Journal for Research in MATHEMATICS LEARNING

Juring (Journal for Research in Mathematics Learning)
p-ISSN: 2621-7430 | e-ISSN: 2621-7422
Volume 8, Issue 4, December 2025, 343 – 354
DOI: http://dx.doi.org/10.24014/juring.v8i4.38732

Exploration of Field Independent Students' Mathematical Problem-Solving Ability in Ordinary Differential Equations Learning

Rezi Ariawan[1]*, Suhandri[2], and Norazman[3]

[1]*Program Studi Pendidikan Matematika, Universitas Islam Riau, Pekanbaru, Indonesia*
[2]*Program Studi Pendidikan Matematika, Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, Indonesia*
[3]*Department of Mathematics, Universiti Pendidikan Sultan Idris, Malaysia*
E-mail: reziariawan@edu.uir.ac.id

ABSTRACT. This study aims to analyze and describe students' mathematical problem-solving abilities in an ordinary differential equations course, using cognitive styles as a framework. This study is qualitative and uses a case study approach. The subjects were students of the Mathematics Education study program at the Faculty of Teacher Training and Education, Riau Islamic University. The selection of research subjects for in-depth interviews was conducted using purposive sampling. The instruments used were mathematical problem-solving ability tests, GEFT tests, and interview sheets that had met the eligibility criteria. The data analysis techniques used were data reduction, data presentation, and conclusion drawing. The results showed that field independent subjects had a strong foundation in solving ordinary differential equations problems, especially in the initial analysis and application of procedures. However, weaknesses remained in evaluating data adequacy and in strategic reflection. Hence, the subjects were not fully able to adjust the length and depth of the solution to the demands of the problem.

Keywords: field independent; mathematical problem solving ability; ordinary differenial equations

ABSTRAK. Penelitian ini bertujuan untuk menganalisis dan mendeskripsikan kemampuan pemecahan masalah matematika mahasiswa dalam menyelesaikan masalah persamaan diferensial biasa berdasarkan gaya kognitif. Penelitian ini merupakan penelitian kualitatif dengan pendekatan studi kasus. Subjek penelitian adalah mahasiswa program studi pendidikan matematika Universitas Islam FKIP Riau. Penentuan subjek untuk wawancara mendalam dilakukan dengan teknik *purposive sampling*. Instrumen yang digunakan adalah soal tes kemampuan pemecahan masalah matematika, tes GEFT, dan lembar wawancara yang telah memenuhi kriteria kelayakan. Teknik analisis data yang digunakan adalah reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan subjek dengan gaya kognitif Independen memiliki dasar yang kuat dalam menyelesaikan masalah persamaan diferensial biasa, terutama pada analisis awal dan penerapan prosedur. Namun, kelemahan masih terlihat pada evaluasi kecukupan data dan refleksi strategis, yang mengakibatkan subjek tidak sepenuhnya mampu menyesuaikan panjang dan kedalaman solusi dengan tuntutan masalah.

Kata kunci: *field independent;* kemampuan pemecahan masalah matematis; persamaan differensial biasa

INTRODUCTION

The purpose of studying Ordinary Differential Equations (ODEs) is to solve real-world problems (Johnson, Almuna, & Silva, 2022). Ordinary differential equations are among the courses offered in the mathematics education study program (Cipta & Dahlan, 2021; Isnawati & Oktaviani, 2022; Ningsih & Jayanti, 2016; Sulistyorini, 2017). Ningsih & Rohana (2018) stated that differential equations are one of the mathematical materials in higher education that play an important role. In the mathematics education study program at Riau Islamic University, the ordinary differential equations course is a compulsory course for students. Learning differential equations can train students' higher-order thinking skills (Arfinanti, 2020) and make an important contribution to the Development of calculus knowledge (Makamure & Jojo, 2022). In reality, students have difficulty in learning ordinary differential equations (Ariawan & Zetriuslita, 2021; Cipta & Dahlan, 2021; Haswati & Nopitasari, 2019; Hyland, van Kampen, & Nolan, 2023; Mayasari, 2017; Murtafiah, 2017; Ningsih & Rohana, 2018). Various studies on ordinary differential equations courses have been carried out, ranging from analyzing difficulties, using specific learning models or methods, analyzing abilities, developing teaching materials, and learning using certain media or software (Haswati & Nopitasari, 2019; Marliani, 2015; Mayasari, 2017; Ningsih & Rohana, 2018; Sulistyorini, 2017). Based on previous research, there are still very few studies analyzing mathematical abilities in terms of cognitive styles in differential equations courses. Therefore, researchers intend to research the exploration of students' mathematical problem-solving ability in solving ordinary differential equation problems based on cognitive style

In learning ordinary differential equations, mathematical problem-solving skills are needed. Mathematical problem-solving ability is one of the cognitive abilities that is very important and must be possessed by students (Kartono, Muttaqi, & Dwidayati, 2020; Maliya, Isnarto, & Sukestiyarno, 2019; Purnomo, Sukestiyarno, Junaedi, & Agoestanto, 2022a; Rejeki, Riyadi, & Siswanto, 2021; Zaenuri, Medyasari, & Dewi, 2021). Mathematical problem-solving skills are a significant part of the learning objectives of mathematics that must be achieved (Dorimana, Uworwabayeho, & Nizeyimana, 2022; Fitriani, Herman, & Fatimah, 2023; Hafidzah, Azis, & Irvan, 2021; Marchy, Murni, Kartini, & Muhammad, 2022; Purnomo, Sukestiyarno, Junaedi, & Agoestanto, 2022b; Sudarsono, Kartono, Mulyono, & Mariani, 2022; Surya & Syahputra, 2017; Yatim, Saleh, Zulnaidi, & Yatim, 2022).

Some indicators of problem solving ability are as follows: (1) identify the elements known, asked, and the sufficiency of the required elements; (2) formulate mathematical problems or create mathematical models; (3) apply strategies to solve problems (and new types of problems) within or outside of mathematics; (4) explain or interpret results in accordance with the original problem; (5) use mathematics in a significant way (Hendriana, Rohaeti, & Sumarmo, 2023). In this study, students' mathematical problem-solving skills are measured by presenting problems in ordinary differential equations that require identifying known elements, asking questions, assessing the adequacy of the required elements, selecting and applying strategies to solve mathematical problems, and explaining and interpreting results.

Mathematical problem-solving ability between individuals is undoubtedly different. One of these differences can be caused by habits of mind or called cognitive style (Faradillah, 2018; H. Ulya, Kartono, & Retnoningsih, 2014; Himmatul Ulya, 2015). Cognitive style can be interpreted as a person's way of preparing, capturing, and processing stimuli or information, and of remembering, thinking, solving problems, responding to tasks, and handling various types of situations, carried out consistently (Purnomo et al., 2022b; Purnomo, Sukestiyarno, Junaedi, & Agoestanto, 2022c). A person's cognitive style describes the differences individuals have in attention, information reception, memory, and thinking (Ariawan & Zetriuslita, 2021; Giancola, D'Amico, & Palmiero, 2023; Nufus & Ariawan, 2019; Zetriuslita & Ariawan, 2021).

Cognitive style consists of field-dependent or field-independent developed by Witkin and friends (Evendi et al., 2022; Kusumaningsih, Saputra, & Aini, 2019). Idris stated that there are three types of cognitive styles, namely field dependent, field intermediate, and field independent (Ulya, 2015). Good and Brophy stated that people with a cognitive style of field dependence have difficulty distinguishing stimuli because their surroundings easily influence them. In contrast, people with the cognitive style field independent are more analytic and can separate the stimulus from its surroundings, so they are less affected by it (Mulbar, Rahman, & Ahmar, 2017; Sutama et al., 2021). Some previous research studies indicate a link between cognitive style and a person's mathematical abilities (Astuti & Wardono, 2022; Hooda & Devi, 2018; Ramlah, 2014; Son, Darhim, & Fatimah, 2020).

Based on the above background, this study is entitled "Exploration of Students' Mathematical Problem-Solving Ability in Ordinary Differential Equations Course Based on Cognitive Style". This research aims to find out: 1. What are the criteria for students' mathematical problem-solving abilities in ordinary differential equations courses; 2. What are the criteria for students' mathematical problem-solving abilities with field dependent and field independent cognitive styles in ordinary differential equations courses 3? How is the mathematical problem-solving ability of students with a field dependent cognitive style in ordinary differential equations courses 4? How is the mathematical problem-solving ability of students with a field dependent cognitive style in ordinary differential equations courses 5? How is the mathematical problem-solving ability of students with field independent cognitive style in ordinary differential equations courses.

METHOD

This study uses a qualitative case study to analyze students' mathematical problem-solving abilities in a differential equations course, with a focus on cognitive styles. This qualitative research aims to examine the conditions of natural objects; it does not involve any actions or experiments, and it examines not only what is visible but also what lies beneath (Sugiyono, 2020; Sukestiyarno, 2021; Sukmadinata, 2017).

The research subjects were all fourth-semester students in the Mathematics Education study program at the Islamic University of Riau, Faculty of Teacher Training and Education, Riau, in the 2023/2024 academic year. Then, using a purposive sampling technique, three independent subjects were selected for an interview. The data collection instruments consisted of a mathematics problem-solving ability test sheet, two essay questions with validity and reliability values of 0.77 and 0.76, a GEFT test sheet with validity and reliability values of 0.84, and an interview sheet. Data analysis techniques consisted of data reduction, data presentation, and conclusion drawing.

RESULTS AND DISCUSSION

In the initial stage, the researchers first reduced the data by analyzing the results of the students' mathematical problem-solving ability test in differential equations and the GEFT scores of 39 subjects. This data aims to determine whether the overall criteria for mathematical problem-solving ability in the differential equations course align with students' criteria. Overall, for the subjects taking the differential equations course, which cognitive style is dominant? The following Table presents the results of the mathematical problem-solving ability test.

Table 1. Data on Students' Mathematical Problem Solving Ability

Indicator of Mathematical Problem-Solving Ability	Average Score obtained	Criteria
Identifying the adequacy of data for problem solving	73,05	Good
Select and apply strategies to solve math problems	78,25	Good
Average Score	75,65	Good

Source: Researcher Processed Data

Based on Table 1, students' overall mathematical problem-solving skills are in the good category. Of the three indicators of mathematical problem-solving ability used, only one meets the criteria. Furthermore, to determine the type of cognitive style of the research subjects, note the information presented in the Table below.

Table 2. Cognitive Style Analysis Result Data of Subjects

Cognitive Style Type	Number of Subjects	Percentase (%)	Average Mathematical Problem-Solving Ability Score	Mathematical Problem-Solving Ability Criteria
Field Dependent	29	74,36	65,94	Good enough
Field Independent	10	25,64	88,75	Very Good
Total Number of Subjects	39	100		

Source: Researcher Processed Data

Based on the data presented in Table 2, the field-dependent cognitive style is the dominant one. Furthermore, after collecting information on students' cognitive styles and mathematical problem-solving abilities, a purposive sampling technique was used to select subjects who represented the field independent cognitive style. Subject selection was based on their ability to express their opinions and their clear and legible writing verbally. Three subjects were selected for interviews. The results of the interviews with the field independent cognitive style subjects are presented below.

Indicator 1: Identify the Sufficiency of Data for Problem Solving

Question

It is stated that the process below shows the differential equation $(3x + 2y)dy + (2x + y)dx = 0$ is an exact differential equation.

$$M(x, y) = (3x + 2y) \Rightarrow \frac{\partial M\ (x,y)}{\partial y} = 2$$

$$N(x, y) = (2x + y) \Rightarrow \frac{\partial N\ (x,y)}{\partial x} = 2$$

Show that the equation is an exact differential equation!

Determine whether the above process is sufficient to determine that the differential equation is exact? Explain!

Questions that require identifying data sufficiency for problem solving require subjects to recognize relevant information from the problem, determine the mathematical conditions needed to solve the problem, and evaluate whether the available information is sufficient to draw the requested conclusion, without performing any further, unrequested procedures. The following is an excerpt of the subjects' answers to these questions.

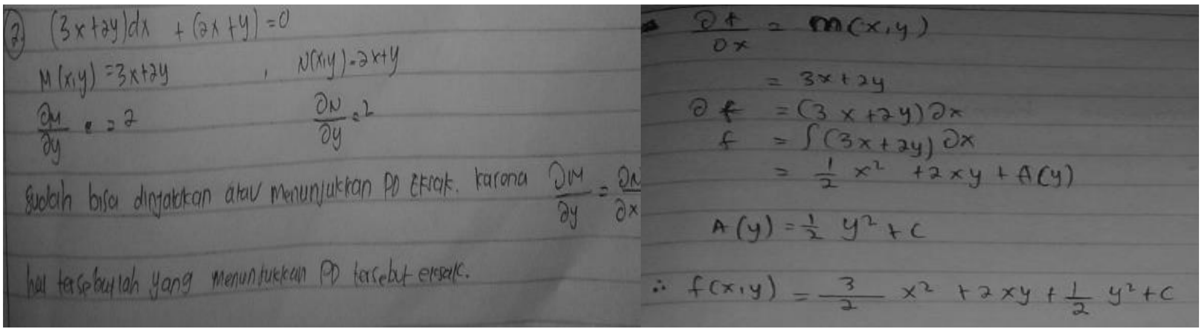

Figure 1. Excerpt of Subject's Answer for Question 1

Based on the excerpt of the subject's answer, the subject has been able to identify essential information from the given differential equation. The subject explicitly wrote $M(x, y) = 3x + 2y$ dan $N(x, y) = 2x + y$). Cognitively, the subject has been able to recognize the relevant data from the problem. Furthermore, based on the excerpt of the subject's answer, it can be seen that the subject calculated $\frac{\partial M}{\partial y} = 2$ dan $\frac{\partial N}{\partial x} = 2$. This answer indicates that the subject has stated that equality of the two partial derivatives implies an exact differential equation. Furthermore, the subject has identified the minimum conditions needed to answer the question. Next, in the excerpt of the subject's answer, it can be seen that the subject continues to find the potential function $f(x, y)$ through the integration $f_x = 3x + 2y \rightarrow f = \frac{3}{2}x^2 + 2xy + g(y)$. This step is not requested in the problem. This answer indicates that the subject does not fully understand the limits of data sufficiency; the subject assumes that the proof of unity must continue until a general solution is obtained, even though, conceptually, this is not necessary. Based on the excerpt from the subject's answer, the subject's problem-solving ability in the indicator of identifying data sufficiency for problem-solving has developed procedurally. Still, it needs strengthening in its critical evaluation of data sufficiency.

To strengthen the analysis of the subjects' answers, in-depth interviews were conducted with the subjects. The following is an excerpt from the researcher's interview with the field-dependent subjects regarding the solutions given to the problem-solving ability questions, with indicators identifying the adequacy of data for problem-solving.

R : *In your opinion, in the given problem, what data is needed to ensure that the differential equation is exact?*

FI-1 : *What is needed are the functions M and N of the equation, then calculate their partial derivatives. If they are equal, then it can be said to be exact. However, we should continue to find the function* $f(x, y)$ *that shows the differential equation is exact.*

FI-2 : *What is important are* $M(x, y)$ *and N* (x, y)*, then check* $\frac{\partial M}{\partial y}$ *dan* $\frac{\partial N}{\partial x}$ *. If the results are equal, then the differential equation is exact, but usually, we proceed directly to find the derivatives*

FI-3 : *The data are just M and N. However, the data is not truly complete until we know the form of the final function.*

R : *Do you think that simply comparing* $\frac{\partial M}{\partial y}$ *and* $\frac{\partial N}{\partial x}$ *is enough to answer the question? Explain why!*

FI-1 : *In theory, yes, but I am not sure if it is enough to stop there.*

FI-2 : *Actually, it is enough to answer the question, but I usually continue by solving it by following the example questions in class.*

FI-3 : *I am still unsure, so to be safe, I will solve it.*

The interview excerpt above shows that the subject identified relevant data. However, the subject still appeared uncertain about whether to continue the resolution process to determine unity. The researcher triangulated the data based on the results of the written test and interviews, as shown in the following Table 3.

Table 3. Triangulation Results of Written Test Data and Interview Data

Aspects	Written Test Findings	Interview Findings	Triangulation Results
Identify relevant data	The three FD subjects explicitly wrote down the functions $M(x, y)$ and N (x, y) and calculated $\frac{\partial M}{\partial y}$ and $\frac{\partial N}{\partial x}$. This indicates that the subjects were procedurally able to recognize relevant data to determine the exactness.	All subjects stated that the primary data needed were *M* and *N*, as well as a comparison of partial derivatives.	The subject did not experience any difficulties during data identification.
Determine the mathematical conditions needed to solve the problem	The subject successfully demonstrated that the equality $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$, which is mathematically sufficient to express an exact differential equation. However, the subject	The subject stated that knowing the similarity of partial derivatives is a requirement for exactness, but does	The subject knows the minimum requirements for demonstrating exactness, but does not use them

Aspects	Written Test Findings	Interview Findings	Triangulation Results
	continued the process to find a potential function that was not requested in the problem.	not feel complete if the calculation process is not continued.	as a limit for stopping the process.
Evaluate whether the available information is sufficient to draw the required conclusions, without performing any further unnecessary procedures.	No explicit statements were found indicating that subjects evaluated whether the steps taken were sufficient to answer the question. Subjects tended to work towards a general solution.	Subjects hesitate to stop at the verification stage of requirements, feel the answer must be complete, or seek safety, and are influenced by learning habits.	The subject is not yet able to independently evaluate the adequacy of the data, even though it technically meets the requirements.

Indicator 2: Select and Apply Strategies to Solve Math Problems

Question

Determine what strategies can be used to determine the solution of the differential equation $\frac{dy}{dx} + \frac{5}{x}y = \frac{12y^{3/2}}{(1+x^2)^{1/2}}$, then state the solution!

To complete the problem-solving ability questions, which involve selecting and applying strategies to solve mathematical problems, subjects are required to recognize the form of the equation, select the appropriate strategy, and apply it consistently and systematically. The following is a summary of the subjects' answers to the problem-solving ability questions, which involve selecting and applying strategies to solve mathematical problems.

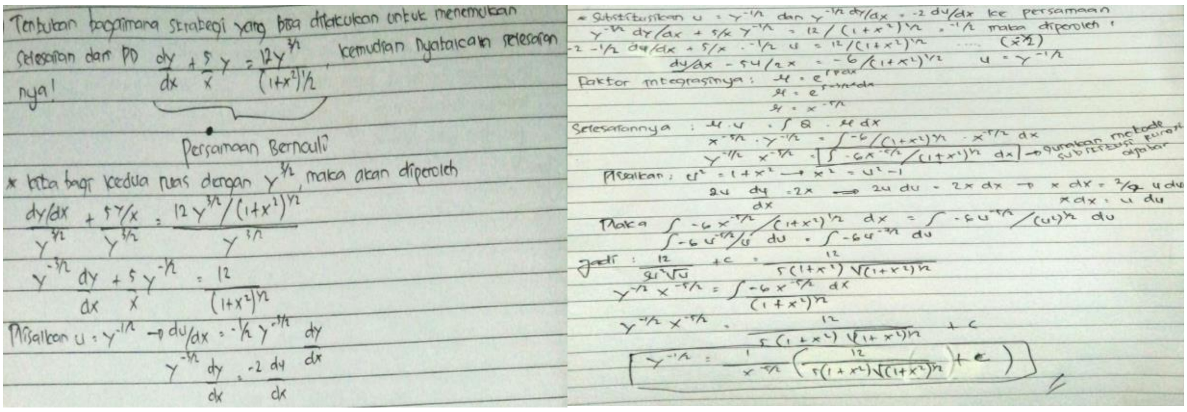

Figure 2. Excerpt of Subject's Answer for Question 2

The excerpt from the subject's written answer above explicitly states that the given equation is a Bernoulli equation. This answer indicates that the subject has been able to classify the problem structurally and relate the algebraic form of the equation to the relevant strategy scheme. The strategy chosen was deemed appropriate and relevant to the nature of the problem. Furthermore, the subject divides the equation by $y^{3/2}$, substitutes $u = y^{-1/2}$, converts the original equation to a linear differential equation, uses an integration factor, and integrates to obtain a solution. These steps demonstrate that the subject understands the strategy for solving the Bernoulli equation and consistently carries out the subsequent procedures, namely the integration factor and integration.

The excerpt from the subject's answer above shows that, in the indicator of selecting and applying strategies to solve mathematical problems, the subject has correctly identified the form of the differential equation and selected the appropriate solution strategy, namely the Bernoulli strategy.

This strategy is applied consistently until a solution is obtained. This answer indicates that the subject has mastered the solution procedure well.

To obtain in-depth information, interviews were conducted with the subjects regarding the solutions to the ability questions, focusing on indicators of selecting and applying strategies to solve mathematical problems. The following presents excerpts from the researcher's interviews with the subjects.

R	:	*How do you recognize the type of differential equation in a problem before deciding how to solve it?*
FI-1	:	*I see a form of* $\frac{dy}{dx}$ *plus y raised to the power of one, and on the right side, a y raised to a power greater than one.*
FI-2	:	*I compare the form to the example in the lecture notes. If there's y raised to a certain power and* $\frac{dy}{dx}$, *it's usually a Bernoulli equation.*
FI-3	:	*I cannot immediately determine it, but after looking at the power of y on the right side, I can confirm it is a Bernoulli equation.*
R	:	*After choosing the Bernoulli method, what's the next step?*
FI-1	:	*I divide the equation by a certain power, then change the variables to make it a linear equation.*
FI-2	:	*I substitute using the Bernoulli formula, then use the integrating factor.*
FI-3	:	*I change the form first, then find the integrating factor and integrate.*

Based on the interview excerpt above, the subjects were able to identify the types of problems structurally, select strategies based on appropriate learning styles and habits, and apply them consistently and algorithmically. However, the subjects also appeared to still rely on the examples provided during the lesson. They did not yet fully demonstrate a comprehensive understanding of strategy selection and implementation. The triangulation results of the written test and interview data are presented in the following Table 4.

Table 4. Triangulation Results of Written Test Data and Interview Data

Aspects	Written Test Findings	Interview Findings	Triangulation Results
Recognition of problem forms and strategy selection	The subject explicitly identifies the given equation as a Bernoulli differential equation.	The subject stated that the choice of the Bernoulli strategy was based on the similarity of the problem form to the examples in class, and the introduction of the strategy was based on memories of the solution patterns taught in class.	Subjects can recognize the problem structure and select an appropriate strategy, though their selection is based on memory rather than conceptual analysis.
Procedural implementation of strategies	The subject applies the Bernoulli strategy sequentially.	Subjects described steps that followed the demonstrated procedure, tending not to evaluate other strategies.	The subject understands the strategy as a series of algorithmic steps.

Data triangulation results indicate that field-independent subjects possess relatively strong problem-solving skills in the initial stages of solving ordinary differential equations, particularly in identifying relevant data. FI subjects have no difficulty recognizing the key mathematical elements of a given problem, such as the equation form, variable components, and formal conditions associated with the type of differential equation. This ability indicates cognitive aptitude for separating important information from the complex context of the problem, a characteristic consistently associated with the field-independent cognitive style. Individuals with this style tend to rely on an internal frame of reference and can conduct structural analysis independently when faced with complex mathematical problems (Witkin, Moore, Goodenough, & Cox, 1977).

However, triangulation results also revealed that although FI subjects are aware of the minimal conditions necessary to solve a problem, such as the exactness condition or the structural form of the Bernoulli equation, they do not fully utilize these conditions as stopping points in the problem-solving process. Subjects tend to continue the solution procedure even though the required mathematical conclusion can already be drawn. This finding suggests that conceptual knowledge of mathematical conditions is not yet fully accompanied by the evaluative ability to determine the sufficiency of the information. Many students can apply mathematical rules correctly but still have difficulty evaluating when a solution is adequate for the requirements of the problem (Barana, Boetti, & Marchisio, 2022).

Furthermore, triangulation results indicate that FI subjects are not yet fully capable of independently evaluating the adequacy of data, even though they technically meet the mathematical requirements. This tendency to continue with procedures can be interpreted as academic prudence or as the perception that "procedurally complete" answers are more valuable than "correct" ones. This phenomenon has been widely reported in mathematics education research, where students often equate step completeness with conceptual correctness, thus neglecting reflection on the problem's objectives (Torres-Peña, Peña-González, Lara-Orozco, Ariza, & Vergara, 2025).

Regarding strategy selection, FI subjects demonstrated a strong ability to recognize problem structure and select appropriate solution strategies, such as identifying Bernoulli differential equations. However, data triangulation indicated that strategy selection was driven more by memory of previously learned solution patterns than by in-depth conceptual analysis of the mathematical rationale behind the strategy's effectiveness. In other words, the subjects recognized the strategy used but had not yet fully articulated why it was appropriate. This condition showed that recognizing the problem type does not always correlate with conceptual understanding of the strategy used (Pjanić, Jurić, & Mišurac, 2025).

In strategy application, FI subjects demonstrated good procedural fluency. Strategies were applied sequentially and consistently, with few technical errors. This condition indicates that the subjects had mastered the algorithmic steps required to solve ordinary differential equations. However, the dominance of this algorithmic approach also indicates that problem-solving could become trapped in routine expertise, namely, the ability to solve familiar problems without high conceptual flexibility. The literature confirms that procedural fluency alone is insufficient to develop adaptive problem solvers, as meaningful mathematical problem-solving requires integrating procedures, concepts, and metacognitive reflection (Choi, Flam-Shepherd, Kyaw, & Aspuru-Guzik, 2022).

Overall, this discussion indicates that field-independent subjects have a strong foundation in solving ordinary differential equations, particularly in the initial analysis and application of procedures. However, weaknesses remained in data sufficiency evaluation and strategic reflection, resulting in subjects not being able to fully adjust the length and depth of the solution to the demands of the problem. This finding implies that differential equation learning in higher education should explicitly emphasize metacognitive exercises, such as evaluating the sufficiency of information and reflecting on the reasons for choosing strategies, so that students become not only procedurally correct problem solvers but also conceptually precise and meaningful.

CONCLUSION

Field independent subjects have a strong foundation in solving ordinary differential equation problems, especially in the initial analysis and application of procedures. However, weaknesses remain in the evaluation of data sufficiency and strategic reflection, resulting in subjects not being fully able to adjust the length and depth of the solution to the demands of the problem.

REFERENCES

Arfinanti, N. (2020). Bahan Ajar Persamaan Diferensial Berbasis Higher Order Thinking Skills. *Jurnal Analisa*, *6*(1), 10–18. https://doi.org/10.15575/ja.v6i1.7782

Ariawan, R., & Zetriuslita. (2021). Kemampuan Berpikir Kritis Matematis Mahasiswa Ditinjau dari Gaya Kognitif (Studi Kasus pada Mata Kuliah Persamaan Differensial). *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(2), 1410–1426. https://doi.org/10.31004/cendekia.v5i2.652

Astuti, R., & Wardono. (2022). Mathematical Literacy in Terms of Cognitive Style with Pendidikan Matematika Realistik Indonesia Learning Assisted by Google Classroom. *Unnes Journal of Mathematics Education*, *11*(3), 264–271. https://doi.org/10.15294/ujme.v11i3.58492

Barana, A., Boetti, G., & Marchisio, M. (2022). Self-Assessment in the Development of Mathematical Problem-Solving Skills. *Education Sciences*, *12*(2), 1–27. https://doi.org/10.3390/educsci12020081

Choi, M., Flam-Shepherd, D., Kyaw, T. H., & Aspuru-Guzik, A. (2022). Learning Quantum Dynamics with Latent Neural Ordinary Differential Equations. *Physical Review A*, *105*(4), 042403.

Cipta, E. S., & Dahlan, J. A. (2021). Analisis Pembelajaran Persamaan Diferensial Berdasarkan Artikel-artikel Penelitian. *Jurnal Analisa*, *7*(2), 164–173. https://doi.org/10.15575/ja.v7i2.10824

Dorimana, A., Uworwabayeho, A., & Nizeyimana, G. (2022). Enhancing Upper Secondary Learners' Problem-solving Abilities using Problem-based Learning in Mathematics. *International Journal of Learning, Teaching and Educational Research*, *21*(8), 235–252. https://doi.org/10.26803/ijlter.21.8.14

Evendi, E., Al Kusaeri, A. K., Pardi, M. H. H., Sucipto, L., Bayani, F., & Prayogi, S. (2022). Assessing Students' Critical Thinking Skills Viewed from Cognitive Style: A Study on the Implementation of the Problem-Based E-Learning Model in Mathematics Courses. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(7), em2129. https://doi.org/10.29333/ejmste/12161

Faradillah, A. (2018). Analysis of Mathematical Reasoning Ability of Pre-Service Mathematics Teachers in Solving Algebra Problem Based on Reflective and Impulsive Cognitive Style. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *8*(2), 119–128. https://doi.org/10.30998/formatif.v8i2.2333

Fitriani, Herman, T., & Fatimah, S. (2023). Considering the Mathematical Resilience in Analyzing Students' Problem-Solving Ability through Learning Model Experimentation. *International Journal of Instruction*, *16*(1), 219–240. https://doi.org/10.29333/iji.2023.16113a

Giancola, M., D'Amico, S., & Palmiero, M. (2023). Working Memory and Divergent Thinking: The Moderating Role of Field-Dependent-Independent Cognitive Style in Adolescence. *Behavioral Sciences*, *13*(5), 397. https://doi.org/10.3390/bs13050397

Hafidzah, N. A., Azis, Z., & Irvan. (2021). The Effect of Open Ended Approach on Problem Solving Ability and Learning Independence in Students' Mathematics Lessons. *IJEMS:Indonesian Journal of Education and Mathematical Science*, *2*(1), 11–18. https://doi.org/10.30596/ijems.v2i1.6176

Haswati, D., & Nopitasari, D. (2019). Implementasi Bahan Ajar Persamaan Diferensial dengan Metode Guided Discovery Berbantuan Software Mathematica untuk Meningkatkan Pemahaman Konsep. *Jurnal Gantang*, *4*(2), 97–102. https://doi.org/10.31629/jg.v4i2.1358

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2023). *Hard Skills dan Soft Skills Matematik Siswa*. Bandung: Refika Aditama.

Hooda, M., & Devi, R. (2018). Significance of Cognitive Style for Academic Achievement in Mathematics. *Scholarly Research Journal for Humanity Science & English Language*, *4*(22), 5521–5527. Retrieved from www.srjis.com

Hyland, D., Van Kampen, P., & Nolan, B. (2023). Student Perceptions of a Guided Inquiry Approach to a Service-Taught Ordinary Differential Equations Course. *International Journal of Mathematical Education in Science and Technology*, *54*(2), 250–276. https://doi.org/10.1080/0020739X.2021.1953627

Isnawati, A. R., & Oktaviani, D. R. (2022). Pengembangan Buku Ajar Kalkulus Berorientasi pada Unity of Sciences (UoS). *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(1), 23–37. https://doi.org/10.24127/ajpm.v11i1.4461

Johnson, P., Almuna, F., & Silva, M. (2022). The Role of Problem Context Familiarity in Modelling First-Order Ordinary Differential Equations. *Journal on Mathematics Education*, *13*(2), 323–336. https://doi.org/10.22342/jme.v13i2.pp323-336

Jonsson, B., Granberg, C., & Lithner, J. (2020). Gaining Mathematical Understanding: The Effects of Creative Mathematical Reasoning and Cognitive Proficiency. *Frontiers in Psychology*, *11*, 574366. https://doi.org/10.3389/fpsyg.2020.574366

Kartono, Muttaqi, U. K., & Dwidayati, N. K. (2020). An Analysis of Students' Error Types in Solving Mathematics Problems in the Implementation of the Osborn Simple Feedback Learning Model. *Journal of Physics: Conference Series*, *1567*(3), 032018. https://doi.org/10.1088/1742-6596/1567/3/032018

Kusumaningsih, W., Saputra, H. A., & Aini, A. N. (2019). Cognitive Style and Gender Differences in Mathematics Students' Conceptual Understanding. *Journal of Physics: Conference Series*, *1280*(4), 042017. https://doi.org/10.1088/1742-6596/1280/4/042017

Makamure, C., & Jojo, Z. M. (2022). An Analysis of Errors Made by Pre-Service Teachers in First-Order Ordinary Differential Equations. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(6), em2117. https://doi.org/10.29333/ejmste/12074

Maliya, N., Isnarto, & Sukestiyarno. (2019). Analysis of Mathematical Problem Solving Ability Based on Self confidence in Creative Problem Solving Learning and Independent Learning Assisted Module. *Unnes Journal of Mathematics Education Research*, *8*(1), 118–124.

Marchy, F., Murni, A., Kartini, & Muhammad, I. (2022). The Effectiveness of Using Problem-Based Learning (PBL) in Mathematics Problem-Solving Ability for Junior High School Students. *AlphaMath : Journal of Mathematics Education*, *8*(2), 185–198. https://doi.org/10.30595/alphamath.v8i2.15047

Marliani, N. (2015). Kemampuan Pemecahan Masalah Matematis dari Pembelajaran Konflik Kognitif yang Terintegrasi dengan Soft Skill. *Jurnal Formatif*, *5*(2), 134–144. https://doi.org/10.30998/formatif.v5i2.333

Mayasari, N. (2017). Beban Kognitif dalm Pembelajaran Persamaan Differensial dengan Koefisien Linier di IKIP PGRI Bojonegoro Tahun Ajaran 2016/2017. *Jurnal Silogisme: Kajian IlmuMatematika Dan Pembelajarannya*, *2*(1), 1–7. https://doi.org/10.24269/js.v2i1.507

Mulbar, U., Rahman, A., & Ahmar, A. S. (2017). An Analysis of Mathematical Problem-Solving Ability Based on SOLO Taxonomy and Cognitive Style. *World Transactions on Engineering and Technology Education*, *15*(1), 68–73. https://doi.org/10.26858/wtetev15i1y2017p6873

Murtafiah, W. (2017). Profil Kemampuan Berpikir Kreatif Mahasiswa dalam Mengajukan Masalah Persamaan Diferensial. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *5*(2), 73. https://doi.org/10.25273/jipm.v5i2.1170

Ningsih, Y. L., & Jayanti. (2016). Hasil Belajar Mahasiswa melalui Penerapan Model Blended Learning pada Mata Kuliah Persamaan Diferensial Parsial. *Jurnal Pendidikan Matematika RAFA*, *2*(1), 1–11. Retrieved from http://jurnal.radenfatah.ac.id/index.php/jpmrafa/article/view/1237

Ningsih, Y. L., & Rohana. (2018). Pemahaman Mahasiswa terhadap Persamaan Diferensial Biasa Berdasarkan Teori Apos. *Jurnal Penelitian Dan Pembelajaran Matematika*, *11*(1), 168–176. https://doi.org/10.30870/jppm.v11i1.2995

Nufus, H., & Ariawan, R. (2019). Relationship between Cognitive Style and Habits of Mind. *Malikussaleh Journal of Mathematics Learning (MJML)*, *2*(1), 23–28. https://doi.org/10.29103/mjml.v2i1.756

Pjanić, K., Jurić, J., & Mišurac, I. (2025). The Use of Different Strategies and Their Impact on Success in Mental Calculation. *Education Sciences*, *15*(9), 1098. https://doi.org/10.3390/educsci15091098

Purnomo, E. A., Sukestiyarno, Y. L., Junaedi, I., & Agoestanto, A. (2022a). Analisis Kemampuan Pemecahan Masalah Calon Guru Ditinjau dari Metakognitif pada Materi Kalkulus Diferensial. *Prosiding Seminar Nasional Pascasarjana*, 310–315. Semarang: Universitas Negeri Semarang. Retrieved from http://pps.unnes.ac.id/pps2/prodi/prosiding-pascasarjana-unnes

Purnomo, E. A., Sukestiyarno, Y. L., Junaedi, I., & Agoestanto, A. (2022b). Analysis of Problem Solving Process on HOTS Test for Integral Calculus. *Mathematics Teaching-Research Journal*, *14*(1), 199–214.

Purnomo, E. A., Sukestiyarno, Y. L., Junaedi, I., & Agoestanto, A. (2022c). The Analysis of Problem Solving Ability Viewed from Intuition in Integral Calculus Course. *International Conference on Science, Education, and Technology*, 246–251. Semarang: Universitas Negeri Semarang. Retrieved from https://proceeding.unnes.ac.id/index.php/iset

Ramlah, J. (2014). Relationship between Students' Cognitive Style (Field-Dependent and Field-Independent Cognitive Styles) with their Mathematic Achievement in Primary School. *International Journal of Humanities Social Sciences and Education (IJHSSE)*, *1*(10), 88–93. Retrieved from www.arcjournals.org

Rejeki, S., Riyadi, & Siswanto. (2021). Analysis of Students' Problem-Solving Ability in Solving Geometry Problems. *Journal of Physics: Conference Series*, *1918*(4), 042075. https://doi.org/10.1088/1742-6596/1918/4/042075

Son, A. L., Darhim, & Fatimah, S. (2020). Students' Mathematical Problem-Solving Ability Based on Teaching Model Interventions and Cognitive Style. *Journal on Mathematics Education*, *11*(2), 209–222. https://doi.org/10.22342/jme.11.2.10744.209-222

Sudarsono, Kartono, Mulyono, & Mariani, S. (2022). The Effect of STEM Model Based on Bima's Local Cultural on Problem Solving Ability. *International Journal of Instruction*, *15*(2), 83–96. https://doi.org/10.29333/iji.2022.1525a

Sugiyono. (2020). *Metode Penelitian & Pengembangan*. Bandung: Alfabeta.

Sukestiyarno, Y. L. (2021). *Metode Penelitian Pendidikan*. Semarang: Alem Print.

Sukmadinata, N. S. (2017). *Metode Penelitian Pendidikan*. Bandung: Remaja Rosdakarya.

Sulistyorini, Y. (2017). Analisis Kesalahan dan Scaffolding dalam Penyelesaian Persamaan Diferensial. *Kalamatika: Jurnal Pendidikan Matematika*, *2*(1), 91–104. https://doi.org/10.22236/kalamatika.vol2no1.2017pp91-104

Surya, E., & Syahputra, E. (2017). Improving High-Level Thinking Skills by Development of Learning PBL Approach on the Learning Mathematics for Senior High School Students. *International Education Studies*, *10*(8), 12–20. https://doi.org/10.5539/ies.v10n8p12

Sutama, Anif, S., Prayitno, H. J., Narimo, S., Fuadi, D., Sari, D. P., & Adnan, M. (2021). Metacognition of Junior High School Students in Mathematics Problem Solving Based on Cognitive Style. *Asian Journal of University Education*, *17*(1), 134–144. https://doi.org/10.24191/ajue.v17i1.12604

Torres-Peña, R. C., Peña-González, D., Lara-Orozco, J. L., Ariza, E. A., & Vergara, D. (2025). Enhancing Numerical Thinking Through Problem Solving: A Teaching Experience for Third-Grade Mathematics. *Education Sciences*, *15*(6), 1–27. https://doi.org/10.3390/educsci15060667

Ulya, H., Kartono, & Retnoningsih, A. (2014). Analysis of Mathematics Problem Solving Ability of Junior High School Students Viewed from Students' Cognitive Style. *International Conference on Mathematics, Science, and Education*, *2014*(Icmse), 1–7. Semarang: Faculty of mathematics and Natural Sciences. Retrieved from http://www.ijern.com/journal/2014/October2014/45.pdf

Ulya, Himmatul. (2015). Hubungan Gaya Kognitif dengan Kemampuan Pemecahan Masalah Matematika Siswa. *Jurnal Konseling Gusjigang*, *1*(2), 1. https://doi.org/10.24176/jkg.v1i2.410

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research*, *47*(1), 1–64. https://doi.org/10.3102/00346543047001001

Yatim, S. S. K. M., Saleh, S., Zulnaidi, H., & Yatim, S. A. M. (2022). Effects of Integrating a Brain-Based Teaching Approach with GeoGebra on Problem-Solving Abilities. *International Journal of Evaluation and Research in Education*, *11*(4), 2078–2086. https://doi.org/10.11591/ijere.v11i4.22873

Zaenuri, Medyasari, L. T., & Dewi, N. R. (2021). Auditory, Intellectual, and Repetition Learning with an Ethnomathematics Nuance in Improving Students' Mathematical Problem-Solving Ability. *Journal of Physics: Conference Series*, *1918*(4), 042093. https://doi.org/10.1088/1742-6596/1918/4/042093

Zetriuslita, & Ariawan, R. (2021). Curiosity Matematis Mahasiswa dalam Pembelajaran Daring Ditinjau Berdasarkan Level Kemampuan Akademik dan Gender. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(3), 3253–3264. https://doi.org/10.31004/cendekia.v5i3.1027