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Research Article

Scientific literacy refinement at Islamic junior high schools using socio-science spirituality learning model

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ABSTRACT

Learners need to possess scientific literacy in order to be able to analyze and explain scientific concepts and solve daily life problems. The current study aimed to analyze the potential of the Socio-Science Spirituality learning model to improve the scientific literacy of students at the junior high school level. The sample of this research contained eight-grade students from an Islamic based school in Surabaya. A quasi-experimental design was used in this study involving the Socio-Science Spirituality class as the experimental group and the conventional class as the control group. Data were collected using multiple choice tests where the questions were developed based on 37 scientific literacy indicators. The data were analyzed using ANCOVA. The results showed that the application of the learning model influenced students' scientific literacy, where the Socio-Science Spirituality group increased their scientific literacy 28.37% higher than the conventional group. In short, the Socio-Science Spirituality learning model has a higher potential to increase students' scientific literacy, so that it can be used as a new reference to empower students' scientific literacy.

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INTRODUCTION

Scientific literacy is one of the most important skills for students to understand and possess. This has implications in several countries where scientific literacy is the primary educational (Dragoş & Mih, 2015; Gen, 2015). Scientific literacy is key to academic success in a 15-year-old child. Fives, et al., (2014) defines scientific literacy as the ability to fully involve oneself in a process associated with everyday life. Scientific literacy aims to develop skills and creativity based on relevant scientific knowledge and scientific evidence for decision making and problem-solving (OECD, 2018).

It consists of three scientific domains, namely scientific knowledge, scientific competencies, and scientific context (OECD, 2018). Scientific domains in scientific literacy that must be mastered by students at the junior high school level through science learning. Since the entire science material has the potential to stimulate aspects of scientific literacy (Situmorang, 2016), it is hoped that learners can better understand and refine scientific literacy skills through science learning (Fitzgerald & Smith, 2016). Armed with scientific literacy skills, learners will eventually develop the ability to understand science and use the skills to solve life problems and make decisions (Jgunkola & Ogunkola, 2013; Tang, 2015). In addition, scientific literacy also helps students face various global challenges in the future (Meldawati, 2017).

Students in junior high school must understand and master scientific literacy skills through science learning. It is well established that students are anticipated to get a better understanding of scientific literacy and develop the skills as a result of science learning, as the entire science curriculum has the potential to bring up components of scientific literacy. Scientific literacy is critical in twenty-first-century education, because students need to apply the skills in everyday life. Scientific literacy is the determinant of the success of student learning (Jufrida et al., 2019; Pratiwi et al., 2019). In Indonesia, scientific literacy is manifested through the implementation of the 2013 curriculum that promotes aspects of scientific inquiry in the learning process (Lederman et al., 2014; Utami et al., 2016). Therefore, scientific literacy is integrated into educational curricula to prepare a globally competitive workforce.

In 2015, PISA ranked Indonesia 62 out of 70 countries for scientific literacy with an average score below the PISA standard (OECD, 2016). Then, in 2018, Indonesia was in the 73rd position out of 79 participating countries (score 396) in the field of science (OECD, 2019). This shows that learners in Indonesia have very poor scientific literacy. Ni'mah (2019) underlines the need for research on the application of science literacy learning in junior high schools to provide an overview of the development of students' scientific literacy in Indonesia. Preliminary studies conducted at two junior high schools in Surabaya in 2019 suggest that only less than fifty percent (31.97%) of the students were able to perform scientific literacy skills. Other Merta et al., (2020); Zhasda et al., (2018) also report that students at the junior high school level have underdeveloped scientific literacy.

Junior high school teachers admit that poor learning patterns may result in students' poor scientific literacy skills because students are rarely given the opportunity to practice solving science problems in real life contexts. Past studies also suggest that instructional strategies contribute to students' lack of scientific literacy. Conventional learning that is frequently applied in the classroom cannot actively involve students in the learning process (Lin et al., 2012; Putra et al., 2016). In fact, learners are not accustomed to responding to scientific literacy questions (Hasana et al., 2017; Rohayati et al., 2016; Siagian et al., 2017). This illustrates that students' scientific literacy has not been enhanced properly to identify, analyze and solve problems as well as to make decisions (Dewi et al., 2020; Fatimahsyam et al., 2018; Jufrida et al., 2019). Therefore, it is necessary to conduct learning that can empower learners to obtain adequate scientific literacy (Aiman et al., 2020; Aprido et al., 2020; Prasasti & Listiani, 2019; Siagian et al., 2017).

In line with the needs of scientific literacy development, it is imperative to apply effective learning strategies in the classroom (Chelvan et al., 2019). Instructional strategies have an effect on students' scientific literacy (Aiman et al., 2020). Problem-based learning (Risa, 2016) and inquiry-based learning (Aiman et al., 2020) using scientific issues can promote scientific literacy. Inquiry-oriented learning is constructivist-based learning that engage students in investigative activities. Each basic competence in the science curriculum contains aspects of scientific literacy which can only be achieved through the application of constructivist-based learning models and student active involvement in demonstrations and experiments (Situmorang, 2016).

Based on the preliminary findings, a new learning model, the Socio-Science Spirituality (3S) learning model, was developed. It is based on the principles of science education's primary objectives, which include acquiring knowledge, conducting scientific investigations in a systematic manner, and comprehending the application of science and technology in life. Socio-Science Spirituality is a constructivist-based learning model that is designed to enhance students' scientific literacy. Constructivist-based learning models are known to develop students' ability to analyze scientific phenomena by utilizing environment as a learning resource (Jufrida et al., 2019). Socio-Science Spirituality learning is distinct from other forms of education in that it involves scientific discussions about a variety of socio-science issues or scientific subjects and culminates in the presentation of a fatwa study by the Indonesian Ulema Council (MUI) that contains the spiritual value of science that assists in the resolution of current socio-scientific issues. Thus, in addition to enhancing students' scientific literacy, Socio-Science Spirituality learning fosters the growth of students' critical thinking skills, which are necessary for resolving a variety of meaningful, relevant, and contextual problems. In line with the growing issues, the MUI Fatwa is present as decisions given by ulama about the Muslims' problems based on Al-Qur'an, Hadith, Ijma', Qiyas, and other reputable propositions (Imaduddin & Khafidin, 2018). Therefore, scientific literacy allows for the development of thinking ability to solve meaningful, relevant and contextual problems.

The Socio-Science Spirituality (3S) syntax comprises: (1) familiarizing oneself with social issues evolving in society (issues orienting); (2) conducting investigations to explore social issues or contextual phenomena (investigating); (3) presenting the results of group discussions, generalization, information justification and conclusions (sharing); (4) drawing conclusions by making associations between the material being studied with spiritual values (evaluating) and (5) practicing self-reflection on the overall process of learning (reflecting). The learning stages in Socio-Science Spirituality reflect the concepts of constructivism by involving learners in constructing knowledge from natural phenomena that exist around them. The detailed explanation of each Socio-Science Spirituality (3S) syntax is presented in the following sections.

First, *issues orienting* enables students to familiarize themselves with scientific issues. Klosterman & Sadler (2015) state that instructions that involves socio-scientific issues can bring a positive impact on scientific understanding. Second, *investigating* requires learners to explore data in the form of literature review, observations on phenomena evolving in society, or scientific data mining through a practicum. Exploration-based learning that is applied through question and answer (Q and A) sessions to extract students' ideas can increase scientific literacy (Hastuti et al., 2019; Ødegaard, 2018). Third, *sharing* has the potential to enhance scientific literacy because learners communicate and discuss ideas with each other to solve problems and make decisions together (Zeidler et al., 2011). Next, *evaluating* allows the teacher to wrap up and conclude the lesson and evaluate students' investigative activity. At this stage, students' scientific literacy is measured using the instrument that has been designed (Arends, 2012; Ratnaningsih, 2017). The assessment is done to examine the progress of students' scientific literacy. It is also conducted to evaluate students' concept mastery, thinking skills and attitudes; therefore, the evaluation instrument needs to be designed properly (Rubini et al., 2018). Fifth, *reflecting* on the scientific understanding obtained from the learning process lets students recognize their competency achievement (Wardani & Djukri, 2019). The self-reflection activity is performed based on the results of observational learning. If the learning objective has not been achieved, improvement planning is prepared (Juhji, 2016; Rafiah et al., 2018). Hastuti et al., (2019) explains that if the reflection stage is carried out appropriately and directed, students will be able to perform reflective thinking because they are accustomed to learning to analyze, evaluate, and acquire meaning.

Despite so, the effectiveness of the Socio-Science Spirituality learning model on students' scientific literacy has never been tested statistically. Based on the background of the study, this study aimed to analyze the effect of Socio-Science Spirituality on junior high school students' scientific literacy.

METHOD

The current study was designed as a quasi-experimental study using the pretest-post-test non equivalent control design, because it involved group comparison (Sugiyono, 2013). The treatment units (2x2 factorial) consisted of Socio-Science Spirituality learning model and a conventional learning model is presented in Table 1.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
A	O1	X1	O2
B	O1	-	O2

Source: (Sugiyono, 2013)

Notes: O1: pretest score; O2: post-test score; A: Socio-Science Spirituality learning model; and B: conventional learning model (control group).

This study aimed to investigate students' scientific literacy refinement through the implementation of Socio-Science Spirituality learning. It was carried out from August to December 2019. The research population contained the eighth graders from SMP Al-Falah Surabaya and MTs Ittaqu Surabaya. The sample of the study was selected using cluster random sampling technique, a sampling technique which randomly picks the participants without considering the strata. The participants selected were 64 students from two Junior High Schools (JHS), namely SMP Al-Falah Surabaya and MTs Ittaqu Surabaya. They were assigned into two treatment groups, the experimental group and the control group.

The instruments used to collect the data consisted of syllabus, lesson plans, student worksheets, scientific literacy tests and teaching implementation sheets. The scientific literacy test comprised multiple choice items that were developed on the following indicators of scientific literacy according to PISA 2018 (OECD, 2018): (1) explaining scientific phenomena; (2) evaluating and designing scientific investigations and (3) interpreting data and evidence scientifically. The test items had undergone expert validation and empirical validation processes before use.

The expert validation process involved two professors from a university and a teacher. One of the professors is an expert in Biology Education and holds a doctoral degree in similar field, while the other is an expert educational development and holds a master degree in the respective field. The teacher involved in the validation process has years of teaching experience and holds a master degree in education. Each of the scientific literacy test items was validated empirically and by the experts to determine its reliability. The empirical validity of each test item was measured using the bi-serial point correlation formula, whereas the reliability of the item was measured using KR-20, item discrimination test, and level of difficulty test. The criteria for assessing the quality of each test item were valid, reliable as well as had varied item discrimination levels and varied difficulty levels. The expert validation showed a mean score of 3.91, which suggests that the test was valid. The empirical validation conducted on 142 learners of different groups indicated a significance level of 0.000 < 0.05. Therefore, the total number of test items that could be used for the pretest and the post-test was 37. It was divided into 10 questions on digestive system, 12 questions on additives and addictive substances and 15 questions on circulatory system. The reliability of each group of the scientific literacy questions is presented in Table 2.

Table 2. Item Reliability

Materials	Score	Category
Digestive System	0.734	High
Additives and Addictive Substances	0.683	High
Circulatory System	0.486	Medium

Analysis of covariance (ANCOVA) at a significance level of 5% was run for data analysis. When a significant value was shown in the hypothesis testing, the Least Significance Difference (LSD) test was performed. The participants' scientific literacy skills were measured using multiple-choice tests. The data contained the pretest, post-test and N-gain scores achieved by the experimental and control groups. Before conducting the data analysis, statistical test assumptions were ensured. The data normality was examined using One Sample Kolmogorov-Smirnov Test and the data homogeneity was measured using Levene's Test of Equality of Error Variances. The normality test showed p > 0.05 at a significance level of 0.976 > 0.05 for pretest scores and a significance level of 0.247 > 0.05 for post-test scores. These values suggest that the data were distributed normally. The homogeneity test showed a significance level of 0.016 < 0.05; hence, it can be said that the data were distributed inhomogeneously. The statistical analysis could be done because the data had been declared normal and inhomogeneous.

RESULTS AND DISCUSSION

The mean scores achieved by the participants in pretest, post-test and N-gain before treatment are presented in Table 3.

Table 3. Mean scores and percentage of increase in students' scientific literacy pretest-post-test

No.	Treatment Groups	Mean score		Increase (%)	Notes
		Pretest	Post-test		
1.	Experimental	39.38	78.00	98.07	Increase
2.	Control	34.50	60.88	76.46	Increase

Table 3 shows that both of the experimental and control students experienced an increase in scientific literacy skills. However, the increase reported by students who were taught using the Socie-Science Spirituality learning model was higher than that obtained by students from the control group. The results of ANCOVA on the effect of Socio-Science Spirituality and conventional learning models on students' scientific literacy skills are summarized in Table 4.

Table 4. Summary of ANCOVA on Learning Model Effect on Scientific Literacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4775.976[a]	4	1193.994	31.390	.000	.680
Intercept	6928.231	1	6928.231	182.141	.000	.755
Pre_Science-Literacy	46.230	1	46.230	1.215	.275	.020
Class	3758.653	1	3758.653	98.814	.000	.626
School	63.477	1	63.477	1.669	.201	.028
Class * School	45.808	1	45.808	1.204	.277	.020
Error	2244.230	59	38.038			
Total	320428.782	64				
Corrected Total	7020.206	63				

a. R Squared = .680 (Adjusted R Squared = .659)

Based on Table 4, F-calculated of 98.814 with p-value (0.000) < (0.05) indicated that the research hypothesis "there is a difference in scientific literacy between students taught with the Socio-Science Spirituality learning model and students learned with conventional learning" was accepted. It further suggests that the learning models had an effect on students' scientific literacy. However, to investigate the significance of the effect, LSD test was performed. The LSD test result can be seen in Table 5.

Table 5. The LSD test result

No.	Group	Pre-test	Post-test	Mean score	LSD Notation
1.	Experimental	38.76	79.67	77.684	A
2.	Control	34.16	60.89	61.206	B

The LSD test result revealed that the post-test mean score achieved by the experimental students (78.88) was higher than that obtained by the control students (61.45). Besides, the percentage of increase observed among students taught with the Socio-Science Spirituality learning model was 26,92% higher than that found among students in the conventional group. The LSD notation suggests that the Socio-Science Spirituality learning model had a more significant effect on students' scientific literacy compared to the conventional learning model. The description of the socio-science spirituality and conventional learning syntax can be seen in Table 6.

Table 6. Presents the description of the socio-science spirituality and conventional learning syntax

	Socio-science spirituality learning syntax	Conventional learning syntax
Orienting Issues	• Orienting students to the learning objectives and learning activities • Organizing students into learning groups • Orienting students to socio-scientific issues and phenomena and finding the link between the issues and spiritual values	Teacher delivers the material orally
Investigating	• Providing directions for investigations • Investigating an issue through experiments or library-based research • Processing and analyzing data • Contemplating on the investigation activities and relating to spiritual values to find solutions to problems and draw conclusions	The teacher asks questions to student individuals
Sharing	• Sharing the results of group discussions • Providing questions, feedback, or input to the presenter group • Making decisions based on the results of discussions between groups	The teacher assigns groupwork to the students
Evaluating	• Drawing conclusions on the material • Providing reinforcement through quizzes	Students discuss the tasks together
Reflecting	• Evaluating the strengths and weaknesses of the learning process • Reflecting on the learning process by linking the learned material with spiritual values	Students and the teacher draw a conclusion on the material and conduct an evaluation

The results of ANACOVA indicate that the Socio-Science Spirituality (3S) learning model has a substantial effect on students' scientific literacy. This study is consistent with the findings of (Afriana et al., 2016; Saefullah et al., 2017) who discovered that applying a learning model in the classroom has the potential to improve students' scientific literacy. According to Iskandar et al., (2019), scientific literacy can be considerably increased by using learning models that allow students to participate directly in science activities. In comparison to conventional learning models, the Socio-Science Spirituality learning approach is more effective at increasing students' scientific literacy. This is demonstrated by the syntax used to construct the Socio-Science Spirituality learning model, which has the potential to significantly improve students' scientific literacy.

The first stage of the Socio-Science Spirituality learning model is orienting issues. During orienting issues, students are aided in identifying actual socio-scientific problems. At the orienting issues stage, students work collaboratively with their group members to discover and discuss scientific discourses relevant to socio-scientific challenges. For instance, students can identify discourses about the stunting phenomenon in Indonesia by underlining the points they believe are significant to complete the following task: "Read and comprehend the article carefully, identify socio-scientific issues by marking/underlining things or sentences that you believe are significant, and then write a report about your identification results!" Once identified, state your predictions for the discourse! Similarly (Marks et al., 2014; Rostikawati & Permanasari, 2016) observed that identifying problems associated with socio-scientific issues has the potential to be used as science learning resources, hence boosting students' scientific literacy (Rubini et al., 2019). Scientific literacy can be developed through activities that engage students in discussion on scientific issues (Ødegaard, 2018).

The orienting issues stage begins with students actively compiling questions about a problem which will be explored to find a solution. This stage is crucial in scientific literacy refinement because learners are trained to enhance important aspects of scientific literacy through identifying problems, formulating questions and evaluating and making decisions (OECD, 2018). At this stage, students become accustomed to formulating problems can enhance students' scientific literacy skills (Dewi et al., 2017). This is revealed by research reporting (Justi et al., 2019; Kind & Osborne, 2017) that the problem formulations result from problem identification, where the solution is sought through scientific investigations, the questions designed before scientific investigations aim to increase student active involvement in learning, boost student self-confidence in demonstrating their abilities and help students solve problems and make decisions. The questions are also designed to develop thinking and writing skills as well as the ability to provide answers based on relevant evidence and to do self-evaluation regarding the understanding of concepts that have been mastered (Chelvan et al., 2019).

The most important syntax in the Socio-Science Spirituality learning model is the investigating stage. It is obvious that during the investigating stage, students collaborate with group members to process data, assess issues, develop conclusions about the phenomena of adequately given socio-scientific topics, and comprehend discourse about those issues from a variety of sources. This finding is consistent with Rubini et al., (2018) research, which demonstrates that the Socio-Science Spirituality learning model is effective at increasing student scientific literacy because the Socio-Science Spirituality learning model requires students to have independence and develop an understanding of scientific investigation. Learning activities at the investigating stage also familiarize students with extracting data from discourse or written information sources in the form of printed media, interpreting data and scientific evidence so that students will be able to analyze data and evaluate scientific information obtained from various sources (Arifin & Sunarti, 2017).

Furthermore, increasing students' scientific literacy through evaluating and designing scientific research is also covered by the investigating stage. This stage requires students to explore data in the form of literature review or observations of phenomena that develop in society and to do scientific data mining through practicum. Research explains that scientific literacy can be improved through the application of exploration-based learning, literature review (Finneran, 2017), data mining, exploration of students' ideas through question and answer sessions about related issues (Hastuti et al., 2019; Vieira & Tenreiro-Vieira, 2016), and practicum (Nisa et al., 2019; Rubini et al., 2017). Piaget's cognitive development suggests that students at the junior high school level already have the ability to carry out scientific investigations and make decisions. The knowledge obtained by direct data mining will automatically support students to practice scientific literacy skills (Gen, 2015). Therefore, in the investigating stage, students are encouraged to use their scientific knowledge in making decisions for everyday life (Justi et al., 2019).

Scientific literacy can be enhanced through sharing stage. The role of the *sharing* stage in improving scientific literacy is evident from the active involvement of students in communicating the results of group discussions, while other students provide responses or arguments. This finding is in line with the research of (Vieira & Tenreiro-Vieira, 2016), who recommend incorporating sharing activities in science classrooms. Students are taught to debate with other groups with the goal of resolving socio-scientific issues and developing the ability to make sound judgments (Gutierez, 2015). Students' activities during the *sharing* stage have been successful but not optimal, since there were still a significant number of students who were less enthusiastic in providing feedback, input, or review of the findings of the presenter group's talks. As a result, future research utilizing the Socio-Science Spirituality learning model should focus on optimizing sharing activities to increase students' scientific literacy. Explaining scientific phenomena is one of scientific literacy components. Students must actively participate in developing and evaluating alternative explanations for scientific phenomena, rather than simply recalling, or comprehending existing ideas and facts (Arifin & Sunarti, 2017). This is an endeavor to increase students' scientific literacy, to engage them in various forms of social conversation (Erduran & Jimenez-Aleixandre, 2012) and to enable them to respond to a variety of science and technology-related concerns that are contested in the public sphere (Sousa et al., 2013).

Scientific literacy can also be enhanced through evaluating activities. This is confirmed by the research findings that, at this stage, students assisted by the teacher were able to draw conclusions on the learning material and work on scientific literacy evaluation questions. Evaluation is critical in determining students' progress toward scientific literacy through data gathering and analysis, as well as offering feedback on students' decisions (Arends, 2012; Ratnaningsih, 2017). The data obtained by the students can provide information in decision making to improve their performance in the learning process and to enhance their scientific literacy skills. Yambi (2020) argues that evaluation is carried out to determine student progress. Evaluation can be carried out by the teacher through testing on certain learning materials.

Reflecting in the Socio-Science Spirituality learning model plays an essential role in developing competence and attitudes of students related to learning material in a global context. The reflecting stage includes reflection on mastery of the learning content to increase students' knowledge and reflection on the cultivation of moral and spiritual values contained in teaching materials to shape the attitudes and personalities of students. The importance of reflection in the learning process is to increase knowledge, develop attitudes, personalities, and skills of both teachers and students. Through *Reflecting*, students can develop the ability to connect subject matter to knowledge and skills to spiritual values (Jumini & Wahyudi, 2015). Integrating spiritual values into the material content of science is a sort of self-reflection that helps students improve their spiritual attitude and personality (Asmarawati et al., 2016). Self-reflection on the spiritual principles inherent in science material is a spiritual practice that aids in the formation of (Pranjia et al., 2020) and personality, which includes self-awareness (Kemper, 2010), morals, discipline, and self-regulation (Sweeney & Fry, 2012). A person with a strong spiritual foundation will exhibit strong attitude management or self-discipline (Fadillah et al., 2021). Therefore, the reflecting stage in the 3S learning syntax is critical for increasing pupils' scientific literacy.

The Socio-Science Spirituality (3S) learning model differed significantly from the conventional model in increasing students' scientific literacy. Compared to the 3S group (experimental group), students in the conventional group reported lower scores on the scientific literacy aspects. Research by (Ristanto et al., 2017; Winarni et al., 2020) also found that students in the conventional class had poor performance in scientific literacy. In comparison to conventional instructional models, Socio-Science Spirituality Learning is more effective at increasing student literacy because conventional models do not assist students in orienting themselves to problems, such as identifying problems or issues, formulating preliminary inquiries about cases or problems offered, and performing investigations. According to Ristanto et al., (2017), conventional learning has no effect on students' scientific literacy since the learning process let only the teacher to convey the learning material, while the students operate as observers who are not permitted to ask questions during class discussion. In conventional classes, students are not empowered to practice identifying issues. Conventional classes do not encourage scientific inquiry and are unable to engage students meaningfully in scientific discussion. Indeed, the teacher has employed discussion techniques in conventional learning, but the discussion does not include topics that can help students develop their analytical abilities, boost their involvement, or improve their ability to resolve a problem. In similar fashion, Pratama (2018) reported that traditional education has not resulted in an increase in students' scientific literacy. Conventional learning patterns have not prepared students to learn by identifying issues and developing problem-solving techniques, resulting in a lack of scientific literacy (Parno et al., 2020). The findings of Twiningsih et al., (2019) research suggest that teachers integrate conventional learning with problem-based or problem-solving modules.

CONCLUSION

Based on the research findings, it can be inferred that the Socio-Science Spirituality learning model is more effective than the conventional learning model in improving students' scientific literacy, indicated by the mean scores reported by the students. Since the Socio-Science Spirituality learning model has a greater potential in improving students' scientific literacy, it can be used as a new reference model to improve students' scientific literacy.

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