Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika
JRPIPM. 2026 (Vol. 10, no. 1, 33-47)
ISSN: 2581-0480 (electronic)
URL: journal.unesa.ac.id/index.php/jrpipm

Analysis of Mathematics Education Students' Intitial Operational Research Skills

Dinar Nirmalasari[1*], Fanisa Dina Amalia Dewi Umbara[2], Avianti Permata Yuniar[3]

[1*]Jl. Ciwaru Raya, Kota Serang, Banten, Universitas Sultan Ageng Tirtayasa, dinar.nirmalasari@untirta.ac.id
[2] Jl. Ciwaru Raya, Kota Serang, Banten, Universitas Sultan Ageng Tirtayasa, fanisa.dina@untirta.ac.id
[3] Jl. Ciwaru Raya, Kota Serang, Banten, Universitas Sultan Ageng Tirtayasa, avianti.permata@untirta.ac.id

Submitted: 22 September 2025; Revised: 5 December 2025; Accepted: 8 April 2026

ABSTRACT

Students' initial ability to understand Operational Research courses is important as a foundation for exploring more complex optimisation concepts. This study aims to describe the initial skills of Mathematics Education students and reveal their perceptions of Operations Research courses. The research method used is quantitative descriptive, with subjects being third-semester Mathematics Education Study Programme students. Data were collected through diagnostic tests in the form of essay questions to measure cognitive aspects and perception questionnaires to explore affective elements. Data analysis was conducted descriptively by calculating the average score, ability categories, and students' attitude tendencies. The results showed that students' initial abilities in Operations Research were still limited, particularly in mathematical model formulation and understanding of duality concepts. Students were relatively more capable of visualization and procedural skills but did not yet demonstrate adequate mastery of modelling that required conceptual abstraction. From an affective perspective, students have a positive perception of the usefulness of Operations Research, a high level of interest in learning it, and confidence in their abilities. However, there are also concerns about the material's difficulty level, especially on complex topics. These findings confirm that the success of Operations Research learning is influenced by a combination of students' cognitive and affective aspects. Therefore, learning strategies that emphasize strengthening modelling skills, applying problem-based learning, and integrating supporting technology to reduce the burden of manual computation are needed. With this approach, students are expected to be better prepared to handle material requiring high-level thinking skills.

Keywords: *Initial Abilities, Operations Research, Mathematics Education, Mathematical Modelling, Student Perceptions*

Analisis Kemampuan Awal Riset Operasi Mahasiswa Pendidikan Matematika

ABSTRAK

Kemampuan awal mahasiswa dalam memahami mata kuliah Riset Operasi berperan penting sebagai fondasi untuk mendalami konsep-konsep optimasi yang lebih kompleks.

Penelitian ini bertujuan untuk mendeskripsikan kemampuan awal mahasiswa Pendidikan Matematika serta mengungkap persepsi mereka terhadap mata kuliah Riset Operasi. Metode penelitian yang digunakan adalah deskriptif kuantitatif dengan subjek mahasiswa semester 3 Program Studi Pendidikan Matematika. Data dikumpulkan melalui tes diagnostik berupa soal uraian untuk mengukur aspek kognitif dan kuesioner persepsi untuk menggali aspek afektif. Analisis data dilakukan secara deskriptif dengan menghitung skor rata-rata, kategori kemampuan, serta kecenderungan sikap mahasiswa. Hasil penelitian menunjukkan bahwa kemampuan awal mahasiswa dalam Riset Operasi masih terbatas, khususnya pada aspek formulasi model matematis dan pemahaman konsep dualitas. Mahasiswa relatif lebih mampu pada aspek visualisasi dan keterampilan prosedural, namun belum menunjukkan penguasaan yang memadai pada pemodelan yang menuntut abstraksi konseptual. Dari sisi afektif, mahasiswa memiliki persepsi positif mengenai kegunaan Riset Operasi, minat yang cukup tinggi untuk mempelajarinya, serta kepercayaan diri terhadap kemampuan mereka. Akan tetapi, muncul pula kekhawatiran terhadap tingkat kesulitan materi, terutama pada topik-topik yang bersifat kompleks. Temuan ini menegaskan bahwa keberhasilan pembelajaran Riset Operasi dipengaruhi oleh kombinasi aspek kognitif dan afektif mahasiswa. Oleh karena itu, diperlukan strategi pembelajaran yang menekankan pada penguatan kemampuan pemodelan, penerapan pembelajaran berbasis masalah, serta integrasi teknologi pendukung untuk mengurangi beban komputasi manual. Dengan pendekatan tersebut, mahasiswa diharapkan lebih siap menghadapi materi yang menuntut keterampilan berpikir tingkat tinggi.

***Kata Kunci*:** *Kemampuan Awal, Riset Operasi, Pendidikan Matematika, Pemodelan Matematis, Persepsi Mahasiswa*

How to cite: Nirmalasari, D., Umbara, F.D.A.D., Avianti Permata Yuniar, A.P. (2026). Analysis of Mathematics Education Students' Intitial Operational Research Skills. *Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika (JRPIPM)*, *10*(1), 33-47. https://doi.org/10.26740/jrpipm.v10n1.p33-47

1. Introduction

Operations Research (OR) is a branch of applied mathematics that emphasises the development of mathematical models and quantitative analysis to support decision-making (Hafni et al., 2021; Kotas, 2017). This course plays a strategic role in the Mathematics Education curriculum as it trains students to think systematically, analyse complex problems, and formulate optimal solutions through a mathematical approach. These competencies are in line with the demands of the 21st century, which emphasize problem-solving skills, data analysis, and the use of technology in various fields (Hafni et al., 2021; Raffaele & Gobbi, 2021; Taranto et al., 2024).

Despite its importance, various studies show that Mathematics Education students often experience difficulties in learning OR courses. These difficulties generally arise not only at the mathematical computation stage, but also in the ability to understand the context of the problem and translate it into an appropriate mathematical model. Taranto et al. (2024) emphasize that most students are still weak in mathematical modelling. Mutawah et al. (2019) find that students focus more on memorizing algorithmic procedures than conceptual understanding. This indicates a gap between the technical and conceptual skills required in OR courses.

From an educational psychology perspective, students' prior knowledge is crucial to learning success (Berro, 2021). Prior knowledge includes learners' prerequisite knowledge and skills before receiving new material (Lin et al., 2011; Muntazhimah et al., 2021). According to Ausubel (1968), existing cognitive structures are 'the most important single factor influencing learning' because they determine how much learners can assimilate new knowledge (Agra et al., 2019). Bruner (1960), through his spiral curriculum, also emphasizes that prior understanding is the foundation for learning more complex concepts gradually (Arsyad et al., 2024). Meanwhile, prior knowledge can be effectively examined in terms of attitudes, motivation, self-confidence, and interest in learning (Lee et al., 2024). Bloom (1956) in his taxonomy distinguishes between the cognitive and affective domains, where the affective domain includes receiving, responding, appreciating values, and forming attitudes (Syaiful et al., 2019). Vygotsky (1978), through the concept of the zone of proximal development (ZPD), emphasizes that readiness to learn is not only determined by existing knowledge, but also by affective factors that influence social interaction and motivation (Alharbi, 2023). Thus, initial ability can be understood as a combination of cognitive aspects (knowledge, understanding, prerequisite skills) and affective aspects (motivation, interest, self-confidence) that influence students' readiness to tackle new material.

Given the importance of these initial abilities, this study began with a diagnostic test (pretest) administered to students in classes 3A and 3B to measure their basic skills in understanding the initial material on RO. The pretest was designed to assess four main aspects: the ability to formulate mathematical models from real-world problems, visual understanding and the concept of feasible regions, procedural skills in graphical methods, and understanding of the concept of duality. In addition, a perception questionnaire was also administered to explore students' beliefs, interests, and expectations regarding the OR course. Thus, this study aims to analyze the initial abilities of Mathematics Education students, identify their difficulties, and provide recommendations for relevant learning strategies.

This study differs from previous studies in that it not only analyses students' difficulties in solving Operations Research problems but also maps their initial abilities through a combination of cognitive data (pretest results) and affective data (perception questionnaire results) (Oktafia et al., 2020). This holistic approach provides a more comprehensive understanding of students' readiness for OR courses and can serve as a foundation for developing more effective and contextual learning strategies. By integrating both cognitive and affective data, this study introduces a theoretical framework that addresses both intellectual and emotional aspects of learning, offering insights into how these factors impact students' learning outcomes and difficulties. This perspective can lead to more nuanced teaching methods that consider the full spectrum of student readiness, helping to improve educational strategies in Mathematics Education. Thus, the contribution of this study lies in presenting a more holistic perspective that can serve as a basis for developing more effective and contextual learning strategies in Mathematics Education.

2. Method

2.1 Research Design

This study used a quantitative descriptive design to describe the initial abilities of Mathematics Education students in the Operations Research course. Quantitative descriptive design is a research approach that aims to explain certain phenomena, characteristics, or variables systematically and objectively through collecting and analyzing numerical data (Lestari et al., 2024). This design was chosen because it is suitable for mapping the actual conditions of students based on diagnostic test data and questionnaires without any special treatment from the researcher (Lestari, 2020).

2.2 Data Sources

The data sources for this study were third-semester students of the Mathematics Education Study Programme at Sultan Ageng Tirtayasa University in the 2025/2026 academic year. The participants consisted of two classes, namely class 3A with 39 students and class 3B with 39 students, bringing the total number of respondents to 78 students. The reason for selecting these two classes was to ensure that the study covered a diverse range of students with varying mathematical abilities. By selecting both classes, the study aimed to capture a comprehensive spectrum of mathematical abilities. The research data covered two aspects, namely: (1) cognitive data from the diagnostic test (pre-test) results, and (2) affective data from the student perception questionnaire results. This is in line with the research conducted by Samsun et al. (2024), where the research data collected was cognitive data based on the pre-test and affective data in the form of a perception questionnaire.

2.3 Data Collection

Data collection was conducted using two instruments. First, a diagnostic test (pretest) consisting of five essay questions designed to measure various aspects of students' initial abilities in Operations Research, including: model formulation skills, visual understanding and the concept of feasible regions, procedural skills in graphical methods, and understanding of the concept of duality. In the study by Colajanni et al. (2024), it is stated that in studying operations research, basic skills are required, such as the ability to use linear, quadratic, exponential, and logarithmic functions; modelling and algorithmic approach skills; graph theory; feasible region concepts; and linear programming. The validity of this test was ensured through expert review, which assessed the relevance and comprehensiveness of the items. Additionally, the reliability of the diagnostic test was tested using Cronbach's Alpha, which yielded a value of 0.72, indicating an acceptable level of internal consistency.

Second, a perception questionnaire consisting of 12 statements using a Likert scale and two open-ended questions to explore students' beliefs, interests, and expectations regarding the Operations Research course. Its validity was confirmed through expert reviews and a pilot study, which refined the questionnaire items. The pretest was given at the beginning of the lecture, while the questionnaire was distributed immediately after the students completed the pretest. Table 1 is an outline of the questionnaire used in the perception questionnaire.

Table 1. Questionnaire Guidelines

No.	Statement	Aspect
1	I believe that operations research is important for my future career	Usefulness
2	I believe that operations research can be used to solve real-world problems	Usefulness
3	Optimization modelling skills will increase my marketability in the workplace	Usefulness
4	I am interested in learning how to optimize a system or process	Interest

Table 1. Questionnaire Guidelines

No.	Statement	Aspect
5	I look forward to solving challenging case studies in the course	Interest
6	Topics such as optimization and decision making are interesting to me	Interest
7	I am confident in my mathematical background to take this course	Confidence
8	I am confident that I can understand the basic concepts of mathematical modelling	Confidence
9	I feel that I can complete the assignments in this course well	Confidence
10	I have heard that operations research is a difficult course	Difficulties
11	I am concerned that I will have difficulty understanding the optimization methods material	Difficulties
12	I have not yet mastered the prerequisite material (such as matrices and linear algebra)	Difficulties
13	In your opinion, which part or topic of operations research are you most looking forward to?	Interest
14	Do you have any particular concerns or expectations regarding this course?	Difficulties/ Expectations

Source: (Hafni et al., 2021; Pintrich & De Groot, 1990)

2.4 Data Analysis Techniques

The data were analysed descriptively through a systematic procedure designed to identify patterns, highlight essential characteristics, and provide a comprehensive summary of the findings.

a. The pretest results were analysed using (Rohadi et al., 2020):
   1) Scoring and Categorization: Each question was weighted with a maximum total score of 100, then categorised into three ability groups (Sianturi et al., 2020; Sinaga, 2022): Poor (0–50), Fair (51–75), and Good (76–100).
   2) Descriptive Statistics: Calculate the mean, median, mode, standard deviation, and range of values to describe the data distribution.
   3) Data Visualisation: This involves presenting results using histograms for score distribution, pie charts for ability category percentages, and bar charts to show the level of mastery of each question indicator.

b. The questionnaire results were analysed by calculating the mean and percentage for each item on the Likert scale. In contrast, the data from the open-ended questions were analysed descriptively to explore students' expectations and concerns regarding the Operations Research course.

c. The flowchart in Figure 1 illustrates the entire research process, from problem formulation to instrument preparation, pretest and questionnaire implementation, and data analysis, to clarify the research flow.

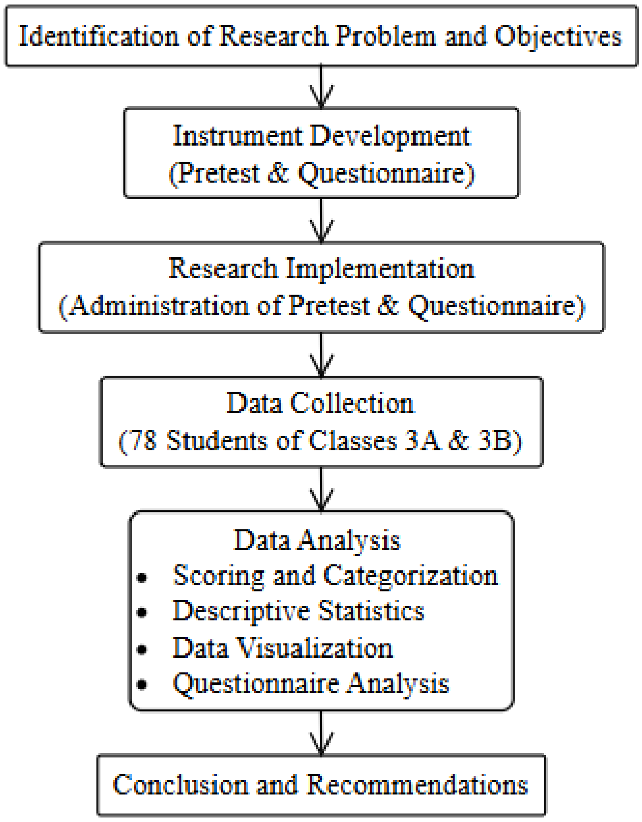

Figure 1. Research Process

3. Results and Discussion

3.1 Results

a. Pretest Results

The diagnostic test administered to 78 students (39 students from class 3A and 39 students from class 3B) yielded an average score of 33.60 with a standard deviation of 26.65, a minimum score of 0, and a maximum score of 98. The distribution of initial abilities showed that most students were in the Poor category (71.79%), while 21.79% were in the Fair category and only 6.41% were in the Good category. Table 2 shows the distribution of students' initial abilities based on the pretest.

Table 2. Distribution of Students' Initial Abilities

Category	Frequency	Percentage
Poor (0–50)	56	71.79%
Fair (51–75)	17	21.79%
Good (76–100)	5	6.41%

We now present a visual representation of the pretest score distribution and the students' initial ability categories that showed in Figure 2 and Figure 3.

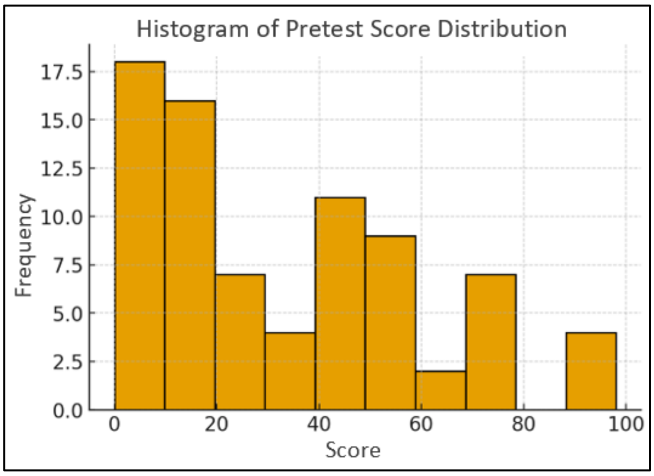

Figure 2. Histogram of Pretest Score Distribution

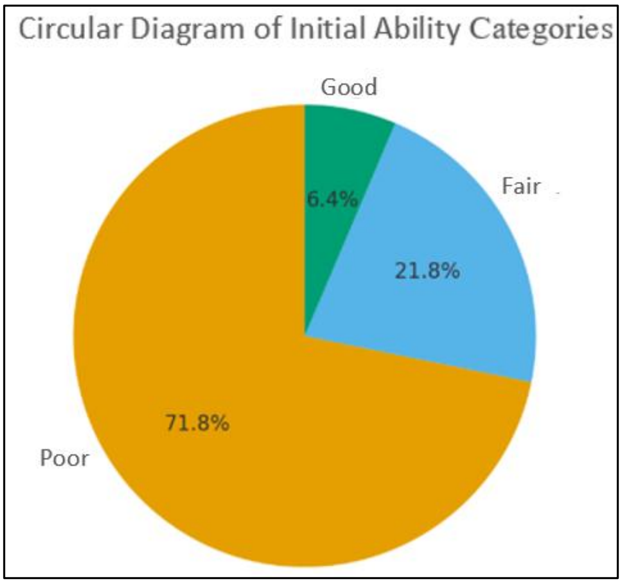

Figure 3. Circular Diagram of Initial Ability Categories

A more detailed analysis per question indicates that mathematical modelling skills (Questions 1 and 5) are still low, with average scores of 11.48 and 7.74. This suggests that while students may grasp basic concepts, they struggle to apply them ini more complex modelling scenarios. Visual understanding and feasible region (Question 2) are relatively better, with an average of 10.57, indicating that students have a basic ability to interpret graphical representations but may lack depth in applying them to real-world problems. Procedural skills in graphical methods (Question 3) average 7.91, demonstrating that while students can perform basic procedures, they may struggle with more advanced or multi-step methods. The weakest aspect is understanding duality concepts (Question 4), with an average of only 4.00. This result highlights the challenge students face in grasping more abstract and theoretical aspects of OR, such as duality, which requires a deeper understanding of optimization theory. Table 3 shows the average student scores per question indicator and the average scores per pretest question.

Table 3. Average Students' Score

Indicator	Average Score
Model Formulation (Question 1)	11.48
Feasible Region (Question 2)	10.57
Graphical Procedure (Question 3)	7.91
Duality (Question 4)	4.00
Model Formulation (Question 5)	7.74

Table 5 indicates that students performed strongest in model formulation and in determining feasible regions, suggesting they are relatively capable of translating problems into mathematical forms and identifying solution areas. Their performance declines when dealing with graphical procedures and varies when model formulation is presented in a different context, indicating emerging difficulties in representation and adaptability. The weakest performance appears in the duality concept, showing that more abstract material is still challenging for students. Overall, this suggests that while foundational skills are fairly well developed, more complex and conceptual understanding needs further strengthening.

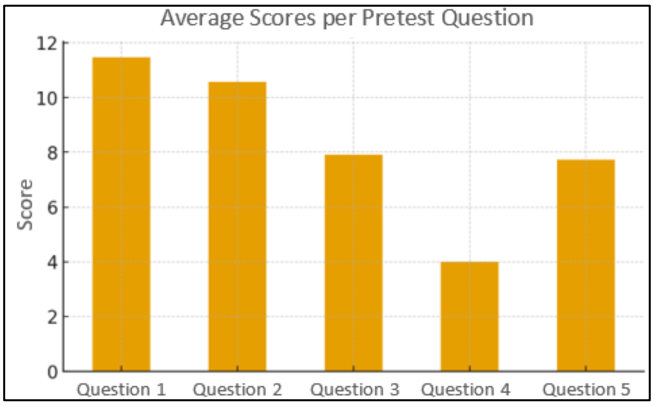

Figure 4. Bar Chart of Average Scores per Pretest Question

From Figure 4, it shows that students' main weaknesses lie in modelling and understanding advanced concepts rather than purely procedural skills.

b. Questionnaire Results

The questionnaire administered to explore affective aspects was analyzed into four main aspects. The results are shown in Table 4.

Table 4. Summary of Student Questionnaire Results by Aspect

Aspect	Average	Standard Deviation	Min	Max
Usefulness	4.39	0.51	1.33	5.00
Interest	4.00	0.50	2.00	5.00
Confidence	4.13	0.66	2.00	5.00
Difficulty	3.40	0.76	1.33	4.67

The data indicate that students generally have a positive perception of the learning or instrument, as reflected in high average scores for usefulness (4.39), interest (4.00), and confidence (4.13), suggesting that most students find the activity beneficial, engaging, and supportive of their self-confidence, with relatively consistent responses across participants despite some variation indicated by the minimum scores. Meanwhile, the difficulty aspect has a lower average (3.40) and the highest standard deviation (0.76), showing that students' perceptions of difficulty are more diverse, where some consider the tasks easy while others find them challenging. Overall, this implies that although the learning is well-received in terms of value and engagement, the level of difficulty may need to be better adjusted to accommodate differences in students' abilities and prior experiences.

The average scores for each aspect of the questionnaire are shown in Figure 5.

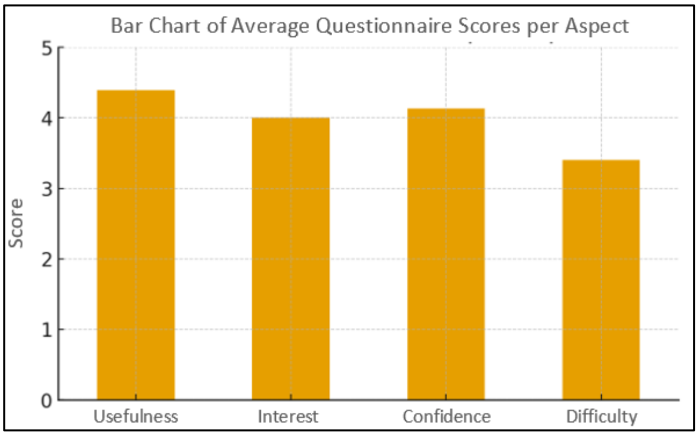

Figure 5. Bar Chart of Average Questionnaire Scores per Aspect

The data shows that students positively perceive the Operations Research course (usefulness = 4.39; interest = 4.00; confidence = 4.13). However, the difficulty aspect is relatively high (3.40), which indicates that there are still concerns about understanding the material.

3.2 Discussion

The results of this study indicate that students' initial abilities in Operations Research courses are still relatively low. This is supported by research showing that many students do not have adequate mathematical prerequisites, which hinders their performance in advanced courses such as Operations Research (Valstar et al., 2019). The average pretest score was 33.60, with most students (71.79%) falling into the 'below average' category, indicating that most students do not yet have adequate cognitive readiness to study more complex material. This is in line with the research by Tsabitah et al. (2024), which explains that students still have difficulty understanding basic material, even though it is needed to learn more abstract mathematical material.

Analysis per indicator reinforces the above Figure. Regarding mathematical model formulation, student achievement is still low, at only around 45.92% and 38.70% of the maximum score on questions 1 and 5. This is in line with the results of research by Hidayanto et al. (2022), which shows that there are still students with low abilities in composing mathematical literacy questions, including mathematical model formulation. Shodikin et al. (2019) identified two of the most common thinking errors: making inappropriate assumptions and failing to construct a mathematical model that accurately represents real-world situations. These errors are attributed to students' incomplete understanding of the problems and their tendency to rely on routine problems they frequently encounter. Shodikin et al. (2024) further identified four types of failure characteristics in model construction, namely misunderstandings, misconnections, misspeculations, and mislogic. Similarly, their understanding of duality only reached 20% of the maximum score, indicating that students had significant difficulties understanding abstract and theoretical concepts. This is in line with the research conducted by Wati et al. (2024), which states that students have difficulty understanding concepts, applying principles, and solving abstract verbal problems, including linear model formulation. The internal factors contributing to these errors include a lack of understanding of the problem components, reliance on personal reasoning or intuition in solving word problems, and failure to recognize the relationships among problem components. Meanwhile, the external factors include the relatively high level of difficulty of the tasks and the lack of adequate reference sources (Fiyah & Shodikin, 2021). Conversely, students' abilities in visualising feasible regions were relatively better, with an achievement of 70.48%, while their procedural skills in graphical methods were still limited, with an accomplishment of around 39.55%. This confirms that students find it easier to understand visual representations than conceptual abstractions that require the ability to transfer representations from contextual problems to mathematical forms. This is supported by research from Ferianti et al. (2023), which reveals that prospective teacher students are more skilled at using visual representations to solve problems than abstract forms; representations are considered crucial in building mathematical concept understanding.

These findings align with the research by Tayibu & Faizah (2021), which found that students were more proficient in procedural steps than mathematical modelling. Hasanah et al. (2019) also emphasised that model formulation was a major obstacle because it required higher analytical and abstract thinking skills. Within the learning theory framework, this condition is consistent with Ausubel's (1968) view that prior knowledge is the most important factor in learning. Without an adequate knowledge base, students will find it difficult to assimilate new, more complex knowledge (Brod, 2021). Bruner's spiral theory (1960) is also relevant, in which concepts must be taught gradually from enactive, iconic, to symbolic representations (Ningsih et al., 2020). Students' weaknesses in modelling and duality indicate that the transition from concrete to symbolic representations has not been optimal. Furthermore, Vygotsky's zone of proximal development (ZPD) theory (1978) emphasises that student learning outcomes are greatly influenced by scaffolding learning support (Marlina & Rahayu, 2025). This means that students' weaknesses in conceptual aspects can be overcome if learning is appropriate to their readiness level.

From an affective perspective, the questionnaire results indicate positive capital to support the learning process. Students have a good perception of the usefulness of Operations Research courses (average 4.39), a fairly high level of interest (4.00), and relatively good self-confidence (4.13). These figures indicate that students view Operations Research as relevant to their career and real-life needs and are motivated to study it. This is in line with Sugiura & Sugiura (2020), who stated that students respond positively when OR material is packaged with a contextual approach that shows its relevance to careers and industry needs, thereby increasing their perception of the relevance of this course. However, the average score on the difficulty aspect of 3.40 indicates that students' concerns about the complexity of the material are still quite high. This concern is closely related to the cognitive weaknesses they experience, particularly in modelling and understanding advanced concepts. According to Bloom (1956), the affective domain, such as motivation, attitude, and self-confidence, greatly influences the quality of learning (Khumaimah, 2024). Santi et al. (2024) also emphasise that high motivation that is not balanced with strong self-efficacy can cause academic anxiety. In other words, even though students are motivated to learn, concerns about the difficulty of the material can hinder the achievement of optimal learning outcomes.

Overall, the findings of this study emphasise the importance of simultaneously paying attention to both students' cognitive and affective aspects. Cognitive weaknesses in model formulation and duality must be addressed through appropriate learning strategies. At the same time, affective capital in the form of interest and motivation needs to be managed so that it is not hindered by academic anxiety. This is in line with the research by Wulandari & Salsabila (2025), which states that many students still experience difficulties understanding and solving duality problems. Hence, learning needs to be directed to encourage students to develop more reflective and meaningful learning strategies.

Furthermore, research by Shekarian Yazd et al. (2019) found that fear of cognitive symptoms of anxiety greatly affects learning motivation, even more so than perfectionism, which reinforces the importance of anxiety management in maintaining academic motivation. Recommended learning strategies include applying problem-based learning, which allows students to learn through contextual problem solving, providing contextual exercises that progress from simple to more complex cases, and using software such as LINGO or Excel Solver to reduce the burden of manual computation. This is supported by research by Yerizon et al. (2018), which shows that students have difficulty understanding operations research material due to a lack of real context. Min's recommended learning strategies include applying problem-based learning, which allows students to learn through contextual problem solving, providing contextual exercises that progress from simple to more complex cases, and using software such as LINGO or Excel Solver to reduce the burden of manual computation. This is supported by research conducted by Yerizon et al. (2018), which shows that students have difficulty understanding operations research material due to a lack of real-world context and minimal involvement in problem solving, so the PBL approach effectively improves their understanding. Furthermore, Sunaryo & Fatimah (2020) mention that providing contextual mathematics exercises in stages (from easy to difficult) helps students build conceptual understanding and critical thinking skills progressively, effectively solving real-world context-based problems such as operations research. Shoaib et al. (2024) add that the optimisation model developed using LINGO, with the results visualised in Excel, can reduce the complexity of manual programming and facilitate the interpretation of results. Thus, students can focus more on conceptual understanding and modelling skills. This is in line with the research by Susanto & Susanta (2022), which found that problem-based learning can improve students' higher-order thinking skills, one of which is in the Operations Research course.

4. Practical Implications

This study's results have several practical implications for teaching Operations Research in Mathematics Education study programmes. First, lecturers need to reinforce prerequisite material, such as linear algebra and spatial geometry solutions, at the beginning of the course, for example, through short diagnostic quizzes or enrichment modules. Second, lecturers must design tiered and contextual learning, starting from simple problems familiar to students' lives before moving on to more complex cases. Third, integrating supporting technologies such as LINGO or Excel Solver needs to be optimised so that manual calculations do not burden students and they can focus more on understanding concepts and interpreting results. Fourth, applying problem-based learning and project-based assignments will help channel students' interests while building critical thinking and modelling skills. Finally, lecturers should provide regular formative feedback to reduce students' learning anxiety and strengthen their confidence.

5. Conclusion

This study aims to describe the initial abilities of Mathematics Education students in Operations Research courses through pretest and perception questionnaires. The results show that most students (71.79%) are in the low initial ability category with an average score of 33.60. Analysis per question indicates that students' main weaknesses are mathematical model formulation and understanding duality concepts, while their feasible region visualization skills are relatively better.

Affectively, students have positive capital to take this course. The average scores for usefulness (4.39), interest (4.00), and confidence (4.13) indicate that students have positive motivation and perceptions towards Operations Research. However, the difficulty score (3.40) confirms students' concerns in understanding complex material, particularly modelling and optimization.

Overall, this study confirms that although students have positive attitudes and high motivation, limitations in their initial cognitive abilities remain a major obstacle. Therefore, learning strategies must be designed to address cognitive gaps while managing students' affective aspects.

6. Acknowledgement

We received a great deal of support and guidance in writing this research article from various parties. We would like to take this opportunity to express our gratitude to the Head of the Mathematics Education Department at Sultan Ageng Tirtayasa University, third-semester Mathematics Education students, and fellow lecturers, whom we cannot mention one by one.

7. References

Agra, G., Formiga, N. S., Oliveira, P. S. D., Costa, M. M. L., Fernandes, M. D. G. M., & Nóbrega, M. M. L. D. (2019). Analysis of the concept of Meaningful Learning in light of the Ausubel's Theory. *Revista Brasileira de Enfermagem*, *72*(1), 248–255. https://doi.org/10.1590/0034-7167-2017-0691

Alharbi, J. M. (2023). Insight into the Role of Interaction in Language Acquisition: Vygotsky's Interactionist Theory of Language. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4497562

Arsyad, S. N., Tangkin, W. P., Sumartono, S., & Astuti, B. (2024). Implications of Bruner's Cognitive Theory on Elementary School Education in the 21st Century. *Klasikal: Journal of Education, Language Teaching and Science*, *6*(3), 697–704. https://doi.org/10.52208/klasikal.v6i3.1225

Berro, M. (2021). Effects of Prior Knowledge on Relations Among Expectancies, Values, Costs, Digital Behavioral Engagement, and Achievement. *Proceedings of the 2021 AERA Annual Meeting*. 2021 AERA Annual Meeting. https://doi.org/10.3102/1688767

Brod, G. (2021). Toward an understanding of when prior knowledge helps or hinders learning. *Npj Science of Learning*, *6*(1), 24. https://doi.org/10.1038/s41539-021-00103-w

Colajanni, G., Gobbi, A., Picchi, M., Raffaele, A., & Taranto, E. (2024). An Operations Research–Based Teaching Unit for Grade 11: The ROAR Experience, Part II. *Informs Transactions on Education*, *24*(3), 238–258. https://doi.org/10.1287/ited.2023.0001

Ferianti, F. W., Saputri, L. D., & Septiadi, W. (2023). Kemampuan Representasi Calon Guru Matematika Dalam Menyelesaikan Masalah Geometri. *Al Khawarizmi: Jurnal Pendidikan Matematika*, *3*(2), 23–30. https://doi.org/10.46368/kjpm.v3i2.1514

Fiyah, M., & Shodikin, A. (2021). Analisis Kesalahan Siswa SMP dalam Membuat Pemodelan Matematika. *Jurnal Pendidikan Matematika (Jupitek)*, *4*(1), 1-6. https://doi.org/10.30598/jupitekvol4iss1pp1-6

Hafni, R., Hanum, Z., & Hasibuan, L. S. (2021). Students Perceptions of Operations Research Learning During the Covid-19 Pandemic with Realistic Mathematics Educations Approach. *Journal of International Conference Proceedings*, *4*(2), 465-473. https://doi.org/10.32535/jicp.v4i2.1279

Hasanah, U., Danaryanti, A., & Suryaningsih, Y. (2019). Analisis Soal Ujian Nasional Matematika SMA Tahun Ajaran 2017/2018 Ditinjau dari Aspek Berpikir Tingkat Tinggi. *EDU-MAT: Jurnal Pendidikan Matematika*, *7*(1), 51-62. https://doi.org/10.20527/edumat.v7i1.6350

Hidayanto, T., Kamaliyah, K., Ramadhan, M. R., & Anwar, M. A. (2022). Identifikasi Kemampuan Mahasiswa Pendidikan Matematika Dalam Menyusun Soal Literasi Matematika Konteks Lingkungan Lahan Basah. *EDU-MAT: Jurnal Pendidikan Matematika*, *10*(2), 215-221. https://doi.org/10.20527/edumat.v10i2.14595

Khumaimah, R. R. (2024). The Application of Affective Taxonomy in Character Development of Students. *Journal of Islamic Elementary Education*, *2*(2), 44–59. https://doi.org/10.35896/jiee.v2i2.823

Kotas, J. (2017). Mathematical Decision-Making with Linear and Convex Programming. Dalam A. Wootton, V. Peterson, & C. Lee (Ed.), *A Primer for Undergraduate Research* (hlm. 171–191). Springer International Publishing. https://doi.org/10.1007/978-3-319-66065-3_8

Lee, H. J., Park, Y., & Bong, M. (2024). Differences in the longitudinal relationship between self-efficacy and interest across domains and student characteristics. *Learning and Individual Differences*, *113*, 102462. https://doi.org/10.1016/j.lindif.2024.102462

Lestari, R. (2020). An Analysis of Student Difficulties in Writing Descriptive at Eight Grade in SMP N 4 Muara Bungo. *Journal of Language Education and Development (JLed)*, *2*(2), 261–271. https://doi.org/10.52060/jled.v2i2.282

Lestari, S., Haryana, G., & Mujiono, M. (2024). The Effectiveness of the Google Classroom Application as a Learning Media to Improve Learning Outcomes in Economics Lessons in Classes XI IPS 1 and XI IPS 2 SMAN 1 Bungaraya Siak Regency. *JETISH: Journal of Education Technology Information Social Sciences and Health*, *3*(2), 837–844. https://doi.org/10.57235/jetish.v3i2.2257

Lin, Y.-C., Lin, Y.-T., & Huang, Y.-M. (2011). Development of a diagnostic system using a testing-based approach for strengthening student prior knowledge. *Computers & Education*, *57*(2), 1557–1570. https://doi.org/10.1016/j.compedu.2011.03.004

Marlina, L., & Rahayu, Y. M. (2025). Penerapan Metode Scaffolding Pada Zone Of Proximal Development (ZPD) Dalam Meningkatkan Hasil Belajar Siswa Kelas X-1 SMAN 6 Kota Tangerang Selatan. *Pro Patria: Jurnal Pendidikan, Kewarganegaraan, Hukum, Sosial, dan Politik*, *8*(1), 42–55. https://doi.org/10.47080/propatria.v8i1.3786

Muntazhimah, M., Turmudi, T., & Prabawanto, S. (2021). The relation between prior knowledge and students' mathematics reflective thinking ability. *Journal of Physics: Conference Series*, *1731*(1), 012043. https://doi.org/10.1088/1742-6596/1731/1/012043

Mutawah, M. A. A., Thomas, R., Eid, A., Mahmoud, E. Y., & Fateel, M. J. (2019). Conceptual Understanding, Procedural Knowledge and Problem-Solving Skills in Mathematics: High School Graduates Work Analysis and Standpoints. *International Journal of Education and Practice*, *7*(3), 258–273. https://doi.org/10.18488/journal.61.2019.73.258.273

Ningsih, R. P., Syahrilfuddin, S., & Lazim, L. (2020). Penerapan Teori Jerome Bruner untuk Meningkatkan Hasil Belajar Matematika Siswa Kelas IV B SD Negeri 158 Pekanbaru. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *9*(1). https://doi.org/10.33578/jpfkip.v9i1.7363

Oktafia, M., Putra, A., & Habibi, M. (2020). The Analysis of Students' Error in Operation Reseach Test for Linear Program Topic Based on Newman's Error Analysis (NEA). *Edumatika : Jurnal Riset Pendidikan Matematika*, *3*(2), 103. https://doi.org/10.32939/ejrpm.v3i2.591

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33

Raffaele, A., & Gobbi, A. (2021). Teaching Operations Research Before University: A Focus on Grades 9–12. *Operations Research Forum*, *2*(1), 13. https://doi.org/10.1007/s43069-021-00054-3

Rohadi, N., Setiawan, I., & Swistoro, E. (2020). Descriptive Qualitative Analysis Based on Physics Mental Model of Students' Cognitif Understanding on the Concepts of Kinematics Particle and Parabolic Motion. *Jurnal Pembelajaran Fisika*, *8*(1), 121–128. https://doi.org/10.23960/jpf.v8.n1.202012

Samsun, S., Tjalla, A., & Sarifah, I. (2024). Understanding Physics: The Influence of Cognitive Styles and Student Interest. *Journal of Comprehensive Science (JCS)*, *3*(12), 5623–5630. https://doi.org/10.59188/jcs.v3i12.2944

Santi, E.-A., Gorghiu, G., & Pribeanu, C. (2024). The Relationship Between Intrinsic Motivation, Academic Self-Efficacy, Learning Engagement, and Test Anxiety, As Perceived By University Students. *Problems of Education in the 21st Century*, *82*(6), 892–903. https://doi.org/10.33225/pec/24.82.892

Shekarian Yazd, F., Abbasi Gharib, N., Bavafa, A., & Jaberghaderi, N. (2019). Relationship of Perfectionism and Anxiety Sensitivity with Academic Motivation in University Students. *International Journal of Health and Life Sciences*, *6*(1), e94708. https://doi.org/10.5812/ijhls.94708

Shoaib, A. M., Atawia, A. A., Hassanean, M. H., Gadallah, A. G., & Bhran, A. A. (2024). Simultaneous Synthesis of Single- and Multiple-Contaminant Water Networks Using LINGO and Excel Software. *Water*, *16*(9), 1244. https://doi.org/10.3390/w16091244

Shodikin, A., Istiandaru, A., Purwanto, Subanji, & Sudirman. (2019). Thinking errors of pre-service mathematics teachers in solving mathematical modelling task. *Journal of Physics: Conference Series*, *1188*(1), 012004. http://doi.org/10.1088/1742-6596/1188/1/012004

Shodikin, A., Ekawati, R., Purnomo, H., & Abdullah, A. H. (2024). Failure in Constructing the Mathematical Model in Real-World Problems. *TEM Journal*, *13*(4), 3335-3345. http://doi.org/10.18421/TEM134-68

Sianturi, H., Siahaan, C., Dinda, S. I., & Sembiring, Y. B. (2020). Students' Comprehension and Difficulties on Reading Descriptive Text at SMA Swasta Pencawan Medan. *Linguistic, English Education and Art (LEEA) Journal*, *3*(2), 265–273. https://doi.org/10.31539/leea.v3i2.1045

Sinaga, A. S. R. (2022). Analysis of Students' Reading Comprehension of Descriptive Text at SMK Negeri 2 Pematangsiantar. *Indonesian Journal Education*, *1*(2), 56–59. https://doi.org/10.56495/ije.v1i2.297

Sugiura, A., & Sugiura, S. (2020). Applying to Motivated Course Management by Operations Research Perspective. *Transactions of Japan Society of Kansei Engineering*, *19*(3), 325–333. https://doi.org/10.5057/jjske.TJSKE-D-19-00076

Sunaryo, Y., & Fatimah, A. T. (2020). Contextual approach with scaffolding: An effort to improve student's mathematical critical thinking. *Journal of Physics: Conference Series*, *1521*(3), 032015. https://doi.org/10.1088/1742-6596/1521/3/032015

Susanto, E., & Susanta, A. (2022). Problem-Based Learning dalam Meningkatkan Higher Order Thinking Skills Mahasiswa. *Arithmetic: Academic Journal of Math*, *4*(2), 185. https://doi.org/10.29240/ja.v4i2.4912

Syaiful, L., Ismail, M., & Aziz, Z. A. (2019). A Review of Methods To Measure Affective Domain in Learning. *2019 IEEE 9th Symposium on Computer Applications & Industrial Electronics (ISCAIE)*, 282–286. https://doi.org/10.1109/ISCAIE.2019.8743903

Taranto, E., Colajanni, G., Gobbi, A., Picchi, M., & Raffaele, A. (2024). Fostering students' modelling and problem-solving skills through Operations Research, digital technologies and collaborative learning. *International Journal of Mathematical Education in Science and Technology*, *55*(8), 1957–1998. https://doi.org/10.1080/0020739X.2022.2115421

Tayibu, N. Q., & Faizah, A. N. (2021). Efektivitas Pembelajaran Matematika melalui Metode Penemuan Terbimbing Setting Kooperatif. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(1), 117–128. https://doi.org/10.31980/mosharafa.v10i1.728

Tsabitah, I., Hidayat, N., Alfaridzi, M., Ilmi, S., & Walida, S. E. (2024). Pendampingan Penguatan Dasar Matematika Untuk Meningkatkan Pemahaman Konsep Calon Guru Matematika. *JMM (Jurnal Masyarakat Mandiri)*, *8*(2), 1590. https://doi.org/10.31764/jmm.v8i2.21157

Valstar, S., Griswold, W. G., & Porter, L. (2019). The Relationship between Prerequisite Proficiency and Student Performance in an Upper-Division Computing Course. *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 794–800. https://doi.org/10.1145/3287324.3287419

Wati, I., Ristiliana, R., Rambe, P., & Susanti, E. (2024). Analisis Kesulitan dalam Penyelesaian Soal Matematika Ekonomi pada Mahasiswa Pendidikan Ekonomi: Perspektif Koneksi Matematis. *Eklektik : Jurnal Pendidikan Ekonomi dan Kewirausahaan*, *7*(1), 82-90. https://doi.org/10.24014/ekl.v7i1.30134

Wulandari, N. P., & Salsabila, N. H. (2025). Strategi belajar mahasiswa dalam menyelesaikan masalah program linier dengan dualitas. *Mandalika Mathematics and Education Journal*, *7*(2), 999-1007. https://doi.org/10.29303/jm.v7i2.9522

Yerizon, Jazwinarti, & Yarman. (2018). Developing learning material of introduction to operation research course based on problem-based learning. *Journal of Physics: Conference Series*, *948*, 012045. https://doi.org/10.1088/1742-6596/948/1/012045