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

Toulmin's Model in Analyzing Students' Combinatoric Argumentation

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Article received: 01-08-2024, revision: 22-09-2024, published: 30-10-2024

Abstrak

Argumentasi kombinatorik merupakan kemampuan penting dalam pembuktian matematika yang menurut model Toulmin, argumentasi tersebut terdiri dari *claim*, *evidence*, *warrant*, dan *backing*. Tujuan dari penelitian yaitu untuk menganalisis struktur argumentasi kombinatorik mahasiswa menggunakan model Toulmin. Jenis penelitian yang digunakan pada penelitian ini adalah deskriptif kualitatif. Pada penelitian ini melibatkan 93 mahasiswa semester dua tahun ajaran 2022/2023 di Jurusan Pendidikan Matematika Universitas Sriwijaya. Pengumpulan data pada penelitian ini melalui tes tertulis. Para mahasiswa diminta untuk memberikan argumentasi kombinatorik pada pembuktian matematika yang berkaitan dengan teorema binomial. Argumentasi kombinatorik tersebut kemudian dianalisis menggunakan model Toulmin. Hasil penelitian menunjukkan bahwa 96% kemampuan argumentasi kombinatorik mahasiswa berada pada level 2 dengan kategori argumentasi kombinatorik disusun dengan kurang baik, serta sebagian besar mahasiswa mengalami kesulitan dalam memberikan *claim*, *evidence*, *warrant*, dan *backing* dalam argumentasi kombinatorik. Berdasarkan temuan ini, disarankan agar program pembelajaran difokuskan pada penguatan keterampilan berpikir kritis dan argumentatif, melalui metode diskusi terbimbing, problem-based learning, serta pemberian latihan soal yang mendorong eksplorasi dan pembenaran logis atas setiap jawaban yang diberikan mahasiswa.
Kata Kunci: Argumentasi Kombinatorik; Model Toulmin; Pembuktian Matematika

Abstract

Combinatorial argumentation is an important ability in mathematical proof, and according to Toulmin's model, the argumentation consists of claim, evidence, warrant, and backing. The purpose of the research is to analyze the combinatorial argumentation structure of undergraduate students using the Toulmin model. The type of research used in this research is descriptive qualitative. This study involved 93 second-semester undergraduate students in the 2022/2023 academic year at the Department of Mathematics Education, Sriwijaya University. Data collection in this study was through written tests. The undergraduate students were instructed to provide combinatorial argumentation on mathematical proofs related to the binomial theorem. The combinatorial argumentation was then analyzed using the Toulmin model. The results showed that 96% of undergraduate students' combinatorial argumentation skills were at level 2 with the category of badly organized combinatorial argumentation, and most undergraduate students had difficulties in providing claim, evidence, warrant, and backing in combinatorial argumentation. Based on these results, it is suggested that the learning program should focus on the improvement of critical and argumentative thinking skills through guided discussions, problem-based learning, and exercises that encourage exploration and logical justification of each answer given by undergraduate students.
Keywords: Combinatorial Argumentation; Toulmin Model; Mathematical Proofs

I. INTRODUCTION

Mathematics has logical structures and deductive thinking patterns that are composed of axioms, theorems, and defined concepts (Sadieda, 2019). The standards of the mathematics learning process consist of five standards such as problem solving, reasoning and proof, mathematical communication, connections, and mathematical representation (NCTM, 2000). Mathematical proof is deductive reasoning because it requires a process in thinking when drawing conclusions on things that have been proven (Fadillah, 2019). This mathematical proof is one of the most important abilities in learning mathematics (Yohanes, 2022). The ability of mathematical proof requires understanding statements and mathematical symbols, after which the proof of the truth of a statement is mathematically arranged (Prabowo, 2023).

According to Thompson et al. (2012), case-specific reasoning is a pedagogical stage that can help in generating general arguments along with the use of example statements without justification. Argumentation is a claim that consists of other components such as evidence, warrant, backing, qualifier, and rebuttal (Toulmin, 2003). Mathematical argumentation has a function to show ideas from the overview results obtained in sources that take mathematical ideas or concepts using their own language or using mathematical symbols and notations (Resmi et al., 2021). General argumentation consists of two types such as deductive argumentation and inductive argumentation. The structure of mathematics has deductive reasoning so that proof in mathematics often uses deductive argumentation (Sadieda, 2019). Mathematical argumentation is also the ability to draw conclusions from the facts and information obtained provided that it contains indicators of the argumentation component of the toulmin model. One of the patterns in argumentation that can be used in supporting and helping the learning process that uses argumentation is Toulmin's Argumentation Pattern or Toulmin's Argumentation Model (Yuanata et al., 2022). The Toulmin model has 6 components in its argumentation pattern, namely claim, evidence, warrant, qualifier, rebuttal, and backing and argumentation can be said to be good if in the argumentation there is a claim and then the warrant connects the evidence and claim with the help of backing (Zulainy et al., 2021). According to Noviyanti et al. (2019), good argumentation is an argumentation that has a correct claim, correctly presented evidence, warrant supported by backing, rebuttal accompanied by supporting reasons and evidence, and can connect data with arguments efficiently.

Combinatorics is one of the branches of mathematics that studies the arrangement of sets of objects without enumerating (counting or counting) all possibilities in their arrangement (Rizqika et al., 2019). Combinatorics has a scope of rules such as factorial notation, addition, multiplication, binomial coefficient, permutation, to combination, and in combinatorics learning has various identities, one of which is derived from the Binomial Theorem (Mujib, 2016). The thinking structure in

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

combinatorics includes determining formulas or expressions of a problem, performing the calculation process, then ending through a series of results which are then used in simple combinatoric problems with the aim of strengthening concept understanding in combinatoric thinking (Rapanca et al., 2020). The topic of combinatorics is one of the problems of mathematics that is quite difficult for students to solve because it is difficult to understand the proof process (Uripno & Rosyidi, 2019). From all the explanations above, it can be concluded that combinatoric argumentation is the ability to draw conclusions from information on the arrangement of objects without enumerating (counting or counting) all possibilities in the arrangement.

Low argumentation skills in working on combinatoric problems often occur in students. In research also conducted by Amalia & Pujiastuti (2020), it shows that students are still unable to understand the information in the problem as a result the student cannot convert the problem into a mathematical model or symbol, cannot relate facts or concepts, and there are errors in the process of mathematical operations on combinatoric problems. According to Cahyani & Aini (2021), the cause of students experiencing procedural errors is due to a lack of understanding of concepts during problem solving. Lack of accuracy in presenting data and the ability to link data affects students when drawing a conclusion (Sundayana & Parani, 2023). The ability of students' mathematical argumentation can be categorized as still low, as in research also conducted by Cahya & Warmi (2019), the results of the study show that the average indicators of giving reasons, compiling evidence, and drawing conclusions are still relatively low. In line with research conducted by Mujib (2019), the difficulties faced by students when constructing proofs such as lack of understanding of concepts, strategies, language, and mathematical symbols. Research conducted by Ishaq et al. (2022) shows the results that the argumentation skills of students in showing the argumentation aspect, namely claim, are in the sufficient category, showing the argumentation aspects, namely evidence and warrant, are in the insufficient category, while showing the argumentation aspect, namely backing, is in the very poor category.

Related research on Toulmin's argumentation model has been conducted by several other researchers. The results of research using the Toulmin model conducted by Mellenia & Admoko (2022) using the method, namely Research & Development (R&D) with 5 stages based on the ADDIE development research model (Analyze, Design, Development, Implementation, and Evaluation), presented the results of Toulmin argumentation-based learning effectively improving argumentation skills. The results of research also conducted by Riwayani et al. (2019), shows that students have been able to provide claims presented with evidence, warrant, rebuttal but the backing provided still does not support the claim. Literature study research conducted by Widhi et al. (2021) describes the results of learning argumentation based on the

Toulmin model from several previous studies showing that there are some results of his research that show the argumentation skills of good students but there are also some research results that show the argumentation skills of poor students. Compared to the results previously described, research conducted by Suartha et al. (2020) which also used the Toulmin argumentation model, showed that the quality of argumentation skills was poor. If the problem of low argumentation skills in combinatorics is not addressed immediately, students will have difficulty in understanding basic concepts, designing solutions systematically, and developing logical thinking skills needed in solving complex mathematical problems. This can have a negative impact on the overall quality of mathematics learning, hampering students' argumentation skills and critical thinking ability.

Based on this description, the researcher is interested in conducting this study which has the aim of analyzing the combinatoric argumentation of students using the Toulmin model. Therefore, the problem that will be answered in this study is "How is the combinatoric argumentation of students using the Toulmin model?". This research has the novelty of using the Toulmin Model in analyzing the combinatorics argumentation ability of students, which has not previously been applied in the context of combinatorics studies at the college level.

II. METHOD

The research conducted by researchers is descriptive qualitative research. This qualitative descriptive research is research that can help describe existing phenomena and display data without the manipulation process (Rusandi & Rusli, 2021). In this study, we chose a qualitative descriptive method because it allows exploring a deeper understanding of individual or group behavior patterns, subjective experiences, and describing the phenomenon of student combinatoric argumentation without data manipulation. The type of test questions given are proof questions so that student answers can be analyzed completely. The selection of this test question in qualitative descriptive research aims to explore students' in-depth understanding of a combinatoric argumentation phenomenon. The questions given were arranged in an open form to allow students to express their interpretations freely. Thus, through these diverse answers the researcher can find patterns of the Toulmin Model that arise naturally from the data collected. The research conducted by this researcher was carried out at the FKIP Campus of Sriwijaya University Palembang. The subjects in this study were 93 students from the Mathematics Education Study Program of FKIP Sriwijaya University in the academic year 2022/2023. Data collection techniques carried out by research using tests and documentation. The written test given to students has a total of 4 items, with 2×45 minutes of test questions with open source tests. Data in the form of student combinatoric argumentation that has been obtained is then analyzed using Toulmin model argumentation indicators. The Toulmin model argumentation indicators are shown in Table 1.

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

Tabel 1.
Indikator Model Toulmin

Level	Level Category	Total Score of All Questions	Score Criteria
1	Not Good	0 – 5	• State the claim clearly and correctly (Score +1) • Explaining evidence/data (Score +1) • Proof using warrant (Score +1) • There is backing that supports (Score +1) • The flow of proof is structured (Score +1)
2	Less Good	6 – 10	
3	Good Enough	11 – 15	
4	Good	16 – 20	
5	Very Good	21 – 25	

In analyzing the results using the Toulmin argumentation model as in Table 1. The Toulmin argumentation model is the right choice in analyzing argumentation because in the Toulmin model there are 6 complex components such as claim, evidence, warrant, backing, qualifier, and rebuttal so that the Toulmin model is very effective in measuring a person's argumentation skills (Afandi et al., 2021). The following is the Toulmin model argumentation scheme as shown in Figure 1.

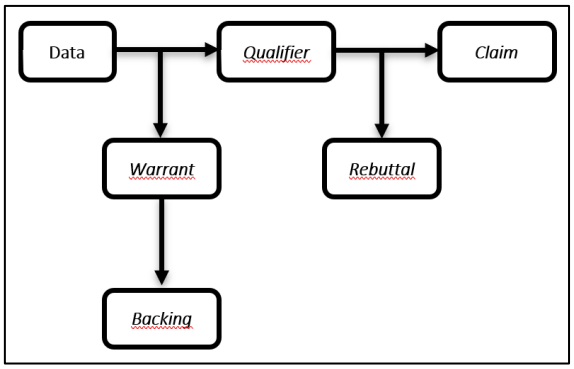

Figure 1. Schematic of the Toulmin Model

The components of the Toulmin model as shown in Figure 1 are the basic components of the Toulmin model, namely claim, data/evidence, warrant, and backing. These basic components are supported by other components, namely rebuttal and qualifiers which are optional (Faizah et al., 2021). The data analysis conducted in this study only uses the basic components of the Toulmin model.

III. RESULT AND DISCUSSION

The results of data analysis show a description of the answers of 93 students from 4 combinatoric proof questions that 96% of students still have low argumentation skills, which are at level 2 with the category of poorly structured argumentation. Details of the analysis results are shown in Table 2.

Tabel 2.
Students' Combinatorics Argumentation Level

Score	Argumentation Level	Category Level	Total Students	Percentage
0 – 5	1	Not Good	2	2%
6 – 10	2	Less Good	89	96%
11 – 15	3	Good Enough	2	2%
16 – 20	4	Good	0	0%
21 – 25	5	Very Good	0	0%
Total			**93**	**100%**
Average Level			**Level 2 Argumentation is poorly organized**	

The results in Table 2 show that 2% of students who have level 1 with the category of students' combinatoric argumentation skills are not good. At level 1, students are only able to state the claim correctly and have not been able to explain the evidence with a structured flow, warrant, to backing. Then there are 96% of students who have level 2 with the category of students' combinatoric argumentation skills are not good. While 2% of other students are at level 3 with the category of students' combinatoric argumentation skills quite well. This has factors that affect the score results when analyzing student answers, these factors can be seen from the attachment of

student answers as in Figure 2 and Figure 3.

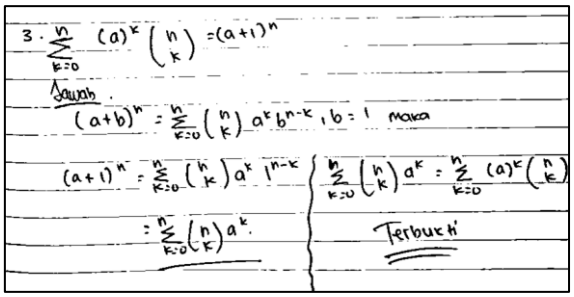

Figure 2. Students Result

In Figure 2, it can be seen that the answers from students have shown the claim, namely $\sum_{k=0}^{n}(a)^k \binom{n}{k} = (a+1)^n$ shows warrant is $(x+y)^n = \sum_{k=0}^{n} \binom{n}{k} x^{n-k}y^k$ but the warrant given by the student shows the value of *x* is *a* and the value of *y* is *b* which then the student chooses the value *b* = 1 so that $\sum_{k=0}^{n} \binom{n}{k} (a)^k.1^{n-k} = (a+1)^n$. In addition, the warrant given by the student has an error that should be $\sum_{k=0}^{n} \binom{n}{k} a^{n-k}.1^k = (a+1)^n$. In this answer, students have been able to carry out the evidence stage but have not been structured and students have not been able to provide backing, namely the value of *n* is a non-negative integer or $n = \{0,1,2,3,4,5,\dots\}$. Then we can see that from the student's answer in Figure 2, there are factors that affect the score of the student's answer, namely the student's error in answering and the lack of understanding of the concepts or data in the problem that has been given. Lack of understanding of concepts is included in conceptual dimension errors which are errors when understanding ideas or ideas in mathematics (Suhady et al., 2019).

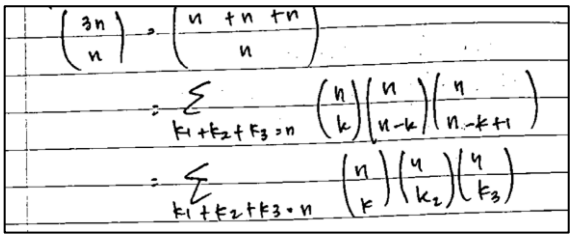

Figure 3. Students Result

In Figure 3, it can be seen that the answers of students have not been able to show the claim in the problem, namely $\binom{3n}{n} = \sum_{k_1+k_2+k_3=n} \binom{n}{k_1}\binom{n}{k_2}\binom{n}{k_3}$, has not been able to show warrant, namely the Vandermonde Identity which states that $\binom{m+n}{r} = \sum_{k=0}^{r} \binom{m}{r-k}\binom{n}{k}$, has not been able to show backing, namely that m,n,r are non-negative numbers or $m,n,r = \{0,1,2,3,4,5,\dots\}$ for $n = m = r$, and students have not been able to do the evidence stage so that the proof is not structured. Then we can see that from the student's answer in Figure 3, there are factors that affect the score of the student's answer, namely the lack of understanding of the concepts or data in the problem given.

In Figure 2 and Figure 3, it can be concluded that the factors that influence the score of students' answers so that they make students' combinatoric argumentation skills at level 2 with the category of argumentation prepared by students is not good, namely because of students' mistakes in answering and students' lack of understanding of the concepts or data in the written questions that have been given. Errors in answering such as in arithmetic operations are included in the technical dimension error (Ulfa & Kartini, 2021).

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

Data analysis through the process of processing data from student answers and analyzed using the Toulmin Model indicators. Each student needs to answer all the questions given, then the results of student answers are analyzed according to the score criteria on the Toulmin Model indicators consisting of claim, evidence, warrant, and backing so as to produce an argumentation ability level category. The answers from students are argumentation in written form that informs what students know. Argumentation that can be said to be good if it has a claim as the main argument, then the data is proven to be true (evidence) with the flow of proof structured, then the data and claims are connected through warrant and supported by backing. There are factors that cause students' argumentation skills to be low, namely students are not accustomed to higher-level thinking skills and the learning methods applied, so that increasing students' argumentation skills is needed to optimize the development of students' ability to understand concepts and build argumentation skills (Sari & Nada, 2022) The low argumentation skills in the field of combinatorics in students have an impact on difficulties in understanding basic concepts, formulating logical solutions, and developing systematic thinking patterns. This condition also hampers students' ability to connect various combinatorics principles critically, which in turn hampers their ability to understand basic concepts, formulate logical solutions, and develop systematic thinking. This condition also hinders students' ability to connect various combinatorics principles critically, which in turn can reduce the quality of analysis, problem solving, and innovation in the development of mathematical theories and applications.

IV. CONCLUSION

Based on the results of research data analysis on students from the FETT Mathematics Education Study Program, Sriwijaya University Academic Year 2022/2023, it can be concluded that the average of students' combinatoric argumentation skills is at level 2 with the category of student combinatoric argumentation is not good. The combinatoric argumentation ability of students who are classified as a category that is still not good has factors that can affect the level of combinatoric argumentation ability. Factors that can affect this are students experiencing errors in answering (technical dimension error) and lack of understanding of the concepts and data in the written problems that have been given (conceptual dimension error). The results of this study can be used as reference material in designing further learning in order to improve students' combinatoric argumentation skills.

ACKNOWLEDGEMENT

The research/publication of this article is funded by the Sriwijaya University General Service Agency DIPA Budget for Fiscal Year 2023 Number SP DIPA-023.17.2.677515/2023, dated November 30, 2022. In accordance with the Rector Decree Number 0188/UN9.3.1/SK/2023 dated April 18, 2023.

REFERENCES

Afandi, Tenriawaru, A. B., & Anita. (2021). Konstruksi Perangkat Pembelajaran Menggunakan Model Argument Driven Inquiry (ADI) disertai Socioscientific Issues (SSI). *Jurnal Biologi Edukasi*, *13*, 6–16.

Amalia, N. A., & Pujiastuti, H. (2020). Analisis Kesulitan Mahasiswa dalam Menyelesaikan Soal ON MIPA Matematika. *Jurnal Pendidikan Matematika Raflesia*, *14*(2), 793. https://doi.org/10.35327/gara.v14i2.167

Cahya, I., & Warmi, A. (2019). Analisis Tingkat Kemampuan Penalaran Matematis Siswa SMP pada Materi Relasi dan Fungsi. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika, Sesiomadika*, 602–609.

Cahyani, A., & Aini, I. N. (2021). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Trigonometri Berdasarkan Kriteria Watson. *Jurnal Pembelajaran Matematika Inovatif*, *4*(2), 365–372. https://doi.org/10.22460/jpmi.v4i2.365-372

Fadillah, A. (2019). Analisis Kemampuan Penalaran Deduktif Matematis Siswa. *Jurnal Teori dan Aplikasi Matematika (JTAM)*, *3*(1), 15–21. https://doi.org/10.31764/jtam.v3i1.752

Faizah, S., Rahmawati, N. D., & Murniasih, T. R. (2021). Investigasi Struktur Argumen Mahasiswa dalam Pembuktian Aljabar Berdasarkan Skema Toulmin. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(3), 1466. https://doi.org/10.24127/ajpm.v10i3.3781

Ishaq, I. M., Khaeruddin, K., & Usman, U. (2022). Analisis Kemampuan Berargumentasi Dalam Pembelajaran Fisika Peserta Didik Sma Negeri 8 Makassar. *Jurnal Sains dan Pendidikan Fisika*, *17*(3), 211. https://doi.org/10.35580/jspf.v17i3.29781

Mellenia, R. P. A., & Admoko, S. (2022). Pengembangan Lembar Kerja Peserta Didik Pembelajaran Diskusi Berbasis Pola Argumentasi Toulmin untuk Melatihkan Keterampilan Argumentasi dan Berpikir Kritis. *Jurnal Ilmiah Pendidikan Fisika*, *6*(2), 313–327. https://doi.org/10.20527/jipf.v6i2.5248

Mujib, A. (2016). Pengembangan Kemampuan Pembuktian dalam Matematika Diskrit Menggunakan Pengajaran Berbasis DNR. *Seminar Nasional Matematika dan Pendidikan Matematika (SNMPM), September*, 176–190.

Mujib, A. (2019). Kesulitan Mahasiswa Dalam Pembuktian Matematis: Problem Matematika Diskrit. *Jurnal MathEducation Nusantara*, *2*(1), 51–57.

NCTM. (2000). *Principles and Standards for School Mathematics*. www.nctm.org

Noviyanti, N. I., Mukti, W. R., Yuliskurniawati, I. D., Mahanal, S., & Zubaidah, S. (2019). Students' scientific argumentation skills based on differences in academic ability. *Journal of Physics: Conference Series*, *1241*(1), 1–8. https://doi.org/10.1088/1742-6596/1241/1/012034

Prabowo, S. H. (2023). Analisis pembuktian formula deret hingga bilangan asli pangkat r menggunakan induksi dan deduksi matematika (kajian literasi kontribusi matematikawan muslim abad pertengahan). *Matematika Sains*, *1*(1), 34–43.

Rapanca, D., Wibowo, T., & Sapti, M. (2020). Struktur Berpikir Kombinatorik Siswa dalam Menyelesaikan Masalah Matematika. *Jurnal Pendidikan Surya*

Edukasi (JPSE), *6*(1), 96–103. https://doi.org/10.37729/jpse.v6i1.6496

Resmi, D. C., Rusdi, M., & Huda, N. (2021). Desain LKPD pada Materi Sistem Persamaan Linear Tiga Variabel Berbasis Generative Learning untuk Meningkatkan Kemampuan Argumentasi Matematika Siswa SMA. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *05*(02), 1854–1868.

Riwayani, R., Perdana, R., Sari, R., Jumadi, J., & Kuswanto, H. (2019). Analisis kemampuan argumentasi ilmiah siswa pada materi optik: Problem-based learning berbantuan edu-media simulation. *Jurnal Inovasi Pendidikan IPA*, *5*(1), 45–53. https://doi.org/10.21831/jipi.v5i1.22548

Rizqika, P., Hobri, & Pratama Murtikusuma, R. (2019). Pengembangan Perangkat Pembelajaran Berbasis Problem Based Learning Dan Jumping Task Pada Pokok Bahasan Kaidah Pencacahan Untuk Siswa Sma. *Kadikma*, *10*(1), 13–24.

Rusandi, & Muhammad Rusli. (2021). Merancang Penelitian Kualitatif Dasar/Deskriptif dan Studi Kasus. *Al-Ubudiyah: Jurnal Pendidikan dan Studi Islam*, *2*(1), 48–60. https://doi.org/10.55623/au.v2i1.18

Sadieda, L. U. (2019). Kemampuan argumentasi mahasiswa melalui model berpikir induktif dengan metode probing-prompting learning. *Pythagoras: Jurnal Pendidikan Matematika*, *14*(1), 23–32. https://doi.org/10.21831/pg.v14i1.24038

Sari, W. K., & Nada, E. I. (2021, June). Analisis kemampuan argumentasi ilmiah mahasiswa pendidikan kimia pada pembelajaran daring. In *NCOINS: National Conference Of Islamic Natural Science* (Vol. 1, No. 1, pp. 1-10).

Suartha, I. N., Setiawn, I. G. A. N., & Sudiatmika, A. A. R. (2020). Pola Argumen Toulmin Pada Proses Pembelajaran Ipa Smp. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, *4*(April), 1–11.

Suhady, W., Roza, Y., & Maimunah, M. (2019). Identifikasi Kesalahan Konseptual Dan Prosedural Siswa Dalam Menyelesaikan Soal Pada Materi Dimensi Tiga. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *3*(2), 494–504. https://doi.org/10.31004/cendekia.v3i2.143

Sundayana, R., & Parani, C. E. (2023). Analyzing Students' Errors in Solving Trigonometric Problems Using Newman's Procedure Based on Students' Cognitive Style. *Mosharafa: Jurnal Pendidikan Matematika*, *12*(1), 135–144. https://doi.org/10.31980/mosharafa.v12i1.2486

Thompson, D. R., Senk, S. L., & Johnson, G. J. (2012). Opportunities to Learn Reasoning and Proof in High School Mathematics Textbooks. *Journal for Research in Mathematics Education*, *43*(3), 253–295. https://doi.org/10.5951/jresematheduc.43.3.0253

Toulmin, S. E. (2003). The Uses of Argument: Updated Edition. In *Cambridge University Press*. https://doi.org/10.1017/CBO9780511840005

Ulfa, D., & Kartini, K. (2021). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Logaritma Menggunakan Tahapan Kesalahan Kastolan. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 542–550. https://doi.org/10.31004/cendekia.v5i

1.507

Uripno, G., & Rosyidi, A. H. (2019). Students' Combinatorial Thinking Processes in Solving Mathematics Problem. *Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika (JRPIPM)*, *2*(2), 80. https://doi.org/10.26740/jrpipm.v2n2.p80-92

Widhi, M. T. W., Hakim, A. R., Wulansari, N. I., Solahuddin, M. I., & Admoko, S. (2021). Analisis Keterampilan Argumentasi Ilmiah Peserta Didik Pada Model Pembelajaran Berbasis Toulmin's Argumentation Pattern (TAP) Dalam Memahami Konsep Fisika Dengan Metode Library Research. *PENDIPA Journal of Science Education*, *5*(1), 79–91. https://doi.org/10.33369/pendipa.5.1.79-91

Yohanes, R. S. (2022). Proses Berpikir Mahasiswa dalam Mengkonstruksi Pembuktian Matematika. *PRISMA, Prosiding Seminar Nasional Matematika*, *5*, 185–194.

Yuanata, B. E., Artanti, K. P., Saregar, A., & Deta, U. A. (2022). Profil Keterampilan Ilmiah Peserta Didik pada Model Pembelajaran Berbasis Toulmin's Argumentation Pattern (TAP) dalam Memahami Konsep Fisika. *Jurnal Ilmu Pendidikan dan Pembelajaran*, *01*(01), 1–6. https://doi.org/10.58706/jipp.v1n1.p1-6

Zulainy, F., Rusdi, R., & Marzal, J. (2021). Pengembangan Lembar Kerja Peserta Didik Berbasis Realistic Mathematics Education untuk Meningkatkan Kemampuan Argumentasi Peserta Didik. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 812–828. https://doi.org/10.31004/cendekia.v5i1.440

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