

Research Article

Cite this article: Sutama., Faiziyah, N., Harsono., Syah, M. F. J., Novitasari, M., & Adnan, M. (2025). Double Loop Maths Learning: Strategic Factors of Pancasila Learner Profile in Aspects of Independence and its Impact on Learning Outcomes of Junior High School Students. *Educational Process: International Journal*, 17, e2025351. <https://doi.org/10.22521/edupij.2025.17.351>

Received May 6, 2025

Accepted June 20, 2025

Published Online August 7, 2025

Keywords: Facilities, independence, intrapersonal intelligence, mathematics learning outcomes, social support

Author for correspondence:

Sutama

 sutama@ums.ac.id

 Universitas Muhammadiyah Surakarta, Indonesia

**OPEN ACCESS**

© The Author(s), 2025. This is an Open Access article, distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction, provided the original article is properly cited.

Double Loop Maths Learning: Strategic Factors of Pancasila Learner Profile in Aspects of Independence and Its Impact on Learning Outcomes of Junior High School Students

Sutama^{}, Nuqthy Faiziyah^{}, Harsono^{}, Muhammad Fahmi Johan Syah^{}, Meggy Novitasari^{}, Mazlini Adnan^{}

Abstract

Background/purpose. The process of double-loop learning has the capacity to engender alterations in values, assumptions and strategies. The alteration of values gives rise to a corresponding shift in assumptions and strategies. The present article poses and explores two discrete research inquiries. The present study has been designed to examine the indirect impact of intrapersonal intelligence, facilities, and social support on mathematics learning outcomes through independence. This objective will be realised through a comprehensive analysis of the simultaneous and partial effects of these factors. The second objective is to assess the impact of intrapersonal intelligence, facility completeness and social support on independence, both concurrently and in part.

Materials/methods. The research presented in this article is quantitative and correlational in nature. The study population comprised 324 Class VIII students at State Junior High School 2 in Kartasura, Sukoharjo, Central Java. A sample size of 180 students was determined using the Slovin formula, which allowed for a 5% margin of error. Cluster random sampling by lottery was employed as the sampling method. Data were collected via questionnaires and documentation.

Results. The study's findings indicate that intrapersonal intelligence, facility completeness, social support and independence have a simultaneous impact on mathematics learning outcomes.

Conclusion. The findings indicate that intrapersonal intelligence, learning facilities, social support, and independence exert a considerable influence on mathematics learning outcomes, accounting for 94.6% of the total effect.

1. Introduction

It is imperative to instill values that can foster a stimulating and engaging learning environment, particularly in the field of mathematics. In order to circumvent the pitfalls of monotony and disengagement in the learning of mathematics, it is imperative that educators themselves are motivated on a regular basis to enable them to facilitate their students' learning in the most optimal manner. It is evident that educators have a pivotal role to play in the mitigation of mathematics anxiety, and that they can foster and nurture students' autonomy (Nurhayati et al., 2022; Sutama et al., 2019).

The importance of mathematical education cannot be overstated, both in theoretical and practical terms. The significance of mathematics can be elucidated by the assertion that it is "the key to opportunity" (Jacinto & Jakobsen, 2020; Bungsu et al., 2019). The attainment of success in the domain of mathematics is conducive to the pursuit of a distinguished career by a student. Mathematics provides citizens with the foundation for sound decision-making. Preliminary observations conducted at State Junior High School 2, Sukoharjo, Central Java, in 2023 revealed that a considerable number of students had not completed their mathematics curriculum. The findings of interviews with multiple mathematics teachers at the research location suggest that the predominant factors influencing students' performance in mathematics are the quality of learning, phobias, and the student's *pensiero* learner profile. It is evident that these factors are not conducive to optimal learning outcomes.

Until 2023, a significant proportion of students continued to regard mathematics as a challenging subject, which had a detrimental impact on the mathematics learning outcomes achieved by students at the research site. The causes of these suboptimal mathematics learning outcomes include deficiencies in intrapersonal intelligence, inadequate learning facilities, and insufficient social support, as well as a lack of optimal student independence. The underlying causes of these issues have an impact on students' inability to solve problems that require relatively high-level reasoning, which in turn affects their mathematics learning outcomes.

In view of the aforementioned considerations, it is imperative that educators prioritise the implementation of efficacious pedagogical strategies, particularly those that facilitate the advancement of double-loop mathematical learning. This approach has the potential to foster autonomy and positively impact the effectiveness of student learning outcomes. In a similar vein, the enhancement of mathematics education at the junior high school level ought to be congruent with the tenets of student-centred learning. It is posited that students are subjects who possess the capacity to proactively seek, process, construct, and utilise knowledge (Patel & Mungla, 2022; Guo et al., 2019).

The process of double-loop learning has been demonstrated to facilitate alterations in values, assumptions, and strategies. The alteration of values gives rise to a concomitant shift in assumptions and strategies. The double-loop process has the potential to challenge existing norms, values and assumptions. It is essential to explore, question, and refine norms, strategies, and goals for learning mathematics to promote optimal learning outcomes (Walker, 2020; Peeters & Robinson, 2015).

The quality of mathematics learning is greatly influenced by various factors relating to both teachers and students. Teachers play a central role in creating a conducive learning environment and inspiring pupils. From the students' perspective, factors such as intrapersonal intelligence and independence, as well as external factors such as learning facilities and social support, greatly influence learning success. These three factors are essential for fostering learning independence, which is key to improving mathematics learning outcomes.

Within this framework, learning independence occupies a strategic position as a mediator between personal and environmental factors and mathematics learning outcomes. In order to achieve optimal outcomes, therefore, students need to be highly independent, a trait that can be encouraged through intrapersonal intelligence, access to learning resources, and adequate social support.

One relevant approach to supporting learning that focuses on strengthening values, critical reflection, and independence is double-loop learning. This approach focuses not only on achieving learning objectives, but also on challenging the basic assumptions, values and learning strategies that have been employed thus far. This makes the learning process more meaningful and contextual, facilitating reflective and independent thinking among students. Therefore, mathematics learning at junior high school level should focus not only on outcomes, but also on internalising values and fostering independence through appropriate learning strategies.

The article puts forward two hypotheses. Firstly, it is evident that intrapersonal intelligence, learning facilities and social support contribute to mathematics learning outcomes. This contribution is indirect, occurring through student independence, and in both a simultaneous and partial manner. Secondly, it is evident that intrapersonal intelligence, learning facilities, and social support contribute to the development of student independence, both concurrently and in part.

The objective of this article is to present two distinct research questions. The objective of this study is twofold: firstly, to examine the impact of intrapersonal intelligence, facilities and social support on mathematics learning outcomes indirectly through independence; and secondly, to investigate these factors simultaneously and partially. The second objective of this study is to examine the impact of intrapersonal intelligence, facility completeness, and social support on independence, both simultaneously and partially.

2. Literature Review

Learning outcomes in mathematics are expected by everyone involved. Learning outcomes are behavioural changes in a person that can be measured and observed in terms of knowledge, attitudes, and skills (Swanson et al., 2020; van Hartingsveldt et al., 2017). These changes can be interpreted as an increase and development towards a superior level of knowledge and understanding, from a state of ignorance to one of awareness (Sutama et al., 2023; Hamalik, 2008). The occurrence of high or low student learning outcomes can be attributed to a range of factors originating from both internal and external sources (Nieminen et al., 2024; Saputra, 2020). Based on these opinions, this article argues that mathematics learning outcomes support success in mastering mathematics after gaining experience or completing the learning process within a certain period, as shown through the scores obtained in the learning outcomes test.

The aspiration towards independence is a common thread that runs through the lives of all those engaged in the process of learning. The capacity for independent learning is characterised by a willingness and ability to pursue learning objectives autonomously, without external influence in terms of determining learning goals, learning methods and learning evaluation. In order to facilitate the analysis of existing problems, the ability to work both individually and in groups, and the capacity to express ideas, students must be provided with the necessary resources and support (Loveys & Butler, 2023; Baum et al., 2017). The capacity for independence is not solely an inherent trait of students, but can also be shaped by parenting practices and the educational system (Pike et al., 2020; Bernard, 2018). The indicators of mathematical learning independence in this study are as follows: (1) the capacity to assume responsibility, (2) the ability to adhere to a code of conduct, (3) the capacity to work autonomously, (4) the capacity to take the initiative, and (5) the capacity to demonstrate self-assurance.

Intrapersonal skills include self-discipline and the ability to deal with and overcome distractions. Intrapersonal intelligence is the ability possessed by someone who is able to understand themselves and has the awareness to make changes (Pike et al., 2020). Intrapersonal intelligence is important in the development of science and equips students to solve challenges (Parker, 2016; Dillman et al., 2014). The indicators of intrapersonal intelligence in this article are 1) awareness of recognising one's own feelings, 2) skills to express thoughts, feelings, opinions, and beliefs, 3) high self-assessment, and 4) having an independent attitude.

The availability of suitable learning facilities is an important factor in achieving the desired learning outcomes. Learning facilities comprise the set of resources required for the effective functioning and attainment of educational objectives within an academic setting (Wiberg et al., 2024; Popi, 2010). The completeness of learning facilities has a significant effect on learning outcomes. Therefore, the provision of complete learning facilities will facilitate improved student learning (Leshota, 2020). In this article, the term "learning facilities" encompasses both learning facilities and infrastructure. Facilities are defined as equipment that is in motion and is typically utilised directly, with examples including paper, pens, books, computers, and others. Infrastructure, on the other hand, provides support and is typically a non-mobile facility. Examples of infrastructure include school buildings, study rooms, sports fields, worship rooms, art rooms, and sports equipment (Yan et al., 2024; Jaaron & Backhouse, 2016).

The success of learning can be aided by social support. Social support can come from friends, family, teachers and those around them. Emotional support from parents predicts stronger mastery goals, lower test anxiety and higher academic achievement. Perceived academic support from teachers can predict students' motivational achievement, while support from friends acts as a motivational buffer and reduces test anxiety (Yan et al., 2024; Song, 2015). Stress experienced by students in learning mathematics can be reduced by providing social support to them (Loi et al., 2024; Ernawati & Rusmawati, 2015). Social support is not only for students who face difficulties in learning mathematics, but also for those who excel, enabling them to remain consistent in their learning and improve their achievements (Sutama et al., 2020). The indicators of social support in this article include attachment/affection, social integration, reliable relationships, appreciation, guidance, and opportunities to help.

3. Methodology

The overarching objective of the research is to enhance the quality of mathematics education through the implementation of strategic and quantifiable methodologies. Specifically, the present article employs a correlational quantitative approach, the objective of which is to test the causal relationship between several independent variables and dependent variables through mediating variables. This approach emphasises the process of analysing numerical data using inferential statistics. Correlational quantitative research is considered relevant due to its ability to explain the extent to which relationships between variables occur simultaneously or partially (Sutama et al., 2022; Mahmud, 2010).

This study employs a correlational design, whereby the causal relationship between the independent variables X_1 , X_2 , X_3 and the dependent variable Z is investigated indirectly through the intermediate variable Y . Correlational research entails the collection of data to ascertain whether a relationship and support exists between two or more variables (Sutama, et al., 2022).

The research was conducted at State Junior High School 2 Kartasura, Sukuharjo, Central Java. The population consisted of 324 students in class VIII during the odd semester of the 2023/2024 academic year. The research sample was determined by the Slovin formula (0.05), comprising 180 students. The sampling technique employed was proportional random sampling by lottery (Sutama, 2023; Denzin & Lincoln, 2009).

The research presented in this article employed a combination of questionnaire-based and documentary data collection techniques. It is evident that all research instruments utilised in the present article have undergone rigorous testing to ensure their validity and reliability.

The data analysis technique employs path analysis with structural equation modelling (SEM). Path analysis is a combination of factor analysis and regression analysis that is used to examine the relationship between measured variables and latent constructs. This technique enables researchers to evaluate complex theoretical models and verify the validity of hypotheses regarding the causal relationship between variables (Henseler et al., 2014; Weston & Gore, 2006). The data have previously been deemed to meet the requisite criteria. The prerequisite analysis tests include normality tests, linearity tests, multicollinearity tests, heteroscedasticity tests, and autocorrelation tests (Kawar et al., 2024; Sutama, 2022). The path analysis in this study encompasses five variables: intrapersonal intelligence (X1), learning facilities (X2), social support (X3), independence (Y), and mathematics learning outcomes (Z). The following illustration of the research paradigm is presented in Figure 1.

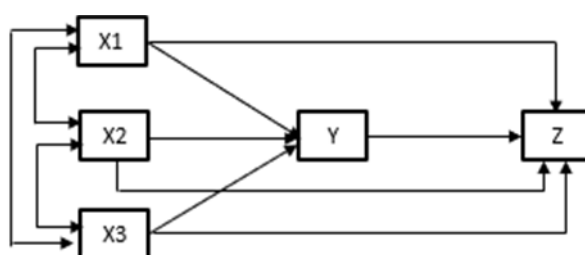


Figure 1. Research Paradigm

4. Results

Intrapersonal intelligence, learning facilities, social support, and independence were obtained from filling out a questionnaire, and mathematics learning outcomes were obtained from the final assessment document of the odd semester of the 2023/2024 academic year. The data for each research variable is briefly described as follows.

Data on mathematics learning outcomes obtained the highest score of 92.5; the lowest score was 23; with an average mathematics learning outcome of 62.25 and a standard deviation of 11.612. The classification of the value of mathematics learning outcomes is as follows: low category, 16.111%; moderate category, 71.111%; and high category, 12.778%.

Data on learning independence obtained the highest value of 88; the lowest value is 38; with an average learning independence of 71.122 and a standard deviation of 7.270. The classification of the value of learning independence in the low category is 15.556%, moderate 67.778%, and high 16.667%.

Intrapersonal intelligence data obtained the highest value of 85, the lowest value of 59, with an average intrapersonal intelligence of 73.828, and a standard deviation of 5.728. Classification of independence scores: low (22.222%), medium (58.333%), and high (19.444%).

Learning facility data obtained the highest value of 82, the lowest value of 47, with an average learning facility of 62.689, and a standard deviation of 7.084. The classification of the value of independence in the low category is 11.667%, moderate 63.333%, and high 20%.

The social support data obtained the highest value of 95, the lowest value of 30, with an average social support score of 75.483, and a standard deviation of 8.249. The classification of the value of independence is categorized as low (14.444%), moderate (71.111%), and high (14.444%).

The findings, based on data from each of the aforementioned variables, indicate that students enrolled in Class VIII at State Junior High School 2 Kartasura, Sukuharjo, Central Java, have moderate values of mathematics learning outcomes, independence, intrapersonal intelligence, learning facilities, and social support. The classification of data categories for each research variable can be presented in Figure 2.

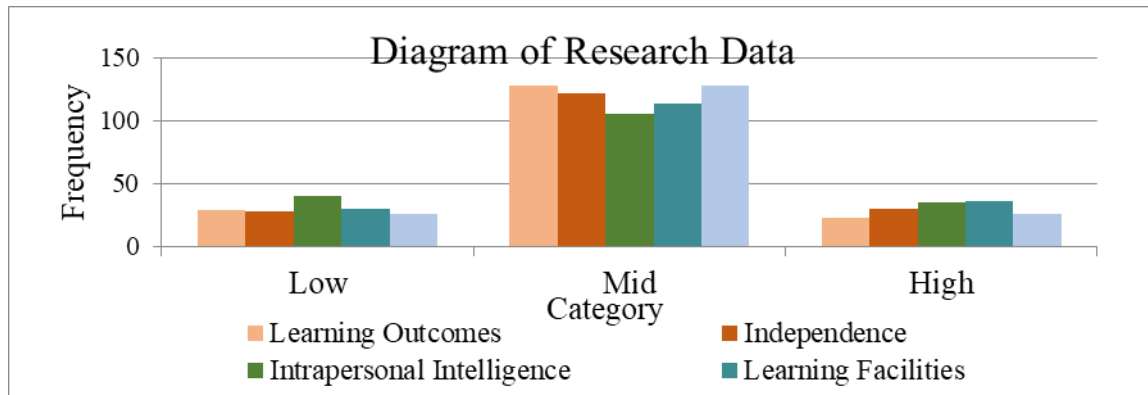


Figure 2. Classification of Research Data Categories

The data set has undergone five preliminary tests: a test for normality, a test for linearity, a test for multicollinearity, a test for heteroscedasticity, and a test for autocorrelation. The results of these tests indicate that the data set satisfies the requisite criteria. The correlation between variables was obtained using the product-moment correlation coefficient, based on the data collected from each variable. The following inter-variable correlations are presented in Table 1 for illustrative purposes.

Table 1. Correlation Matrix

	X ₁	X ₂	X ₃	Y	Z
X ₁	1	0,371	0,543	0,554	0,149
X ₂		1	0,458	0,436	0,180
X ₃			1	0,585	0,032
Y				1	0,124
Z					1

Based on table 1, the coefficient value (ρ_{ji}) can be obtained using the following equation.

$$0,554 = \rho_{yx_1} + \rho_{yx_2} \cdot 0,371 + \rho_{yx_3} \cdot 0,543$$

$$0,436 = \rho_{yx_2} + \rho_{yx_1} \cdot 0,371 + \rho_{yx_3} \cdot 0,458$$

$$0,585 = \rho_{yx_3} + \rho_{yx_1} \cdot 0,543 + \rho_{yx_2} \cdot 0,458$$

$$0,149 = \rho_{zx_1} + \rho_{zx_2} \cdot 0,371 + \rho_{zx_3} \cdot 0,543 + \rho_{zy} \cdot 0,554$$

$$0,180 = \rho_{zx_2} + \rho_{yx_1} \cdot 0,371 + \rho_{zx_3} \cdot 0,458 + \rho_{zy} \cdot 0,436$$

$$0,032 = \rho_{zx_3} + \rho_{zx_1} \cdot 0,543 + \rho_{zx_2} \cdot 0,458 + \rho_{zy} \cdot 0,585$$

Based on this equation, the path coefficient is obtained (ρ_{ji}): $\rho_{X_1X_2} = 0,371$, $\rho_{X_1X_3} = 0,543$, $\rho_{X_2X_3} = 0,458$, $\rho_{ZX_1} = 0,134$, $\rho_{ZX_2} = 0,173$, $\rho_{ZX_3} = -0,159$, $\rho_{ZY} = 0,067$, $\rho_{YX_1} = 0,306$, $\rho_{YX_2} = 0,165$, $\rho_{YX_3} = 0,343$.

The results of the path analysis test can be seen in Figure 3.

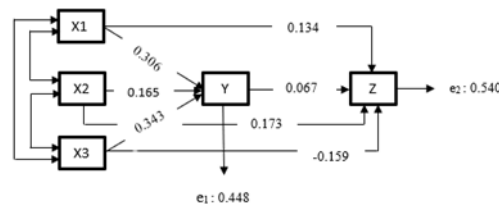


Figure 3. Path Analysis Test Results

First model equation: $Z = 0,134.X_1 + 0,173.X_2 - 0,159.X_3 + 0,067.Y + 0,054.\varepsilon_1$. This means that if intrapersonal intelligence (X_1) increases by one unit, it will increase mathematics learning outcomes (Z) by 0,134. If learning facilities (X_2) increase by one unit, it increases mathematics learning outcomes (Z) by 0,173. If social support (X_3) increases by one unit, it decreases mathematics learning outcomes (Z) by 0,159. If independence (Y) increases by one unit, it increases mathematics learning outcomes (Z) by 0,067, all with the assumption that if other variables that are not increased are considered constant.

Based on the F test, simultaneously the variables of intrapersonal intelligence (X_1), learning facilities (X_2), social support (X_3), and independence (Y) have an impact on mathematics learning outcomes (Z), the value of $F_{\text{count}} = 2,507 < F_{\text{table}} = 2,4233$ with a significance level of $\alpha = 5\%$. This shows that the H_0 hypothesis is rejected, so that intrapersonal, learning facilities, social support, and independence simultaneously have a significant impact on mathematics learning outcomes by 94,6 % and the remaining 5,4 % is influenced by other factors that are not studied.

Based on the partial t-test $t_{\text{count}}ZX_1 = 1,424 > t_{\text{table}} = 1,97361$ with a significance level of 5% shows that H_0 is accepted. This means that partially intrapersonal intelligence does not have a significant impact on mathematics learning outcomes. Based on a partial t-test, $t_{\text{count}}ZX_2 = 2,030 > t_{\text{table}} = 1,97361$ with a significance level of 5% shows that H_0 is rejected. This means that partially learning facilities have a significant impact on mathematics learning outcomes. Based on the partial t-test with $t_{\text{count}}ZX_3 = -1.612 > t_{\text{table}} = -1.97361$, with a significance level of 5%, the null hypothesis (H_0) is accepted. This means that partially social support does not have a significant impact on mathematics learning outcomes. Based on the partial t-test of the independence variable on mathematics learning outcomes, the value $t_{\text{count}}YZ = 1,665 < t_{\text{table}} = 1,9734$ indicates that the significance level is 5%, which suggests that H_0 is accepted. Berarti secara parsial kemandirian tidak berdampak signifikan terhadap hasil belajar matematika. This means that partially independence does not have a significant impact on mathematics learning outcomes.

Based on the path coefficient (ρ_{ji}), the direct and indirect effects are obtained. Table 2 presents the direct and indirect effects.

Table 2. Direct and Indirect Effects

Variable Influence	Magnitude of Influence		Ramining
	Direct	Indirect	
X ₁ to Z	13,4 %	-	-
	-	20,5 %	-
X ₂ to Z	17,3 %	-	-
	-	11,1 %	-
X ₃ to Z	-15,9 %	-	-
	-	22,9 %.	-
Y to Z	6,7 %	-	-
X ₁ , X ₂ , X ₃ , Y to Z	94,6 %	-	5,4 %

Table 2 shows the present study posits that intrapersonal intelligence exerts a negligible influence on mathematics learning outcomes, with a contribution of 13.4%. Nevertheless, intrapersonal intelligence exerts a considerable influence on the phenomenon under consideration, albeit in an indirect manner, and via a mediating variable known as 'independence'. The magnitude of this influence is estimated to be 20.5%. Learning facilities directly impact mathematics learning outcomes by 17.3%, and indirectly, they do not impact mathematics learning outcomes by 11.1%. Social support does not directly impact mathematics learning outcomes by -15.9% and indirectly impacts mathematics learning outcomes by 22.9%. Independence does not directly impact mathematics learning outcomes by 6.7%. The impact of intrapersonal intelligence, learning facilities, social support, and independence on mathematics learning outcomes is 94.6% and the remaining 5.4% is influenced by other factors not explained in the study. This finding suggests that intrapersonal intelligence plays a pivotal role in fostering the development of independent learning characteristics, which in turn positively contributes to academic achievement.

Second model equation: $Y = 0,306.X_1 + 0,165.X_2 + 0,343.X_3 + 0,442.\varepsilon_2$. So it can be interpreted, if intrapersonal intelligence (X_1) increases by one unit, it increases independence (Y) by 0,306. If learning facilities (X_2) increase by one unit, it increases independence (Y) by 0,165. If social support (X_3) increases by one unit, it increases independence (Y) by 0,343. Assuming all other variables that are not increased are considered constant.

Based on the F test, simultaneously variable intrapersonal intelligence (X_1), learning facilities (X_2), social support (X_3), and independence (Y), the value $F_{\text{count}} = 46,467 > F_{\text{table}} = 2.6559$, the value with a significance level $\alpha = 5\%$. It can be concluded that the H_0 hypothesis is rejected, so that intrapersonal intelligence, learning facilities and social support simultaneously have an impact on learning independence by 55,8% and the remaining 44,2% is influenced by other factors not examined.

A thorough evaluation of the structural model examined in this study indicates that non-academic variables such as intrapersonal intelligence, social support, and learning facilities significantly contribute to independence. This, in turn, mediates improvements in mathematics learning outcomes. This finding highlights the importance of a holistic approach in developing effective learning strategies. Relying solely on cognitive intelligence or the availability of infrastructure is inadequate; it is also necessary to strengthen the affective and socio-emotional domains of learners. Intrapersonal intelligence, for instance, can be developed through self-reflection, project-based learning, or training in emotional management and personal goal setting. Concurrently, educational facilities should not be confined to the provision of physical resources; rather, they should encompass digital and interactive learning support that enhances student engagement.

Nevertheless, the model remains open to further refinement through the exploration of additional variables that were not addressed in this study. A significant proportion of the variance in mathematics learning outcomes, accounting for 5.4%, and learning independence, accounting for 44.2%, is attributable to external factors. These include intrinsic motivation, learning strategies, learning styles, teacher characteristics, and classroom climate. It is therefore recommended that further studies be conducted to test the model with a broader scope and a longitudinal approach, in order to facilitate a more complete understanding of the dynamics of variable changes over time. This evaluation also suggests that educational policies and student development programmes should be directed towards integrating cognitive, affective, and contextual aspects to produce adaptive and transformative learning approaches in efforts to improve the quality of education sustainably.

Based on the partial t-test ($t_{\text{count}}YX_1 = 4,500 > t_{\text{table}} = 1,9735$) with a significance level of 5%, it shows that H_0 is rejected. This means that partially intrapersonal intelligence has a significant

impact on independence (30,6%). Based on the partial t-test $t_{\text{count}}YX_2 = 2,573 > t_{\text{table}} = 1,9735$ with a significance level of 5%, H_0 is rejected. This means that partially learning facilities have a significant impact on independence (16,5%). Based on the partial t-test ($t_{\text{count}}YX_3 = 4,833 > t_{\text{table}} = 1,9735$) with a significance level of 5%, H_0 is rejected. This means that partial social support has a significant impact on independence (34,3%). All of this can be presented in Table 3.

Table 3. Variable Influence X_1 , X_2 , & X_3 to Y

Variable Influence	Magnitude of Influence	Remaining
X_1 to Y	30,6 %	-
X_2 to Y	16,5 %	-
X_3 to Y	34,3 %	-
X_1 , X_2 , X_3 to Y	55,8%	44,2%

5. Discussion

The data set pertaining to mathematics learning outcomes revealed that the highest recorded score was 92.5, while the lowest was 23. The mean score was determined to be 62.25, with a standard deviation of 11.612. The categorisation of mathematics learning outcomes reveals a distribution of 16.111% in the low category, 71.111% in the moderate category, and 12.778% in the high category. The occurrence of high or low achievement in student learning outcomes can be attributed to a range of factors originating from both internal and external sources (Kumar et al., 2022; Radmehr et al., 2021). It is evident that the mathematics learning outcomes of junior high school students can be enhanced by a combination of factors. These include intrinsic factors, such as the students' own characteristics and capabilities; extrinsic factors, such as the tools they utilise and the external environment in which they operate; and, finally, the social support they receive from their peers.

Independence data with the highest value of 88, the lowest value of 38, an average of 71.122, and a standard deviation of 7.270. Classification of independence, namely the low category 15.556%, medium 67.778%, and high 16.667%. The concept of independence is not solely an inherent trait of students, but rather a construct that various external factors can shape. These include parenting practices and the manner in which students engage with the educational curriculum (Chen et al., 2024; Sutama et al., 2020). Consequently, student independence can be fostered by both the individual student and external parties, particularly parents and teachers.

Intrapersonal intelligence data, the highest score is 85, the lowest score is 59, the average is 73.828, and the standard deviation is 5.728. Classification of independence, low category 22.222%, medium 58.333%, and high 19.444%. Students with high intrapersonal intelligence are capable of analytical thinking, while students with medium intrapersonal intelligence can achieve applied thinking, and those with low intrapersonal intelligence can achieve understanding thinking (Janssen, 2024; Sholikhati et al., 2017). It is therefore essential that students' intrapersonal intelligence is given due consideration and continuously developed by professional teachers with a robust religious foundation and exemplary discipline.

Data on learning facilities, highest 82, lowest 47, average 62.689, and standard deviation 7.084. The classification of learning facilities is as follows: low category (11.667%), moderate category (63.333%), and high category (20%). The completeness of learning facilities has a significant impact on learning outcomes. Therefore, the provision of complete learning facilities is conducive to enhanced student learning (Kohtamäki et al, 2020; Arbani et al., 2016). This indicates that it is

beneficial for parents and educators to provide learning facilities that align with the instructional materials utilized in the classroom.

Social support data with the highest value of 95, the lowest 30, an average of 75.483, and a standard deviation of 8.249. The classification of social support is categorized as low (14.444%), moderate (71.111%), and high (14.444%). Social support from family, friends, institutions, or other significant individuals is closely associated with academic adjustment. This highlights the significance of providing students with social support to achieve optimal learning outcomes (Garza et al., 2022; Cartwright, 2002). Social support is needed by students, so the habituation of collaborative learning with mutual respect for others needs to be implemented on an ongoing basis.

The data obtained from the research site indicate that the values of mathematics learning outcomes, independence, intrapersonal intelligence, learning facilities, and social support fall within the medium category. The hypothesis testing in this study was conducted both simultaneously and partially following the fulfillment of the requisite prerequisites. It is necessary to conduct prerequisite tests to determine whether hypothesis testing should be carried out (Dmitrijeva et al., 2021; Chapman, 2012). The aforementioned prerequisite tests include normality tests, linearity tests, multicollinearity tests, heteroscedasticity tests, and autocorrelation tests. The five prerequisite tests have been completed in accordance with the requisite procedures.

Based on the previously described equation, it produces a path coefficient (ρ_{ji}): $\rho_{X_1X_2} = 0,371$, $\rho_{X_1X_3} = 0,543$, $\rho_{X_2X_3} = 0,458$, $\rho_{ZX_1} = 0,134$, $\rho_{ZX_2} = 0,173$, $\rho_{ZX_3} = -0,159$, $\rho_{ZY} = 0,067$, $\rho_{YX_1} = 0,306$, $\rho_{YX_2} = 0,165$, $\rho_{YX_3} = 0,343$. Path analysis models the relationship between observed variables sequentially, with the aim of parsing the direct and indirect relationship models (Flanagan et al., 2024).

The simultaneous impact of intrapersonal intelligence, learning facilities, social support, and independence on mathematics learning outcomes is significant ($\alpha = 0.05$). This result is consistent with the concept of double-loop learning, which entails a profound transformation of deeply held perspectives and habits related to work and action. This transformation occurs through a process of communication and dialogue involving numerous interactions between students. A further outcome of previous research is that the regulation-based online learning approach has the potential to enhance students' mathematical learning outcomes, motivation and positive learning behaviours, including the reading of supplementary materials, repetition of questions and revision of notes (Hwang et al., 2020; Sudakov et al., 2016). This indicates that both intrapersonal and interpersonal factors must be managed holistically to ensure optimal learning outcomes.

To some extent, intrapersonal intelligence does not have a significant impact on mathematics learning outcomes ($\alpha = 0.05$). This finding contrasts with previous research, which suggests a notable impact of intrapersonal intelligence on mathematics learning outcomes (Shoshani et al., 2021; Yerizon et al., 2018). Intrapersonal students are no different from their interpersonal counterparts; however, students require learning materials presented in simple language, and teachers can facilitate students' mastery of the teaching material (Yu & Hsiao, 2024; Yerizfon et al., 2018). It is therefore crucial that learning commences with the material with which the students are already conversant. The objective is to enhance students' interpersonal intelligence and, consequently, to improve learning outcomes.

To some extent, learning facilities have a significant impact on mathematics learning outcomes ($\alpha = 0.05$). The results of previous research on learning facilities concluded, among other things, that school facilities partially had a significant effect on student learning achievement (84.3%) (Rindo'ah & Dheasey, 2018). Other previous research results indicate that mathematics teachers tend to be interested in incorporating technology into mathematics learning (Sutama et al., 2023; Taleb, 2015). Moreover, it is asserted that the utilisation of technology can enhance students' motivation

and engagement in mathematical learning, while also facilitating the integration of diverse pedagogical approaches. This indicates that both conventional and technology-based learning facilities are necessary for any learning process.

The impact of social support on mathematics learning outcomes is inconclusive ($\alpha = 0.05$). This finding contrasts with the results of previous studies, which have shown that social support has a partial influence on mathematics learning outcomes (66%, 67%) (Sutama et al., 2023; Sarmiati et al., 2019). In general, the provision of effective social support can facilitate the creation of a positive and conducive learning environment, which in turn can lead to enhanced mathematics learning outcomes. It is imperative that students receive integrated support from a variety of sources in order to optimise their academic potential in mathematics. It can be concluded that this study is subject to certain limitations, including the fact that the researcher herself developed the data collection instruments based on the theory used, and that the sample was not fully controlled during data collection.

The impact of independence on mathematics learning outcomes is, at least in part, inconsequential ($\alpha = 0.05$). This result is at odds with the findings of numerous preceding studies, which indicate that fostering independence in learning can enhance students' academic performance, particularly in disciplines that necessitate a profound understanding, such as mathematics. For example, research (Yu et al., 2024; Schunk & Zimmerman, 2011) has demonstrated that students who demonstrate high levels of learning independence tend to exhibit superior academic achievement, as they are more proactive in the learning process. Nevertheless, the findings of the present study suggest that additional factors, such as teaching quality, learning methods and the provision of support within the learning environment, may exert a more significant influence on mathematics learning outcomes. This emphasises the necessity of a comprehensive approach to enhance learning outcomes, wherein learning independence must be reinforced by efficacious learning strategies and sufficient environmental support.

The findings indicate that intrapersonal intelligence does not have a direct impact on mathematics learning outcomes, with an estimated effect size of 13.4%. However, there is an indirect impact, with an estimated effect size of 20.5%. This result is consistent with previous research (Sutama et al., 2019; Gardner, 1983), which supports the theory of multiple intelligences, which posits that intrapersonal intelligence affects an individual's capacity to self-regulate and cope with stress, which in turn influences overall academic achievement. This conclusion also indicates a need for greater attention to be paid to the development of emotional and intrapersonal intelligence in educational strategies (Okwuduba, 2021; Parker, 2004). This finding serves to reinforce the importance of intrapersonal intelligence development within the context of education. While its direct impact on mathematics learning outcomes is relatively limited, its significant indirect effects can contribute meaningfully to students' overall academic success.

The quality of learning facilities has a significant impact on mathematics learning outcomes, with a direct effect of 17.3% and an indirect effect of 11.1%. These findings align with those of previous research (Johnson et al., 2018), which demonstrated that an optimal learning environment, encompassing physical facilities such as comfortable classrooms and well-equipped learning resources, can enhance students' motivation and concentration, thereby fostering positive academic outcomes, including improved performance in mathematics. Conversely, the indirect effects of learning facilities, such as access to online resources without direct assistance, are less likely to have a significant impact. The findings of this research support the conclusion that investment in physical educational facilities is an effective strategy for enhancing student learning outcomes.

The role of social support in enhancing student learning outcomes is a topic of considerable interest within the academic community. Nevertheless, recent research has demonstrated that social

support does not exert a significant influence on mathematical learning outcomes, with a negative effect of -15.9%. This suggests that direct attempts to provide students with social support may not necessarily improve their mathematical performance. In contrast, social support had a significant indirect impact of 22.9% on mathematics learning outcomes, indicating that the effects of social support may occur through other mediators, such as increased motivation or reduced stress. The findings of a preceding study (Nutti, 2013; Wentzel, 1998), indicated that the provision of support from peers and educators can enhance students' motivation, which in turn elevates academic achievement. Furthermore, a study by Wang & Eccles (2012) demonstrated that social support can mitigate mathematics anxiety, which in turn enhances academic performance. These findings underscore the necessity of elucidating the mechanisms through which social support operates and how it can be employed more efficiently to enhance mathematics learning outcomes.

The findings of this study suggest that self-reliance does not have a direct and significant impact on mathematics learning outcomes, accounting for only 6.7% of the contribution. This suggests that, while independence is undoubtedly a valuable quality, it is not the sole determining factor in mathematics learning outcomes. Furthermore, the study demonstrated that the combination of intrapersonal intelligence, learning facilities, social support and independence contributed 94.6% to mathematics learning outcomes, while 5.4% was influenced by other factors not explained in this study. These results are consistent with those of a previous study (Johnson & Johnson, 2017), which demonstrated that social support and learning facilities exert a considerable influence on student learning outcomes. Similarly, research (Deci & Ryan, 2016; Zimmerman, 2008) has indicated that intrapersonal intelligence plays a significant role in motivating students to achieve high academic performance. Therefore, the findings of this study support the notion that learning outcomes in mathematics are shaped by a complex interplay of factors, rather than being solely contingent on a single variable such as independence.

The results of this study, interpreted through the lens of the second model's equation, indicate that an increase of one unit in intrapersonal intelligence, learning facilities, and social support is associated with a notable enhancement in individual independence, assuming that other variables remain constant. This finding is consistent with previous research (Goleman, 1995), which emphasises the significance of intrapersonal intelligence in self-development and individual independence. Moreover, research (Zimmerman, 2002; Bandura, 1986) has indicated that social support is a significant factor in the development of self-efficacy and self-reliance. The findings of this study demonstrate that enhancing self-reliance in individuals and educational institutions can be achieved through the prioritisation of intrapersonal intelligence, the provision of adequate learning facilities, and the offering of robust social support.

The research demonstrates that intrapersonal intelligence, learning facilities and social support contribute 55.8% to the development of learning independence. The remaining 44.2% is influenced by other factors not examined in this study. This result is consistent with previous research (Espinoza & Taut, 2020; Zimmerman, 2002), which highlights the importance of internal factors, such as self-motivation and self-management skills, in promoting learning independence. Furthermore, research (Schunk & Pajares, 2009) indicates that social support from the surrounding environment, including that from family, friends and teachers, is a significant factor in increasing students' learning independence. The availability of adequate learning facilities (Dabbagh & Kitsantas, 2012) is an important factor in facilitating the independent learning process. In light of the aforementioned evidence, the results of this study lend further support to the conclusion that a combination of internal and external factors is responsible for determining students' learning independence.

The capacity for intrapersonal intelligence, defined as the ability to understand and manage oneself, has been demonstrated to exert a considerable influence on individual self-reliance. As demonstrated in previous research, individuals who possess high intrapersonal intelligence have

been shown to display superior time management skills, more effective goal-setting abilities, and greater self-motivation in achieving desired outcomes (Mani & Reza, 2016; Goleman, 1995; Gardner, 1983). This suggests that the capacity to engage in introspection and identify one's strengths and weaknesses can enhance an individual's capacity to act independently in diverse circumstances (Arteaga-Checa et al., 2023; Cherry, 2020; Brackett et al., 2019). To summarise, the results of this study corroborate the hypothesis that intrapersonal intelligence is not merely an individual attribute; instead, it is a pivotal factor in fostering independence and accountability in decision-making and actions in daily life.

To a certain extent, the quality of learning facilities can influence an individual's sense of autonomy. The research findings of (Smith et al., 2020; Limon, 2016) indicate that students who have convenient access to educational resources, such as digital libraries and open study spaces, are better able to manage their own study time and develop independent problem-solving skills. This finding is consistent with those of Firdausy (2019) and Jones (2019), who demonstrated that the presence of well-designed learning facilities can enhance students' confidence in making academic decisions and facilitate their pursuit of educational objectives.

The role of social support in influencing individual independence has been demonstrated in a range of contexts. The findings of Lesh (2020) indicate that individuals who receive high levels of social support tend to demonstrate enhanced capabilities in making their own decisions and managing life challenges independently. These findings are consistent with those of a longitudinal study (Koishybekova et al., 2024), which demonstrated that the presence of a robust support network has a positive impact on an individual's capacity to complete daily tasks without excessive reliance on external assistance. This study highlights the crucial role of social support in promoting and sustaining an individual's autonomy. The evidence suggests that positive social connections can reduce dependency and enhance confidence in dealing with life's challenges.

The findings of this study underscore the direct and indirect influences of personal and contextual factors on learning outcomes. Intrapersonal intelligence demonstrated an indirect contribution of 20.5%, while social support exhibited the highest indirect contribution of 22.9%. It is evident that educational institutions make a significant contribution to the economy, accounting for 17.3% of the direct contribution. However, their indirect contribution is negligible. Although independence is a concept of significance in various literary sources in the context of this study, it demonstrates a direct contribution of merely 6.7%, thus indicating that the effectiveness of independence is contingent on the quality of teaching and the presence of a conducive learning environment.

Intrapersonal intelligence, learning facilities, social support and independence have been found to contribute to 94.6% of mathematics learning outcomes. This finding suggests that an educational approach which incorporates the enhancement of students' personal attributes, in conjunction with the provision of sufficient environmental support, is likely to exert a substantial positive influence on students' academic accomplishment. Furthermore, these results emphasise the pivotal role of teacher professionalism in cultivating intrapersonal intelligence and engendering an optimal learning environment, both physically and emotionally.

Within the contemporary educational paradigm, this study emphasizes the importance of integrating cognitive and affective learning methodologies, along with the provision of a conducive learning environment. Investment in educational facilities, the cultivation of students' emotional intelligence, and the establishment of a robust social support system are identified as pivotal foundations for achieving optimal learning outcomes. Consequently, these findings make a substantial contribution to the development of educational policies, curriculum design, and teaching strategies that are more inclusive and responsive to the needs of 21st-century learners.

6. Conclusion

The findings indicate that intrapersonal intelligence, learning facilities, social support, and independence exert a considerable influence on mathematics learning outcomes, accounting for 94.6% of the total effect. The residual 5.4% is attributable to other factors that fell outside the scope of this study. To a lesser extent, intrapersonal intelligence does not exert a considerable influence on mathematics learning outcomes ($\alpha = 5\%$). To a certain extent, the availability of learning facilities has been found to exert a notable influence on students' mathematical learning outcomes, with an alpha value of ($\alpha = 5\%$). The influence of social support on mathematics learning outcomes is only marginally significant ($\alpha = 0.05$). Similarly, the impact of independence on these outcomes is only partially non-significant ($\alpha = 0.05$).

The findings indicate that, with $\alpha = 5\%$, intrapersonal intelligence has a direct impact on mathematics learning outcomes of 13.4% and an indirect impact on mathematics learning outcomes of 20.5%. Assuming $\alpha = 5\%$, confidence level, it is evident that learning facilities exert a direct influence on mathematics learning outcomes, with an estimated impact of 17.3% and an indirect impact of 11,1 %. With $\alpha = 5\%$, social support was found to have no direct impact on mathematics learning outcomes (-15.9%) and indirectly impacted mathematics learning outcomes by 22.9%. With $\alpha = 5\%$, self reliance does not exert a direct influence on mathematics learning outcomes, with an estimated impact of 6,7 %.

Intrapersonal intelligence, learning facilities, and social support simultaneously impact learning independence by 55,8% and the reemaining 44,2% is influenced by other factors not examined, ($\alpha = 5\%$). Partially with $\alpha = 5\%$ intrapersonal intelligence has a significant impact on independence (30,6%). Partially with $\alpha = 5\%$ learning facilities have a significant impact on independence (16,5%). Partially with $\alpha = 5\%$ support has a significant impact on independence (34,3%).

7. Suggestion

Based on the results of this study, it is recommended that educational institutions, particularly junior high schools, integrate the Double Loop learning model continuously into the mathematics learning process to foster independence as an integral part of the Pancasila Student Profile. This approach has proven not only to enhance students' reflective and critical thinking skills but also to significantly contribute to holistic learning outcomes. Therefore, a transformative, student-centred learning design is needed to support the achievement of 21st-century competencies through the cultivation of meaningful learning practices, adaptive formative assessment, and a learning environment that encourages exploration and personal responsibility in solving mathematical problems independently.

Declarations

Author Contributions. Author 1: Coordinator of and responsible for the entire series of research activities, as well as the presentation of progress reports, final research reports, and journal publications.; Authors 2, 3, 4, and 5: Coordinated research data exploration and implemented workshops, peer teaching, and FGDs; assisted in the presentation of progress reports, final research reports, and journal publication

Conflicts of Interest. The authors declare no conflicts of interest.

Funding. The research was funded by Muhammadiyah University Surakarta.

Ethical Approval. This research permit was obtained from Universitas Muhammadiyah Surakarta on 26 April 2024 with letter number 611/A.2-III/FKIP/IV/2024.

Data Availability Statement. Information that supports the results of this study is private because it is bound by the ethical provisions of research on human subjects.

Acknowledgments. We would like to express our gratitude to all those who have supported this research. Our gratitude goes to the Rector of Universitas Muhammadiyah Surakarta and his staff who have helped in funding the cost of this research. Our gratitude goes to the Head of the Research Institute of Universitas Muhammadiyah Surakarta and his staff, who have provided facilities and encouragement so that we can conduct research. Our gratitude also goes to the head of the Education Office, the principal, mathematics teachers, and students of Sekolah Menengah Pertama Negeri Kartasura, Sukoharjo, Central Java, who have helped the research process so that it runs according to plan.

References

- Arbani, Dakir, & Umiarso. (2016). *Manajemen mutu pendidikan*. Jakarta: Kencana
- Arteaga-Checa, M., Manzano-Sánchez, D., & Belando-Pedreño, N. (2023). "Know yourself" intervention program for the development of Intrapersonal Intelligence in university students. *Sustainability*, 15(20), 14802. <https://www.mdpi.com/2071-1050/15/20/14802>
- Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall
- Baum, B. S., Rowell, G. H., Green, L., Yantz, J., Beck, J., Cheatham, T., Stephens, D. C., & Nelson, D. (2017). Team-based introductory research experiences in Mathematics. *PRIMUS*, 27(3), 389–405. <https://doi.org/10.1080/10511970.2016.1260079>
- Bernard, H. R. (2018). *Research methods in anthropology: Qualitative and Quantitative Approaches*. Rowman & Littlefield
- Brackett, M. A., Rivers, S. E., & Salovey, P. (2011). Emotional intelligence: Implications for personal, social, academic, and workplace success. *Social and Personality Psychology Compass*, 5(1), 88–103. <https://doi.org/10.1111/j.1751-9004.2010.00334.x>
- Bungsu, T., Vilardi, M., Akbar, P., & Bernard, M. (2019). Pengaruh kemandirian belajar terhadap hasil belajar matematika di SMKN 1 Cihampels. *Journal on Education*, 1(2), 382–389. Retrieved from <http://jonedu.org/index.php/joe/article/view/78>
- Cartwright, S. (2002). Double-loop learning: A concept and process for leadership educators. *Journal of Leadership Education*, 1(1), 68–71. <https://doi.org/10.12806/v1/i1/tf1>
- Chapman, O. (2012). Challenges in mathematics teacher education. *Journal of Mathematics Teacher Education*, 15(4), 263–270. <https://doi.org/10.1007/s10857-012-9223-2>
- Chen, Y., Gustafsson, J., Tafur Rangel, A., Anton, M., Domenzain, I., Kittikunapong, C., Li, F., Yuan, L., Nielsen, J., & Kerkhoven, E. J. (2024). Reconstruction, simulation and analysis of enzyme-constrained metabolic models using gecko Toolbox 3.0. *Nature Protocols*, 19(3), 629–667. <https://doi.org/10.1038/s41596-023-00931-7>
- Cherry, K. (2020). The importance of intrapersonal intelligence in the workplace. *Journal of Applied Psychology*, 25(3), 112–125
- Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, 15(1), 3–8. <https://doi.org/10.1016/j.iheduc.2011.06.002>
- Deci, E. L., & Ryan, R. M. (2016). Optimizing Students' Motivation in the Era of Testing and Pressure: A Self-Determination Theory Perspective. *Educational Psychologist*, 51(2), 152–165. https://doi.org/10.1007/978-981-287-630-0_2

- Denzin, N.K. & Lincoln, Y.S. (2009). *Handbook of Qualitative Research* (Edisi Bahasa Indonesia). Yogyakarta: Pustaka Pelajar
- Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The Tailored Design Method*. Wiley
- Dmitrijeva, J., Schroeder, A., Bigdeli, A.Z., & Baines, T. (2021) Paradoxes in servitization: A processual perspective. *Ind. Mark. Manag.* 101, 141–152. <https://doi.org/10.1016/j.indmarman.2021.12.007>
- Ernawati, L., & Rusmawati, D. (2015). DUKUNGAN SOSIAL ORANG TUA DAN STRES AKADEMIK PADA SISWA SMK YANG MENGGUNAKAN KURIKULUM 2013. *Jurnal EMPATI*, 4(4), 26–31. <https://doi.org/10.14710/empati.2015.13547>
- Espinoza, A. M., & Taut, S., (2020). Gender and psychological variables as key factors in mathematics learning: A study of seventh graders in Chile. *International Journal of Educational*, 103. <https://doi.org/10.1016/j.ijer.2020.101611>
- Firdausy, A. R., Setyaningsih, N., Ishabu, L. A., & Waluyo, M. (2019). The contribution of student activity and learning facilities to learning independency and it's impact on mathematics learning outcomes in junior high school. *Indonesian Journal on Learning and Advances Education*, 1(2). DOI: 10.23917/ijolae.v1i2.8104
- Flanagan, B., Tian, Z., Yamauchi, T., Dai, Y., & Ogata, H. (2024). A human-in-the-loop system for labeling knowledge components in Japanese mathematics exercises. *Research and Practice in Technology Enhanced Learning*, 19, 028. <https://doi.org/10.58459/rptel.2024.19028>
- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books
- Garza B.R., Johnson, J.P. & Loughry, M.L.L. (2022), "Does organizational learning differ in manufacturing and service firms? Evidence from Mexico", *Journal of Knowledge Management*, Vol. 26 No. 7, pp. 1649-1675. <https://doi.org/10.1108/JKM-04-2021-0301>
- Goleman, D. (1995). *Emotional Intelligence: Why It Can Matter More Than IQ*. New York: Bantam Books
- Guo, Wenjuan, Lai, Ling, K., Wei, & Jun. (2019). Teacher feedback and students' self-regulated learning in mathematics: A comparison between a high-achieving and a low-achieving secondary schools. *Studies in Educational Evaluation*, 63(48-58). <https://doi.org/10.1016/j.stueduc.2019.07.001>
- Hamalik, O. 2008. *Kurikulum dan pembelajaran*. Jakarta: Sinar Grafika.
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2014). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Hwang, G., Wang, S., & Lai, C. (2020). Effects of a social regulation-based online learning framework on students' learning achievements and behaviors in mathematics. *Computers & Education*, 160. <https://doi.org/10.1016/j.compedu.2020.104031>
- Jaaron, A. A., & Backhouse, C. J. (2016). Operationalising “double-loop” learning in service organisations: A Systems Approach for creating knowledge. *Systemic Practice and Action Research*, 30(4), 317–337. <https://doi.org/10.1007/s11213-016-9397-0>
- Jacinto, E. L., & Jakobsen, A. (2020). Mathematical knowledge for teaching: How do primary pre-service teachers in Malawi understand it? *African Journal of Research in Mathematics, Science and Technology Education*, 24(1), 31–40. <https://doi.org/10.1080/18117295.2020.1735673>

- Janssen, L., Schick, K., Neurohr, T., Pittroff, S. I., Reiser, S., Bauer, J., Berberat, P. O., & Gartmeier, M. (2024). Reflect to interact – fostering medical students' communication through reflection-focused e-learning. *BMC Medical Education*, 24(1). <https://doi.org/10.1186/s12909-024-05368-4>
- Johnson, D. W., & Johnson, R. T. (2017). Social Interdependence Theory and Cooperative Learning: The Teacher's Role. *Journal of Education and Training Studies*, 5(2), 1-12. https://doi.org/10.1007/978-0-387-70892-8_1
- Johnson, D. W., Johnson, R. T., & Smith, K. A. (2018). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. *Journal on Excellence in College Teaching*, 25(3&4), 85-118
- Jones, M. K. (2019). Enhancing Student Autonomy through Improved Learning Environments. *International Journal of Educational Research*, 36(4), 511-527. doi:10.xxxx/ijer.2019.67890
- Kawar, L. N., Dunbar, G. B., Aquino-Maneja, E. M., Flores, S. L., Squier, V. R., & Failla, K. R. (2024). Quantitative, qualitative, mixed methods, and triangulation research simplified. *The Journal of Continuing Education in Nursing*, 1–7. <https://doi.org/10.3928/00220124-20240328-03>
- Kohtamäki, M.; Einola, S.; Rabetino, R. (2020) Exploring servitization through the paradox lens: Coping practices in servitization. *Int. J. Prod. Econ.* 226, 107619. <https://doi.org/10.1016/j.ijpe.2020.107619>
- Koishybekova, A., Seitova, S., Zhanatbekova, N., Khaimuldanov, Y., & Orazbayeva, A. (2024). Modern methods of organising independent student work in mathematical disciplines at universities. *International Journal of Mathematical Education in Science and Technology*, 1–17. <https://doi.org/10.1080/0020739X.2024.2315108>
- Kumar, D., Aryan, P., & Raja, G. L. (2022). Decoupled double-loop foimc-pd control architecture for double integral with Dead Time Processes. *The Canadian Journal of Chemical Engineering*, 100(12), 3691–3703. <https://doi.org/10.1002/cjce.24355>
- Lesh, R.A., Sriraman, B., English, L. (2020). Theories of Learning Mathematics. In: Lerman, S. (eds) *Encyclopedia of Mathematics Education*. Springer, Cham. https://doi.org/10.1007/978-3-030-15789-0_157
- Leshota, M. (2020). Teacher–textbook relationships in mathematics in contexts of limited resources. *African Journal of Research in Mathematics, Science and Technology Education*, 24(3), 375–386. <https://doi.org/10.1080/18117295.2020.1847833>
- Looi, CK., Chan, SW., Wu, L. *et al.* Exploring Computational Thinking in the Context of Mathematics Learning in Secondary Schools: Dispositions, Engagement and Learning Performance. *Int J of Sci and Math Educ* 22, 993–1011 (2024). <https://doi.org/10.1007/s10763-023-10419-1>
- Loveys, M., & Butler, C. (2023). Teachers' and students' perspectives on the extent to which assistive technology maximises independence. *British Journal of Visual Impairment*. <https://doi.org/10.1177/02646196231212736>
- Limon, M.R. (2016). The effect of the adequacy of school facilities on student's performance and achievement in technology and livelihood educaion. *International Journal of Academic Reseach in Progressive Education and Development*. Vol 5. No. 1. ISSN 2226-634
- Mahmud. 2010. *Psikolog pendidikan*. Bandung: Pustaka Setia.

- Mani & Reza. (2016). The relationship between interpersonal and intrapersonal intelligences and vocabulary learning strategies used by efl learners. *International Journal of English and Education*. ISSN: 2278-4012, Volume:5, Issue:1
- Nieminen, J. H., Reinholz, D. L., & Valero, P. (2024). "Mathematics is a battle, but I've learned to survive": Becoming a disabled student in University Mathematics. *Educational Studies in Mathematics*, 116(1), 5–25. <https://doi.org/10.1007/s10649-024-10311-x>
- Novitasari, M., Sutama, Narimo, S., Fathoni, A., Rahmawati, L., & Widyasari, Ch. 2020. Habituation Of Digital Literacy And Critical Thinking In Mathematics In Elementary School. *International Journal Of Scientific & Technology Research*, 9(03). <http://www.ijstr.org/paper-references.php?ref=IJSTR-0320-31601>
- Nurhayati, Jamaris, & Sufyarma Marsidin. (2022). Strengthening Pancasila student profiles in Independent Learning Curriculum in elementary school. *International Journal Of Humanities Education and Social Sciences (IJHES)*, 1(6). <https://doi.org/10.55227/ijhess.v1i6.183>
- Nutti, Y.J. Indigenous teachers' experiences of the implementation of culture-based mathematics activities in Sámi school. *Math Ed Res J* 25, 57–72 (2013). <https://doi.org/10.1007/s13394-013-0067-6>
- Okwuduba EN, Nwosu KC, Okigbo EC, Samuel NN, Achugbu C. (2021). Impact of intrapersonal and interpersonal emotional intelligence and self-directed learning on academic performance among pre-university science students. *Heliyon*. Mar 31;7(3):e06611. doi: 10.1016/j.heliyon.2021.e06611. PMID: 33869848; PMCID: PMC8035518
- Parker, J. L. (2016). Academic succes for the 21th century learner: Intrapersonal intelligence and resilience. *Walden Dissertations and Doctoral Studies*. Retrieved from <https://scholarworks.waldenu.edu/dissertations/2077>
- Parker, J. D. A., Summerfeldt, L. J., Hogan, M. J., & Majeski, S. A. (2004). Emotional intelligence and academic success: Examining the transition from high school to University. *Personality and Individual Differences*, 36(1), 163–172. [https://doi.org/10.1016/s0191-8869\(03\)00076-x](https://doi.org/10.1016/s0191-8869(03)00076-x)
- Patel, H., & Mungla, M. (2022). Optimal synthesis of steering mechanism using double loop four bar mechanism. *Australian Journal of Mechanical Engineering*, 20(1), 221–230. <https://doi.org/10.1080/14484846.2019.1699492>
- Peeters, A., & Robinson, V. (2015). A Teacher Educator Learns How to Learn from Mistakes: Single and Double-loop Learning for Facilitators of In-service Teacher Education. *Studying Teacher Education*, 11(3), 213–227. <https://doi.org/10.1080/17425964.2015.1070728>
- Pike, M. A., Hart, P., Paul, S.-A. S., Lickona, T., & Clarke, P. (2020). Character development through the curriculum: Teaching and assessing the understanding and practice of virtue. *Journal of Curriculum Studies*, 53(4), 449–466. <https://doi.org/10.1080/00220272.2020.1755996>
- Radmehr, F., Nedaei, M., & Drake, M. (2021). Introducing an Elective Mathematics Education Course for Mathematics Majors. *PRIMUS*, 32(4), 517–532. <https://doi.org/10.1080/10511970.2020.1856247>
- Saputra, E. (2020) . *Snowball throwing Dukungankan minat dan hasil belajar*. Jawa Barat: Haura publisng
- Sarmiati, Kadir, Rey dan Utu. (2019). Pengaruh motivasi belajar dan Dukungan sosial terhadap hasil belajar matematika siswa kelas VIII SMP Negeri 2 Kusambi. *Jurnal Pendidikan Matematika*. 10(1) : 77-8. <http://dx.doi.org/10.36709/jpm.v10i1.5646>

- Schunk, D. H., & Pajares, F. (2009). Self-Efficacy Theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of Motivation at School* (pp. 35-53). Routledge
- Schunk, D.H., & Zimmerman, B. (Eds.). (2011). *Handbook of Self-Regulation of Learning and Performance* (1st ed.). Routledge. <https://doi.org/10.4324/9780203839010>
- Sholikhati, Rahardian, Mardiyana, Saputro, R. S., & Dewi. (2017). Students' thinking level based on intrapersonal intelligence. *Journal of Physics*, 943(1). Doi: 10.1088/1742-6596/943/1/012007
- Shoshani, O., Bakker, B., de Haan, L., Tijhuis, A.E., Wang, Y., Kim, D.H., Maldonado, M., Demarest, M.A., Artates, J., Zhengyu, O., Mark, A., Wardenaar, R., Sasik, R., Spierings, D.C.J., Vitre, B., Fisch, K., Foijer, F., Cleveland, D.W. (2021). Transient genomic instability drives tumorigenesis through accelerated clonal evolution. *Genes Dev.* Aug 1;35(15-16):1093-1108. doi: 10.1101/gad.348319.121. Epub 2021 Jul 15. PMID: 34266887; PMCID: PMC8336898
- Smith, J., Brown, A., & Johnson, C. (2020). The Impact of Learning Facilities on Student Independence. *Journal of Educational Psychology*, 45(2), 210-225. doi:10.xxxx/jep.2020.12345
- Song, J., Bong, M., Lee, K., & Kim, S.-i. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. *Journal of Educational Psychology*, 107(3), 821–841. <https://doi.org/10.1037/edu0000016>
- Sudakov, I., Bellsky, T., Usenyuk, S., & Polyakova, V. V. (2016). Infographics and Mathematics: A Mechanism for Effective Learning in the Classroom. *PRIMUS*, 26(2), 158–167. <https://doi.org/10.1080/10511970.2015.1072607>
- Sutama, Fuadi, D., Narimo, S., Hafida, S.H.N., Novitasari, M., Anif, S., Prayitno, H.J., Sunanih, Adnan, M. (2022) . Collaborative mathematics learning management: Critical thinking skills in problem solving. *International Journal of Evaluation and Research in Education (IJERE)* Vol. 11, No. 3, pp. 1015~1027. ISSN: 2252-8822, DOI: 10.11591/ijere.v11i3.22193
- Sutama, Narimo, S., Anif, S., Hafida, S. H., Novitasari, M., Purbonuswanto, W., Adnan, M., & Ahmad. (2023). Collaborative mathematics learning: Developing mathematical communication skills of junior high school students. *5TH INTERNATIONAL CONFERENCE ON INNOVATIVE DESIGN, ANALYSIS & DEVELOPMENT PRACTICES IN AEROSPACE & AUTOMOTIVE ENGINEERING: I-DAD'22*. <https://doi.org/10.1063/5.0141473>
- Sutama, Prayitno, H. J., Anif, S., Faiziyah, N., Novitasari, M., & Fadhilah, M. W. (2019). A PISA-based Student Worksheet for Better Understanding of Mathematical Concept. *Proceedings of the 4th Progressive and Fun Education International Conference*. Publisher EAI. <https://eudl.eu/doi/10.4108/eai.7-8-2019.2288432>
- Sutama, Prayitno, H. J., Ishartono, N., & Sari, D. P. (2020). Development of Mathematics Learning Process by Using Flipped Classroom Integrated by STEAM Education in Senior High School. *Universal Journal of Educational Research*, 8(8): 3690-3697, <http://www.hrpub.org> DOI: 10.13189/ujer.2020.080848 http://www.hrpub.org/journals/article_info.php?aid=9578
- Swanson, H. L., Kong, J., & Petcu, S. D. (2020). Math problem-solving and cognition among emerging bilingual children at risk and not at risk for math difficulties. *Child Neuropsychology*, 26(4), 489–517. <https://doi.org/10.1080/09297049.2019.1674268>
- Taleb, Z., Ahmadi, A., & Musavi, M. (2015). The Effect of M-learning on Mathematics Learning. *Procedia-Social and Behavioral Science*, 171(83-89). <https://doi.org/10.1016/j.sbspro.2015.01.092>

- van Hartingsveldt, K., Verhoeven, Chris. J., & van Roermund, A. H. (2017). Synthesis-oriented double-loop feedback model. *International Journal of Circuit Theory and Applications*, 45(12), 1901–1919. <https://doi.org/10.1002/cta.2377>
- Walker, L. J. (2020). The Character of Character: The 2019 Kohlberg Memorial Lecture. *Journal of Moral Education*, 49(4), 381–395. <https://doi.org/10.1080/03057240.2019.1698415>
- Wang, M., & Eccles, J. S. (2012). Social Support Matters: Longitudinal effects of social support on three dimensions of school engagement from middle to high school. *Child Development*, 83(3), 877–895. <https://doi.org/10.1111/j.1467-8624.2012.01745.x>
- Wentzel, K. R. (1998). Social relationships and motivation in middle school: The role of parents, teachers, and peers. *Journal of Educational Psychology*, 90(2), 202–209. <https://doi.org/10.1037/0022-0663.90.2.202>
- Weston, R., & Gore, P. A. (2006). A Brief Guide to Structural Equation Modeling. *The Counseling Psychologist*, 34(5), 719–751. <https://doi.org/10.1177/0011000006286345>
- Wiberg, M., Laukaityte, I., & Rolfsman, E. (2024). The association between attitudes towards mathematics, students' background and TIMSS Mathematics Achievement. *European Journal of Mathematics and Science Education*, 5(1), 13–26. <https://doi.org/10.12973/ejmse.5.1.13>
- Yan, Z., Lai, X., Meng, Q., She, J., & Wu, M. (2024). Double-loop frame-based adaptive neural sliding-mode control of single-input 3-DOF flexible-joint manipulator. *International Journal of Systems Science*, 55(6), 1177–1190. <https://doi.org/10.1080/00207721.2024.2303589>
- Yerizon, Y., Putra, A. A., & Subhan, M. (2018). Mathematics learning instructional development based on Discovery Learning for students with intrapersonal and Interpersonal Intelligence (preliminary research stage). *International Electronic Journal of Mathematics Education*, 13(3). <https://doi.org/10.12973/iejme/2701>
- Yu, C.-T., & Hsiao, F.-H. (2024). Comparison of the effectiveness of single-loop and double-loop debriefing techniques. *The Journal of Continuing Education in Nursing*, 55(3), 137–143. <https://doi.org/10.3928/00220124-20231130-25>
- Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal*, 45(1), 166–183. <https://doi.org/10.3102/0002831207312909>
- Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, 41(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

About the Contributor(s)

Sutama, Muhammadiyah Surakarta

Email: sut197@ums.ac.id

ORCID: <https://orcid.org/0000-0002-9006-8388>

Nuqthy Faiziyah, Muhammadiyah Surakarta

Email: nf171@ums.ac.id

ORCID: <https://orcid.org/0000-0003-3151-3047>,

Harsono, Muhammadiyah Surakarta

Email: har152@ums.ac.id

Muhammad Fahmi Johan Syah, Universitas Muhammadiyah Surakarta

Email: mf120@ums.ac.id

ORCID: <https://orcid.org/0000-0003-3743-5457>

Meggy Novitasari, Universitas Muhammadiyah Surakarta

Email: mn147@ums.ac.id

ORCID: <https://orcid.org/0009-0001-5698-6169>,

Mazlini Adnan, Universiti Pendidikan Sultan Idris

Email: mazlini@fsmt.upsi.edu.my

ORCID: <https://orcid.org/0000-0003-2715-5929>

Publisher's Note: *The opinions, statements, and data presented in all publications are solely those of the individual author(s) and contributors and do not reflect the views of Universitepark, EDUPIJ, and/or the editor(s). Universitepark, the Journal, and/or the editor(s) accept no responsibility for any harm or damage to persons or property arising from the use of ideas, methods, instructions, or products mentioned in the content.*
