p-ISSN: 2086-4280
e-ISSN: 2527-8827

# Flipped Classroom Learning Model, Assisted by R&D Statistics Advanced Material Module on Learning Outcomes of viewed from Mathematical Logical Intelligence

**Joko Suharianto[1*], Thamrin[2], Andi Taufiq Umar[3], Mica Siar Meiriza[4]**

**[1*,2,3,4]Economics Department, Universitas Negeri Medan**
**Jalan W. Iskandar Psr V Medan Estate Deli Serdang Regency, Indonesia**
[1*]*djoko@unimed.ac.id*; [2]*thamrin@unimed.ac.id*; [3]*a.taufiq.u@unimed.ac.id*;
[4]*althamira@unimed.ac.id*

**Article received: 24-05-2024, revision: 18-06-2024, published: 30-07-2024**

## Abstrak

Penelitian ini melibatkan faktor internal berupa kecerdasan logis matematis, dan mengontrol pengetahuan awal mahasiswa. Penelitian ini membandingkan hasil belajar mata kuliah statistik inferensial yang menggunakan flipped classroom dengan direct instraction ditinjau dari kecerdasan logis matematis dengan mengontrol pengetahuan awal. Subjek penelitian terdiri dari dua kelas prodi Pendidikan Ekonomi Unimed semester ganjil 2023/2024. Jenis penelitian adalah quasi eksperimen dengan desain posttest only group control. Pengumpulan data menggunakan soal tes berupa pilihan berganda. Teknik analisis data menggunakan analisis kovarians. Hasil penelitian menunjukan terdapat perbedaan hasil belajar mahasiswa yang signifikan, model flipped classroom dibandikan metode direct instruction, setelah mengontrol pengetahuan awal; terdapat perbedaan hasil belajar yang signifikan mahasiswa dengan kecerdasan logis matematis tinggi dibanding yang rendah, setelah mengontrol pengetahuan awal; Model flipped classroom lebih efektif dalam meningkatkan hasil belajar, terutama bagi mahasiswa dengan kecerdasan logis-matematis rendah; kedua model pembelajaran dapat memberikan hasil yang baik bagi mahasiswa dengan kecerdasan logis-matematis tinggi.
**Kata Kunci**: Flipped Classroom; Statistik Inferensial; Kecerdasan Logis.

## Abstract

This research involves internal factors in the form of mathematical logical intelligence, and controlling students' initial knowledge. This research compares the learning outcomes of an inferential statistics course that uses a flipped classroom with direct attraction in terms of mathematical logical intelligence by controlling prior knowledge. The research subjects comprised two Unimed Economic Education study program classes for the odd semester of 2023/2024. This type of research is quasi-experimental with a posttest-only control group design. Data collection uses test questions in the form of multiple choices. The data analysis technique uses covariance analysis. The research results show that there are significant differences in student learning outcomes, in the flipped classroom model compared to the direct instruction method, after controlling for prior knowledge; there is a significant difference in learning outcomes for students with high mathematical logical intelligence compared to those with low, after controlling for prior knowledge; The flipped classroom model is more effective in improving learning outcomes, especially for students with low logical-mathematical intelligence; Both learning models can provide good results for students with high logical-mathematical intelligence.
**Keywords**: Flipped Classroom; Inferential Statistics; Logical Intelligence.

## I. INTRODUCTION

The phenomenon of difficulties in thesis completion is prevalent in the Economics Education Program at the Faculty of Economics, Universitas Negeri Medan. The most common complaints revolve around the research methodology section, particularly among students facing challenges from their academic advisors to conduct research involving advanced data processing techniques, such as two-way ANOVA and path analysis (Gliner et al., 2011). Based on observations within the program, at least 9 out of 12 students, or approximately 75%, have reported difficulties in completing their thesis, specifically in the research methodology section involving these data analysis techniques.

The ability to complete academic studies is an important indicator of a student's critical thinking skills and the academic foundation acquired during research, serving as one of the requirements for obtaining an academic degree. In the Economics program at Universitas Negeri Medan, the thesis represents an integrated thought process that combines students' creativity in identifying problems and solving them, expressed both orally and in writing, to fulfill their final project requirements. However, many students encounter significant obstacles in completing this final assignment (Ananda & Purwanto, 2021). The challenges arise from various factors. Studies conducted by the program have identified that these obstacles stem from multiple sources, including (Zain et al., 2021) The main difficulties in thesis preparation are dominated by the development of the problem background (49%) and data processing (24%). In terms of content comprehension, the most challenging factors are research methodology (21%) and the guidance process (25%). This aligns with the findings of Kocimaheni et al. (2020), who reported that thesis preparation challenges are largely dominated by difficulties in data interpretation and analysis (63%).

The connection between thesis completion and understanding of research methodology cannot be separated from internal and external factors, both of which contribute to the success of thesis preparation. Academic performance also plays an essential role in demonstrating intellectual capability (Prahmana, 2015). A person with high intelligence will find it easier to learn new things. As demonstrated by (Zain et al., 2021).

The factor contributing to students' difficulty in understanding the content of their thesis is their ability to grasp research methodology, which includes understanding the population, sample, variables, research design, operational definitions, data collection techniques, research instruments, data processing methods, data analysis, and data interpretation.

Based on the previous background, it is very urgent to carry out a series of R&D to prepare inferential advanced statistics teaching materials that are relevant to the needs of students. Furthermore, to measure the effectiveness of the product combined with other supporting factors.

This research contains novelties that distinguish it from previous research, including developing Inferential Statistics

p-ISSN: 2086-4280
e-ISSN: 2527-8827

advance materials that have been prepared in advance using R&D attacks, then integrated with learning models, prior knowledge and students' innate mathematical logical intelligence. Research with this kind of carrying capacity is very rare, especially within the faculty of economics of Medan State University.

## II. METHOD

This research is a type of quasi-experimental study with a post-test only control group design. The subjects of this study are sixth-semester students from the Economics Education program at Universitas Negeri Medan odd semester of the 2023/2024 academic years, enrolled in the Inferential Statistics course, with Class A consisting of 34 students and Class B consisting of 36 students. The integration of the experiment using the flipped classroom learning model, in terms of students' logical-mathematical abilities, is expected to explain the learning outcomes of the students (Nurlaelah et al., 2024; Tajuddin et al., 2023). However, to improve the accuracy of the experiment, this study includes a control procedure using statistical methods on variables that are considered to influence students' learning outcomes, specifically the students' prior knowledge.

The experiment was conducted to provide information on the following objectives: 1) To determine the difference in learning outcomes of inferential statistics between students applying the flipped classroom model with the assistance of an advanced statistics R&D module, compared to those using direct instruction, while controlling for prior knowledge; 2) To examine the difference in learning outcomes of inferential statistics between students with high logical-mathematical intelligence and those with low logical-mathematical intelligence, while controlling for prior knowledge; 3) To assess the difference in learning outcomes between students with high logical-mathematical intelligence taught using the flipped classroom model and those taught using direct instruction, after controlling for prior knowledge; 4) To evaluate the significant difference in learning outcomes between students with low logical-mathematical intelligence taught using the flipped classroom model and those taught using direct instruction, after controlling for prior knowledge.

The experiment was conducted over three face-to-face sessions, each lasting 3 credit hours, and took place in the Faculty's Computer Laboratory, where each student used one computer with internet access and the SPSS application. The logical-mathematical intelligence instrument consisted of 25 items with indicators including number sequences, number operations, logic, and problem-solving. This questionnaire had previously undergone instrument testing (validity and reliability) and was adapted from Thamrin's (2019) research. The prior knowledge instrument consisted of 25 multiple-choice questions, which had passed previous instrument testing and was administered to students in Class C of the Economics Education program, yielding a reliability score of 0.852 using Cronbach's alpha, which is greater than 0.6. The inferential statistics

instrument, focused on path analysis, included 20 questions that were deemed valid based on expert judgment. The inferential statistics teaching module on path analysis, developed using the R&D method, had also been validated by experts prior to its use.

The data analysis technique used in this study employed analysis of covariance (ANCOVA) by level with a 2x2 design at a 5% alpha level, as outlined in the following design:

Table 1.
Experiment Design by Level 2 x 2

| Logical-Mathematical Intelligence | Learning Strategy (A) | |
|---|---|---|
| | FC ($A_1$) | Direct ($A_2$) |
| High ($B_1$) | $A_1B_1$ | $A_2B_1$ |
| Low ($B_2$) | $A_1B_2$ | $A_2B_2$ |

The prerequisite tests for the ANCOVA analysis data are the normality test, homogeneity test, and regression linearity test (Kadir, 2015). For further testing hypothesis is done by the Scheffe test. All data processing uses SPSS version 22 tools.

## III. Result and Discussion

### A. Result

Table 2.
Statistics Descriptive of Posttest Mean Score

| Logical-Mathematical Intelligence (B) | Learning Strategy (A) | | | | n | x̄ |
|---|---|---|---|---|---|---|
| | N | FC ($A_1$) | n | DI($A_2$) | | |
| High ($B_1$) | 17 | 82.35 | 18 | 80.00 | 35 | 81,14 |
| Low ($B_2$) | 17 | 70.58 | 18 | 65.55 | 35 | 68.00 |
| x̄ | 34 | 76.47 | 36 | 72.77 | 70 | 74.57 |

Based on Table 2 above, it is known that the average value of FC class student learning outcomes is 76.47> compared to the DI class of 72.77. While the average learning outcome of students who have a high Logical-Mathematical Intelligence is 81.14> compared to a low Logical-Mathematical Intelligence of 68.

Table 3.
Summary of Normality Test Results

| No | Group | Sig. Value | Decision |
|---|---|---|---|
| 1 | A1 | 0.397 | Normal |
| 2 | A2 | 0.383 | Normal |
| 3 | B1 | 0.236 | Normal |
| 4 | B2 | 0.237 | Normal |
| 5 | A1B1 | 0.662 | Normal |
| 6 | A1B2 | 0.645 | Normal |
| 7 | A2B1 | 0.699 | Normal |
| 8 | A2B2 | 0.277 | Normal |

Based on Table 3 it can be seen that the sig. the normality test using the Kolmogorov-Smirnov test as a whole> 0.05, meaning that all variables in the study group are normally distributed.

Table 4.
Summary of Homogeneity Test Results

| No | Group | df1 | df2 | Sig. Value | Decision |
|---|---|---|---|---|---|
| 1 | Between A | 1 | 68 | 0.437 | Homogeneous |
| 2 | Between B | 1 | 68 | 0.079 | Homogeneous |
| 3 | combined | 3 | 66 | 0.745 | Homogeneous |

Based on Table 4 it can be seen that the sig. value of the homogeneity test between A, between B, and the Combined (A1B1, A1B2, A2B1, A2B2) are all greater than 0.05, meaning that all groups are still in the homogeneous category.

Table 5.
Summary of Linearity Test Results

| Data | F | Sig. Value | Decision |
|---|---|---|---|
| *Deviation from* | 1.245 | 0.441 | linear |

p-ISSN: 2086-4280
e-ISSN: 2527-8827

| Data | F | Sig. Value | Decision |
|---|---|---|---|
| *Linearity* | | | |

Based on Table 5 it can be seen that the sig. value of deviation from the linearity test between initial knowledge variables and learning outcomes of 0.441>0.05, meaning that the relationship between the two variables is linear.

Table 6.
Hypothesis Test (ANCOVA) Tests of Between-Subjects Effects
Dependent Variable: Learning Outcomes

| Source | Type III Sum of Squares | Df | MeanSquare | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 3288.003a | 4 | 822,001 | 18,706 | .000 |
| Intercepts | 5876818 | 1 | 5876818 | 133,738 | .000 |
| PA | 171,496 | 1 | 171,496 | 3,903 | 052 |
| Class | 217,992 | 1 | 217,992 | 4,961 | .029 |
| Group | 1065786 | 1 | 1065786 | 24,254 | .000 |
| Class * Group | 4,599 | 1 | 4,599 | .105 | .747 |
| Error | 2856282 | 65 | 43,943 | | |
| Total | 396900,000 | 70 | | | |
| Corrected Total | 6144286 | 69 | | | |
| a. R Squared = .535 (Adjusted R Squared = .507). | | | | | |

Based on Table 6 above, it is concluded that:

a) There is a significant difference in learning outcomes between classes using the FC learning model compared to DI after controlling for initial knowledge with a Sig acquisition of 0.029<0.05, then Ho is rejected.
b) There is a significant difference in learning outcomes between students who have high logical-mathematical intelligence compared to student learning outcomes with low logical-mathematical intelligence after controlling for prior knowledge with a Sig acquisition of 0.000<0.05, then Ho is rejected.

Table 7.
Summary of ANCOVA
Advanced Test with Scheffe Test

| No | Group | df1 | df2 | $F_{count}$ | $F_{table}$ | Decision |
|---|---|---|---|---|---|---|
| 1 | A1B1:A2B1 | 1 | 32 | 3,44 | 4,15 | Ho was accepted |
| 2 | A1B2:A2B2 | 1 | 32 | 6,22 | 4,15 | Ho was rejected |

Based on Table 7 above, it is concluded that:

a) There is no significant difference in learning outcomes between students who have high logical-mathematical intelligence who are taught using the flipped classroom model compared to the learning outcomes of students who are taught using direct instruction after controlling prior knowledge with a $F_{count}$ of 3.44 < $F_{table}$ of 4.15, then Ho is accepted.
b) There is a significant difference in learning outcomes between students

who have low logical-mathematical intelligence who are taught using the flipped classroom model compared to the learning outcomes of students who are taught using direct instruction after controlling prior knowledge with a $F_{count}$ of 3.44 < $F_{table}$ of 4.15, then Ho is rejected.

## B. Discussion

1) Results of Difference Analysis in Learning Outcomes Between The Flipped Classroom Model (A1) and Direct Instruction Model (A2).

There is a significant difference in learning outcomes between the class using the flipped classroom model and the class using the direct instruction model after controlling for prior knowledge, with a Sig value of 0.029 < 0.05, thus supporting the proposed hypothesis.

This is consistent with the findings of previous research (Ario & Asra, 2018) concluding that there is a significant difference in learning outcomes between students using the flipped classroom model and those receiving direct instruction. (Ziana Walidah et al., 2020) concluding that the flipped classroom model is able to significantly improve students' learning outcomes. In addition (Ruiz Palmero et al., 2023) which states that the flipped classroom model has a significant impact on learning outcomes.

Several reasons for the improved learning outcomes with the flipped classroom model include the extended time it provides students to understand the material, along with the pre-class provision of videos or instructional materials, case studies, and comprehensive learning instructions (Fung et al., 2021). Through this approach, students can review the material repeatedly at home and have ample time to discuss it with their peers (Fung et al., 2021). This ample time allows students to optimize their learning according to their individual learning styles (Lo et al., 2017). This further reinforces the findings of the research (Cevikbas & Kaiser, 2020) which states that students taught using the flipped learning model experience innovative learning that enhances their learning outcomes. (Güler et al., 2023; Wei et al., 2020).

In relation to the design of this research in the course of inferential statistics, both treatment groups were provided with the same instructional material, an R&D module on path analysis, which had been validated by experts. This module outlines, step by step, the data analysis process, complete with examples and case solutions using data processing application tools. It is hoped that this R&D module will enhance students' learning autonomy, enabling them to independently study and practice data analysis using application tools. In fact, not all students are equipped with learning facilities such as laptops. Therefore, in alignment with the course requirements that involve both theory and practice, the experiment was conducted in a computer lab, ensuring that each student had access to the same learning resources.

The differences in students' learning outcomes in this experiment were more precise and accurate for several reasons: first, both treatment groups were provided with the same R&D module; second, both groups were taught in a computer lab; and third, to enhance the accuracy of the

p-ISSN: 2086-4280
e-ISSN: 2527-8827

experiment, the students' prior knowledge was controlled.

2) Results of Difference Analysis in Learning Outcomes Between Students with High Logical-Mathematical Intelligence (B1) and Those with Low Logical-Mathematical Intelligence (B2)

There is a significant difference in learning outcomes between students with high logical-mathematical intelligence and those with low logical-mathematical intelligence, after controlling for prior knowledge, with a Sig value of 0.000 < 0.05. Therefore, the hypothesis is accepted.

This is in line with previous research findings, (Mayu & Widjajanti, 2022) It was found that multiple intelligences have a significant impact on learning outcomes. One of these is logical-mathematical intelligence. Furthermore, this is reinforced by research findings (Herawati et al., 2021) It can be concluded that there is a significant difference in learning outcomes between students with high logical-mathematical intelligence and those with low logical-mathematical intelligence. Furthermore, (Rahmawati & Ibrahim, 2021) It is stated that logical-mathematical intelligence has a positive and significant impact on students' learning outcomes.

The results of this study align with the opinion (Scherer, 2022) It is explained that logical-mathematical intelligence is most likely the most robust among all types of intelligence. This intelligence is related to scientific abilities and is often described as critical thinking. Logical-mathematical intelligence is supported by Piaget's stages of cognitive development and has shown a strong connection with other aspects of daily life (Babakr et al., 2019). Furthermore, (Wanabuliandari et al., 2024) It is stated that an individual with high logical-mathematical intelligence will enjoy working with data, collecting and organizing it, analyzing and interpreting, drawing conclusions and making predictions, recognizing and examining patterns and connections between data, solving mathematical problems, and tends to use various graphs.

Based on the above opinion, logical-mathematical intelligence plays an important role for individuals both in learning and in daily life. Moreover, in this experiment, the material provided is closely related to mathematical, systematic, and logical elements, which is particularly relevant for students with high logical-mathematical intelligence. Therefore, students with high logical-mathematical intelligence achieve significantly higher learning outcomes compared to students with low logical-mathematical intelligence.

3) Results of Difference Analysis in Learning Outcomes Between High Logical-Mathematical Intelligence in The Flipped Classroom Model (A1B1) and Direct Instruction (A2B1)

There is no significant difference in the learning outcomes of students with high logical-mathematical intelligence taught using the flipped classroom model compared to those taught using direct instruction after controlling for prior knowledge, with the calculated F-value of 3.44 < the F-critical value of 4.15. Therefore, the proposed hypothesis is rejected.

There are several logical reasons why the hypothesis is rejected. First, both groups possess high logical-mathematical intelligence; second, both groups were provided with the same R&D module on the same material; and third, both groups received the same learning facilities, including computers with internet access and the same data processing application tools.

This is in line with the opinion of (Nunes et al., 2007) It is explained that intelligence plays a significant role in learning progress, one of which is logical-mathematical intelligence. Based on this statement, it can be reinforced that students with high logical-mathematical intelligence, when they study seriously and are willing to be taught using any learning model, will still show better learning progress compared to students with low logical-mathematical intelligence.

The flipped classroom in instructions are designed so that the material is studied at home, whereas in the direct instruction class, this is not the case. However, because students with high logical-mathematical intelligence possess strong reasoning and logical thinking abilities, and the classroom sessions are supported with R&D teaching modules and computer learning facilities for each student, any gaps in knowledge for students with high logical-mathematical intelligence in the direct instruction class can still be compensated for. As a result, there is no significant difference in the learning outcomes between the students in the flipped classroom and those in the direct instruction class.

This indicates that the role of teaching media, learning facilities, and teaching strategies relevant to the course content also influences students' learning outcomes. This is in line with the opinion (Nurhikmayati & Jatisunda, 2019) It explains that in the effort to educate students, the presentation of learning materials with specific teaching strategies is crucial. Therefore, if a course involves both theory and practice, such as inferential statistics, which requires computer facilities and supporting applications, it is recommended to be taught in a computer laboratory.

4) Results of Difference Analysis in Learning Outcomes Between Low Mathematical-Logical Intelligence Students in The Flipped Classroom Model (A1B2) and Direct Instruction (A2B2)

There is a significant difference in learning outcomes between students with high mathematical-logical intelligence and those with low mathematical-logical intelligence after controlling for prior knowledge, with an F-calculated value of 3.44 < F-table value of 4.15. Therefore, the proposed hypothesis is accepted.

The learning outcomes of students with low mathematical-logical intelligence taught using the flipped classroom model were significantly higher compared to the direct instruction class after controlling for prior knowledge. This contradicts the opinion of (Zhang et al., 2021) It is explained that direct instruction is very useful and highly effective when applied to students with lower intelligence. Direct instruction encompasses approaches that

p-ISSN: 2086-4280
e-ISSN: 2527-8827

are highly structured, almost scripted, to more flexible implementations.

Several logical reasons for this contradiction include the flipped classroom learning process, which provides students with more time to understand the course material outside of class. For students with lower mathematical-logical intelligence, this situation offers them additional time. Thus, they can study the learning instructions from the beginning, and if there are still aspects they do not understand, they can discuss them with their classmates. This form of discussion reflects peer learning interactions. The knowledge gained outside the classroom, combined with the learning experience inside the classroom with supportive learning facilities, ultimately leads to better learning outcomes, even for students with lower mathematical-logical intelligence, compared to their performance in a direct instruction class.

## IV. CONCLUSION

This study shows that the flipped classroom model, supported by an R&D module for advanced statistical material, has a significant impact on students' learning outcomes in inferential statistics, especially when compared to the direct instruction method, after controlling for prior knowledge. The flipped classroom allows students to learn independently first, with time allocated for a deeper understanding of the material, which is then applied in more interactive classroom activities. Logical-mathematical intelligence also proves to play an important role in learning outcomes. Students with high logical-mathematical intelligence show better results, although no significant difference was found between those taught with flipped classroom and direct instruction. On the other hand, students with low logical-mathematical intelligence achieved better learning outcomes when using flipped classroom compared to direct instruction. These findings emphasize that flipped classroom is more effective in supporting student learning and can improve inferential statistics learning outcomes, especially for students with low logical-mathematical intelligence, while students with high logical-mathematical intelligence show optimal results with both learning models.

The suggestion of this research is in the form of exploring more relevant results, the hope is that learning outcome tests, early knowledge tests and especially mathematical logical intelligence tests can be done with essay questions. Of course, this will greatly minimize the answers of students who originally answered. In addition, it is recommended for students with low mathematical logical intelligence to use the flipped classroom model, so that when entering the classroom each student has the initial knowledge that he has learned outside the classroom.

The contribution of this research is an input on learning innovation, especially research products that can be applied in learning at the Unimed Faculty of Economics. The findings of this research can be developed and have the potential to improve the quality of learning and student learning outcomes that can be applied in other study programs.

## ACKNOWLEDGEMENT

The author would like to thank the Institute for Research and Community Service, State University of Medan for funding this research. This research is applied product research for the 2023 budget year. Thanks to the research team and students of the economic education study program, FE UNIMED.

## REFERENCES

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, *126*, 334–345. https://doi.org/10.1016/j.compedu.2018.07.021

Ananda, E. D., & Purwanto, W. (2021). Kendala Penyelesaian Tugas Akhir. *AEEJ: Journal of Automotive Engineering and Vocational Education*, *2*(2), 61–72. https://doi.org/10.24036/aeej.v2i2.49

Ario, M., & Asra, A. (2018). Pengaruh Pembelajaran Flipped Classroom terhadap Hasil Belajar Kalkulus Integral Mahasiswa Pendidikan Matematika. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, *1*(2), 82–88. https://doi.org/10.24176/anargya.v1i2.2477

Babakr, Z. H., Mohamedamin, P., & Kakamad, K. (2019). Piaget's Cognitive Developmental Theory: Critical Review. *Education Quarterly Reviews*, *2*(3), 517–524. https://doi.org/10.31014/aior.1993.02.03.84

Cevikbas, M., & Kaiser, G. (2020). Flipped classroom as a reform-oriented approach to teaching mathematics. *ZDM*, *52*(7), 1291–1305. https://doi.org/10.1007/s11858-020-01191-5

Fung, C.-H., Besser, M., & Poon, K.-K. (2021). Systematic Literature Review of Flipped Classroom in Mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(6), em1974. https://doi.org/10.29333/ejmste/10900

Gliner, J. A., Morgan, G. A., & Leech, N. L. (2011). Quantitative Research Approaches, Questions, and Designs. In *Research Methods in Applied Settings* (2nd ed., p. 2). Routledge. https://doi.org/10.4324/9780203843109

Güler, M., Kokoç, M., & Önder Bütüner, S. (2023). Does a flipped classroom model work in mathematics education? A meta-analysis. *Education and Information Technologies*, *28*(1), 57–79. https://doi.org/10.1007/s10639-022-11143-z

Herawati, A., Astra, I. M., & Supriyati, Y. (2021). The effect of inquiry learning model and logical mathematical intelligence on the learning outcomes of high school students. *Journal of Physics: Conference Series*, *1816*(1), 012010. https://doi.org/10.1088/1742-6596/1816/1/012010

Lo, C. K., Hew, K. F., & Chen, G. (2017). Toward a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education. *Educational Research Review*, *22*, 50–73. https://doi.org/10.1016/j.edurev.2017.08.002

Mayu, T. U., & Widjajanti, D. B. (2022). The impact of multiple intelligences on students' mathematics learning outcomes: A review. *Proceedings Of The 4th International Seminar On Innovation In Mathematics And Mathematics Education (ISIMMED) 2020: Rethinking the Role of Statistics,*

*Mathematics and Mathematics Education in Society 5.0: Theory, Research, and Practice*, 080024. https://doi.org/10.1063/5.0109002

Nunes, T., Bryant, P., Evans, D., Bell, D., Gardner, S., Gardner, A., & Carraher, J. (2007). The contribution of logical reasoning to the learning of mathematics in primary school. *British Journal of Developmental Psychology*, *25*(1), 147–166. https://doi.org/10.1348/026151006X153127

Nurhikmayati, I., & Jatisunda, M. G. (2019). Pengembangan Bahan Ajar Matematika Berbasis Scientific yang Berorientasi pada Kemampuan Berpikir Kritis Matematis Siswa. *Mosharafa: Jurnal Pendidikan Matematika*, *8*(1), 49–60. https://doi.org/10.31980/mosharafa.v8i1.534

Nurlaelah, E., Usdiyana, D., & Fadilah, N. (2024). The Relationship Between Computational Thinking Ability and Logical Mathematical Intelligence. *Mosharafa: Jurnal Pendidikan Matematika*, *13*(1), 87–96. https://doi.org/10.31980/mosharafa.v13i1.1978

Prahmana, R. C. I. (2015). Hubungan Antara Keterampilan Meneliti Dan Pembuatan Skripsi Mahasiswa Pendidikan Matematika. *Numeracy*, *2*(2 SE-Articles), 55–62. https://doi.org/10.46244/numeracy.v2i2.168

Priyaadharshini, M., & Sundaram, B. V. (2018). Evaluation of higher-order thinking skills using learning style in an undergraduate engineering in flipped classroom. *Computer Applications in Engineering Education*, *26*(6), 2237–2254. https://doi.org/10.1002/cae.22035

Rahmawati, L., & Ibrahim. (2021). Kecerdasan Logis Matematis dan Linguistik sebagai Prediktor Hasil Belajar Matematika. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(2), 245–256. https://doi.org/10.31980/mosharafa.v10i2.658

Ruiz Palmero, J., Guillén Gámez, F. D., Colomo Magaña, E., & Sánchez Vega, E. (2023). Effectiveness of the Flipped Classroom in the Teaching of Mathematics in an Online Environment: Identification of Factors Affecting the Learning Process. *Online Learning*, *27*(2), 304–323. https://doi.org/10.24059/olj.v27i2.3239

Scherer, V. E. R. (2022). Supplemental Material for The Relation Between Executive Functions and Math Intelligence in Preschool Children: A Systematic Review and Meta-Analysis. *Psychological Bulletin*, *148*(5–6), 337–369. https://doi.org/10.1037/bul0000369.supp

Tajuddin, A. T., Sujadi, I., Slamet, I., & Hendriyanto, A. (2023). Mathematical Critical Thinking: Analysis of Middle School Students' Thinking Processes in Solving Trigonometry Problems. *Mosharafa: Jurnal Pendidikan Matematika*, *12*(4), 703–720. https://doi.org/10.31980/mosharafa.v12i4.1185

Walidah, Z., Wijayanti, R., & Affaf, M. (2020). The Effect of Learning Model Flipped Classroom (FC) on Learning Outcomes. *Edumatica: Jurnal Pendidikan Matematika*, *10*(2 SE-), 71–77. https://doi.org/10.22437/edumatica.v10i2.10546

Wanabuliandari, S., Ulya, F. F., Sumaji, S., Ardianti, S. D., & Ghozali, M. I. (2024).

Pengaruh Model Pembelajaran Matematika Realistik Berbantuan Modul Digital Interaktif Berbasis Keunggulan Lokal PANTURA JATENG Terhadap Kecerdasan Logis Matematis Siswa Mental Retardation. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *4*(1). https://doi.org/10.51574/kognitif.v4i1.1380

Wei, X., Cheng, I.-L., Chen, N.-S., Yang, X., Liu, Y., Dong, Y., Zhai, X., & Kinshuk. (2020). Effect of the flipped classroom on the mathematics performance of middle school students. *Educational Technology Research and Development*, *68*(3), 1461–1484. https://doi.org/10.1007/s11423-020-09752-x

Zain, M. I., Radiusman, R., Syazali, M., Hasnawati, H., & Amrullah, L. W. Z. (2021). Identifikasi Kesulitan Mahasiswa Dalam Penyusunan Skripsi Prodi Pgsd Universitas Mataram. *Tunjuk Ajar: Jurnal Penelitian Ilmu Pendidikan*, *4*(1), 73. https://doi.org/10.31258/jta.v4i1.73-85

Zhang, Q., Cheung, E. S. T., & Cheung, C. S. T. (2021). The Impact of Flipped Classroom on College Students' Academic Performance: A Meta-Analysis Based on 20 Experimental Studies. *Science Insights Education Frontiers*, *8*(2), 1059–1080. https://doi.org/10.15354/sief.21.re019

## AUTHOR'S BIOGRAPHY

**Joko Suharianto, S.Pd., M.Si.**

Born in Binjai, February 4, 1986. Lecturer at Medan State University. Bachelor's degree in Economic Education, Medan State University, North Sumatra, graduated in 2008; Master's degree in Economics, Medan State University, North Sumatra, graduated in 2012.

**Prof. Dr. Thamrin, M.Si.**

Born in Sei Kepayang on July 19, 1964. He is a teaching staff and a professor in the field of Educational Technology Science at the State University of Medan.

**Andi Taufiq Umar, M.Pd.**

Born in Malili, January 16, 1994. Lecturer at Medan State University. Bachelor of Education study, Makassar State University, graduated in 2015; Master of Education Research and Evaluation, Jakarta State University, graduated in 2018.

**Dr. Mica Siar Meiriza., M.Si.**

Born in Klambir Lima, May 16, 1978. Lecturer at Medan State University. Bachelor of English Studies STBA Harapan Medan, North Sumatra, Master of Development Economics, University of North Sumatra, North Sumatra, Doctorate of Economic Education, Malang State University.