MTsN 3 Medan students in the 2023/2024 academic year. Apart from that, from the table, it is known that the a value is 77.929 and the b value is 0.107, which shows that mathematics learning outcomes will increase by 0.107 with each additional 1% learning style. Therefore, the regression equation is Y = 77.929 + 0.107X.

Table 8. R Square Value Test Results for Learning Styles

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.346[a]	.120	.106	1.865

a. Predictors: (Constant), Learning Styles
(Source: SPSS 25 Output)

The table shows that the R square is 0.120, which means that the influence of learning style on students' mathematics learning outcomes is 12% if included in the formula, and other variables not studied influence 88% of students' mathematics learning outcomes.

3.4.3. Multiple Linear Regression Test

The results of the Multiple Linear Regression Test using SPSS 25 are shown in the following table:

Table 9. Results of Multiple Linear Regression Analysis (X_1, X_2, Y)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	74.092	2.731		27.130	.000
	Digital Literacy	.137	.064	.260	2.128	.037
	Learning Style	.081	.038	.264	2.159	.035

a. Dependent Variable: Mathematics Learning Outcomes

The table above shows that Ho is rejected and Ha is accepted, with a Sig value. digital literacy 0.037 and Sig. learning style 0.035 < 0.05, which shows that there is an influence between digital literacy and learning style on mathematics learning outcomes. By using the regression formula, the following equation can be concluded: $Y = 74.092 + 0.137X_1 + 0.081X_2$.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.425[a]	.181	.154	1.814

a. Predictors: (Constant), Learning Styles, Digital Literacy

Apart from that, the value in column R, namely 0.425, means that variations in all independent variables can influence the dependent variable by 42.5%. On the other hand, variables outside the research can influence 57.5%.

The research results show that digital literacy improves mathematics learning outcomes. These regression coefficients indicate that better mathematics learning outcomes correlate with better digital proficiency. Conversely, a decline in digital literacy is related to a decline in mathematics learning outcomes. Digital literacy factors influencing mathematics learning outcomes include family and environmental support in the form of the availability of access to technology and digital resources such as computers, the internet, and mobile devices, as well as teachers' ability to apply their digital skills in mathematics learning. Students are also motivated and interested in using digital technology in mathematics lessons.

Positive learning styles have an impact on mathematical learning outcomes. The regression coefficient shows that mathematics learning outcomes are higher with a higher learning style and, conversely, lower with a lower learning style. The learning style factor influences mathematics learning outcomes because each individual has different habits in carrying out their duties and is more likely to use certain methods to get a positive learning experience. Teachers understand students' learning styles and adjust their teaching methods. There are also factors outside the student, such as the school education system, which requires students to learn independently, as well as factors in the home environment and community where the student lives.

Overall, increasing digital literacy and supporting learning styles will likely improve mathematics learning outcomes and vice versa. The influence of digital literacy and learning styles on mathematics learning outcomes is caused by students' intrinsic factors such as interest, talent, and motivation. There are also external factors, such as support from teachers and schools in facilitating the availability of resources and technology in learning and a home environment that supports student learning facilities. In line with what was expressed by Setiawati & Coesamin (2023), learning independence and digital literacy positively influence student learning outcomes. The higher the learning independence and digital literacy, the better the student's learning outcomes will be. Meanwhile, Arryadna and Pratiwi (2022) state that digital literacy has a significant and positive impact on the success of learning outcomes. According to Kadir et al. (2020), their research states that the higher the visual learning style, the better the students' physics learning outcomes. So students who like reading and are not disturbed by noise will be able to improve their learning outcomes in physics. In line with what was stated by Hasanah et al. (2018), learning styles have a joint influence, and the dominant influence is between visual learning styles, auditory learning styles, and kinesthetic learning styles on the learning outcomes of class XI students majoring in accounting at state vocational schools 1 Jember, even semester of the 2017/2018 academic year.

4. Conclusion

Based on the results previously explained, this research reached the following conclusions: First, the results of simple linear regression analysis with a value of (Sig.) 0.005 < 0.05 indicate that there is an influence of digital literacy on the mathematics learning outcomes of class IX MTsN 3 Medan students in the academic year 2023/2024. Second, the results of simple linear regression analysis with a value (Sig.) 0.005 < 0.05 show that there is an influence of learning style on the mathematics learning outcomes of class IX MTsN 3 Medan students for the 2023/2024 academic year. Third, there is an influence between digital literacy and learning styles on the mathematics learning outcomes of class IX MTsN 3 Medan students for the 2023/2024 academic year, as seen from the results of multiple linear regression analysis with Sig values of

digital literacy of 0.037 and Sig. learning style of 0.035 < 0.05. Digital literacy and learning styles contribute to student mathematics learning outcomes by 42.5%. So that the teaching and learning process can be effective and provide maximum results, especially in mathematics lessons, several suggestions can be made as follows: (1) Teachers can further improve students' digital literacy by utilizing technology such as learning software, mathematics applications, and digital resources to help improve student learning outcomes in mathematics material. For example, geogebra, desmos, mathway, and others. (2) Teachers need to understand the various learning styles that students have, such as visual, auditory, and kinesthetic. By understanding students' learning styles, teachers can adjust teaching methods to suit students' needs. Using a variety of teaching methods that accommodate different learning styles can help improve students' understanding of mathematical concepts. For example, using visual approaches such as videos, infographics, or animations for visual students, group discussions or presentations for auditory students, and for kinesthetic students, teachers can use mathematical manipulatives, such as building blocks, coins, or other physical objects, to help students visualize and manipulate mathematical concepts directly. These manipulatives can help students understand abstract mathematical concepts through sensory experience.

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