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# The Contribution of the Inquiry Learning Model to Student Scientific Argumentation Skills on Fluid

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**Abstract:** The inquiry learning model is a model that facilitates the construction of students' scientific knowledge which can also improve students' argumentation skills. According to several research results, inquiry-based learning has proven to be effective in improving scientific argumentation skills because in the learning process students are directed in investigative activities to find scientific evidence as a basis for scientific argumentation. By considering the student learning process, the aim of this research is to describe whether the use of three types of inquiry learning models can teach fluid material and influence the student learning process, one of which is students' argumentation abilities. This research method uses mixed method triangulation. The instruments used were interview questionnaires and argumentation tests. The data obtained was then analyzed using simple statistical tests and N-gain scores. Interview data was analyzed to find out clarification of students' answers. The research results of the inquiry learning model were successful in developing argumentation skills, namely the n-gain score resulted in the use of the structured inquiry learning model gaining 0.88, the guided inquiry learning model 0.84 and the open inquiry learning model 0.74.

**Keywords:** Fluid; Inquiry learning model; Scientific argumentation

## Introduction

Learning science and literacy in tertiary institutions can help students become productive and responsible (Sato et al., 2016). Universities are responsible for achieving this goal and the role of lecturers is very important in learning. Many lecturers still regard students as rather simple thinkers. This is wrong thinking. If students are guided properly, students can think precisely and abstractly (Hwang et al., 2023). Therefore, lecturers are required to apply learning models that are considered suitable to help students to build scientific knowledge with accompanying abilities such as predicting and analyzing. Education practitioners are now experiencing a shift from the previous learning model to a learning model that actively engages students using problems in everyday life (Buchanan et al., 2016). The use of learning models assists lecturers in conveying material to students so that students are able to explain phenomena and encourage the development of their own argumentation skills. Because there is a relationship between the acquisition of knowledge during the learning process (Moutinho et al., 2013). So we need a learning model that can provide opportunities for students to research, explore, collaborate, make choices and imagine.

Based on the explanation above, the inquiry learning model can be chosen in conveying material that gives students opportunities to explore, because the inquiry learning model is a category of investigative approach in the learning process (Damşa & Nerland, 2016) and as learning that allows students to experience the process of generating new knowledge (Zeivots et al., 2023). The inquiry learning model uses problems in complex everyday life (Yuliati et al., 2021). Although the inquiry learning model may have been considered to have been carried out in the twentieth century and the inquiry learning model is not a new phenomenon in education, teachers believe that everyone must strive to develop themselves in a sustainable manner until

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excellence is achieved. So that the inquiry learning model is still believed to be able to activate students in the classroom (Tan, 2016). The purpose of the inquiry learning model is to position students as creators of new knowledge and meaning through exploration of the learning process (Shea et al., 2022).

The inquiry learning model is a learning model that uses questions to encourage the thinking process, build knowledge, is student-centered, students are responsible for their learning, and focuses on learning (Lin et al., 2023). The inquiry learning model varies in conveying material to students, namely in a demonstrated, structured, guided and open inquiry (Llewellyn, 2013). In demonstrated inquiry, the lecturer conducts an experiment and presents the results of the experiment in front of students, and structured inquiry activities are the lecturer giving questions related to everyday life problems in relation to learning material then students investigate the problems presented by the lecturer through specified procedures, and students are given an explicit step-by-step guide at each stage, leading to a predetermined outcome. Students are involved through hands-on investigation and develop skills such as making observations, proposing hypotheses, collecting and analyzing data, drawing conclusions, and finding solutions. However, students do not acquire the ability to think independently because in structured inquiry, questions, processes and results are known beforehand.

In guided inquiry, the lecturer gives questions related to the problems of daily life in relation to the learning material then students investigate the problems independently presented by the lecturer through specified procedures, work collaboratively, and decide on the process to be followed and the solution to be targeted. The results are not known by the lecturer. In guided inquiry, lecturers provide questions and investigative procedures to students to reduce errors in the investigation process. Students lead the investigation process, and are involved in decision making from the data collection stage, and conclusions (Vishnumolakala et al., 2017).

Open inquiry is the most complex level of inquiry learning, the lecturer defines the knowledge framework in which the investigation will be carried out, but students can choose a variety of questions and investigations designed or selected by students. So that students are involved in continuous decision making at each stage the process of open inquiry, starting from the stage of finding interesting phenomena to investigate. Open inquiry simulates and reflects the types of research carried out by scientists, and demands higher-order thinking skills (asking questions, designing experiments, critical and logical thinking, reflection). Students participate in inquiry being open shows responsibility for determining the objectives of the investigation and the questions to be investigated as a scientist (Zion & Mendelovici, 2012). The role of students is closely related to lecturers' efforts to facilitate students. Open inquiry does not separate the learning process, but creates a learning community for lecturers and students for the success of the inquiry process (Rodríguez et al., 2019).

In the investigation process, students' skills in drawing conclusions as a decision from the available information based on this fact are argumentation skills. When faced with problems related to socioscientific issues, students submit claims based on data, scientific concepts, experiences and also opinions (Tang, 2022). Scientific argument puts forward criteria for the construction and evaluation of scientific knowledge, which are often mediated by technical terms such as claim, evidence, refutation, and reasoning.

In developing scientific argumentation skills, the learning approach used should give students more opportunities to construct and critique explanations or arguments about natural phenomena as part of the inquiry process. Empirical research shows that much of inquiry-based learning not only improves students' skills to develop and critique arguments, but also enhances conceptual understanding (Katchevich et al., 2013; Muntholib et al., 2021). On the other hand, implementing inquiry-based learning can also improve students' scientific argumentation skills (Muntholib et al., 2021; Stanford et al., 2016). The purpose of this study was to describe whether the use of three types of inquiry learning models integrated into interventions can teach fluid material and influence student learning processes, especially in scientific argumentation skills (structured, guided and open).

Research on inquiry learning models using three types of structured inquiry learning, guided inquiry learning models and open inquiry in improving scientific argumentation skills in fluid material is important because scientific argumentation skills are one of the high-level thinking skills needed in the era of globalization (Frey et al., 2015). Scientific argumentation skills can help students to develop conceptual, critical, creative and reflective understanding of scientific phenomena (Fakhriyah et al., 2022). The use of fluid material is because it is a complex and abstract material, so it requires in-depth understanding and broad application. Fluid material is also related to various social, environmental and technological issues that are relevant to everyday life. The inquiry learning model is a learning strategy that can develop students' scientific argumentation skills, because this model emphasizes the process of investigation, observation, data collection,

hypothesis testing, and conclusions based on evidence and scientific reasoning (Urdanivia Alarcon et al., 2023).

## Method

The research method used is mixed methods, namely the triangulation method by combining quantitative and qualitative methods simultaneously. In this study, quantitative and qualitative data were collected simultaneously, without giving greater meaning to one of them. Participants were students of the Science Education Study Program at Unesa with the number per class consisting of 20 students with a total of 60 students. Each class is carried out with different inquiry learning models, namely structured inquiry learning models, guided inquiry learning models, open inquiry learning models. The learning process with fluid material is carried out for 3 hours of lessons with three face-to-face meetings in 1 semester. The instruments and data collection used were the pretest and posttest of fluid material with a total of 4 open-ended questions with the aim of analyzing scientific argumentation skills. Lastly, interviews were conducted to clarify participants from the pretest and posttest answers to analyze the consistency of scientific argumentation skills and the use of inquiry learning models. The fluid material questions and interview questions have been validated. The research procedure is as follows.

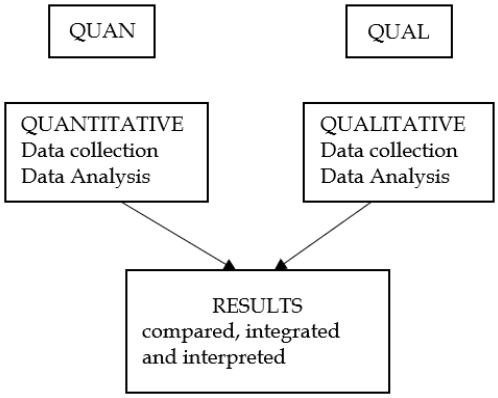


**Figure 1**. The research design is based on the triangulation method

## Result and Discussion

The triangulation method results in the collection of various types of quantitative data (through pretest and posttest), and qualitative data (through interviews). Data collection is in accordance with the research objectives which are analyzed more deeply. Thus, the analysis and discussion of data is organized into three different sub-sections: development of student argumentation skills; assessment of the typology of inquiry learning models; and the importance of learning models in conveying the material. For each of these subsections, which contribute to the achievement of objectives, data is collected through different instruments, described previously in the research methods section: pretest, posttest and interviews for the analysis of students' scientific argumentation skills development, for the assessment of the typology of inquiry learning models and for analyzing the importance learning model in conveying the material.

*Development of Student Argumentation Skills*

The results of developing argumentation skills using the question indicator rubric (pretest and posttest scores based on the number of students and the level of 5-sound understanding, 4-partial understanding, 3-incorrect understanding, 2-no understanding, 1-no response) are as follows:

The class with the lecturer's treatment conveys fluid material using a structured inquiry learning model as follows

**Table 1**. Pretest and Posttest with Structured Inquiry Learning

| Question | Pretest | | | | | Posttest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 | 5 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 19 |
| 2 | 5 | 10 | 5 | 0 | 0 | 0 | 0 | 2 | 8 | 10 |
| 3 | 5 | 11 | 4 | 0 | 0 | 0 | 0 | 2 | 6 | 12 |
| 4 | 5 | 10 | 5 | 0 | 0 | 0 | 0 | 1 | 1 | 18 |

The class with the lecturer's treatment conveys fluid material using the guided inquiry learning model as follows.

**Table 2**. Pretest and Posttest with Guided Inquiry Learning

| Question | Pretest | | | | | Posttest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 | 5 | 10 | 5 | 0 | 0 | 0 | 0 | 2 | 3 | 15 |
| 2 | 2 | 13 | 5 | 0 | 0 | 0 | 0 | 2 | 9 | 9 |
| 3 | 5 | 10 | 5 | 0 | 0 | 0 | 0 | 2 | 6 | 12 |
| 4 | 4 | 11 | 5 | 0 | 0 | 0 | 0 | 2 | 3 | 15 |

The class with the lecturer's treatment conveys fluid material using the open inquiry learning model as follows.

**Table 3**. Pretest and Posttest with Open Inquiry Learning

| Question | Pretest | | | | | Posttest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 | 3 | 12 | 5 | 0 | 0 | 0 | 0 | 4 | 7 | 9 |
| 2 | 4 | 10 | 6 | 0 | 0 | 0 | 0 | 5 | 7 | 8 |
| 3 | 6 | 10 | 4 | 0 | 0 | 0 | 0 | 2 | 9 | 9 |
| 4 | 3 | 12 | 5 | 0 | 0 | 0 | 0 | 4 | 7 | 9 |

Then interviews were recorded and transcribed to ensure objectivity and facilitate data analysis. One of the objectives of this interview is to understand whether the change in answers is caused by the content discussed during the lesson. Questions for the following students: Did the fluid material discussed in class affect the change in your answer?; Does the lecturer in conveying fluid material in learning allow you to understand fluid material so that you change your answers?.

*Alternative posttest answers for student A*


"... Tembok yang jebol terpantau adalah pambatas antara permukiman warga dengan parit yang mengalir di lokasi tersebut. Bagian tembok yang jebol terpantau mencapai sekitar lima meter. **Perbaikan dilakukan dengan cara menumpuk karung-karung berisi pasir di bagian tembok yang jebol**..." Kondisi tanggul yang jebol di RT 03/RW 06 Kelurahan Jatipadang, Pasar Minggu, Jakarta Selatan, Jumat (20/10/2017).(Kompas.com/Alsadad Rudi). Artikel ini telah tayang di Kompas.com dengan judul "Bagian Tembok Jebol Penyebab Banjir Jatipadang Ditumpuk Karung Pasir",

Klik untuk baca: https://megapolitan.kompas.com/read/2017/10/20/11272331/bagian-tembok-jebol-penyebab-banjir-jatipadang-ditumpuk-karung-pasir. Penulis : Alsadad Rudi

Karung pasir yang ditempatkan di sekitar kebocoran di luar tanggul dapat secara efektif menghentikan aliran air di bawah tanggul karena:

1. Karung pasir dapat menyerap air yang keluar dari kebocoran dan membentuk suatu lapisan yang kedap air. Karung pasir juga dapat menahan tekanan air dari belakang tanggul dan mencegah kebocoran yang lebih besar
2. Karung pasir dapat mengisi celah-celah yang ada di antara batu-batu tanggul dan menutup kebocoran. Karung pasir juga dapat menstabilkan struktur tanggul dan mengurangi resiko longsor atau runtuh
3. Karung pasir dapat membentuk suatu hambatan yang menghalangi aliran air yang keluar dari kebocoran. Karung pasir juga dapat menyeimbangkan tekanan air di dalam dan di luar tanggul dan menghindari kerusakan yang lebih parah
4. Karung pasir dapat mengurangi kecepatan dan volume air yang keluar dari kebocoran. Karung pasir juga dapat meningkatkan gesekan dan tahanan terhadap aliran air dan mengurangi erosi tanggul
5. Karung pasir dapat mengubah arah dan pola aliran air yang keluar dari kebocoran. Karung pasir juga dapat mengalihkan aliran air ke tempat yang lebih aman dan mengurangi dampak banjir.

**Jawablah pertanyaan ini** : 1) Menurut pendapat Anda, manakah dari kelima pilihan untuk karung pasir yang ditempatkan di sekitar kebocoran di luar tanggul dapat secara efektif menghentikan aliran air di bawah tanggul yang paling efektif?, 2) Bukti apa yang Anda gunakan untuk memperkuat pendapat Anda berikan pada poin 1?, 3) Jelaskan bagaimana bukti yang Anda gunakan dapat memperkuat pendapat Anda berikan pada poin 1?, 4) Andi menyatakan bahwa pilihan 1 lebih efektif daripada pilihan lainnya, bagaimana tanggapan Anda?, 5) Apabila Anda tidak setuju dengan pernyataan Andi, jelaskan bagaimana sanggahan yang dapat Anda berikan terhadap pernyataan tersebut?

**Figure 2**. Alternative posttest answers for student A

Based on the student's work, the student has answered according to the question in the form of a claim, which is a statement submitted to be accepted as truth, data is a fact used as evidence to support the claim, warrant is a statement that explains the relationship between the data and the claim (Epinur & Minarni, 2023). Backing is additional support for a warrant, qualifiers are the strength given to a warrant which can be in the form of words, such as: mostly, usually, always, or sometimes, rebuttal or refutation, namely arguments refuting a claim, data and warrant, even though there are incorrect answer (Syuzita et al., 2023). Argumentation skills are the ability to present and evaluate claims based on evidence and scientific reasoning, so students provide answers using conceptual, critical, creative and reflective understanding of scientific phenomena (Setiawan & Jumadi, 2023).

The ability to argue to express cause and effect relationships is reflected in students' answers, that is, students can answer correctly, describe a logical and systematic flow of thought, using good and correct language. The student's ability to argue is actually already owned by the student within himself. This ability is not yet used to being honed by students, possibly due to the learning carried out so far, namely conventional learning such as lectures and discussions which are still dominated among teachers, so that students are less accustomed and trained in expressing opinions, constructing ideas that exist within students (Seprianingsih et al., 2017). Students are still not free to express their ideas to solve problems between concepts and facts in the field, so appropriate learning is needed to improve argumentation skills (Hosbein et al., 2021).

The opinions of students differ for each class that uses a structured inquiry learning model as follows, fluid material in class influences the answers, because the learning process students carry out experiments and work procedures are provided by the lecturer, but data processing and presentations are carried out by students, so the lecturer always guides in learning process. While the class that uses the guided inquiry learning model is as follows, the fluid material in class affects the answers, because the learning process of students carries out experiments given by the lecturer but in the learning activities the lecturer does not help in designing investigations, so that in answering questions on argumentation skills some are not sure of the truth. For classes that use the open inquiry learning model as follows, the fluid material in class does not affect the answers much, because the lecturer only gives problems and asks students as scientists to solve them on their own, this causes doubts in answering the questions. Clarification of questions, each student answered the same according to the final result (posttest).

The data above needs to be analyzed in more depth to find out whether there are differences in pretest and posttest student results in this study. For this purpose, we start with a simple statistical analysis of the mean and standard deviation across the two tests, as follows.

**Table 4.** Student Results (Pretest and Posttest)

| Treatment | Pretest | Standard Deviation | Posttest | Standard Deviation |
|---|---|---|---|---|
| Structured Inquiry | 24.04 | 16.74 | 91.25 | 13.36 |
| Guided Inquiry | 26.25 | 15.77 | 88.44 | 15.87 |
| Open inquiry | 26.25 | 16.17 | 81.25 | 18.19 |

Based on table 4 data, the average posttest results are higher than the pretest. This data is to confirm an increase in student argumentation skills in fluid material. In order for this information to be relevant, an n-gain test is carried out, which is obtained as follows.

**Table 5**. N-gain Score Results

| Treatment | Pretest | Posttest | N-gain | Category |
|---|---|---|---|---|
| Structured Inquiry | 24.04 | 91.25 | 0.88 | High |
| Guided Inquiry | 26.25 | 88.44 | 0.84 | High |
| Open inquiry | 26.25 | 81.25 | 0.74 | High |

The results of the n-gain score test showed that the posttest data showed a significant increase in student results. This shows that students develop their argumentation skills on fluid material.

*Evaluation of Typology of Inquiry Learning Models*

Based on the results collected (student opinions about the treatment of the three types of inquiry learning models) to assess learning models that encourage more meaningful learning. There is a difference in the results between the treatment of the structured inquiry learning model, the guided inquiry learning model and the open inquiry learning model, even though the results of the n-gain test are all in the high category, there is an increase in posttest results. The highest score is for students who receive structured inquiry learning model treatment, for reasons students are given clear guidelines that they must follow, then submit an investigation report. The inquiry report is written in the form of a scientific work, with a theoretical introduction, detailed methods, tables of data collected by students and discussion of the results (Gültepe & Kılıç, 2021). Students who carry out practicum activities, methods for collecting and analyzing data, building hypotheses, and drawing conclusions. Students also become able to do scientific research. The role of the lecturer in this learning model emphasizes related substantive knowledge in combination with procedural knowledge (Weiss et al., 2022).

*The Importance of Learning Models in Delivering Material*

In today's era, there is no doubt that learning by inquiry is an important step in developing a scientifically literate, critical, logical, and creative society (Spernes & Afdal, 2021). The advantage of the inquiry process in an environment such as a school, is preparation for a modern way of life with many aspects of dynamism, entrepreneurship, teamwork and metacognitive thinking. Critical and logical thinking plays an important role in the inquiry process and develops scientific argumentation skills (Falk et al., 2013; Gültepe & Kılıç, 2021). The inquiry learning model is carried out to emphasize gradual experiences through the inquiry process. Improving the use of appropriate inquiry learning models in delivering material will be beneficial for students. This learning model facilitates student scientific skills, develops and improves scientific knowledge and strengthens student understanding (Siregar & Pakpahan, 2020). The right learning model as a means of the learning process makes students have argumentation skills that are able to support and evaluate ideas to understand problems and knowledge (Walker & Sampson, 2013).

## Conclusion

This research is to develop argumentation skills by processing it with a structured inquiry learning model, a guided inquiry learning model and an open inquiry learning model and this analysis has limitations. These three inquiry learning models were developed and adapted to the research sample. All students actively participated in this activity, they asked questions and debated about the material being taught. Interview analysis resulted in the conclusion that the inquiry learning model was successful in developing students' argumentation skills.

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**Author Contributions**
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**Conflict of Interest**
The author declare no conflict of interest.

## References

Buchanan, S., Harlan, M., Bruce, C., & Edwards, S. (2016). Inquiry Based Learning Models, Information Literacy, and Student Engagement: A literature review. *School Libraries Worldwide*, 23–39. https://doi.org/10.29173/slw6914

Damşa, C. I., & Nerland, M. (2016). Student Learning Through Participation in Inquiry Activities: Two Case Studies in Teacher and Computer Engineering Education. *Vocations and Learning*, *9*(3), 275–294. https://doi.org/10.1007/s12186-016-9152-9

Epinur, E., & Minarni, M. (2023). Development of Student Worksheets on the Inquiry-Flipped Classroom Model on Addictive and Addictive

Substance Material to Improve Student's Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6292–6299. https://doi.org/10.29303/jppipa.v9i8.4499

Fakhriyah, F., Rusilowati, A., Nugroho, S. E., Saptono, S., Ridlo, S., Mindyarto, B., & Susilaningsih, E. (2022). The scientific argumentative skill analysis reviewed from the science literacy aspect of pre-service teacher. *International Journal of Evaluation and Research in Education*, *11*(4), 2129–2139. https://doi.org/10.11591/ijere.v11i4.22847

Falk, A., Brodsky, L., & Hall, L. (2013). *Inquiry-Based Science Instruction*. *13*(1), 27–55. https://doi.org/10.25891/8B5N-RJ84

Frey, B. B., Ellis, J. D., Bulgren, J., Craig-Hare, J., & Ault, M. (2015). Development of a Test of Scientific Argumentation. *Electronic Journal of Science Education*, *19*(4). Retrieved from https://files.eric.ed.gov/fulltext/EJ1188271.pdf

Gültepe, N., & Kılıç, Z. (2021). The Effects of Scientific Argumentation on High School Students' Critical Thinking Skills. *International Journal of Progressive Education*, *17*(6), 183–200. https://doi.org/10.29329/ijpe.2021.382.13

Hosbein, K. N., Lower, M. A., & Walker, J. P. (2021). Tracking Student Argumentation Skills across General Chemistry through Argument-Driven Inquiry Using the Assessment of Scientific Argumentation in the Classroom Observation Protocol. *Journal of Chemical Education*, *98*(6), 1875–1887. https://doi.org/10.1021/acs.jchemed.0c01225

Hwang, G. J., Zou, D., & Wu, Y. X. (2023). Learning by storytelling and critiquing: a peer assessment-enhanced digital storytelling approach to promoting young students' information literacy, self-efficacy, and critical thinking awareness. *Educational Technology Research and Development*, *0123456789*. https://doi.org/10.1007/s11423-022-10184-y

Katchevich, D., Hofstein, A., & Mamlok-Naaman, R. (2013). Argumentation in the Chemistry Laboratory: Inquiry and Confirmatory Experiments. *Research in Science Education*, *43*(1), 317–345. https://doi.org/10.1007/s11165-011-9267-9

Lin, V., Barrett, N. E., Liu, G. Z., & Chen, H. H. J. (2023). A Systematic Review on Inquiry-Based Writing Instruction in Tertiary Settings. *Written Communication*, *40*(1), 238–281. https://doi.org/10.1177/07410883221129605

Llewellyn. (2013). *Teaching High Scholl Science Through Inquiry and Argumentation*. USA: Corwin.

Moutinho, S., Torres, J., Almeida, A., & Vasconcelos, C. (2013). *Portuguese Teachers ' Views*, *1970*, 9–12. Retrieved from https://raco.cat/index.php/Ensenanza/article/view/307888

Muntholib, M., Munadhiroh, A., Setiawan, N. C. E., & Yahmin, Y. (2021). High school students' scientific argumentation on chemical equilibrium. *AIP Conference Proceedings*, *2330*(May 2017). https://doi.org/10.1063/5.0043236

Rodríguez, G., Pérez, N., Núñez, G., Baños, J. E., & Carrió, M. (2019). Developing creative and research skills through an open and interprofessional inquiry-based learning course. *BMC Medical Education*, *19*(1), 1–13. https://doi.org/10.1186/s12909-019-1563-5

Sato, M., Bartiromo, M., & Elko, S. (2016). Investigating your school's science teaching and learning culture. *Phi Delta Kappan*, *97*(6), 42–47. https://doi.org/10.1177/0031721716636872

Seprianingsih, D.,& Jufri, A. W. (2017). Pengembangan Perangkat Pembelajaran Biologi Berbasis Inkuiri Terbimbing (Ppbit) Dalam Meningkatkan Kemampuan Berargumen Siswa. *Jurnal Penelitian Pendidikan IPA*, *3*(2). https://doi.org/10.29303/jppipa.v3i2.86

Setiawan, A., & Jumadi, J. (2023). Analysis of the Implementation of Argument Driven Inquiry (ADI) in Students' Argumentation Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 127–133. https://doi.org/10.29303/jppipa.v9i6.2725

Shea, P., Richardson, J., & Swan, K. (2022). Building bridges to advance the Community of Inquiry framework for online learning. *Educational Psychologist*, *57*(3), 148–161. https://doi.org/10.1080/00461520.2022.2089989

Siregar, N., & Pakpahan, R. A. (2020). Kemampuan Argumentasi IPA Siswa Melalui Pembelajaran Argumentasi Driven Inquiry (ADI). *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *10*(2), 94–103. https://doi.org/10.24929/lensa.v10i2.113

Spernes, K., & Afdal, H. W. (2021). Scientific methods assignments as a basis for developing a profession-oriented inquiry-based learning approach in teacher education. *European Journal of Teacher Education*, *00*(00), 1–15. https://doi.org/10.1080/02619768.2021.1928628

Stanford, C., Moon, A., Towns, M., & Cole, R. (2016). Analysis of Instructor Facilitation Strategies and Their Influences on Student Argumentation: A Case Study of a Process Oriented Guided Inquiry Learning Physical Chemistry Classroom. *Journal of Chemical Education*, *93*(9), 1501–1513. https://doi.org/10.1021/acs.jchemed.5b00993

Syuzita, A., Susilawati, S., & Sukarso, A. (2023).

Validation of E-Module Based on Argument-Driven Inquiry using 3D Page Flip Professional to Improve Students' Generic Science, Critical Thinking and Scientific Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6272–6277. https://doi.org/10.29303/jppipa.v9i8.4947

Tan, C. (2016). Beyond 'either-or' thinking: John Dewey and Confucius on subject matter and the learner. *Pedagogy, Culture and Society*, *24*(1), 55–74. https://doi.org/10.1080/14681366.2015.1083046

Tang, K. S. (2022). Material inquiry and transformation as prerequisite processes of scientific argumentation: Toward a social-material theory of argumentation. *Journal of Research in Science Teaching*, *59*(6), 969–1009. https://doi.org/10.1002/tea.21749

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023). Science and inquiry-based teaching and learning: a systematic review. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1170487

Vishnumolakala, V. R., Southam, D. C., Treagust, D. F., Mocerino, M., & Qureshi, S. (2017). Students' attitudes, self-efficacy and experiences in a modified process-oriented guided inquiry learning undergraduate chemistry classroom. *Chemistry Education Research and Practice*, *18*(2), 340–352. https://doi.org/10.1039/c6rp00233a

Walker, J. P., & Sampson, V. (2013). Learning to argue and arguing to learn: Argument-driven inquiry as a way to help undergraduate chemistry students learn how to construct arguments and engage in argumentation during a laboratory course. *Journal of Research in Science Teaching*, *50*(5), 561–596. https://doi.org/10.1002/tea.21082

Weiss, K. A., McDermott, M. A., & Hand, B. (2022). Characterising immersive argument-based inquiry learning environments in school-based education: a systematic literature review. *Studies in Science Education*, *58*(1), 15–47. https://doi.org/10.1080/03057267.2021.1897931

Yuliati, Y., Doyan, A., & Sahidu, H. (2021). Development of Inkuiri Model Learning Tools Guided to Improve Concept Mastery Learner Physics. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 422. https://doi.org/10.29303/jppipa.v7i3.564

Zeivots, S., Buchanan, J. D., & Pressick-Kilborn, K. (2023). Pre-service teachers becoming researchers: the role of professional learning groups in creating a community of inquiry. *Australian Educational Researcher*, *0123456789*. https://doi.org/10.1007/s13384-022-00589-2

Zion, M., & Mendelovici, R. (2012). Moving from structured to open inquiry: Challenges and limits. *Science Education International*, *23*(4), 383–399. Retrieved from https://files.eric.ed.gov/fulltext/EJ1001631.pdf