

**ANALYSIS OF STUDENTS' SCIENTIFIC ARGUMENTATION SKILLS
THROUGH PROBLEM-BASED LEARNING ON
ENERGY RESOURCES TOPIC**

RESEARCH PAPER

Submitted as Requirement to Obtain Degree of *Sarjana Pendidikan* in
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**ANALISIS KETERAMPILAN ARGUMENTASI ILMIAH SISWA
MELALUI PEMBELAJARAN BERBASIS MASALAH
PADA TOPIK SUMBER DAYA ENERGI**

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Skripsi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar
Sarjana Pendidikan pada Fakultas Pendidikan Matematika dan
Ilmu Pengetahuan Alam

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DECLARATION

I do hereby declare with respect that every part of this research paper entitled “Analysis of Students’ Scientific Argumentation Skills through Problem-Based Learning on Energy Resources Topic” is purely the outcome of my own efforts and ideas, without plagiarizing any other studies. The findings or perspectives of experts gathered in this research paper have been cited or referred to in accordance with scientifically appropriate ethics. This statement was made with all sincerity and full awareness. If there is a infringement found in this study, or if there is a claim made by another party to the validity of this research, then I am willing to take responsibility and accept academic sanctions as necessary.

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ABSTRACT

This research aims to investigate the profile of students' scientific argumentation skills. The method used in this research was non-experimental with descriptive correlational design. The sample was taken conveniently (n=14 students) with grade 7 at one of the International School in Bandung. Generally, scientific argumentation component determined based on Toulmin Argumentation Pattern. Based on the analysis result, it shows that the learning process of problem-based learning had directed students to recognize and provide arguments, and the results of the argumentation quality in both of written and oral were mostly distribute at level 2 with the most frequent components was claim and qualifier at the lowest. However, there is a vary level in written argumentation when student answer the question number 3. Moreover, the quality of oral argumentation tends to be better than written argumentation since 42.46 % of students already include the rebuttal component in oral argumentation. In addition, there are also vary results of the correlation between oral and written argumentation. The correlation of oral and written problem number 1 about the relationship of increasing population with energy demand showed no correlation, the correlation of oral and written problem number 3 about the potential of renewable energy sources as the alternative to meets the world's energy showed no correlation, while oral and written problem number 2 demand about the use of fossil energy as a part of non-renewable energy sources showed a medium correlation with the correlation coefficient of 0.541.

Keyword: Scientific Argumentation, Problem-Based Learning, Energy Resources

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ABSTRAK

Penelitian ini bertujuan untuk menyelidiki profil keterampilan argumentasi ilmiah siswa. Metode yang digunakan dalam penelitian ini adalah non-eksperimental dengan desain *descriptive correlational*. Sampel diambil dengan teknik *convenience sampling* ($n = 14$ siswa) pada kelas 7 di salah satu Sekolah Internasional di Kota Bandung. Secara umum komponen argumentasi ilmiah ditentukan berdasarkan Pola Argumentasi Toulmin. Berdasarkan hasil analisis, ditunjukkan bahwa penerapan pembelajaran berbasis masalah mampu mengarahkan siswa untuk mengenal dan menyampaikan argumentasi, dan hasil kualitas argumentasi baik lisan maupun tertulis sebagian besar tersebar pada Level 2 dengan komponen yang paling sering muncul adalah klaim dan komponen kualifikasi ditemukan paling rendah. Namun terdapat variasi pada tingkat argumentasi tertulis ketika siswa menjawab soal nomor 3. Kualitas argumentasi lisan memiliki kecenderungan lebih baik daripada argumentasi tertulis karena 42,46% siswa sudah mampu memasukkan komponen sanggahan pada argumentasi verbal. Selain itu, terdapat perbedaan hasil korelasi antara argumentasi lisan dan tertulis. Korelasi argumentasi lisan dan tertulis nomor 1 tentang hubungan pertumbuhan penduduk dengan kebutuhan energi tidak menunjukkan adanya korelasi, korelasi argumentasi lisan dan tertulis nomor 3 terbarukan tentang potensi sumber energi terbarukan sebagai alternatif pemenuhan kebutuhan energi dunia tidak menunjukkan adanya korelasi, sedangkan argumentasi lisan dan tertulis nomor 2 tentang penggunaan energi fosil sebagai bagian dari sumber energi tak menunjukkan korelasi sedang dengan koefisien korelasi 0,541 dengan koefisien korelasi sebesar 0,541 yang mengindikasikan korelasi sedang (*medium*).

Kata Kunci: Argumentasi Ilmiah, Pembelajaran Berbasis Masalah, Sumber Daya Energi

PREFACE

Praise and gratitude, the author devote to the presence of God because of His grace and bless the author can complete this research paper entitled "Analysis of Students' Scientific Argumentation Skills through Problem-Based Learning on Energy Resources Topic". This research paper is prepared to fulfill one of the requirements for completing study at the university level, to obtain a bachelor's degree in the International Program on Science Education (IPSE).

This research paper is also as the platform to examine the knowledge that the author have received for 4 years at the university. To finish this research paper, the authors first propose a research, conduct the research, and finally make a report on this research. The author realizes that this research may have weaknesses, therefore suggestions or comments related to this research are highly welcomed by the author, and as a closing, the authors hope that with this research many parties can get benefit.

Bandung, August 2020

Author

Lina Christina

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REFERENCES

- Acar, Ö. (2014). Scientific reasoning, conceptual knowledge, & achievement differences between prospective science teachers having a consistent misconception and those having a scientific conception in an argumentation-based guided inquiry course. *Learning and Individual Differences, 30*, 148-154.
- Agustina, K., Kristiyanto, W., & Noviandini, D. (2017). Learning design of problem based learning model based on recommendations of syntax study and contents issues on physics impulse materials with experimental activities. *International Journal of Active Learning, 2*(2), 68-81.
- Anisa, A., Widodo, A., Riandi, R., & Muslim, M. (2019). Exploring high school student's argumentation structure through ecology: A case study. *Journal of Physics: Conference Series, 1157*(2).
- Anwar, Y., Susanti, R., & Ermayanti. (2019). Analyzing scientific argumentation skills of biology education students in general biology courses. *Journal of Physics: Conference Series, 1166*(1).
- Arends, R. I. (2007). Learning to teach: jilid dua (terjemahan). Yogyakarta: Pustaka Pelajar.
- Bilgin, I., Şenocak, E., & Sözbilir, M. (2009). The effects of problem-based learning instruction on university students' performance of conceptual and quantitative problems in gas concepts. *Eurasia Journal of Mathematics, Science and Technology Education, 5*(2), 153-164.
- Borgwardt, F., Robinson, L., Trauner, D., Teixeira, H., Nogueira, A. J. A., Lillebø, A. I., ... Culhane, F. (2019). Exploring variability in environmental impact risk from human activities across aquatic ecosystems. *Science of the Total Environment, 652*, 1396–1408.
- BP Statistical Review of World Energy. (2010). Energy in 2009 from recession to recovery. London: bp.com/statisticalreview.
- Chin, C. C., Yang, W. C., & Tuan, H. L. (2016). Argumentation in a socioscientific context and its influence on fundamental and derived science literacies. *International Journal of Science and Mathematics Education, 14*(4), 603-617.
- Crusius, T. W., & Channell, C. E. (2002). *The Aims of Argument: A Brief Rhetoric*. McGraw-Hill Humanities, Social Sciences & World Languages.

- Cunningham, J. B., & Aldrich, J. O. (2011). *Using SPSS: An interactive hands-on approach*. New York: Sage.
- Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, 12(1), 1207-1222.
- Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*, 500. Washington, DC: National Academies Press.
- Erduran, S. (2007). Methodological foundations in the study of argumentation in science classrooms. In *Argumentation in science education* (pp. 47-69). Dordrecht: 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.
- Faize, F. A., & Akhtar, M. (2020). Addressing environmental knowledge and environmental attitude in undergraduate students through scientific argumentation. *Journal of Cleaner Production*, 252, 119928.
- Faize, F. A., Husain, W., & Nisar, F. (2017). A critical review of scientific argumentation in science education. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 475-483.
- Fraenkel, J. R., & Wallen, N. E. (2008). How to design and evaluate research in education (pp. 146-164).
- Fraenkel, W., & Wallen, N. Hyun (2011). How to design and evaluate research in education.
- Garson, G. D. (2013). *Validity and reliability*. Asheboro, NC: Statistical Associates Publishers, 9-28.
- Gould, K., & Sadera, W. (2015). Evaluation of health profession student attitudes toward an online nutrition education problem-based learning module. *International Journal on E-Learning*, 14(2), 181-198.
- Ho, H. Y., Chang, T. L., Lee, T. N., Chou, C. C., Hsiao, S. H., Chen, Y. H., & Lu, Y. L. (2019). Above- and below-average students think differently: Their scientific argumentation patterns. *Thinking Skills and Creativity*, 34, 100607.

- Hsu, C. C., Chiu, C. H., Lin, C. H., & Wang, T. I. (2015). Enhancing skill in constructing scientific explanations using a structured argumentation scaffold in scientific inquiry. *Computers & Education*, *91*, 46-59.
- Hung, W. (2009). The 9-step problem design process for problem-based learning: Application of the 3C3R model. *Educational Research Review*, *4*(2), 118-141.
- IEA. (2019, November). *World Energy Outlook*. Retrieved from <https://www.iea.org/reports/world-energy-outlook-2019/electricity>
- Ika Noviyanti, N., Rosyadah Mukti, W., Dahlia Yuliskurniawati, I., Mahanal, S., & Zubaidah, S. (2019). Students' scientific argumentation skills based on differences in academic ability. *Journal of Physics: Conference Series*, *1241*(1).
- İskenderoğlu, Ö., & Akdağ, S. (2019). Comparison of nuclear energy and renewable energy consumption in terms of energy efficiency: An analysis on the EU members and candidates. *International Journal of Energy Economics and Policy*, *9*(6), 193–198.
- Jabarullah, N. H., & Hussain, H. I. (2019). The effectiveness of problem-based learning in technical and vocational education in Malaysia. *Education+ Training*.
- Kennett, H., Konrad, N., & Duncan, T. (2014). *Cambridge IGCSE physics*. Hodder Education.
- Klopp, E., & Stark, R. (2019). Scientific controversies and epistemological sensitization-Effects of an intervention on psychology students' epistemological beliefs and argumentation skills.
- Kuhn, D., & Crowell, A. (2011). Dialogic argumentation as a vehicle for developing young adolescents' thinking. *Psychological science*, *22*(4), 545-552.
- Kuhn, D., & Pease, M. (2006). Do children and adults learn differently?. *Journal of cognition and development*, *7*(3), 279-293.
- Lee, H. S., Liu, O. L., Pallant, A., Roohr, K. C., Pryputniewicz, S., & Buck, Z. E. (2014). Assessment of uncertainty-infused scientific argumentation. *Journal of Research in Science Teaching*, *51*(5), 581-605.
- Leech, N. L., Barrett, K. C., & Morgan, G. A. (2005). *SPSS for intermediate statistics: Use and interpretation*. Psychology Press.

- Merritt, J., Lee, M. Y., Rillero, P., & Kinach, B. M. (2017). Problem-based learning in K–8 mathematics and science education: A literature review. *Interdisciplinary Journal of Problem-Based Learning*, 11(2).
- Mózo, B. S. (2017). 濟無No Title No Title. *Journal of Chemical Information and Modeling*, 53(9), 1689–1699.
- Noviyanti, N. I., Mukti, W. R., Yuliskurniawati, I. D., Mahanal, S., & Zubaidah, S. (2019, June). Students' Scientific Argumentation Skills Based on Differences in Academic Ability. In *Journal of Physics: Conference Series*, 1241(1). IOP Publishing.
- Nurinda, S., Sajidan, S., & Prayitno, B. A. (2017, August). Enhancing High School Students's Rebuttals as An Important Aspect of Scientific Argumentation Skill Through Problem Based Learning. In *1st Annual International Conference on Mathematics, Science, and Education (ICoMSE 2017)*. Atlantis Press.
- Nurinda, S., Sajidan, S., & Prayitno, B. A. (2018). Effectiveness of Problem-Based Learning Module as An Instructional Tool in Improving Scientific Argumentation Skill. *Biosaintifika: Journal of Biology & Biology Education*, 10(2), 334–340.
- Ochoa, G. V., Alvarez, J. N., & Acevedo, C. (2019). Research evolution on renewable energies resources from 2007 to 2017: A comparative study on solar, geothermal, wind and biomass energy. *International Journal of Energy Economics and Policy*, 9(6), 242–253.
- Osborne, J. F., & Patterson, A. (2011). Scientific argument and explanation: A necessary distinction?. *Science Education*, 95(4), 627-638.
- Osborne, J., Simon, S., Christodoulou, A., Howell-Richardson, C., & Richardson, K. (2013). Learning to argue: A study of four schools and their attempt to develop the use of argumentation as a common instructional practice and its impact on students. *Journal of Research in Science Teaching*, 50(3), 315-347.
- Ozdem, Y., Ertepinar, H., Cakiroglu, J., & Erduran, S. (2013). The nature of pre-service science teachers' argumentation in inquiry-oriented laboratory context. *International Journal of Science Education*, 35(15), 2559-2586.
- Pendidikan, P. M. Kebudayaan [Permendikbud] RI Nomor 103 Tahun 2014. *Penilaian Hasil Belajar oleh Pendidik pada Pendidikan Dasar dan Pendidikan Menengah*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

- Pisa, O. E. C. D. (2015). Draft science framework. 2014-07-17]. [http://www.oecd.org/pisa/pisaproducts/Draft PISA 2015 Science Framework. pdf](http://www.oecd.org/pisa/pisaproducts/Draft_PISA_2015_Science_Framework.pdf).
- Pruzan, P. (2016). *Research methodology: the aims, practices and ethics of science*. Springer.
- Putri, M. D., & Rusdiana, D. (2017). Identifying Students' Scientific Argumentation Skill At Junior High School 1 Argamakmur, North Bengkulu. *IJAEDU- International E-Journal of Advances in Education*, III(9), 556–572.
- Nabavi-Pelesaraei, A., Rafiee, S., Mohtasebi, S. S., Hosseinzadeh-Bandbafha, H., & Chau, K. W. (2019). Comprehensive model of energy, environmental impacts and economic in rice milling factories by coupling adaptive neuro-fuzzy inference system and life cycle assessment. *Journal of cleaner production*, 217, 742-756.
- Roshayanti, F., & Rustaman, N. Y. (2013). Pengembangan Asesmen Argumentatif Untuk Meningkatkan Pola Wacana Argumentasi Mahasiswa Pada Konsep Fisiologi Manusia. *Bioma*, 2(1), 85-100.
- Sampson & Gerbino. (2010). *Argument-Driven Inquiry as a Way to Help Students Learn How to Participate in Scientific Argumentation and Craft Written Arguments: An Exploratory Study*. *Science Education*, 95, 217-257.
- Sampson, V., & Blanchard, M. R. (2012). Science teachers and scientific argumentation: Trends in views and practice. *Journal of Research in Science Teaching*, 49(9), 1122-1148.
- Schmidt, H. G. (1983). Problem-based learning: Rationale and description. *Medical education*, 17(1), 11-16.
- Servant-Miklos, V. F. (2019). Fifty years on: A retrospective on the world's first problem-based learning programme at McMaster University Medical School. *Health Professions Education*, 5(1), 3-12.
- Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The journal of educational research*, 99(5), 307-320.
- Syerliana, L., Muslim, & Setiawan, W. (2018). Argumentation skill profile using “toulmin Argumentation Pattern” analysis of high school student at Subang on topic hydrostatic pressure. *Journal of Physics: Conference Series*, 1013(1).

- Tan, O. S., Chye, S., & Teo, C. T. (2009). Problem-based learning and creativity: A review of the literature. *Problem-based learning and creativity*, 15-38.
- Thoubboron, K. (2018, October 25). *Advantages and disadvantages of renewable energy*. Retrieved from energysage: <https://news.energysage.com/advantages-and-disadvantages-of-renewable-energy/>
- Toulmin, S. E. (2003). *The uses of argument*. Cambridge university press.
- Valencia Ochoa, G., Nunez Alvarez, J., & Acevedo, C. (2019). Research evolution on renewable energies resources from 2007 to 2017: a comparative study on solar, geothermal, wind and biomass energy.
- Victor Sampson and Sharon Schleigh. (2016). Scientific argumentation in biology: 30 classroom activities. National science teachers association.
- Wang, J., & Buck, G. A. (2018). Exploring the Use of Debate to Enhance Elementary Teacher Candidates' Argumentation Skills. *New Waves-Educational Research and Development Journal*, 21(1), 30-47.
- Yoon, H., Woo, A. J., Treagust, D., & Chandrasegaran, A. L. (2014). The efficacy of problem-based learning in an analytical laboratory course for pre-service chemistry teachers. *International Journal of Science Education*, 36(1), 79-102.