Jurnal Pendidikan Kimia Indonesia
Volume 6, Issue 1, 2022, pp. 38-45
p-ISSN: 2087-9040 e-ISSN: 2613-9537
Open Access: https://doi.org/10.23887/jpk.v6i1

Application of the Argument-Driven Inquiry Learning Model in Stimulating Students' Scientific Argumentation Skills on Acid-Base Material

Siti Salsabila Utami[1]*, Ratna Sari Siti Aisyah[2], Isriyanti Affifah[3]

[1,2,3] Prodi Pendidkan Kimia, Universitas Sultan Ageng Tirtayasa, Serang, Indonesia

ARTICLE INFO

Article history:
Received September 03, 2021
Revised September 05, 2021
Accepted March 20, 2022
Available online April 25, 2022

Kata Kunci:
Argument Driven Inquiry, Argumentasi Ilmiah, Asam Basa

Keywords:
Argument Driven Inquiry, Scientific Argument, Acid-Base

ABSTRAK

Literasi sains merupakan kemampuan abad 21 yang perlu dimiliki untuk menghadapi permasalahan yang terjadi di lingkungan sekitar dan menyelesaikannya dengan konsep serta pengetahuan yang telah dimiliki. Namun masih banyak siswa yang kurang memiliki literasi sains. Rendahnya literasi sains peserta didik mengakibatkan sulitnya peserta didik dalam mengintegritaskan pengetahuan yang didapat dengan empat aspek litersi sains. Tujuan penelitian ini yaitu untuk menganalisis penerapan dan perbedaan hasil belajar sebelum dan sesudah menggunakan model pembelajaran Argument-Driven Inquiry pada materi asam basa. Pada penelitian ini menggunakan desain penelitian pre-eksperimen dengan One-Group Pretest-Postest. Sampel yang digunakan yaitu 30 orang peserta didik kelas XI IPA. Pemilihan sampel menggunakan cara Purposive Sampling. Instrument penelitian yaitu instrument tes pilihan ganda beralasan, lembar observasi dan rencana pelaksanaan pembelajaran. Teknik analisis data yang digunakan uji paired sample t-test. Hasil perhitungan uji paired sample t-test sebesar 0,000 sehingga terdapat perbedaan keterampilan argumentasi ilmiah peserta didik setelah diterapkan model pembelajaran Argument Driven Inquiry (ADI). Peserta didik lebih aktif saat pembelajaran dan memberikan argumentasi ilmiah sesuai dengan komponen argumentasi ilmiah yang baik.

ABSTRACT

Scientific literacy is a 21st-century ability that needs to be possessed to deal with problems that occur in the surrounding environment and solve them with concepts and knowledge that they already have. However, there are still many students who lack scientific literacy. The low scientific literacy of students makes it difficult for students to integrate the knowledge gained with the four aspects of scientific literacy. This study aimed to analyze the application and differences in learning outcomes before and after using the Argument-Driven Inquiry learning model on acid-base materials. This study uses a pre-experimental research design with One-Group Pretest-Postest. The sample used is 30 students of class XI IPA. Sample selection using purposive sampling. The research instrument is the multiple-choice reasoned test instrument, the observation sheet, and the lesson plan. The data analysis technique used was the paired sample t-test. The result of the calculation of the paired sample t-test is 0.000. There are differences in students' scientific argumentation skills after the Argument-Driven Inquiry (ADI) learning model is applied. Students are more active during learning and provide scientific arguments according to the components of a sound scientific argument.

1. INTRODUCTION

Literacy is basic knowledge and competence that must be possessed by the community based on the context of community needs and the times (Asyhari & Putri, 2017; Hasanah, 2018; Srirahayu & Arty, 2018). Literacy is not focused only on reading. However, the ability of the 21st century has become the focus of this GLN. The New Vision for Education diagram from the World Economic Forum (WEF) and The Boston Consulting Group (BCG) is a learning concept facing the 21st century. GLN displays the same three categories as New Vision for Education from WEF & BCG, namely basic literacy, competence, and character (Raharjo et al., 2017; Rahayuni, 2016). One of the basic literacy of WEF and BCG is scientific

Corresponding author.
*E-mail address: Salsabila11@gmail.com (Siti Salsabila Utami)

literacy. The Program for International Student Assessment (PISA) from 2000 to 2018 was still below the Organization for Economic Co-operation and Development (OECD) average of 489. The results of the 2018 PISA study in Indonesia gave an average score of 371 in reading, mathematics 379, and science 396 (Kismiantini et al., 2021; Rastuti et al., 2021). The low scientific literacy of students makes it difficult for students to integrate the knowledge gained with the four aspects of scientific literacy (Asyhari & Putri, 2017; Handayani, 2021). These aspects are context, knowledge, competence, and attitude. Scientific literacy is a 21st-century ability that needs to be possessed to deal with problems that occur in the surrounding environment and solve them with concepts and knowledge that they already have (Samsu et al., 2020; Srirahayu & Arty, 2018). In addition, literacy can create a critical society and shape a person to adapt to a knowledgeable society (Aiman & Ahmad, 2020; Rahayuni, 2016). Argumentation is the basic ability to solve environmental problems through facts and data (Probosari et al., 2016; Suraya et al., 2019). As an example of the global warming phenomenon, argumentation serves as a supporter and assists students in explaining the phenomenon. Students can explore more ideas about how and why global warming occurs (Salsabila *et al.,* 2019). In addition, the phenomenon that is currently happening is the Covid-19 disease (Barrot et al., 2021; Busyra & Sani, 2020; Ode et al., 2021). The Covid-19 fatality rate has a high percentage of 80% compared to the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003 oat10% and the Middle East Respiratory Syndrome (MERS) outbreak in 2012 and 2019 oat34% (Mahase, 2020). This phenomenon requires students' scientific argumentation skills to study so that students can find solutions to reduce the percentage of the spread of Covid-19. It requires students to apply argumentation to classroom learning.

Scientific argumentation is the ability to compose a statement based on evidence and justifiable reasons useful in convincing an attitude or value (Ho et al., 2019; Suraya et al., 2019). However, scientific arguments have different meanings from arguments in general. The difference in scientific argumentation lies in the statement (Claim), evidence (evidence), and considerations (justification). The statement contains a descriptive statement that can solve the research problem. The evidence contains measurements, observations, or other research results carried out. The argument component explains a phenomenon with relevant evidence and pivots on the right concept (Berndt et al., 2021; Probosari et al., 2016). According to Toulmin, the important components in an argument are claims, grounds, warrants, backings, rebuttals, and qualifications (Toulmin, 2003). The components of scientific argumentation consist of 3, namely claim, evidence, and reasoning (McNeill, 2011). A claim is a statement that answers a question or problem. Evidence is scientific data that supports the claim, while reasoning is the application of science to solve problems and explain the reasons for the evidence supporting the claim. The warrant component, according to Toulmin, is the same as the reasoning component according to McNeill. Several studies have proven that scientific argumentation is beneficial for students, such as helping students to improve their understanding of scientific concepts and processes, making correct decisions or problem-solving, and improving their argumentation skills (Sampson et al.,2011; Demircioglu & Ucar 2,015). Arguments also become a strong basis for a complete and correct understanding of the concept. Previous research stated that the ADI learning model affected students' metacognitive and critical thinking skills (Amin et al., 2020; Siahaan et al., 2019). The benefits of scientific argumentation that have been put forward require science teachers to get used to learning that can stimulate scientific argumentation skills. To make learning active in earning is to use learning models, one of which is Argument Driven Inquiry (ADI).

The Argument Driven Inquiry (ADI) learning model is one of the Inquiry learning models that focuses on student participation by emphasizing the construction and validation of knowledge through problem-solving activities (Nurrahman et al., 2018; Rahayu et al., 2020). This learning model facilitates students to stimulate the scientific arguments contained in each stage. The ADI learning model can improve scientific processes and argumentation skills (Demircioglu & Ucar, 2015; Rosidin et al., 2019). Other studies found that to improve scientific literacy, namely the ADI, Inquiry, and STEM learning models (Ginanjar et al., 2015; Herlanti et al., 2019; Nurrahman et al., 2018). However, this ADI model is still rarely used in teaching and learning activities. One teaching and learning activity rarely uses the ADI model in chemistry learning, especially on acid-base materials. Usually, acid-base materials are mixed and matched with lab checking pH, testing natural indicators, and so on. The ADI model can be used in practicum activities and learning in class (Demircioglu & Ucar, 2015). Acid-base material is the main subject taught in eleventh grade SMA/MA. This material includes real objects and phenomena that can be felt in students' daily lives, such as household chemicals, media news, acid rain news, and industry (Cigdemoglu et al., 2017; Muchson et al. In addition, the concept of an acid-base solution is experimental so that that process competence can be measured through a chemical practicum of the concept of an acid-base solution (El Islami et al., 2016; Rahmawati & Partana, 2019). Acid-base material suitable for the ADI learning model is the concept of identifying acid-base solutions because it is easy to design a scientific investigation of facts that exist in the environment and relate them to the concepts studied. Arguments will become scientific discourses to connect students' understanding with facts and data in the environment. This study aims to analyze the application of learning acid-base materials using the Argument Driven Inquiry learning model and find out the differences in learning outcomes after using the Argument-Driven Inquiry learning model to stimulate scientific knowledge argumentation skills acid-base materials.

2. METHODS

This study uses a pre-experimental research design (pre-experimental) with One-Group Pretest-Postest. The population in this study were all eleventh-grade science students at SMAN Cahaya Madani Banten Boarding School, with a sample of 30 students. Sample selection using purposive sampling. Sample selection uses the purposive sampling technique to select individuals to be sampled according to the criteria for the research objectives so that they will represent the population and conclusions can be drawn from the research results. The data collection techniques in this study were a matter of scientific argumentation skills, observation sheets on the implementation of the syntax of the Argument Driven Inquiry online learning model, and documentation. The scientific argumentation ability question is reasoned multiple-choice, consisting of 25 questions. The provision of tests in the form of pretest and post-test to measure the argumentation ability of students before and after the treatment of the Argument Driven Inquiry (ADI) learning model on acid and base learning. Observation techniques to determine the achievement of each syntax of the ADI learning model and documentation to attach evidence of research that has been carried out. Documentation in the form of videos during learning, screenshots of learning evidence, and photos. Data analysis in the form of validity, reliability, descriptive, and inferential analysis. The descriptive analysis interprets data with maximum-minimum values, mean, and sum—inferential analysis using normality test and paired sample t-test using SPSS 26 software for Windows.

3. RESULTS AND DICCUSSION

Results

As many as 30 questions that have been content validated by eight panelists using the CVR (Content Validity Ratio) method get a conclusion from 8 panelists that 28 questions will be used properly but need some revisions. The results of the reliability calculation show that the scientific argumentation test instrument is consistent with using (reliable). Cronbach's alpha score is 0.855, indicating that Cronbach's alpha score is > 0.6. This value concludes that the scientific argumentation test instrument is reliable and can be used. Based on the pretest results (N = 30), which were processed using SPSS, the average score was 26.00, the minimum score was 7, and the maximum score was 50. The post-test results obtained an average score of 61.60, the minimum score was 42, and the maximum score was 75. The data on the average pretest and post-test scores in the figure below shows that the post-test average score is greater than the average pretest score. The results of the observation of the implementation of the syntax of the learning model from ADI were presented in the form of a percent and calculated using Microsoft Excel. The results of observing the implementation of the ADI syntax are presented in Figure 1.

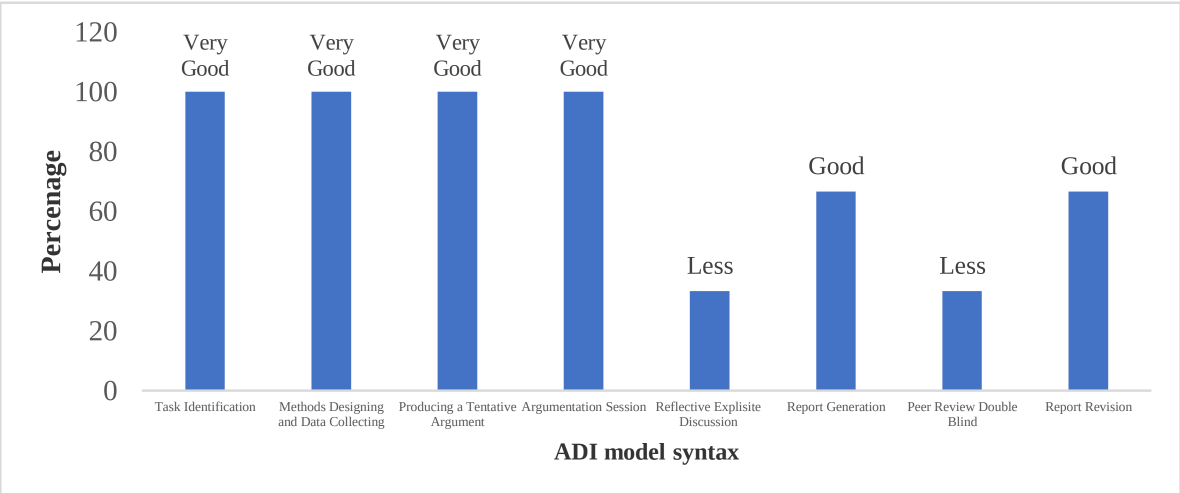

Figure 1. Results of observing the implementation of the syntax of the online learning model Arguments Driven Inquiry

Based on Figure 1, the syntax of task identification, designing methods and collecting data, producing tentative arguments, and argumentation sessions have very good criteria because all students carry out the syntax. The syntax for making reports and revising reports has good criteria because, at the time of making reports, some students did not participate in making reports carried out in groups. In the syntax of the revised report, not all students participated because only two groups experienced improvements. However, during explicit reflective discussions and double-blind peer review, the criteria were lacking because they encountered several obstacles, such as participants not discussing through the menu in the eduflow virtual class and at the double-blind peer review stage to assess the practicum report in the eduflow virtual class, there was an error so that not all students can rate reports belonging to his friends. The percentage diagram of scientific argumentation for each level at the pretest and post-test is presented in Figure 2.

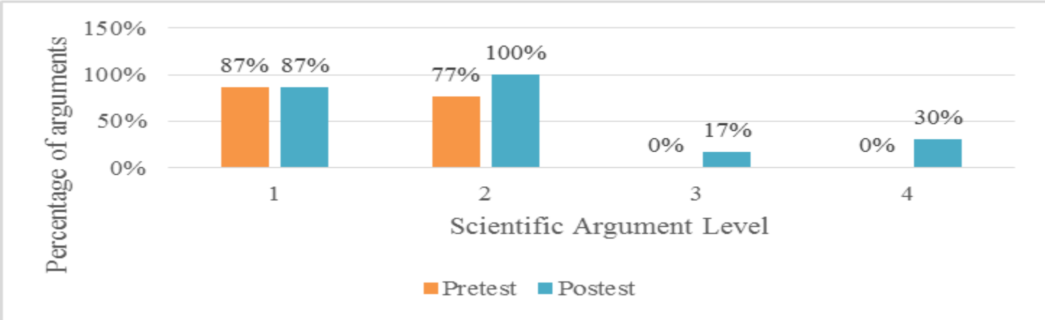

Figure 2. Graph of the quality of students' scientific arguments at the pretest and post-test

The data above shows that at the time of the pretest there were 87% of students' scientific arguments reached level 1, 77% of scientific arguments reached level 2, and 0% of scientific arguments reached levels 3 and 4 Wulandari (2020) before being treated with the ADI model of learning, on average, students were able to argue scientifically at the first and second levels. The first level argument only contains a claim that has been presented in the answer choices, and the second level has provided data to support the claim. Before applying the Argument Driven Inquiry learning model in this research, most students achieved scientific arguments at the first and second levels. At the first level, students can only submit a claim without providing evidence and reasons to support the claim that has been stated in the answer choices. To make a claim, students do not need to think critically, but students only need to recognize, remember, understand, classify, and apply their knowledge (Parlan et al., 2020). The second level of argumentation already provides evidence and reasons to support a claim but does not provide a rebuttal. After learning using the Argument Driven Inquiry (ADI) learning model, there was an increase of 23% on the second level of scientific argumentation, 17% on the third level of scientific argumentation, and 30% on the fourth level. Increase scientific argumentation ability because the ADI model provides learning steps that stimulate scientific argumentation, especially at the argumentation session stage (Wulandari, 2020). The normality test obtained was 0.409 for the pretest and 0.076 for the post-test. When compared with a significance level of 0.05, the score for the normality test for pretest and post-test is greater than 0.05. if the significance score or probability score > 0.05, then the data distribution can be normal. Furthermore, the Paired Sample T-Test was tested to determine the differences in students' scientific argumentation skills after the Argument Driven Inquiry (ADI) learning model was applied. The result of the Paired Sample T-Test calculation is 0.000, and when compared with a significance score of 0.05, the result is 0.000 <0.05. Applying the Argument Driven Inquiry (ADI) learning model indicates differences in students' scientific argumentation skills.

Discussion

There is an increase in students' scientific argumentation skills after being given treatment. The difference in scientific argumentation ability after using the ADI learning model is because the ADI learning model provides a space that helps students build quality scientific arguments through the argumentation session stage and make reports on practical results that improve their ability to draw valid conclusions based on the evidence found in practice (Rahayu et al., 2020; Rosidin et al., 2019; Walker et al., 2019). The first stage of the ADI learning model is task identification. At this stage, learning is carried out synchronously through Google meet. Students are given a stimulus regarding the characteristics of acidic and basic solutions. It will improve students' abilities (Agina, 2012; Masrom et al., 2021; Setiawati et al., 2013). Then a problem is presented if, in the laboratory, two solutions have the same physical properties (a colorless solution and a liquid). Then a question was asked about how to find out the nature of the two solutions, and the student with the initials AK answered by using litmus paper. Students' scientific argumentation skills are at the first level because they only convey a claim without providing evidence and reasoning why a litmus paper can be used to determine the nature of a solution. The first level of argument only contains simple claims or counterclaims by Osborne's scientific argument framework. In addition, an explanation of the importance of scientific argumentation, components of scientific argumentation, criteria for good scientific argumentation, and examples of scientific argumentation are also given. When learning occurs, the teacher asks a question about the Arrhenius acid-base theory. Students can make scientific arguments at the second level because they have provided a complete scientific argument, but there is no refutation. In addition to being carried out synchronously, the task identification stage is also carried out asynchronously. Asynchronous activities provide a source of reading about the characteristics of acids and bases found in the Eduflow application classroom. Task identification is carried out asynchronously so that students can reread the material that has been explained. The task identification stage focuses students on ongoing learning (Ginanjar et al., 2015; Putri, 2017; Salsabila et al., 2019). The second stage is designing methods and collecting data. Students are given a link to the eduflow classroom for the acid-base identification practicum. Then students enter the eduflow application using their respective emails and select group tags in activity 5 according to the group divisions that have been given. Group division is an important activity in generating and improving scientific argumentation skills. Group work on the ADI learning model can stimulate students to discuss and present scientific arguments (Demircioglu & Ucar, 2015; Ginanjar et al., 2015; Siahaan et al., 2019). In the next activity, a video identification of acid-base solutions using universal indicators is given to stimulate students to identify acid-base solutions in many ways. One of them is using universal indicators. Activity 6, which contains an acid-base identification practicum video, has been seen by 24 students, and six students have not seen the video. In the third stage, namely the production of tentative arguments, each group makes a scientific argument consisting of claims, evidence, and reasoning. Before making scientific arguments, each group discusses in activity 7 group discussions. Each student must express an opinion and comment on his friend's opinion to open the next activity (Sampson et al., 2011; Walker et al., 2019). The guiding question in the discussion is how to identify a solution as an acid or a base? In this activity, only 14 students had discussions. However, each group had a discussion even though some group members were not actively involved. Then each member is obliged to comment or provide reinforcement on the scientific arguments of their group mates.

To determine a suitable method for identifying acid-base solutions at the discussion stage, students with the initials NA gave a rebuttal (rebuttal). The scientific arguments do not provide strong evidence for why acid-base solutions are corrosive, so they are categorized as level 3. However, most students argue scientifically at the discussion stage at level 2. Students can compose complete scientific arguments containing claims, evidence, and reasoning (Ginanjar et al., 2015; Kua, 2018). The fourth stage, namely the argumentation session, can stimulate scientific argumentation skills because at this stage, students present and assess their friends' scientific arguments. Activity 9 is the presentation of the results of each group's scientific arguments. The result of the presentation is a video screen record of the presentation of scientific arguments for 2-3 minutes. Activity 10 is a peer review video presentation of scientific argumentation of other groups. Not all students get a share to assess other groups' videos because if learning uses the ADI model offline (outside the network), there is a division of tasks within the group. The division of tasks in the form of a note-taker and presenter. The learning system is that there are groups that move/visit other groups to assess and listen to the scientific arguments of other groups. The note-taker will write down the information obtained when visiting other groups. At the same time, the presenters just sit in silence, waiting for another group to come and explain the results of their group's scientific arguments (Probosari et al., 2016; Walker et al., 2019). In the peer review activity of scientific argument videos, there are arguments at level 3 because they have shown a rebuttal.

Activity 11 reflects the results of peer review videos of scientific arguments. In this menu, students can find out their friends' assessments, reflect on deficiencies and improve scientific arguments if there are improvements. It is useful so that students know the mistakes in making scientific arguments. The fifth stage of explicit reflective discussion aims to facilitate students discussing and designing practicums by the scientific arguments that have been put forward. In the virtual class, 12 activity menus have been provided for designing practicums. The activity contains instructions for identifying acid-base solutions, examples of observation tables, and links for conducting practical identification of acid-base solutions. Next, each group discusses the right method to identify acid-base solutions. The sixth stage is reporting. After designing a method to identify acid-base solutions, each group conducted an online practicum by selecting the appropriate link. The link provided contains lab work on identifying acid-base solutions using litmus solution, acid-base reactions with carbonate compounds, acid-base reactions with metals, pH meters, universal indicators, and electrical conductivity. Each group chooses a practicum that they think is appropriate. The most widely chosen method is the acid-base test with litmus solution. Making a practicum report is available in activity 17. A practicum report template has been provided in this activity so that students only fill in according to the data obtained. This stage is useful for facilitating students in proving a claim and training in scientific argumentation by its components (Rahayu et al., 2020; Rosidin et al., 2019; Walker et al., 2019). In addition, making a practicum report facilitates students to analyze data and information to understand a concept that can be used as evidence to support a claim (Putri, 2017). For example, a theoretical study must contain accurate material/information and attach sources of information in a theoretical study. It trains students in compiling reasoning about the principles/laws of knowledge. The seventh stage is the Double-Blind Peer Review. This stage provides an opportunity for each group to exchange information in the form of observational data. In addition, this stage can encourage students to assess the quality of a scientific argument, develop students' metacognition, and make students appreciate the importance of evidence and critical thinking (Indriyani et al., 2019; Trimahesri & Hardini, 2019; Wulandari, 2020). This step should be carried out in the eduflow virtual class. However, the practicum report for each group does not appear in each student's account. So the researchers got around this by displaying the practicum report of each group synchronously through Google meet. Furthermore, the representatives of each group provide suggestions/comments on the practicum reports of other groups.

The eighth stage is the revision of the report. If there are improvements, submit the practicum report to the teacher via Google Drive. Only two groups experienced improvement among seven groups. Improvements were found in the discussion section; groups 2 and 5 did not provide clear evidence and were lacking in correlating data with applicable theory. This revision improves writing skills, makes excuses, and understands concepts (Probosari et al., 2016; Sampson et al., 2011). The quality of students' scientific argumentation was analyzed using Osborne's analytical framework, which classifies the level of scientific argumentation consisting of the first to fifth levels. A scientific argument needs to be analyzed to know the improvement and quality of scientific argumentation. It determines the quality of a student's scientific argument using an analytical framework. It aims to determine the mastery of the scientific argumentation skills of students. Previous research also stated that the argumentation session stage aims to enable students to have critical thinking skills when reviewing an argument, process or method, and the basis of a theory (Kua, 2018; Probosari et al., 2016; Suraya et al., 2019). Therefore, the argumentation session can assist students in reviewing the social aspects of a scientific argument with evidence or data and applicable knowledge. The third level is a scientific argument because it has a rebuttal, but the refutation is weak. The students did not explain what caused the difference in the composition of the waste to affect the voltage and electric current, so the rebuttal was said to be weak. Next is an example of a fourth-level scientific argument because the argument has given a claim that contains identifiable data, reasons, and rebuttals.

4. CONCLUSION

Acid-base material has very good criteria for task identification syntax, designing methods and collecting data, producing tentative arguments, and argumentation sessions. The syntax of report generation and report revision has good criteria, and explicit reflective discussion and double-blind peer review have poor criteria. There are differences in students' scientific argumentation skills after applying the Argument Driven Inquiry (ADI) learning model. Students are more active during learning and provide scientific arguments according to the components of a good scientific argument.

5. REFERENCES

Agina, A. M. (2012). The Effect of Nonhuman's External Regulation on Young Children's Creative Thinking and Thinking Aloud Verbalization During Learning Mathematical Tasks. *Computers in Human Behavior*, *28*(4), 1213–1226. https://doi.org/10.1016/j.chb.2012.02.005.

Aiman, U., & Ahmad, R. A. R. (2020). Model Pembelajaran Berbasis Masalah (PBL) terhadap literasi sains siswa kelas V Sekolah Dasar. *Jurnal Pendidikan Dasar Flobamorata*, *1*(1). https://doi.org/10.51494/jpdf.v1i1.195.

Amin, A. M., Corebima, A. D., Zubaidah, S., & Mahanal, S. (2020). The correlation between metacognitive skills and critical thinking skills at the implementation of four different learning strategies in animal physiology lectures. *European Journal of Educational Research*, *9*(1), 143–163. https://doi.org/10.12973/eu-jer.9.1.143.

Asyhari, A., & Putri, G. (2017). Pengaruh Pembelajaran Levels of Inquiry Terhadap Kemampuan Literasi Sains Siswa pembelajaran yang berorientasi inkuiri. *Scientae Educatia: Jurnal Pendidikan Sains*, *6*(2), 87–101. https://doi.org/10.24235/sc.educatia.v6i2.2000.

Barrot, J. S., Llenares, I. I., & Del Rosario, L. S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies*, 1–18. https://doi.org/10.1007/s10639-021-10589-x.

Berndt, M., Schmidt, F. M., Sailer, M., Fischer, F., Fischer, M. R., & Zottmann, J. M. (2021). Investigating statistical literacy and scientific reasoning & argumentation in medical-, social sciences-, and economics students. *Learning and Individual Differences*, *86*. https://doi.org/10.1016/j.lindif.2020.101963.

Busyra, S., & Sani, L. (2020). Kinerja Mengajar dengan Sistem Work From Home (WFH) pada Guru di SMK Purnawarman Purwakarta. *IQ (Ilmu Al-Qur'an): Jurnal Pendidikan Islam*, *3*(01), 1–16. https://doi.org/10.37542/iq.v3i01.51.

Cigdemoglu, C., Arslan, H. O., & Cam, A. (2017). Argumentation to foster pre-service science teachers' knowledge, competency, and attitude on the domains of chemical literacy of acids and bases. *Chemistry Education Research and Practice*, *18*(2), 288–303. https://doi.org/10.1039/c6rp00167j.

Demircioglu, T., & Ucar, S. (2015). Investigating the effect of argument-driven inquiry in laboratory instruction. *Kuram ve Uygulamada Egitim Bilimleri*, *15*(1), 267–283. https://doi.org/10.12738/estp.2015.1.2324.

El Islami, R. A. Z., Nahadi, N., & Permanasari, A. (2016). Membangun Literasi Sains Siswa Pada Konsep Asam Basa Melalui Pembelajaran Inkuiri Terbimbing. *Jurnal Penelitian Dan Pembelajaran IPA*, *2*(2), 110. https://doi.org/10.30870/jppi.v2i2.662.

Ginanjar, W. S., Utari, S., & Muslim, D. (2015). Penerapan Model Argument-Driven Inquiry Dalam Pembelajaran Ipa Untuk Meningkatkan Kemampuan Argumentasi Ilmiah Siswa Smp. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, *20*(1), 32. https://doi.org/10.18269/jpmipa.v20i1.559.

Handayani, T. (2021). Pengembangan Media Komik Digital Berbasis STEM untuk Meningkatkan Literasi Sains Siswa Sekolah Dasar. *Jurnal Didaktika Pendidikan Dasar*, *5*(3), 737–756. https://doi.org/10.26811/didaktika.v5i3.343.

Hasanah, M. (2018). Pengembangan Model Pembelajaran Baca-Tulis Permulaan Dalam Perspektif Emergent Literacy. *Literasi: Indonesian Journal Of Humanities*, *14*(1). https://doi.org/10.21831/ltr.v14i1.4409.

Herlanti, Y., Mardiati, Y., Rahmawati, R., Putri, A. M. K., Jamil, N., Miftahuzzakiyah, M., Sofyan, A., Zulfiani, Z., & Sugiarti, S. (2019). Finding Learning Strategy in Improving Science Literacy. *Jurnal Penelitian Dan Pembelajaran IPA*, *5*(1), 59. https://doi.org/10.30870/jppi.v5i1.4902.

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*. https://doi.org/10.1016/j.tsc.2019.100607.

Indriyani, D., Mawardi, M., & Wardani, K. W. (2019). Peningkatan Keterampilan Berpikir Kritis Melalui Model Inkuiri Berbantuan Media Konkret Pada Siswa Kelas 5 SD Negeri Mangunsari 05 Tahun Pelajaran 2018/2019. *Jurnal Basicedu*, *3*(1). https://doi.org/10.31004/basicedu.v3i1.74.

Kismiantini, Setiawan, E. P., Pierewan, A. C., & Montesinos-López, O. A. (2021). Growth mindset, school context, and mathematics achievement in Indonesia: A multilevel model. *Journal on Mathematics Education*, *12*(2), 279–294. https://doi.org/10.22342/jme.12.2.13690.279-294.

Kua, M. Y. (2018). Penerapan Real World Problem Solving menggunakan Setting Argumentasi untuk Meningkatkan Kemampuan Berpikir Kritis dalam Pembelajaran Fisika Siswa SMA. *Jurnal Ilmiah Pendidikan Citra Bakti*, *5*(2), 93–102. https://doi.org/10.5281/zenodo.3402640.

Mahase, E. (2020). Coronavirus covid-19 has killed more people than SARS and MERS combined, despite lower case fatality rate. *BMJ (Clinical Research Ed.)*, *368*(February), m641. https://doi.org/10.1136/bmj.m641.

Masrom, M. B., Busalim, A. H., Abuhassna, H., & Mahmood, N. H. N. (2021). Understanding students' behavior in online social networks: a systematic literature review. In *International Journal of Educational Technology in Higher Education*. https://doi.org/10.1186/s41239-021-00240-7.

McNeill, K. L. (2011). Elementary students' views of explanation, argumentation, and evidence, and their abilities to construct arguments over the school year. *Journal of Research in Science Teaching*, *48*(7), 793–823. https://doi.org/10.1002/tea.20430.

Muchson, M., Munzil, M., Winarni, B. E., & Agusningtyas, D. (2019). Pengembangan Virtual Lab Berbasis Android Pada Materi Asam Basa Untuk Siswa SMA. *Jurnal Pembelajaran Kimia*, *4*(1). https://doi.org/10.17977/um026v4i12019p051.

Nurrahman, A., Kadaritna, N., & Tania, L. (2018). Efektivitas Model Pembelajaran ADI dalam Meningkatkan Penguasaan Konsep Siswa berdasarkan Kemampuan Akademik. *FKIP Universitas Lampung*, *20*(1), 1–14.

Ode, M. K. L. O., Aswat, H., Sari, E. R., & Meliza, N. (2021). Analisis Pelaksanaan Pembelajaran Tatap Muka Terbatas (TMT) di Masa New Normal terhadap Hasil Belajar Matematika di Sekolah Dasar. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(6), 4400–4406. https://doi.org/10.31004/edukatif.v3i6.1449.

Parlan, P., Latifah, U., & Muntholib, M. (2020). Development and Implementation of Students' Scientific Argumentation Skills Test in Acid-Base Chemistry. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *5*(2), 179–190. https://doi.org/10.24042/tadris.v5i2.6388.

Probosari, R. M., Ramli, M., Harlita, H., Indrowati, M., & Sajidan, S. (2016). Profil Keterampilan Argumentasi Ilmiah Mahasiswa Pendidikan Biologi FKIP UNS pada Mata Kuliah Anatomi Tumbuhan. *Bioedukasi: Jurnal Pendidikan Biologi*, *8*(2), 29. https://doi.org/10.20961/bioedukasi-uns.v9i1.3880.

Putri, A. M. K. (2017). *Pengaruh Model Pembelajaran Argument Driven Inquiry (ADI) Terhadap Kemampuan Literasi Sains Peserta Didik*.

Raharjo, M. W. C., Suryati, S., & Khery, Y. (2017). Pengembangan E-Modul Interaktif Menggunakan Adobe Flash Pada Materi Ikatan Kimia Untuk Mendorong Literasi Sains Siswa. *Hydrogen: Jurnal Kependidikan Kimia*, *5*(1), 8. https://doi.org/10.33394/hjkk.v5i1.102.

Rahayu, S., Bambut, K. E. N., & Fajaroh, F. (2020). Do different discussion activities in developing scientific argumentation affect students' motivation in chemistry? *Cakrawala Pendidikan*, *39*(3), 679–693. https://doi.org/10.21831/cp.v39i3.32228.

Rahayuni, G. (2016). Hubungan Keterampilan Berpikir Kritis Dan Literasi Sains Pada Pembelajaran Ipa Terpadu Dengan Model Pbm Dan Stm. *Jurnal Penelitian Dan Pembelajaran IPA*, *2*(2), 131. https://doi.org/10.30870/jppi.v2i2.926.

Rahmawati, T., & Partana, C. F. (2019). Pengaruh Media Pembelajaran Asam Basa Berbasis Android Terhadap Efikasi Diri Peserta Didik. *JTK (Jurnal Tadris Kimiya)*, *4*(2). https://doi.org/10.15575/jtk.v4i2.5022.

Rastuti, M., Indra, R. C., & Prahmana. (2021). The Programme for International Student Assessment Research in Indonesia. *Jurnal Elemen*, *7*(2). https://doi.org/10.29408/jel.v7i2.3289.

Rosidin, U., Kadaritna, N., & Hasnunidah, N. (2019). Can argument-driven inquiry models have impact on critical thinking skills for students with differentpersonality types? *Cakrawala Pendidikan*. https://doi.org/10.21831/cp.v38i3.24725.

Salsabila, E. R., Wijaya, A. F. C., & Winarno, N. (2019). Improving Students' Sustainability Awareness through Argument-driven Inquiry. *Journal of Science Learning*, *2*(2), 58. https://doi.org/10.17509/jsl.v2i2.13104.

Sampson, V., Grooms, J., & Walker, J. P. (2011). 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*(2), 217–257. https://doi.org/10.1002/sce.20421.

Samsu, N., Mustika, D., Nafaida, R., & Manurung, N. (2020). Analisis Kelayakan dan Kepraktisan Modul Praktikum Berbasis Literasi Sains untuk Pembelajaran IPA. *Jurnal IPA & Pembelajaran IPA*, *4*(1), 29–40. https://doi.org/10.24815/jipi.v4i1.15546.

Setiawati, F. A., Mardapi, D., & Azwar, S. (2013). Penskalaan Teori Klasik Instrumen Multiple Intelligences Tipe Thurstone Dan Likert. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *17*(2), 259–274. https://doi.org/10.21831/pep.v17i2.1699.

Siahaan, A. T., Liliasari, & Hernani. (2019). Effectiveness of Argument-Driven Inquiry Model on Student' Generic Science Skills and Concept Mastery. *Journal of Physics: Conference Series*, *1233*(1). https://doi.org/10.1088/1742-6596/1233/1/012020.

Srirahayu, R. R. Y., & Arty, I. S. (2018). Validitas dan reliabilitas instrumen asesmen kinerja literasi sains pelajaran Fisika berbasis STEM. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *22*(2), 168–181. https://doi.org/10.21831/pep.v22i2.20270.

Suraya, S., Setiadi, A. E., & Muldayanti, N. D. (2019). Argumentasi Ilmiah Dan Keterampilan Berpikir Kritis Melalui Metode Debat. *Edusains*, *11*(2), 233–241. https://doi.org/10.15408/es.v11i2.10479.

Toulmin, S. E. (2003). *The Uses of Argument*. Cambridge University Press.

Trimahesri, I., & Hardini, A. T. A. (2019). Peningkatan Kemampuan Berpikir Kritis dan Hasil Belajar Pada Mata Pelajaran Matematika Menggunakan Model Realistic Mathematics Education. *Pendidikan Tambusai*, *2*(2), 621–631. https://doi.org/10.23887/tscj.v2i2.22272.

Walker, J. P., Van Duzor, A. G., & Lower, M. A. (2019). Facilitating Argumentation in the Laboratory: The Challenges of Claim Change and Justification by Theory. *Journal of Chemical Education*, *96*(3), 435–444. https://doi.org/10.1021/acs.jchemed.8b00745.

Wulandari, D. (2020). *Pembelajaran Argument Driven Inquiry untuk Meningkatkan Keterampilan Berpikir Kritis dan Argumentasi Mahasiswa pada Materi Laju Reaksi*. Universitas Pendidikan Indonesia.