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Analysis of Students' Argumentation Skills related Hydrostatic Pressure

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Abstract

Argumentation skills are one of the skills needed to stimulate critical thinking skills in facing challenges in the 21st century. Therefore, students' argumentation skills need to be analyzed to find out the extent of students' argumentation skills and what causes them. This study aims to analyze the quality of students' argumentation skills on the topic of hydrostatic pressure. The research adopts a cross-sectional survey design using a one-shot survey or test. The study involved 45 students from a public university in South Sulawesi who had received instruction on hydrostatic pressure material. Data collection was conducted using a random sampling technique with an essay-based test instrument. The data analysis technique used in this study is descriptive analysis. The results indicate that the quality of students' argumentation skills remains at level 1 and level 2. The percentage of students who have argumentation skills at level 1 is 26.66% and argumentation skills at level 2 is 73.33% while the percentage of students who have argumentation skills at level 4, level 5, and level 5 is 0%. Overall, students' argumentative skills at a state university in South Sulawesi are still considered low. Therefore, it is necessary to plan and implement learning that can train students' argumentative skills.

Keywords: Argumentation Skills, Hydrostatic Pressure, Science Education

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INTRODUCTION

Preparing students to endure and thrive in their future lives is a fundamental goal of higher education. This is increasingly important given the growing complexity and diversity of challenges in the 21st century (Stevens, 2012). Therefore, higher education must design learning strategies that not only focus on knowledge transfer but also on the development of skills and competencies relevant to the demands of the era. Teaching in the 21st century emphasizes mastery of three key areas: skills, knowledge, and competencies. In terms of knowledge, students are expected to develop critical thinking, problem-solving, effective communication, and productive collaboration skills (Binkley et al., 2010). These skills are essential not only in academic settings but also as foundation for success in the workforce and in dynamic social environments. However, this situation presents a significant challenge for the

education sector. Educational institutions are required to discover approaches and learning strategies that effectively and sustainably foster these skills (Lamb et al., 2017). This includes innovation in teaching methods, the use of technology, and the creation of learning environments that support exploration and student creativity.

One of the essential skills that needs to be enhanced is critical thinking. This skill serves as a fundamental foundation that must be mastered before developing other learning and innovation abilities. Indicators of critical thinking skills include the ability to analyze, comprehend, and evaluate arguments within the learning process (Binkley et al., 2010), as well as the ability to construct and defend arguments and beliefs (Jonassen & Kim, 2010).

Argumentation skills are a fundamental aspect, as they are essential in everyday life. The habit of engaging in discussions or debates is highly beneficial in daily activities, as the ability to argue helps individuals make logical and analytical decisions on various controversial issues (Lim, 2011). Moreover, argumentation serves as a crucial foundation for students to practice thinking, working, and interacting within science learning environments (Erduran, 2007). Therefore, learning that emphasizes argumentation or debating skills can significantly contribute to the enhancement of students' critical thinking abilities.

The model considered effective in enhancing students' argumentation skills through activities such as information gathering, responding to contradictions, and decision-making is Toulmin's Argument Pattern (TAP) (Torun, 2019). According to TAP, argumentation skills consist of six key components: claim, data, warrant, backing, qualifier, and rebuttal. A claim refers to the main statement or opinion, data serves as the evidence supporting the claim, while the warrant explains the logical connection between the two. Backing provides additional theoretical support to strengthen the warrant, the qualifier indicates the degree of certainty regarding the claim, and the rebuttal presents counterarguments or challenges to the existing argument or data (Toulmin, 2003).

Hydrostatic pressure is crucial for developing students' argumentative skills because it directly relates to phenomena around us, integrating an understanding of scientific concepts, evidence-based reasoning, and the ability to take logical positions on real-world problems (Suminar et al., 2025). Through discussions, experiments, and analysis of relevant social issues, students can develop critical, rational, and contextual scientific arguments.

Therefore, based on the background described, it is necessary to analyze students' argumentation skills in the topic of hydrostatic pressure. This study aims to examine the level of students' argumentation skills in the topic of hydrostatic pressure.

METHOD

This study adopts a cross-sectional survey design using a one-shot survey or test. The research was conducted at a public university in South Sulawesi. Forty-five first-semester students participated in the study. The study followed several stages, including a preliminary phase, data collection, and data analysis. The preliminary phase involved preparing the research instruments. The data collection phase was carried out by distributing the argumentation test instrument via Google Forms. The collected argumentation data were then processed, analyzed, and compiled into an article.

Data collection was based on a random sampling technique using an essay test instrument consisting of a single question as in Figure 1.

> A diver was diving in the waters off Makassar. At a depth of 10 meters, he felt increased pressure or pain in his ears compared to when he was at the surface. His friend, who was just learning to dive, panicked and asked, "Why does the pressure feel so much greater at such a depth, even though the water above us seems calm and doesn't exert any direct pressure?"

Toulmin's Argumentation Pattern. The results of the argumentation skill analysis were then converted according to the level criteria defined by Toulmin's Argumentation Pattern, as presented in Table 1.

Tabel 1. Toulmin Framework Based on Level Criteria

Level	Criteria
Level 1	Argumentation consisting of a simple claim in the form of claim vs counter-claim or claim vs claim
Level 2	Argumentation that includes a claim supported by data, warrant, or backing, but without a rebuttal
Level 3	Argumentation with a series of claims or counter-claims supported by data, warrant, or backing, accompanied by a weak rebuttal
Level 4	Argumentation with a clear claim and several well-defined rebuttals
Level 5	More complex and extended argumentation with more than one rebuttal

(Erduran et al., 2004)

RESULT AND DISCUSSION

The research findings on students' argumentation skills in the hydrostatic pressure topic are presented in Figure 1. Based on Figure 1, the highest quality of students' argumentation is at level 2 73,33%, followed by level 1 % 26,66%. Meanwhile, levels 3, 4, and 5 show lower percentages 0%. The research findings indicate that the quality of students' argumentation on the topic of hydrostatic pressure is still relatively low, as reflected by the highest percentages being at levels 1 and 2.

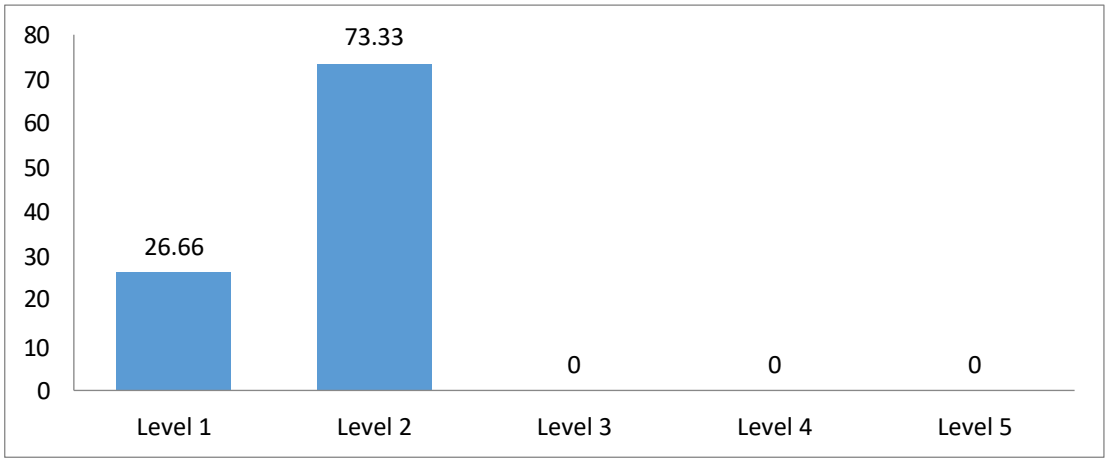

Figure 2. The results of student argumentation based on the Toulmin Argumentation pattern level criteria

Students' argumentation skills are divided into five levels, ranging from level 1 to level 5 (Erduran et al., 2004). The higher the students' argumentation pattern, the more complete the structure of the argument they present (Ho et al., 2019). Student argumentation at level 1 reflects a claim versus claim pattern. Responses at this level contain only a claim, without any supporting evidence, warrant, backing, reinforcement, or rebuttal (Erduran et al., 2004).

Based on the research findings, the percentage of student responses at level 1 is 26,66%, indicating that the quality of their argumentation is still low. This aligns with the statement by (Wardani et al., 2018). (Osborne et al., 2004), which explains that argumentation quality at level 1 consists of a single claim only, without strong reasoning supported by data, warrant, or backing. Such responses can be categorized as low-quality arguments.

In addition, at level 2, no rebuttals were found in students' responses—neither weak nor strong rebuttals. This is consistent with the findings of (Wardani et al., 2018) (Hoffmann, 2017), which explain that students were able to construct responses containing other argument elements to support a claim, but were unable to complete their arguments with a rebuttal. In the written argumentation instrument, the qualifier aspect was added to indicate the strength of the argument. According to (Toulmin, 2003), the qualifier indicator can serve as a benchmark for the strength of the evidence or data presented to support a claim.

The next levels-levels 3, 4, and 5 showed the lowest percentages in this study, each at 0%. There were no responses indicating that the quality of argumentation reached level 3, 4, or 5, as no rebuttals were found in the written arguments produced by the students. At level 3, argumentation includes a structure consisting of a claim, data, warrant or support, and a weak rebuttal (Erduran et al., 2004). Students' argumentation skills at this level are considered adequate but still need improvement (Demircioglu et al., 2022). Level 4 represents argumentation that includes a clear rebuttal and multiple claims (Erduran et al., 2004). Meanwhile, level 5 reflects a complete and well-developed argument that contains more than one rebuttal or reinforcement (Erduran et al., 2004).

The results of this study demonstrate that the quality of students' argumentation skills on the topic of hydrostatic pressure remains relatively low. Several factors

contribute to this low level of argumentation. First, based on the argument patterns constructed by students, it is evident that they have not yet fully understood the elements of scientific argumentation (Berland & McNeill, 2010) (Wardani et al., 2018). This is due to students' lack of familiarity with written argumentation models or direct debates in the classroom.,Second, students' content knowledge and conceptual understanding significantly influence the quality of their arguments. Students with adequate subject knowledge and conceptual comprehension are able to construct higher-quality arguments (Wardani et al., 2018). Arguments become more complete and coherent when students grasp the learning concepts (Aufschnaiter et al., 2007) (Rahman, 2018). Mastery of content knowledge relevant to a topic significantly contributes to their argumentation skills (Foong & Daniel, 2010). Students' conceptual understanding and reasoning can be observed through both written and oral forms of argumentation (Cetin, 2014) (Sudarmo et al., 2018). Third, students' experience in explaining their arguments using data and connecting it to the subject matter also plays a role. Thus, students' argumentation skills are stimulated by the experiences they gain (Demircioglu et al., 2022). Models or methods that can be used to develop students' argumentation skills include inquiry-based learning experiences (Hakim et al., 2020) (Noer et al., 2020), or implementing argumentation-based learning models (Ayoobi et al., 2021) (Wardani et al., 2018). In the learning process, teachers are expected to facilitate argumentation activities, both in written form and through direct discussion (Foong & Daniel, 2010).

CONCLUSION

Students' argumentation skills on hydrostatic pressure show that the quality of most students' argumentation skills is still low. The quality of students' argumentation skills is still at level 1 and level 2. Overall, students' argumentation abilities based on argumentation indicators are lacking. Therefore, learning that can train students' argumentation skills is needed, such as inquiry-based learning experiences or implementing argumentation-based learning models. In the learning process, teachers are expected to facilitate argumentation activities, both in written form and through direct discussion.

REFERENCES

Aufschnaiter, C. Von, Erduran, S., Osborne, J., & Simon, S. (2007). Arguing to Learn and Learning to Argue : Case Studies of How Students ' Argumentation Relates to Their Scientific Knowledge. *Journal of Research in Science Teaching*, *45*(1), 101–131. https://doi.org/10.1002/tea

Ayoobi, H., Cao, M., Verbrugge, R., & Verheij, B. (2021). *Argue to Learn : Accelerated Argumentation-Based Learning* *. 1118–1123. https://doi.org/10.1109/ICMLA52953.2021.00183

Berland, L. K., & McNeill, K. L. (2010). *A Learning Progression for Scientific Argumentation : Understanding Student Work and Designing Supportive*. 765–793. https://doi.org/10.1002/sce.20402

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., & Rumble, M. (2010). Defining 21st century skills. *White Paper Commissioned for the Assessment and*

Teaching of 21st Century Skills Project (ATC21S).

Cetin, P. S. (2014). Research in Science & Technological Education Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills. *Research in Science & Technological Education*, *October*, 37–41. https://doi.org/10.1080/02635143.2013.850071

Demircioglu, T., Karakus, M., & Ucar, S. (2022). *Developing Students ' Critical Thinking Skills and Argumentation Abilities Through Augmented Reality – Based Argumentation Activities in Science Classes* (Issue 0123456789). https://doi.org/10.1007/s11191-022-00369-5

Erduran, S. (2007). *Argumentation in Science Education*. Springer.

Erduran, S., Simon, S., & Osborne, J. (2004). Tapping into argumentation:Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education*, *88*(6), 915–933. https://doi.org/https://doi.org/10.1002/sce.20012

Foong, C. C., & Daniel, E. G. S. (2010). Incompetent grounds in science student's arguments: What is amiss in the argumentation process? *Procedia - Social and Behavioral Sciences*, *9*, 1198–1207. https://doi.org/https://doi.org/10.1016/j.sbspro.2010.12.307

Hakim, A., Sahmadesti, I., & Hadisaputra, S. (2020). Promoting students ' argumentation skill through development science teaching materials based on guided inquiry models Promoting students ' argumentation skill through development science teaching materials based on guided inquiry models. *Journal of Physics:Conference Series*. https://doi.org/10.1088/1742-6596/1521/4/042117

Ho, H., Chang, T., Lee, T., Chou, C., & Hsiao, S. H. (2019). Higher- and lower-achieving students think differently: Analysis of the scientific argumentation of Taiwanese elementary students. *Thinking Skills and Creativity*, 100607. https://doi.org/10.1016/j.tsc.2019.100607

Hoffmann, M. H. G. (2017). The Elusive Notion of " Argument Quality ." *Argumentation*. https://doi.org/10.1007/s10503-017-9442-x

Jonassen, D. H., & Kim, B. (2010). Arguing to learn and learning to argue: design justifications and guidelines. *Education Tech Research*, 439–457. https://doi.org/10.1007/s11423-009-9143-8

Lamb, S., Maire, Q., & Doecke, E. (2017). *Key Skills for the 21st Century : an evidence-based review*. Education Future Frontiers.

Lim, L. (2011). *Beyond logic and argument analysis : Critical thinking , everyday problems and democratic deliberation in Cambridge International Examinations ' Thinking Skills curriculum*. *43*(6), 783–807.

Noer, H. A., Setiono, & Pauzi, R. Y. (2020). Profil Kemampuan Argumentasi Siswa SMP Pada Materi Sistem Pernapasan. *Jurnal Pelita Pendidikan*, *8*(2), 138–144.

Osborne, J., Erduran, S., & Simon, S. (2004). *Enhancing the Quality of Argumentation in School Science*. *41*(10), 994–1020. https://doi.org/10.1002/tea.20035

Rahman, D. F. (2018). Analisis Argumentasi dalam Isu Sosiosaintifik Siswa SMP. *Thabiea : Journal of Natural Science Teaching*, *01*(01), 9–13.

Stevens, R. (2012). Identifying 21st Century Capabilities. *International Journal of Learning and Change*, *6*(3/4), 123–137. https://doi.org/10.1504/IJLC.2012.050857

Sudarmo, N. A., Lesmono, A. D., & Harijanto, A. (2018). Analisis kemampuan berargumentasi ilmiah siswa sma pada konsep termodinamika. *Jurnal*

Pembelajaran Fisika, 196–201.

Suminar, I., Nurdini, N., Fratiwi, N. J., Abdurrahman, D., & Purwanto, M. G. (2025). Inquiry-driven essay assessment (IDEA) as a framework for evaluating students ' argumentation in static fluids. *Indonesian Journal of Science and Mathematics Education*, *08*(March), 26–40. https://doi.org/10.24042/ijsme.v8i1.26194

Torun, F. (2019). Investigation of the Relationship Between Argumentation Level and Decision Making Skills of Secondary School Students. *Pamukkale Universitesi Egitim Fakultesi Dergisi*, 287–310. https://doi.org/10.9779/pauefd.528973

Toulmin, S. E. (2003). The uses of argument:Updated edition. *In the Uses of Argument:Updated Edition*. https://doi.org/https://doi.org/10.1017/CBO9780511840005

Wardani, A. D., Yuliati, L., & Taufiq, A. (2018). Kualitas Argumentasi Ilmiah Siswa pada Materi Hukum Newton. *Jurnal Pendidikan:Teori, Penelitian, Dan Pengembangan*.