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Guided Inquiry Learning: How to Improve Students' Argumentation Abilities in Science Learning?

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ABSTRAK

Tantangan besar bagi pendidik dalam melaksanakan pembelajaran yang telah mengalami perubahan drastis. Kegiatan pembelajaran dalam masa pandemi dilaksanakan secara daring kembali dilaksanakan secara luring. Adaptasi pembelajaran ini memberikan dampak yang cukup besar dalam hasil pembelajaran. Siswa mengalami kesulitan dalam memahami konsep kimia dan pasif dalam memberikan pendapat dalam pembelajaran sehingga sulit dalam mengintegrasikan pengetahuan. Selama kegiatan pembelajaran daring, sumber belajar siswa masih terfokus pada konsep abstrak dan buku yang disediakan. Tujuan penelitian ini adalah untuk meningkatkan kemampuan argumentasi siswa pada materi kimia dalam menginterpretasikan pengetahuan yang diperoleh dengan model pembelajaran inkuiri terbimbing. Jenis penelitian ini merupakan penelitian deskriptif dengan pendekatan kuantitatif. Teknik pengumpulan data yang digunakan observasi, tes kemampuan argumentasi, dan dokumentasi. Data yang diperoleh dianalisis menggunakan teknik analisis kuantitatif. Berdasarkan hasil penelitian menunjukkan bahwa siswa mampu memberikan claim namun mengalami kesulitan untuk mengemukakan data dan pembuktian bukti. Kemampuan argumentasi awal siswa dapat menjadi acuan bagi pendidik untuk menentukan kegiatan pembelajaran kedepannya, dengan harapan pembelajaran yang dirancang tidak hanya berfokus pada pencapaian pemahaman konsep tetapi dapat mengembangkan kemampuan siswa dalam berargumentasi.

ABSTRACT

A big challenge for educators in carrying out learning that has undergone drastic changes. During the pandemic, learning activities carried out online were again carried out offline. This learning adaptation has a considerable impact on learning outcomes. Students have difficulty understanding chemical concepts and are passive in giving opinions in learning so it is difficult to integrate knowledge. During online learning activities, student learning resources are still focused on abstract concepts and books provided. The purpose of this study was to improve students' argumentation skills on chemistry in interpreting the knowledge obtained with the guided inquiry learning model. This type of research is a descriptive research with a quantitative approach. Data collection techniques used observation, argumentation ability tests, and documentation. The data obtained were analyzed using quantitative analysis techniques. Based on the results of the study, it showed that students were able to make claims but had difficulty presenting data and proving evidence. Students' initial argumentation abilities can be a reference for educators to determine future learning activities, with the hope that learning is designed not only to focus on achieving conceptual understanding but to develop students' argumentation abilities.

1. INTRODUCTION

An important part of chemistry education at all levels is learning how to do science i.e. engaging in inquiry and developing argumentation skills. In learning how to do science, students engage in discussion activities that build arguments to answer research questions (Kurniawan et al., 2018; Soysal, 2022). In teaching students how to do science and supporting them in developing the required knowledge, it is helpful to view inquiry as the construction of scientifically compelling arguments (Dudu & Vhurumuku, 2012; Papadakis et al., 2020). Weighing evidence of alternative methods and explanations of observed phenomena, being able to interpret data, using underlying theory to support investigations, and the idea of proactively defending claims against potential critics by setting limits on conclusions are components in scientific arguments (Rositawati, 2018; Sharon & Baram-Tsabari, 2020; Suraya et al., 2019).

Higher education students usually practice argumentation skills through different learning activities through investigation, writing argumentative essays and engaging in argumentative feedback processes are two activities to improve argumentative competence (Corneli et al., 2019; Groenendijk et al., 2013; Sadieda, 2019).

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But in fact, students have very poor argumentation skills in investigations, they are not able to present arguments properly accompanied by supporting evidence. The causes of the low ability of students in argumentation are the influence of the learning style of adapting online learning to offline, and the lack of variety in science learning designs that spur student argumentation (Brown, 2017; Fischer et al., 2014; Soucy McCrone, 2005). So that students only understand the concept but do not interpret the knowledge obtained. In line with several studies that students experience difficulties in explaining symptoms empirically in class discussions. To determine the success of learning, reflection on learning is needed by providing opportunities for students to convey their arguments against the material being studied (Brown, 2017; Buck, 2017; Hidayat et al., 2018). Thus, it is necessary to reflect on learning with an argumentation approach to improve students' investigative and argumentative abilities in finding evidence of scientific investigations.

Scientific inquiry with the support of argumentation is one of the common genres in the context of higher education that contributes to student learning. In the process of scientific investigation students practice argumentation skills by designing problem solutions to disputed scientific phenomena, claiming something, providing arguments that support scientific phenomena, providing facts that support their arguments, considering possible counterarguments, and making conclusions (Demirtas & Cayir, 2021; Oriji, A., & Anikpo, 2019). The application of an argumentative approach is able to increase students' understanding, this is supported by three reasons, namely (1) scientists use arguments in developing and increasing their scientific knowledge, (2) people use scientific arguments, and (3) learning requires arguments to strengthen their understanding (Fatmawati et al., 2018; Sadieda, 2019). Inquiry learning with this argumentation approach is a reflection of learning for students in adapting online to offline learning. Students go through a high-level cognitive process where they have to recall their previous knowledge of scientific subject matter, investigate the topic, use higher-order thinking skills such as analysis, elaboration, justification, evaluation and critical reasoning to conclude argumentative topics (Constantinou et al., 2018; Papadakis et al., 2020). By applying an argumentative approach in learning, students can provide a useful methodological framework for student understanding, so that students can add ideas or opinions that they can indirectly think of or their own ideas.

In addition, conceptual understanding of the core ideas of science can be achieved better when students present arguments. Because building arguments allows students to construct explanations about their knowledge of science topics. This kind of learning becomes a friend's feedback that can influence their perspective on knowledge. What can be understood here is that not all students have the same understanding and justification. Students with different perceptions of knowledge respond differently to argumentative issues in disciplines. Studies have found that students with higher epistemic beliefs produce higher quality arguments than students with low epistemic beliefs who are less critical in their arguments (Prafitasari et al., 2021; Zazkis & Villanueva, 2016). This difference in ability is also a major factor in the need to implement an argumentation approach with inquiry so that learning objectives are achieved for each student. Differences in the quality of this ability can also be influenced by the internet which provides most of the information and information with different levels of quality from various types of sources. Variations in internet knowledge can lead to different understandings of the sources on which students' evidence is based (Karagöz & Çakir, 2011; Tan et al., 2019). This raises the need to consider students' beliefs about the justification of knowledge received from the internet.

Based on previous studies and current facts, this study tries to overcome differences in students' argumentation abilities from adaptation of online to offline learning which aims to improve students' argumentation abilities towards the investigations carried out and find out the extent to which guided inquiry learning with an argumentative approach to the quality of chemistry learning. This study aims to improve students' argumentation skills on chemistry in interpreting the knowledge obtained with the guided inquiry learning model.

2. METHOD

This study uses a descriptive research method with a quantitative approach. Research with a descriptive type is a research method that seeks to describe and interpret objects according to what they are (Almeida, 2020; Atmowardoyo, 2018). The researcher did not manipulate the variables nor did he control the research variables. The quantitative approach in question is by interpreting the argumentation data obtained in the form of arguments. This research was conducted on students of class XI SMA 2 Boyolali. The sample was selected by purposive sampling technique. Classes are selected based on the average end of the odd semester as a sample.

Collecting data on the sample used an argumentative test instrument, namely a multiple-choice test with 20 questions arranged based on indicators of argumentation ability (the claim, the evidence, and a justification of the evidence). Students' argumentation ability tests were given to measure students' argumentation abilities before and after being given treatment on the subject of solubility product. The learning implementation instrument in the form of an observation sheet is used to determine the achievement of each syntax of the guided inquiry learning model using the argumentation method. The instrument used has been validated by three validators, namely two

expert lecturers and one chemistry teacher. after following the suggestions for improvement, the argumentation test instrument has been declared feasible to be implemented.

Instruments were given to students, as many as 20 reasoned multiple choice questions were worked on by students. then the students' answers were analyzed based on the argumentation component contained therein. Argumentation Component is show in Table 1.

Table 1. Argumentation Component

Argumentation Indicator	Criteria
Claim	Students write statements in the form of opinions or decisions submitted related to the scientific phenomena presented
Evidence	Students write down typical evidence or facts to support claims
Justification of the evidence	Students write down basic assumptions in the form of support or theory that can strengthen a claim so that it can be trusted

If each indicator is correctly written, the student will be given a score of 1 for each of these components, if it is incorrect, a score of 0 will be given. The data obtained was analyzed descriptively quantitatively. The test data of argumentation and implementation of learning with the guided inquiry model obtained were analyzed using quantitative descriptive analysis, then the results of the data analysis were translated into numbers arranged in the form of diagrams. The results of data analysis are used as a guide in making general conclusions or generalizing in the form of statements that describe the quality of the existing figures. The arguments that are trying to be built aim to determine students' argumentation abilities and not only direct students to understanding concepts but also to build or train their abilities in argumentation.

3. RESULT AND DISCUSSION

Result

This study succeeded in developing 20 questions of scientific argumentation ability that were packaged in the form of student worksheets that had been validated by four expert judgments using the CVR (Content Validity Ratio) method. revision. The results of the reliability calculation show that the scientific argumentation test instrument is in accordance with its usefulness. Cronbach's alpha score > 0.60. This value states that the scientific argumentation test instrument is reliable and can be used. The results of the pretest-posttest are interpreted based on the adaptation criteria of is show in Table 2.

Table 2. Criteria For Argumentation Ability

Skor tes	Kriteria
>81,25%-100%	Sangat baik
>62,50%-≤81,25%	Baik
>43,75%-≤62,50%	Kurang baik
>25,00%-≤43,75%	Sangat kurang baik

Base on Table 2 the results of the pre-test got a percentage of 58% in the poor category. Posttest results get a percentage of 87%. Based on the test results, there was an increase in students' scientific argumentation skills by 15%. Argumentation ability is assessed based on the argumentation indicators presented in Figure 1.

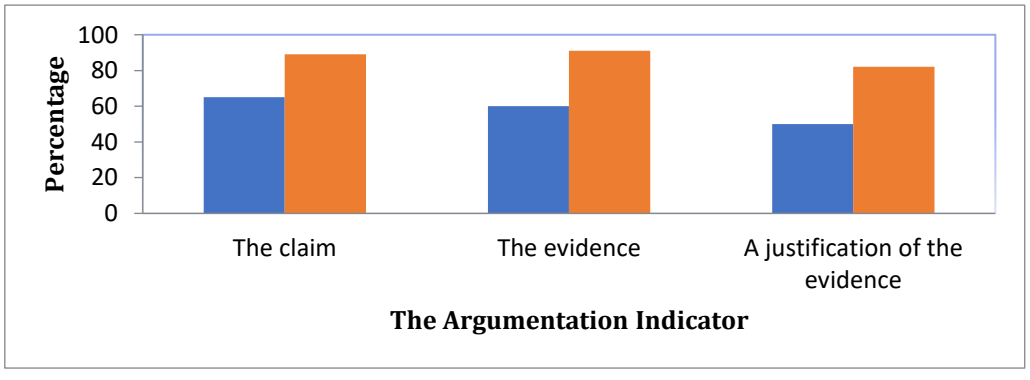

Figure 1. The results of the achievement of the argumentation indicator

Figure 1 shows that at the pretest the argumentation ability of students reached the claim aspect 65%, the evidence aspect 60%, and a justification of evidence aspect 50%. before being given treatment with a scientific argumentation test with a guided inquiry model, on average students were able to argue the first and second stages. The first-level argument students only wrote down the claims that had been presented in the answer choices and the second-level students wrote down the data that had been provided, but students had difficulty in writing justifications for the data with knowledge related to claims. After being given treatment, there was an increase in students' argumentation skills with aspects of the claim 89%, aspects of the evidence 91%, and aspects of a justification of evidence 82%. The improvement of students' argumentation skills reaches the third level. Scientific argumentation ability test can improve student learning ability. Implementation of the syntax of guided inquiry learning is show in Figure 2.

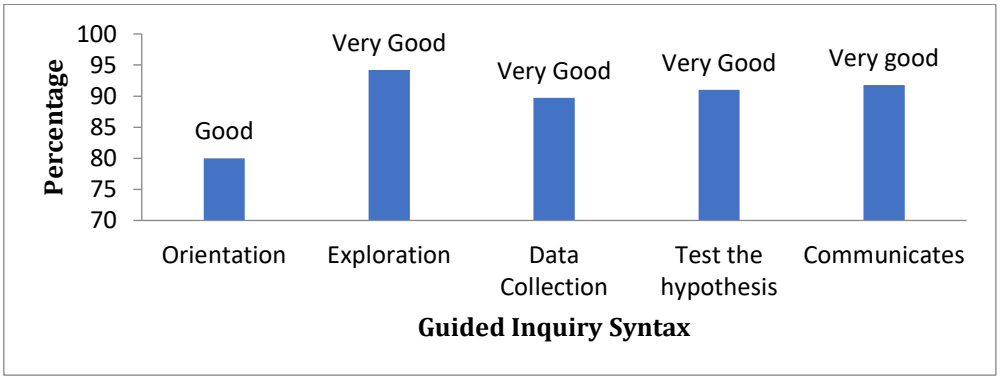

Figure 2. Result of observing the implementation of the syntax of guided inquiry learning.

Based on Figure 2, the syntax of guided inquiry is orientation, exploration, data collection, hypothesis testing, and communicating. In the orientation and exploration phase, students develop and study the material for the solubility product, examine, and analyze information about the experimental procedure (The claim). In the data collection and hypothesis testing stages, students conduct experiments, analyze data, record data, and students produce tentative arguments (The evidence). The communication stage of students explains the data that has been analyzed and makes explicit arguments and interpretations about the solubility product material. Each session of learning activities obtains very good criteria, this is because students carry out the syntax well. The guided inquiry model is one model that can train students' argumentation skills that direct students to make claims, reasons, and provide reinforcement so that students can strengthen scientific argumentation skills that hone mental activity with the knowledge they already have.

Discussion

Argumentative ability is a component that can be observed and is important in learning. In our view, selecting the guided inquiry model can increase the level of students' argumentation abilities. The guided inquiry dimension refers to facts or scientific issues and requires students to find solutions through investigation by providing scientific arguments (Sadieda, 2019; Ubaque Casallas & Pinilla Castellanos, 2016). Scientific argumentation skills are integrated into student worksheets and are structured based on the guided inquiry learning model. This means that the implementation of this research study must meet the syntax of guided inquiry and fulfill every indicator of the ability to think scientifically. The tests that have been carried out show that the argumentation abilities of students learn to increase after the implementation of guided inquiry learning, compared to inquiry learning without arguments (Hadianto et al., 2021; Hong & Talib, 2018). Throughout the argumentation activity, students are given the opportunity to generate and justify claims. But make sure the discussion phase in learning functions as an initiation point in the development of arguments. while in the analysis phase, students are given reinforcement to expand science process skills along with argumentation skills. This is in line with constructivist theory which explains that knowledge cannot be built outside students' minds but built into minds based on experience (Üce & Ceyhan, 2019). Thus, students must utilize their science process skills to produce evidence that supports claims, students will experience meaningful learning. Scientific argumentation through guided inquiry can encourage students' scientific inquiry in chemistry subjects.

The stepwise inquiry applied in this argumentation lesson ranges from the lowest to the highest level. The application of this method provides the ability to integrate knowledge. The lowest level of inquiry is by involving the teacher in learning. This stage of inquiry is considered a "pre-learning" by giving a pretest, the teacher is involved in helping students provide arguments in learning. This phase aims to help students develop their further arguments with a higher level of inquiry (Grant, 2019; Gunawan et al., 2019; Khaitova, 2021). The results showed that the level of scientific argumentation ability of the participating students was moderate. This can be explained

that students have not been exposed to chemistry teaching related to scientific argumentation. Most students have not been able to convey arguments with evidence. The difficulties students experience are when supporting statements with evidence and reasoning and the biggest difficulty is how they retrieve key information from a source, then relate it to the facts and data they obtain. Moreover, students often insist on their original claims even in the presence of data contradicting those claims. This happens because students have not been able to adapt well in this inquiry-based argumentation lesson.

This is also in accordance with previous study the low involvement of students in learning activities that spur arguments thus affecting students' understanding of the material being studied Students sometimes still have difficulty distinguishing types of chemical solutions and types of solubility in chemistry (Khasanah et al., 2021). Thus if students are given the opportunity to explore argumentative activities it will increase their ability to provide classics and provide evidence. Previous study believes that learning argumentation gives students the opportunity to reflect on learning outcomes so that students develop the ability to evaluate arguments and appreciate the importance of evidence in learning science (Hong & Talib, 2018). This finding is in line with other study state students need to be guided to deepen argumentation activities so that they are able to plan and carry out investigations and analyze data and justify their ideas to one another (Fischer et al., 2014; Ješková et al., 2018). Thus, teaching argumentation provides students with meaningful knowledge to help them develop logical evidence to support their claims. An important element is involving students so that they are given the opportunity to construct and develop evidence-based explanations or arguments from the scientific phenomena they are investigating.

Guided inquiry learning involves students designing their own observation activities under teacher supervision. Guided inquiry gives freedom to students to express their ideas, answer the statements given, make suggestions for solving problems. Previous study states that learning that supports increasing argumentation skills is to provide directions for students to analyze, synthesize, and evaluate information to make decisions. Inquiry learning trains students to find facts, data to be analyzed, to provide arguments against the data obtained (Goeltz & Cuevas, 2021). Previous studies have shown that arguments based on guided inquiry lead to increased scientific thinking skills as well as their conceptual understanding (Marshall et al., 2017). This guided inquiry learning model can trigger conflict and form restructuring of ideas because students share ideas from their own point of view, the more interactions that are created, the more skilled students are in evaluating and selecting information that is useful for themselves. In line with other study the scientific process in inquiry makes argumentation sessions in science learning enable students to ask questions to evaluate their colleagues' explanations, interpret data to consider and think of alternative explanations (Ješková et al., 2018). In this study, students through discussion activities took a more active role in evaluating their observations in interpreting data, and in deciding the ways their evidence was presented. Students can use operational definitions to build answers to questions, use conclusions to justify their views regarding the scientific views they observe.

The implication of this study is provides a way of applying a non-disruptive learning approach for teachers who normally have to meet the many demands of being a teacher. In addition, the argumentation approach is an alternative approach to the general way to develop argumentation skills, namely through the provision of socio-scientific issues where students who are dominated by teacher centered scenarios will need time to adapt. However, the implementation of the argumentation approach in science classes requires the teacher to play various roles, not only as a source of information for students but also as a facilitator, mentor, trainer or elicitor for students. These various roles played by the teacher are aimed at increasing student engagement. Therefore, the training is related to role development and how to use scientific argumentation teaching types in science classes.

4. CONCLUSION

Overall learning with guided inquiry model with argumentation approach The general level of scientific argumentation ability is medium level. Argumentative ability has increased after learning with the argumentation-based guided inquiry model. Students are able to provide claims and evidence in elaboration during learning. These findings provide useful insights for science educators and educational designers interested in promoting and supporting argumentation in scientific learning. This research also shows that students are able to develop and improve argumentation skills, science process skills, and understanding of concepts by engaging in the production of oral and written arguments. Therefore, the teaching and learning process that uses the guided inquiry model with an argumentation approach to build scientific arguments must be designed to improve students' argumentation abilities and scientific processes along with increasing students' understanding of chemistry.

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