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Characteristics of Scaffolding Argument-Driven by Inquiry Learning Design based on Scientific Literacy to Improve Students' Scientific Argumentation Ability

Fina Fakhriyah^{1*}, Ani Rusilowati², Sunyoto Eko Nugroho³, Sigit Saptono⁴

¹Universitas Muria Kudus, Indonesia, ²⁻⁴Universitas Negeri Semarang, Indonesia

*corresponding author : fina.fakhriyah@umk.ac.id

Abstract

Improving the quality of learning is a challenge in creating superior primary school teacher candidates. Educators need to strive for a variety of learning methods that are carried out so that students' scientific argumentation skills develop. This research aimed to describe the characteristics of the Scaffolding Argument Driven by Inquiry learning design based on scientific literacy (SCARDIN) and measure its validity in developing superior scientific argumentation competencies for prospective primary school teachers. This study used the Research & Development (R & D) research procedure with the ADDIE stages. This study was part of a development research project that aimed to develop a SCARDIN learning design based on scientific literacy. Validation of the SCARDIN learning design based on scientific literacy used the Lawshe's proof of concept. The results of the CVR score with the number of experts used in this study were 12 people. After looking at each item, the calculation of the CVR and CVI scores met Lawshe's minimum limit of 0.0667 and met the acceptable value limit with a score of 0.91. Meanwhile, the results of the validation of the completeness of the SCARDIN learning design based on scientific literacy recommended by experts could be used with slight revisions. Based on this, the Learning Design developed, namely the SCARDIN design based on Scientific Literacy, was declared valid, relevant, and feasible to be used and applied in the learning process. The recommendation suggested by researchers is that this model should be socialized and implemented widely in other relevant courses. Future research can develop a scientific literacy-based SCARDIN learning design with a different approach.

Keywords: *Scaffolding argument driven by inquiry, scientific literacy, scientific argumentation, pre-service teacher.*

INTRODUCTION

In this era of industrial evolution 4.0, students must master thinking skills, master the technology, and other soft skills to equip them to become superior elementary school teacher candidates. The industrial era 4.0 demands teachers who have various skills, including critical thinking skills, problem solving, communication,

collaboration, and scientific argumentation. This research has the potential to contribute to the provision of quality teachers. The realization of superior teacher candidates can be done by equipping students with various competencies, skills, and abilities (personal, academic, and social). Students are given in-depth knowledge regarding the four main competencies of prospective teachers, namely student understanding competencies, educational learning competencies, competency in mastering scientific fields or expertise, and attitude and personality competencies as required by the KKNI. Strengthening is in qualified skills including critical thinking skills, creative thinking skills, problem-solving skills, communication, and collaboration skills as well as scientific argumentation skills. The development of these skills is necessary before considering cognitive competence (Aydede, 2022). Providing the provision of these various skills needs to be prepared by educators in order to improve the quality of human resources, especially for superior prospective elementary school teacher students. (Rahmawati & Yulianti, 2020) revealed that one of the successes of education is determined by the teacher because the teaching profession is the foundation for the state in terms of education. In other words, strengthening the quality of education for excellent teacher candidates really needs to be done in order to realize the quality of education.

Efforts to realize an increase in the quality of education can be pursued by improving the learning design carried out by educators. The construction of a learning design can be used with the application of innovative learning models. Learning design can be expressed as a systematic development of learning specifications using learning and learning theory to ensure the quality of learning and to solve learning problems. (Kemp et al., 2004) stated that the design of learning systems will help educators as program designers or practitioners of learning activities better understand the theoretical framework, and apply theory to create activities that are more effective, efficient, productive and fun. Prospective elementary school teachers should have special skills in understanding detailed and specific information in science so that they can transfer their knowledge to students in the corridor of meaningful learning. Disclosed by (Albab & Anisyah, 2020) that argumentative ability has an important role in the learning process at all levels of education, especially in tertiary institutions. With scientific argumentation skills, a student is able to develop this when they have high conceptual understanding (Fina Fakhriyah et al., 2022). The ability to argue scientifically equips students to be able to think critically through extracting information, empirical evidence to support an opinion and verifying the data or information they receive. (Nichols et al., 2016) mentioned that teaching scientific argumentation can help explain



some complex phenomena clearly. With argumentation skills, students have been able to carry out a scientific mindset. This is reinforced by the opinion (Norris & Phillips, 2003) that one of the main goals of science education is the realization of a scientifically literate society. By engaging students in seeking information and explaining phenomena with evidence, learning the quality of argumentation has evolved from a theoretical and methodological framework for the conception and analysis of argumentation in science ((Jiménez-Aleixandre et al., 2000); (Zohar & Nemet, 2002); (Sibel Erduran et al., 2004).

It is important to train scientific argumentation skills so that students are able to explain scientific phenomena based on relevant scientific evidence and concepts. This is because the involvement of students in argumentation generates new ideas and knowledge as scientists do ((Faize et al., 2017). Scientists who obtain discoveries must go through a series of confirmations by presenting their findings, discussions regarding their findings and scientific debates. In scientific discussion and debate it is usually centered around some phenomenon or evidence and different parties propose theories to explain the phenomenon or evidence ((Dauphin & Cramer, 2018).

Submission of scientific evidence to explain these various scientific phenomena (in the context of scientific literacy) an educator can use learning technology to make it easier to convey abstract material to be easily understood by students (Maeng et al., 2013). (Osborne, 2014) stated that validating or disproving existing opinions by reflecting scientific facts is an activity of reasoning. Argumentation is a very important and necessary cognitive-linguistic skill for twenty-first century thinking (Pablo Antonio Archila, 2013); (P A Archila, 2015); (Pablo Antonio Archila, 2017). Based on the results of previous research by (F Fakhriyah et al., 2019) showed that students' scientific literacy skills are at a nominal level of 38%. While the results of the distribution of scientific argumentation ability profiles based on scientific literacy show level 3 of 52%, this shows that students already have scientific argumentation skills based on scientific literacy in conveying arguments with claims or counter-claims that are equipped with data, warrants, or backing and accompanied by rebuttal but weakly (Fina Fakhriyah et al., 2022). (S Erduran, 2015) which stated that the ability of scientific argumentation in science education is very important, so it must be taught and learned in science classes as part of investigation and literacy.

In addition, strengthening scaffolding can help students solve complex problems (F. Azevedo, 2015; R. Azevedo & Hadwin, 2005; Ge et al., 2005; Van den Boom et al., 2007). The results of Saman et al., (2017) study revealed that accurately diagnosing students' actual skill levels, by using scaffolding to gradually increase student



competence until finally giving students responsibility to solve the problems given independently. The use of scaffolding has been proven to support the implementation of inquiry learning, especially in problem solving (Kim & Hannafin, 2011b), while the combination of argumentation skills with the context of scientific literacy has not been found in previous studies.

Therefore, it is necessary to develop an argument driven by inquiry scaffolding learning design based on scientific literacy. The use of scaffolding is proven to be able to support the implementation of inquiry learning, especially in problem solving (Kim & Hannafin, 2011a), whereas (Cetin & Eymur, 2017) revealed that the ADI model provides opportunities for students to face serious scientific presentation practices, such as preparing, presenting, and revising their presentations, so as to assist students in developing scientific presentation skills. This opinion is reinforced (Erenler & Cetin, 2019) that ADI's activities include reflective argumentation and a structured peer review process that is considered to have an impact on the monitoring strategy. Therefore, it is necessary to innovate learning scaffolding argument driven by inquiry (SCARDIN) based on scientific literacy that is valid and practical to improve the scientific argumentation skills of prospective elementary school excellent teachers.

The purpose of this research was to describe the characteristics of scientific literacy-based SCARDIN learning design and to measure its validity in the development of scientific argumentation competencies for primary school excellent teacher candidates. This research was believed to contribute the development of innovative learning designs that improve scientific argumentation skills, improve the competence of prospective elementary school teachers, especially in scientific argumentation skills, which are important for facing the challenges of education in the modern era, so that it will have an impact on the quality of science learning in elementary schools.

METHODS

This research was part of development research that aimed to develop a scientific literacy-based argument driven by inquiry (ScArDin) scaffolding design to improve the scientific argumentation skills of pre-eminent elementary school teacher candidates. To obtain a new learning system, research methods and the development of learning systems were needed. The learning design product developed followed a model from the hypothetical level to the implementation level. Furthermore, from the hypothetical model obtained, model development could be forwarded to the development of an implementation-level learning model. The development of this learning design followed a cycle of analysis, design, development, implementation, and



evaluation or Analysis, Design, Development, Implementation, and Evaluation, abbreviated as ADDIE (Molenda, 2003); (Branch, 2009). The initial study showed the importance of developing ScArDIn learning designs based on scientific literacy. The results of student scientific literacy at the nominal level and scientific argumentation skills were at level 3 as much as 52%. analysis step learning target needs, learning environment, technology, and characteristic student. Related to the design and development steps of the learning design, in this study, the researcher arranged the learning design scaffolding Argument Driven by Inquiry (ScArDIn) based on Science Literacy which consisted of learning plans with scientific arguments developed based on competing theories ((Sibel Erduran et al., 2004; Hasnunidah & Susilo, 2015), knowledge tests (for critical thinking and problem-solving skills), interview sheets, and questionnaires. Next, the researchers formulated the learning outcomes of courses that were appropriate for each topic of Biophysics material, including; prepare lesson plans, develop worksheet, teaching materials, and learning media, manufacture test instruments, and determine the question grid, questions, and answer keys. While the design development was carried out, it was continued with the implementation and evaluation stages. The detail stage was explained bellow. The following is Figure 1. ADDIE research steps.

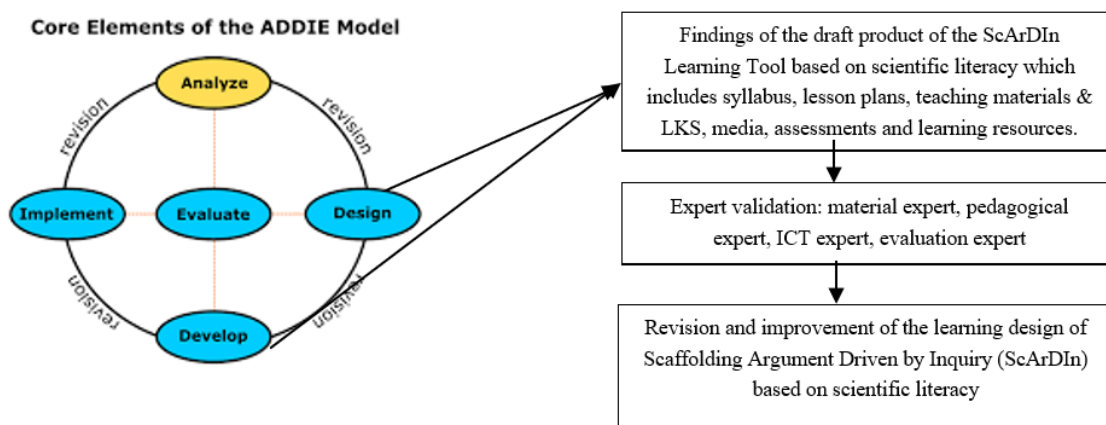


Figure. ADDIE's research steps

The research data source at the expert validation stage used 12 experts from science education expertise (materials expert, pedagogy expert, ICT expert, and assessment expert). Data collection techniques were carried out by giving a set of questions or written statements to respondents to answer. Data related to the validity



and feasibility of the developed learning design were obtained with a learning design validation sheet consisting of statements related to rationality, literature review, development steps, SCArDIn design characteristics, ScArDIn scenarios, social systems, reaction principles, support systems, instructional impact and accompaniment, planning, implementation of scenarios, application of social systems, application of the principle of reaction, learning environment, and evaluation.

Data on the acquisition of scientific literacy-based SCArDIn learning design characteristics were obtained from the results of preliminary studies, theoretical studies, and FGDs between lecturers supporting biophysics courses. After obtaining the data from the FGD results with the lecturers of the Biophysics course, the researchers conducted a study and listed the characteristics in a scientific literacy-based ScArDIn design characteristic book/guideline which was then given to the validator/expert for validation. Product validity analysis was intended to (1) test the accuracy of the material and learning design by experts; (2) test the quality of products made; (3) test the achievement of the expected goals; (4) revise products before general use; and (5) test the feasibility and suitability of the product as a learning tool.

Products validated by experts in this study formulated the learning outcomes which were appropriate for each topic of science concept material, compiling lesson plans, compiling Worksheet, teaching materials, learning media, making test instruments, determining question grids, questions, and answer keys. The researcher compiled a guide sheet for filling out expert validation based on the Likert scale for complete components to get a score of 4, while incomplete/incomplete components got a score of 1. The results of expert validation were analysed by proving using the Lawshe concept (Lawshe, 1975)(Azwar, 2012) with the following formula.

$$CVR = \frac{2ne}{n} - 1$$

Note: ne = the number of SME (Subject Matter Experts) who evaluate an essential item; n = the number of SMEs conducting the assessment.

(Lawshe, 1975) revealed that the CVR value has a range from -1 to 1. If half of the SME states essential, the CVR value will be 0. The CVR will have a value of 1 if all SME states that it is essential for an item. The overall test validity value can be determined using the CVI (Content Validity Index). CVI determination (Lawshe, 1975)(Azwar, 2012)done using the formula.



$$CVI = \frac{\sum CVR}{k}$$

Note: CVR = Content Validity Ratio of each item; k = number of statement items.

Furthermore, these results could also be given recommendations by the validator in three categories; 1) be used without revisions, 2) be used with minor revisions, and 3) be used with major revisions.

RESULTS AND DISCUSSION

The development of learning design has a theoretical or conceptual model, a procedural model, and a hypothetical model. (Kusmaryono et al., 2012) states that a model is a representation of reality that describes the structure and arrangement of a concept and displays one form of verbal description, steps or activity procedures, physical or visual replicas, equations or formulas. The theoretical or conceptual model is an analytical model by describing product components, analyzing components in detail, and showing the relationships between components to be developed. This conceptual model describes ideas and concepts based on related theories and is supported by empirical evidence in the field. While the procedural model is the steps of SCARDIN learning design and learning syntax based on scientific literacy. The hypothetical model is a model obtained from input from experts and professional experts during the Focus Group Discussion (FGD). This model is a model that will be tested empirically in the field. This article discusses the conceptual model and hypothetical model levels.

At this stage, a hypothetical model is compiled based on the acquisition of information that the ScArDIn learning design based on Scientific Literacy has been tested by experts with valid criteria. In the process of developing this learning design, each stage of evaluation is carried out in order to obtain a valid and effective learning design. This is in accordance with what was expressed by Suparman (2014) that each instructional design model has the aim of producing an effective and efficient instructional system in facilitating the achievement of instructional goals. Instructional strategy is important and as one of the components for achieving instructional design, therefore researchers design instructional strategies as a learning implementation process.

In efforts to realize this, the implementation of learning needs to be done as well as possible by maximizing students' abilities including the ability to scientific argumentation. The results of this learning design construction serve as a theoretical or conceptual model which is then reviewed and validated by experts. The expert



validation stage used 12 experts from science education expertise (material experts, pedagogy experts, ICT experts, and assessment experts). Data acquisition began with a Focus Group Discussion (FGD) activity which brought together experts and invited lecturers from the Elementary School Teacher Education study program to discuss learning design and the completeness of learning tools. The FGD activity resulted in a description of the characteristics of the SCARDIN learning design based on scientific literacy. After the FGD activities took place, further improvements to the learning design were carried out. The results of improving the learning design were then validated by experts to obtain input and further improvements. Validation of argument-driven inquiry scaffolding learning design based on scientific literacy used Lawshe's concept proof. The characteristics of the SCARDIN learning design based on scientific literacy were validated by 12 experts. The content validation results obtained then followed the provisions, namely the CVR index according to (Lawshe, 1975) as follows:

- a. When the number of respondents who agreed or strongly agreed was less than $\frac{1}{2}$ of the total respondents, the CVR value = -
- b. When the number of respondents who agreed or strongly agreed was $\frac{1}{2}$ of the total respondents, the CVR value = 0
- c. When all respondents agreed or strongly agreed, the CVR value = 1 (this was set to 0.91 according to the number of respondents). Because the number of respondents used in this study was 12 people, the critical value of CVR = 0.667.
- d. When the number of respondents who agreed or strongly agreed was more than $\frac{1}{2}$ of the total respondents, the CVR value = 0 - 0.99.

After the CVR value was obtained, then the CVI value was calculated to be seen per statement item. (Lynn, 1986) recommends CVI not lower than 0.78. From the results of the calculation, the calculation of CVR and CVI scores met Lawshe's minimum limit of 0.0667 and met the acceptable value limit with a score of 0.91, therefore illustrating that the overall Scaffolding Argument-Driven by Inquiry design based on Scientific Literacy was valid, relevant and feasible to be used and applied in the learning process. The development of this learning design has taken into account several things which include learning scenarios, social systems, reaction principles, support systems, instructional impacts, and accompanying impacts.

Furthermore, validation of the completeness of the material/content and presentation in the lesson was carried out by 7 experts based on the construction and technical components. The validated product was in the form of a Semester Learning



Plan (RPS). The results of the validation can be seen in Table 1 below

Table. Results of Obtaining Expert Validation Scores

No	Product	Validators							Average	Recommendation
		1	2	3	4	5	6	7		
1	Learning Scenario	100%	94%	98%	98%	95%	95%	98%	96.8%	can be used with minor revisions
2	Argumentation Ability Instrument	100%	86%	98%	93%	93%	98%	98%	95.1%	can be used with minor revisions
3	Test Instruments	100%	91%	95%	95%	95%	100%	98%	96.3%	can be used with minor revisions
4	Instrument for Observing Teamwork Skills	100%	98%	98%	93%	93%	98%	97%	96.7%	can be used with minor revisions
5	Scientific Attitude Measurement Instrument	100%	95%	98%	90%	95%	100%	98%	96.6%	can be used with minor revisions
6	Teaching Skills Measurement Instrument	100%	90%	98%	95%	97%	100%	100%	97.1%	can be used with minor revisions
7	Response Questionnaire Instrument	100%	97%	95%	95%	95%	100%	98%	97.1%	can be used with minor revisions

Based on the results of expert validation regarding the completeness of the scientific literacy of Scardin's learning design, the criteria could be used with minor revisions. Revisions by experts related to grammar, namely writing errors, diction/choice of words used in the argumentation test, teaching skills measurement instrument sheets, and the remaining response questionnaire instruments were appropriate and could be used for the Implementation stage.

Based on the results of expert FGDs and expert validation, information was obtained that the Scaffolding Argument-Driven by Inquiry based on Scientific Literacy learning design was valid, relevant, and feasible to be used and applied in the learning process. From the FGD between experts, input was obtained to improve the learning design. Expert Statement 1 stated that related to the competence of superior teacher candidates could be explicitly raised in learning activities, for SCARDIN learning steps were following social cognitive theory, and constructivism theory with mentoring behavior that needed to be adapted to andragogy learning. (Fakhriyah et al., 2022) in



their preliminary research provide input to science educators to prepare prospective elementary school teachers who are qualified in scientific argumentation skills by developing learning innovations. This is following the opinion (Erduran & Jiménez-Aleixandre., 2008) that there are five dimensions of argumentation development in science learning namely existence; 1) cognitive and metacognitive processes according to the performance characteristics of experts as a model for students; 2) developing communicative competence and critical thinking; 3) achieving scientific literacy, training students to have the courage to express opinions and write arguments in scientific language; 4) habituation of scientific cultural practices and the development of epistemic criteria in the clarification of knowledge; 5) development of scientific reasoning, especially in selecting the appropriateness of the theory and determining the scientific attitude according to the criteria of rationality.

Furthermore, there were additions from other experts who provided input that laboratory activities or problems in the real world were needed every day to strengthen the theory as a basis for providing specific and in-depth claims, warrants, backings, and rebuttals. This input has been carried out and added to the learning design which was then completeness of the design content validation by the expert. This is the opinion of (Sampson et al., 2013) who revealed that learning is based on ADI social cognitive learning, and is believed to be more effective in developing scientific writing and presentation skills, understanding of scientific concepts, and scientific practice because it presents more authentic laboratory activities. Also disclosed by (Duschl et al., 2007) and (Tobin, 1990) that learning science through practice is a subject that has benefited from decades of research, and recent theory supports that meaningful science learning occurs when students are actively engaged in science. the learning design that has been developed has been equipped with a learning implementation plan, teaching materials are equipped with student activity sheets.

Another input from other experts tended to be the same, namely in accordance with the items needed in the learning design, rationality, literature review, development steps, SCARDIN design characteristics based on scientific literacy, SCARDIN scenarios with scientific literacy, social systems, reaction principles, support systems, instructional impacts, and accompaniments, planning, implementing scenarios, implementing social systems, applying the principle of reaction, learning environment, and evaluation. Meanwhile, learning design as a process according to (Sagala, 2005) is the development of systematic teaching that uses specific learning theories to ensure the quality of learning. Efforts to realize superior teacher candidates are a milestone for



developing an appropriate learning process. In this process, the lecturer also has a very important strategic role in building student behavior related to their cognitive, attitudinal, and psychomotor skills. ScArDIn learning design based on scientific literacy is systematically adapted to strengthen scientific argumentation skills.

In the development, Scaffolding Argument-Driven by the Inquiry (ScArDIn) model based on scientific literacy was developed from Vygotsky's theory related to scaffolding. Scaffolding is translated into Indonesian as "scaffolding", namely bamboo (beams, etc.) that is installed as a pedestal when you want to build a house, make walls, and so on (Fakhriyah et al., 2023). (Shea et al., 2012) define scaffolding as the form of guidance given by a teacher to students in the learning process with focused issues and positive interactions. In line with that (Joyce-Gibbons, 2017) revealed that scaffolding refers to a variety of ways that we can help students acquire increasing metacognitive control. Furthermore, to develop scientific argumentation skills, many studies discuss the argument-driven inquiry (ADI) model as a model that can be used to build and develop scientific argumentation skills (Sampson et al., 2011); (Cetin & Eymur, 2017); (Hasnunidah, 2016); (Erenler & Cetin, 2019); (Walker, 2019). Argument-driven inquiry (ADI) is one of the newest learning models that underlie the role of argumentation and inquiry in science education ((Walker et al., 2012). It has been mentioned in (Fina Fakhriyah et al., 2021) the ADI model is a learning model that is oriented to the inquiry syntax. The learning approach is carried out in order to achieve the learning objectives to be achieved. The Scientific argumentation model was developed and modified from the Argument-Driven Inquiry (ADI) learning model. This is supported by his research (Hosbein et al., 2021) conveyed the results of their research which stated by using ADI, students could make significant improvements in their attitudes towards science and their ability to participate in arguments, design and carry out investigations, analyze and interpret data, and write scientifically. Scientists engaged in scientific activities know very well how physical laws are used to determine experimental results when they have a series of observational data (Gerspacher, 2018). (Sampson et al., 2013) also revealed that the learning based on ADI social cognitive learning theory is believed to be more effective in developing their scientific writing and presentation skills, understanding of scientific concepts, and their scientific practice because it presents more authentic laboratory activities. Furthermore (Cetin & Eymur, 2017b) revealing the steps of the ADI model specifically in "tentative argument production" and "argumentation sessions" helps students revise written arguments and presentations. In this form of learning, students actively involve themselves in scientific practices that include social and personal processes.



Disclosed by (Erenler & Cetin, 2019) that ADI's activities include reflective argumentation and a structured peer review process that is considered to have an impact on the monitoring strategy. This process gives pre-service teachers to pay attention to the strong points and weeks of their investigations by comparing their work with peers' investigations. Primary Educational Teacher Department students have special characteristics, so they need an appropriate model in developing scientific argumentation skills. This scientific argumentation skill can be obtained by applying the appropriate model. This is because the involvement of students in argumentation produces new ideas and knowledge as scientists do (Faize et al., 2017). Researchers continue to modify and develop scientific argumentation skills with scaffolding. Broadly speaking, this model follows the steps and syntax of ADI but is modified by combining it with scaffolding so that the results are maximized to achieve the learning objectives that have been set. Based on theoretical and conceptual studies, the Scaffolding Argument Driven by Inquiry (ScArDIn) Model based on scientific literacy uses a syntax with 6 phases which include; 1) the main topic identification stage (conceptual scaffolding) which is obtained by guiding questions prepared by the lecturer, 2) the method design stage and collecting data with the lecturer who assisting and directing students in obtaining and analyzing data with the scaffolding strategy and procedural scaffolding phases, 3) the tentative argument production stage done by students individually or in group work (strategic scaffolding and procedural scaffolding), 4) the stage of expressing arguments and making explicitly reflective (procedural scaffolding), 5) the stage of preparing reports, 6) the stage of peer-review and revision of review results (metacognitive scaffolding). Furthermore, learning by implementing scientific literacy essentially teaches science as a product, process, attitude, and technology. Implementation of science learning teaches students to acquire knowledge by being actively involved in learning such as finding knowledge (Fakhriyah et al., 2017) (Aynas & Aslan, 2021) (Suyatman et al., 2021).

Expressed by (Kristyowati & Purwanto, 2019) that scientific literacy is the abilities, skills, and competencies possessed by students in using knowledge and understanding of scientific concepts and processes to identify, acquire new knowledge, explain scientific phenomena, and draw conclusions regarding nature based on changes in nature through human activity. For this reason, learning with the Scardin design based on scientific literacy is appropriate and can strengthen scientific argumentation competence for superior teacher candidates. Scientific argumentation skills are strongly influenced by the understanding of concepts received by students as a whole so that there are no misconceptions or missing concepts (F. S. M. Fakhriyah, 2021). A good



argument needs to be based on adequate conceptual knowledge (Hong, 2013); (Widodo et al., 2016). Disclosed by (Siswanto & Suhandi, 2014) and (Hyppa-Martin et al., 2016) that the ability of scientific argumentation can help students understand the concept of science. With an emphasis on scientific argumentation, students can construct and understand concepts they already understand in the science learning process (Khishfe, 2014); (Siswanto & Suhandi, 2014); (Nichols et al., 2016), improve scientific literacy (Topalsan, 2020) and help students make decisions and solve problems (Ibrahim & Rebello, 2012).

CONCLUSION

Learning design can be stated as a systematic development of learning specifications in which the learning theories is used to guarantee the quality of learning and to solve learning problems. Elementary school teacher candidates have special characteristics, so they need an appropriate model in developing scientific argumentation skills. The expert validation results in this study showed that the SCARDIN learning design based on scientific literacy was valid, relevant, and suitable to be used in learning to strengthen the scientific argumentation competencies for superior teacher candidates. Learning activities were centered on students with the role of lecturers as mentors, facilitators, and mediators. The SCARDIN model based on scientific literacy in this study uses syntax with 6 phases including; 1) the main topic identification stage (conceptual scaffolding) obtained by guiding questions prepared by the lecturer, 2) the stage of designing methods and collecting data with the lecturer, in this step the lecturer helped and directed students in obtaining and analyzing data at the scaffolding strategies and procedural scaffolding stages, 3) the stage of producing tentative arguments carried out by students individually or in groups (scaffolding strategies and procedural scaffolding), 4) the stage of putting forward arguments and reflecting explicitly (procedural scaffolding), 5) the stage of making reports, 6) the stage of peer-review and revision of review results (metacognitive scaffolding).

This research had limitations in face-to-face time when implementing scientific literacy-based SCARDIN. The advantages of developing a SCARDIN design based on Scientific Literacy based on this study could be drawn as it could improve the competence, involvement, responsibility and communication skills of prospective teacher students. The recommendation suggested by researchers was this model should be socialized and implemented widely in other relevant courses. Future research can develop a scientific literacy-based SCARDIN learning design with a different approach, for example by using blended learning or a flipped classroom. Furthermore, it can also



be done to examine the effectiveness of the scientific literacy-based SCARDIN learning design in improving students' scientific literacy skills more comprehensively.

REFERENCES

- Albab, U., & Anisyah, Q. (2020). Analisis Kemampuan Berargumentasi Ilmiah Mahasiswa Jurusan Fisika Universitas Negeri Malang pada Materi Suhu dan Kalor. *Jurnal Riset Pendidikan Fisika*, 3(1), 1–7.
- Archila, P. A. (2013). La Argumentación y sus aportes a la enseñanza bilingüe de las ciencias. *Revista Eureka Sobre Enseñanza y Divulgación de Las Ciencias*, 10(3), 406–423.
https://doi.org/10.25267/rev_eureka_ensen_divulg_cienc.2013.v10.i3.07
- Archila, P. A. (2015). The spontaneous use of connectors and vocabulary in written argumentation: Contributions to science literacy. *Revista Eureka*, 12(3), 402–418.
https://doi.org/10.25267/rev_eureka_ensen_divulg_cienc.2015.v12.i3.02
- Archila, P. A. (2017). Using Drama to Promote Argumentation in Science Education: The Case of “Should’ve.” *Science and Education*, 26(3–4), 345–375.
<https://doi.org/10.1007/s11191-017-9901-7>
- Aydede, M. N. (2022). Examining the Primary School Teacher Candidates’ Science Learning Skills in Terms of Their Attitudes towards Science and Their Science Teaching Self-Efficacy Beliefs. *International Journal of Educational Methodology*, 8(4), 853–864. <https://doi.org/10.12973/ijem.8.4.853>
- Aynas, N., & Aslan, M. (2021). The effects of authentic learning practices on academic success in science courses. *Educational Research Quarterly*, 44(4), 3–30.
- Azevedo, F. (2015). The discourse of design-based science classroom activities. *Cultural Studies of Science Education*, 10(2), 285–315. <https://doi.org/10.1007/s11422-013-9540-5>
- Azevedo, R., & Hadwin, A. F. (2005). Scaffolding self-regulated learning and metacognition—Implications for the design of computer-based scaffolds. *Instructional Science*, 33(5/6), 367–379.
- Azwar, S. (2012). Reliabilitas dan validitas edisi 4. Pustaka Pelajar.
- Branch, R. M. (2009). *Instructional design: The ADDIE approach* (Vol. 722). Springer.
- Cetin, P. S., & Eymur, G. (2017a). Developing Students’ Scientific Writing and Presentation Skills through Argument Driven Inquiry: An Exploratory Study. *Journal of Chemical Education*, 94(7), 837–843.
<https://doi.org/10.1021/acs.jchemed.6b00915>
- Cetin, P. S., & Eymur, G. (2017b). Developing Students’ Scientific Writing and Presentation Skills through Argument Driven Inquiry: An Exploratory Study. *Journal of Chemical Education*, 94(7), 837–843.
<https://doi.org/10.1021/acs.jchemed.6b00915>
- Dauphin, J., & Cramer, M. (2018). ASPIC-END: structured argumentation with explanations and natural deduction. *Theory and Applications of Formal Argumentation: 4th International Workshop, TAFE 2017, Melbourne, VIC, Australia, August 19-20, 2017, Revised Selected Papers 4*, 51–66.
- Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (2007). *Taking science to school: Learning and teaching science in grades K-8* (Vol. 500). National Academies Press Washington, DC.



- Erduran, S. (2015). Research trends on argumentation in science education: a journal content analysis from 1998–2014. *International Journal of STEM Education*, 2(1). <https://doi.org/10.1186/s40594-015-0020-1>
- Erduran, S., & Jiménez-Aleixandre, M. P. (2008). *Argumentation in science education*. Springer.
- Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education*, 88(6), 915–933. <https://doi.org/10.1002/sce.20012>
- Erenler, S., & Cetin, P. S. (2019). Utilizing argument-driven-inquiry to develop pre-service teachers' metacognitive awareness and writing skills. *International Journal of Research in Education and Science*, 5(2), 628–638.
- Faize, F. A., Husain, W., & Nisar, F. (2017). A critical review of scientific argumentation in science education. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 475–483.
- Fakhriyah, F., Ani, R., Sigit, S., & Nugroho, S. E. (2023). Karakteristik Desain Pembelajaran Scaffolding Argumen Driven by Inquiry Berbasis Literasi Sains Karakteristik Desain Pembelajaran Scaffolding Argumen Driven by Inquiry Berbasis Literasi Sains (Moh. Nasrudin, Ed.; 1st ed.). PT Nasya Expanding Management.
- Fakhriyah, F., Masfuah, S., & Mardapi, D. (2019). Jurnal Pendidikan IPA Indonesia Developing Scientific Literacy-Based Teaching Materials To Improve Students' Computational Thinking Skills. 8(4), 482–491. <https://doi.org/10.15294/jpii.v8i4.19259>
- Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student' S Science Literacy In The Aspect Of Content Science? *Jurnal Pendidikan IPA Indonesia*, 6(1), 81–87. <https://doi.org/10.15294/jpii.v6i1.7245>
- 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>
- Fakhriyah, F., Rusilowati, A., & Susilaningsih, E. (2021). Argument-Driven Inquiry Learning Model: A Systematic Review. *International Journal of Research in Education and Science*, 7(3), 767–784.
- Fakhriyah, F. S. M. (2021). The Analysis of Scientific Argumentation Skill and Computational Thinking Skill of The Primary Educational Teacher Depar. The 2nd Science and Mathematics International Conference (SMIC 2020). AIP Conference Proceedings, 2331, 030005–1– 030005–030006. <https://doi.org/https://doi.org/10.1063/5.0041655>
- Ge, X., Chen, C.-H., & Davis, K. A. (2005). Scaffolding novice instructional designers' problem-solving processes using question prompts in a web-based learning environment. *Journal of Educational Computing Research*, 33(2), 219–248.
- Gerspacher, R. (2018). Knowledge Argument: Scientific Reasoning and the Explanatory Gap. *Axiomathes*, 28(1), 63–71.
- Hasnunidah, N. (2016). The Effect of Argument-Driven Inquiry with Scaffolding and Academic Ability on Argumentation Skills, Critical Thinking Skills, and Understanding of Basic Biology Concepts for Students of the Mathematics and



- Natural Sciences Education Department. Universitas Lampung. Diss, unpublished. Malang: Universitas Negeri Malang.
- Hasnunidah, N., & Susilo, H. (2015). Improved the Discourse Pattern in Students Argumentation Through the Use Of Scaffolding on Strategy Argument-Driven Inquiry.
- Hong, Z.-R. (2013). Promoting and scaffolding elementary school students' attitudes toward science and argumentation through a science and society intervention. *International Journal of Science Education*, 35(10), 1625–1648.
- 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.
- Hyppa-Martin, J., Collins, D., Chen, M., & ... (2016). Comparing First Graders' Attitudes and Preferences Toward a Peer Using an iPad®-Based Speech-Generating Device and a Non-Electronic AAC System. *Augmentative and ...* <https://doi.org/10.3109/07434618.2016.1146332>
- Ibrahim, B., & Rebello, N. S. (2012). Representational task formats and problem solving strategies in kinematics and work. *Physical Review Special Topics-Physics Education Research*, 010126(November 2011), 1–19. <https://doi.org/10.1103/PhysRevSTPER.8.010126>
- Jiménez-Aleixandre, M. P., Rodríguez, A. B., & Duschl, R. A. (2000). “Doing the lesson” or “doing science”: Argument in high school genetics. *Science Education*, 84(6), 757–792.
- Joyce-Gibbons, A. (2017). Observe, interact and act: teachers' initiation of mini-plenaries to scaffold small-group collaboration. *Technology, Pedagogy and Education*, 26(1), 51–68.
- Kemp, J. E., Morrison, G. R., Ross, S. M., & Kalman, H. K. (2004). *Designing effective instruction* Hoboken, NJ: John Wiley & Sons.
- Khishfe, R. (2014). Explicit Nature of Science and Argumentation Instruction in the Context of Socioscientific Issues: An effect on student learning and transfer. *International Journal of Science Education*, 36(6), 974–1016. <https://doi.org/10.1080/09500693.2013.832004>
- Kim, M. C., & Hannafin, M. J. (2011a). Scaffolding 6th graders' problem solving in technology-enhanced science classrooms: A qualitative case study. *Instructional Science*, 39, 255–282.
- Kim, M. C., & Hannafin, M. J. (2011b). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers & Education*, 56(2), 403–417.
- Kristyowati, R., & Purwanto, A. (2019). Pembelajaran Literasi Sains Melalui Pemanfaatan Lingkungan. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, 9(2), 183–191. <https://doi.org/10.24246/j.js.2019.v9.i2.p183-191>
- Lawshe, C. H. (1975). a Quantitative Approach To Content Validity. *Personnel Psychology*, 28(4), 563–575. <https://doi.org/10.1111/j.1744-6570.1975.tb01393.x>
- Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, 35(6), 382–386.



- Maeng, J. L., Mulvey, B. K., Smetana, L. K., & Bell, R. L. (2013). Preservice Teachers' TPACK: Using Technology to Support Inquiry Instruction. *Journal of Science Education and Technology*, 22(6), 838–857. <https://doi.org/10.1007/s10956-013-9434-z>
- Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement*, 42(5), 34–37.
- Nichols, K., Gillies, R., & Hedberg, J. (2016). Argumentation-Based Collaborative Inquiry in Science Through Representational Work: Impact on Primary Students' Representational Fluency. *Research in Science Education*, 46(3), 343–364. <https://doi.org/10.1007/s11165-014-9456-4>
- Norris, S. P., & Phillips, L. M. (2003). How Literacy in Its Fundamental Sense Is Central to Scientific Literacy. *Science Education*, 87(2), 224–240. <https://doi.org/10.1002/sce.10066>
- Osborne, J. (2014). Teaching Scientific Practices: Meeting the Challenge of Change. *Journal of Science Teacher Education*, 25(2), 177–196. <https://doi.org/10.1007/s10972-014-9384-1>
- Rahmawati, I. Y., & Yulianti, D. B. (2020). Kreativitas guru dalam proses pembelajaran ditinjau dari penggunaan metode pembelajaran jarak jauh di tengah wabah COVID-19. *Al-Asasiyya: Journal Of Basic Education*, 5(1), 27–39.
- Sagala, S. (2005). Perencana Pendidikan Penyedia Informasi sebagai Landasan Penentuan Kebijakan Pendidikan di Sekolah. *Mimbar-Pendidikan*, 69.
- Saman, M. I., Handayanto, S. K., & Sunaryono, S. (2017). E-Scaffolding untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika. *Seminar Nasional Pendidikan IPA 2017*, 2.
- Sampson, V., Enderle, P., Grooms, J., & Witte, S. (2013). Writing to learn by learning to write during the school science laboratory: Helping middle and high school students develop argumentative writing skills as they learn core ideas. *Science Education*, 97(5), 643–670.
- 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.
- Shea, P., Hayes, S., Smith, S. U., Vickers, J., Bidjerano, T., Pickett, A., Gozza-Cohen, M., Wilde, J., & Jian, S. (2012). Learning presence: Additional research on a new conceptual element within the Community of Inquiry (CoI) framework. *The Internet and Higher Education*, 15(2), 89–95.
- Siswanto, I. K., & Suhandi, A. (2014). Penerapan Model Pembelajaran Pembangkit Argumen Menggunakan Metode Saintifik Untuk Meningkatkan Kemampuan Kognitif dan Keterampilan Berargumentasi Siswa. *Indonesian Journal of Physics Education*, 10(2), 104–116.
- Suyatman, S., Saputro, S., Sunarno, W., & Sukarmin, S. (2021). Profile of Student Analytical Thinking Skills in the Natural Sciences by Implementing Problem-Based Learning Model. *Journal of Educational, Cultural and Psychological Studies (ECPS Journal)*, 23, 89–111.
- Tobin, K. (1990). Changing metaphors and beliefs: A master switch for teaching? *Theory into Practice*, 29(2), 122–127.
- Topalsan, A. K. (2020). Development of Scientific Inquiry Skills of Science Teaching



- Through Argument-Focused Virtual Laboratory Applications. *Journal of Baltic Science Education*, 19(4), 628–646.
- Van den Boom, G., Paas, F., & Van Merriënboer, J. J. G. (2007). Effects of elicited reflections combined with tutor or peer feedback on self-regulated learning and learning outcomes. *Learning and Instruction*, 17(5), 532–548.
- Walker, J. (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>
- Walker, J. P., Sampson, V., Grooms, J., Anderson, B., & Zimmerman, C. O. (2012). Argument-driven inquiry in undergraduate chemistry labs: The impact on students' conceptual understanding, argument skills, and attitudes toward science. *Journal of College Science Teaching*, 41(4), 74–81.
- Widodo, A., Waldrip, B., & Herawati, D. (2016). Students argumentation in science lessons: A story of two research projects. *Jurnal Pendidikan IPA Indonesia*, 5(2), 199–208.
- Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching*, 39(1), 35–62. <https://doi.org/https://doi.org/10.1002/tea.10008>.

