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Development of a Natural and Social Sciences Learning Model Based on Socio Scientific Issues to Strengthen Scientific Literacy of Islamic Elementary School Students

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Abstract: Science learning in the independent curriculum seems to still stand alone, is oriented cognitive learning outcomes, does not relate to social issues, and is not yet oriented towards scientific literacy. In the field, there is no yet available natural and social science learning model framework that structurally involved social, ethical and moral issues, through a Socio Scientific Issues (SSI) approach that is applicable to educational practitioners. This research aims to produce a framework for a natural and social science (IPAS) learning model based on Socio Scientific Issues (SSI) approach to strengthen students' scientific literacy in elementary school. This Design Based Research (DBR) was carried out through stages problem identification and analysis; design; testing and evaluation); and reflection. This research involved teachers and students of grade IV Islamic elementary schools in Kartasura, Sukoharjo, were taken using purposive sampling. The model validity test was carried out by experts in the fields of learning models, content and language. The resulting IPAS learning model based on Socio Scientific Issues (SSI) approach framework has a validity of 99.2% (very valid) and a learning tool of 96.5% (very valid). This model is very practical to implement (score 86%), and is quite effective in strengthening the scientific literacy of elementary school students. This model is suitable for application at other elementary school levels in a wider scope, with careful planning in terms of infrastructure and time management.

Keywords: Natural and social sciences; Scientific literacy; Socio scientific issues

Introduction

In the independent curriculum, science in elementary schools are combined with social knowledge, so they are termed a series of science lessons (science and social studies). Natural and social science learning has a role in realizing the Pancasila Student Profile. Natural and social science helps students to understand natural phenomena that occur. This understanding can then be used to identify various problems faced and find solutions (Zurqoni & Hariyanie, 2018). In science, students study science content about living things and inanimate objects in the universe and their interactions, and examine human life as individuals and as social creatures who interact with their environment (Hudaya & Barni, 2024). It is hoped that from this interaction, students can resolve or provide solutions to social issues that occur in society in accordance with current developments (Sari, 2016; Sayekti et al., 2019; Susanto et al., 2019).

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Social issues currently occurring in society are closely related to science, and this involves moral and ethical aspects to overcome them. In this context, the socio scientific issues (SSI) approach is a top priority where students' ability to reason and solve problems is emphasized so that they are able to make decisions regarding social issues with moral implications that exist in a scientific context (Badeo & Duque, 2022; Zeidler et al., 2005; Zeidler & Nichols, 2009). The ability to reason and solve problems is an illustration of scientific literacy which is highly emphasized in natural and social science (IPAS) learning in the Independent Curriculum in Elementary Schools. Based on data in the field regarding scientific literacy which is covered in the Program for International Student Assessment (PISA) scores from year to year it is said to be relatively low. From 2000 – 2018, Indonesia's PISA score relatively fell, with a position of 70 out of 78 countries, which is still lower than Thailand, Malaysia and Vietnam (OECD, 2018).

Scientific literacy is the ability to understand scientific concepts and principles, use skills, attitudes and knowledge related to science to think critically, solve problems and make decisions needed to overcome science-based issues (Sutiani, 2021; Sutrisna, 2021). Scientific literacy really needs to be instilled in students (Agustina & Ningsih, 2017; Bröder et al., 2017; Purwanti & Desstya, 2023; Putrautama & Desstya, 2023; Solihatul & Desstya, 2023; Widiyanto & Desstya, 2023). Data findings in the field showed that students' scientific literacy is still low, with an achievement percentage of less than 55% (Kelly et al., 2013; Nofiana, 2017; Utami & Desstya, 2021). These facts indicate that the quality of the learning implementation applied to students still needs to be improved. The natural and social science learning implemented in the independent curriculum seems to still stand alone, oriented towards cognitive learning outcomes and many do not yet relate to social issues. It was also found that moral and ethical involvement had not been integrated into science learning. This does not condition students to be scientifically literate. Likewise, educational practitioners in elementary schools. They do not have a structured reference for instilling scientific literacy. Up to now, there is still no framework for a natural and social science learning model that structuredly involves social, ethical and moral issues through a Socio Scientific Issues (SSI) approach that is applicable to educational practitioners, so they have not been directed to implement it in elementary schools.

Socioscientific Issues is a learning approach that presents science material in the context of social issues involving moral or ethical components. SSI presents an ideal context that seeks to involve students in making decisions regarding social issues with moral implications that exist in a scientific context (Utami et al., 2022). SSI-based teaching is able to facilitate science and science learning which supports the formation of scientific literacy (Harris & Rooks, 2010; Nazilah et al., 2019; Nuangchalerm, 2009; Rohmawati et al., 2018; Rostikawati & Permanasari, 2016).

This description shows that it is very important and necessary to actualize the natural and social science learning model which links social issues in the surrounding community and involves morals and ethics, with the form of a learning model framework that can be applied by educational practitioners in the classroom in accordance with the demands of the Independent Curriculum. Based on these problems, this research aims to produce a natural and social science learning model framework using a Socio Scientific Issues (SSI) approach to strengthen elementary school students' scientific literacy. The formulation problem in this research are what is the framework of the natural and social science (IPAS) learning model based on Socio Scientific Issues (SSI) approach; How effective is the framework of natural and social science (IPAS) learning model based on Socio Scientific Issues (SSI) approach to strengthen the scientific literacy of elementary school students?

Method

This was Design Based Research (DBR) design, with stages: identification and analysis of problems by researchers and practitioners; develop a solution plan based on theoretical benchmarks, existing design principles, and technological innovation (design stage); carrying out an iterative process to practically test and improve the solution (testing and evaluation phase); reflection to produce design principles and improve practical implementation of solutions (reflection stage) (Gerholz & Wagner, 2022; Plomp, 2013) .

Problem Identification and Analysis . At this stage, problems related to IPAS learning and strengthening elementary school students' scientific literacy are identified. Researchers collaborate with educational practitioners to examine IPAS learning with existing models, analyze weaknesses and identify the required model framework specifications. Design. Based on the specifications obtained, the researcher designed a prototype of the IPAS learning model framework based on the SSI approach in the Independent Curriculum in elementary school. Testing and Evaluation. This activity is an implementation of IPAS learning model framework based on Socio Scientific Issues (SSI) approach in the independent curriculum in elementary schools. At this stage, teachers measure elementary school students' scientific literacy. Data on teacher implementation in applying the model framework is used to measure the practicality of the model framework. Scientific literacy data was collected to evaluate the accompanying impact

of the model that has been implemented. At this stage, the output produced is a framework for IPAS learning model based on SSI approach in elementary schools in the Independent Curriculum which is categorized as valid. Reflection. Reflection activities are carried out by analyzing the suitability of problem analysis and problem identification, solution analysis, goal formulation, and the results of implementation and testing of the IPAS learning model framework based on the SSI approach in the Independent Curriculum to strengthen elementary school students' scientific literacy. At this stage, comments and input continue to be made to improve the final product. Output from this stage: Final product of the IPAS learning model framework based on the SSI approach in the Independent Curriculum to strengthen elementary school students' scientific literacy, was valid category.

Research Subjects, Data Collection Techniques and Research Instruments

This research involved grade IV Islamic-based elementary school teachers and students from SD IT Muhammadiyah Al Kautsar, MI Muhammadiyah PK Kartasura, MI Muhammadiyah Kertonatan, MI Muhammadiyah Wirogunan, MI Muhammadiyah Pucangan, and MI Muhammadiyah Gonilan, in Kartasura sub-district, Sukoharjo, who were taken using purposive sampling with consideration of aspects: the school has implemented the Independent Curriculum; the ability of class IV students in terms of scientific literacy; class IV students have studied science content.

Data collection techniques were carried out through interviews, observation, model framework validation sheet questionnaires by experts, and students' scientific literacy tests. Interviews were conducted at the problem identification and analysis, design, and reflection. At this stage, interviews were conducted with grade 4 teachers using a semi-structured interview guide. Interviews at the problem identification and analysis stage were conducted to explore the conditions of IPAS learning and students' scientific literacy conditions. At the design stage, interviews were conducted to explore the learning models that have been implemented and those that will be developed. At the reflection stage, interviews were conducted to explore the suitability of the problem analysis, implementation results of the learning model framework. Observation are used to observe the implementation of science learning using existing models, as well as observing the results of model implementation. The model framework validation sheet questionnaire is used to provide an assessment of the learning model. This validation sheet is to assess the constructs and learning tools developed (both contain 8 indicators). This validation sheet consists of 5 scales (1 to 5). The scientific literacy test is used to measure students' scientific literacy. This test consists of 15 multiple choice questions with 4 choices, and 5 true and false type questions, which have gone through an expert validation process.

Data analysis

Testing the validity of the IPAS learning model based on the SSI approach was carried out by validating experts in the field of learning models, content and language. The three experts provided comments and input until they were declared valid based on the agreement of the experts. The expert validation results are then calculated using the Formula 1.

$$P = \frac{\Sigma R}{N} x\ 100\% \quad (1)$$

With P: percentage; ΣR = total score from validators; N = maximum score value.

Table 1. Validity Level Criteria (Widiyanti, 2021)

Achievement Rate (%)	Information
81-100	Very valid and not revised
61-80	Valid and not revised
41-60	less valid and needs revision
21–40	invalid and needs revision

Testing the practicality of the IPAS learning model based on the SSI approach was carried out by testing the framework of this model with class teachers. The teacher assesses the practicality of the model according to the practicality assessment sheet that has been presented. The percentage value obtained is then qualified by referring to Table 2.

Table 2. Practicality Value Criteria

Practicality (%)	Qualification
86 – 100	Very practical
81 – 85	Practical
66 – 70	Quite practical
< 65	Not practical

Data analysis for the effectiveness test was carried out by calculating the N Gain value with three qualifications: high, medium and low. N Gain is calculated using the Formula 2.

Table 3. The N Gain Results are Then Qualified N Gain Category (Hake, 1999)

N Gain Value	Information
G > 0.7	Tall
0.3 ≤ G ≤ 0.3	Currently
G < 0.3	Low

$$N\ Gain = = \frac{Score\ Postest - score\ pretest}{score\ ideal - score\ pretest} \quad (2)$$

Result and Discussion

Result

The findings of this research refer to the problem formulation that has been determined, and are integrated according to the research steps that have been determined.

To develop the IPAS learning based on SSI model framework, a problem identification and analysis process was carried out. Based on the results of interviews with teachers and observations of IPAS learning activities at SD/MI Muhammadiyah in the Kartasura, (including SD IT Muhammadiyah Al Kautsar, MI Muhammadiyah PK Kartasura, MI Muhammadiyah Kertonatan, MI Muhammadiyah Wirogunan, MI Muhammadiyah Pucangan, and MI Muhammadiyah Gonilan) it was obtained data that before entering the science and science learning model in the Independent curriculum, the following aspects are explained.

Understanding of the IPAS Learning Model

Results of interviews with all the teachers were obtained that the IPAS learning model was implemented in the Independent Curriculum. The choice of learning model is adjusted to the characteristics and mood of the students. The PBL model is more often applied in science and science learning. PjBL is implemented once a month, because it is related to Pancasila student profile. The advantages of PBL will be seen in children's activity. Science were taught taking into consideration the level of difficulty of the material, the presentation of the material in the book. Science were taught independently, not combined in an integrated manner. Some textbooks are integrated directly, some are their own. Learning resources need to be supplemented because the presentation is still minimal. If science is difficult, then science will be completed first, then teach social science later.

Teachers' Understanding of Socio-Scientific Approaches to Issues

Results of interviews with all the teachers were obtained that teachers didn't yet understand SSI. The teacher has already carried out a lesson which turned out to be SSI. IPAS learning using the SSI approach is very important to do. This is so they can relate it to daily activities. The SSI approach has never been applied in science learning.

Strengthening Science Literacy with the IPAS learning Model Based on SSI Approach

Based on the results of interviews with several Muhammadiyah SD/MI teachers in the Kartasura, then reinforced by observations of learning activities in the classroom, it showed that in science and social learning in the Independent Curriculum a certain learning model has been implemented which facilitates students to behave scientifically. The process of instilling scientific literacy is limited to reading related to scientific content, and applicable actions or behaviors that are instilled in students have not yet emerged. IPAS learning is still taught separately, not integrated. In IPAS learning, teachers have linked several social issues, but only in the apperception section or as trigger questions. On the other hand, the demands of IPAS learning are the formation of students who are literate in science, have a scientific attitude, and can form morals and ethics in the form of operational actions in dealing with social problems. Meanwhile, there is no learning model that can accommodate teaching science and social studies material simultaneously.

Based on the results of the needs analysis and problem identification regarding the urgency of developing the IPAS learning model based on SSI approach. This design stage was carried out by a focus group discussion (FGD) process of 9 Muhammadiyah Elementary/MI teachers in the Kartasura. It was concluded that the contextual learning model is a model that is very suitable for learning science and technology and is suitable for any material. The design stage is carried out by designing a prototype of the expected learning model. The first step is to examine the contextual learning model and evaluate its advantages and disadvantages across several syntaxes. The second step is to examine the socio-scientific approach to issues and scientific literacy in elementary school students. The third step is to modify the syntax of the contextual learning model and integrate it with the SSI approach. After obtaining the initial prototype, the construct validation process was continued with experts, and then revised according to input as the results.

This socioscientific issue-based IPAS learning model design is equipped with learning tools including teaching materials, student worksheets (LKPD), media, and assessment. This learning model prototype was validated by learning experts from Malang State University lecturers. The validation results obtained from the IPAS Learning based on SSI model design are viewed from the aspects: model clarity; model consistency in accordance with scientific literacy theory; Contextual Teaching Learning theory; practicality of the model used in each syntax; model suitability; model application; graphics; language; and instructions for implementing the model. From 9 aspects, a score percentage of 99.20 % was obtained (very valid category). The reviewer's results was that steps such as video links or materials that lead to literacy need to be more specific.

Results of validation of IPAS Learning Model based on SSI tools in terms of aspects: identity and general information; learning outcomes (CP); learning objectives; implementation of learning; aspects of material suitability; media suitability; g) suitability of LKPD; h) learning evaluation aspects. From 8 aspects, a score of 96.5% was obtained (very valid category).

Several revisions related to this prototype model include the need to emphasize the integration of science material and socio-scientific approaches to issues. This result of the review was then revised so that it is suitable for application in the field. At this stage, the IPAS learning model based on SSI framework in elementary schools at the Independent Curriculum was categorized as very valid.

The Effectiveness of the IPAS Learning based on SSI Approach Model Framework to Strengthen Elementary School Students' Scientific Literacy

To determine the effectiveness of this learning model, this was carried out through a trial and evaluation stage. This activity was carried out by implementing the learning model framework at Al Kautsar Special Program Muhammadiyah Elementary School, Sukoharjo. The subject 27 students 4A class, there are 14 boys and 15 girls. This learning model was completed by: LKPD, broadcast materials, teaching materials, media and assessment.

At this stage, teachers measure elementary school students' scientific literacy. At this stage, data was obtained on the implementation of the learning model framework carried out by the teacher. This implementation data is also used to measure the practicality of the model framework. At this stage, pretest and posttest data related to students' scientific literacy were obtained, which are presented in Table 4.

Table 4. Results of Students' Scientific Literacy Competencies

Test	Average	Minimal	Maximum
Pretest	40.92	20	65
Posttest	71.29	50	95

Based on the Table 4, it is known that before IPAS learning based on SSI model was implemented, the students' scientific literacy level had an average of 40.92; the minimum score is 20, and the maximum is 65. After applying the learning model, the students' scientific literacy level was obtained on average 71.29; minimum score 65, and maximum 95 (both from a maximum score of 100).

Based on the pre-test and post-test scores on scientific literacy, the effectiveness of the learning model have score of 0.538 (medium category). It was this learning model was effective (in the medium category) in strengthening students' scientific literacy. This scientific literacy level data is used to evaluate the accompanying impact, in this case the moral and ethical level of students in dealing with social problems from the model that has been implemented.

Based on the implementation results, reflection was carried out by analyzing the suitability of problem analysis and problem identification, solution analysis, goal formulation, and the results of implementation and testing of the IPAS learning based on SSI approach model framework in the Independent Curriculum to strengthen elementary school students' scientific literacy. At this stage, a reflection was obtained from the development team that from the aspect of the learning model, from the first syntax to the next, it was coherent, sustainable, and easy to implement. The syntax in this learning model is easy to apply. The learning steps are very practical to implement (with a practicality percentage of 86%) in the very practical category.

From the aspect of device application, non-digital assessments have been implemented well in the pretest and posttest. Teaching media needs to be slightly modified and adapted to the syntax. Everything presented in the teaching media cannot be conveyed, especially the quiz section (due to time constraints). Teaching materials have been implemented well in accordance with the learning steps. LKPD and teaching materials can be continuously implemented to help students strengthen scientific literacy.

Discussion

IPAS Based on SSI Learning Model Framework

This research produced a prototype of IPAS based on SSI learning model framework with components: objectives, syntax, social system, reaction principle, support system, instructional impact and accompanying impact. This is in accordance with what was conveyed by Joyce & Calhoun (2024). The learning model consists of 5 syntaxes: presentation of issues; investigation of problems; construction of thoughts; reflective interpretation, (v) authentic assessment. This syntax was adapted from the CTL model syntax and modified at several stages, so that it can strengthen the scientific literacy of elementary school students.

This IPAS learning based on SSI model framework is applied to elementary school students and aims to strengthen students' scientific literacy. The Learning Model is supported by a social system, involving interactions between students, starting from the "issue presentation" stage to the "authentic assessment" stage. In addition, this learning model was developed based on the reaction principle which places participants at the center of learning. The reaction principles in question are: conditioning collaborative learning activities; ensuring that students carry out all activities; guiding

students so that their scientific literacy increases; and providing feedback. The IPAS learning based on SSI model framework was packaged in a model book which is equipped with a support system including teaching materials, LKPD, learning media, and assessment. The instructional impact in this learning model is scientific literacy. The accompanying impact is a long-term side learning result, which is achieved as a result of implementing IPAS learning based on SSI model framework. The accompanying impact that is expected to emerge is students' morals and ethics in dealing with social problems that occur in society. These environmental moral and ethical indicators are moral obligations, individual attitudes, and moral responsibility.

The Effectiveness of the IPAS Learning Based on SSI Approach Model Framework to Strengthen Elementary School Students' Scientific Literacy

The results of the trial at the Al Kautsar Special Program Muhammadiyah Elementary School showed an increase in scientific literacy, from the pretest to posttest average from 40.92 to 71.29 (on a maximum scale of 100) (an increase of 74.20%). Judging from the N gain value, it can be seen that this learning model is effective (medium category) at 0.538, in strengthening students' scientific literacy. Students' scientific literacy can increase, because the syntax can strengthen students' scientific literacy. This can be explained in each syntax.

The syntax for presenting the issue is carried out by the teacher by attracting students' attention by presenting the issue from a scientific perspective. In this research, the teacher shows a video about a flood disaster. The teacher asks what the problem is? Why did this event happen? Students pay attention, pay attention to the issues presented by the teacher. This directs students to be able to analyze problems regarding flooding. This activity is the stage of presenting material related to daily life, which is related to scientific literacy indicators in scientific concepts. From the aspect of the science process, students are conditioned to identify scientific phenomena regarding flooding, analyze and apply the scientific knowledge they have (namely about what causes it, how to deal with it and how to prevent it), and evaluate how to explore "why floods occur". In terms of the science context, when students pay attention to the phenomenon of flooding, they are conditioned to apply science to contextually appropriate fields.

In the problem investigation syntax, the teacher instructs students to search from various sources regarding the source of the flood problem, how to overcome it and how to prevent it. Students search for several key words about the “flood” being investigated. Students then evaluate the issue of flooding, by relating several concepts to the science material being studied. This is in line with Rohmaya (2022), who states that students' scientific literacy can be instilled through presenting scientific phenomena that are contextually appropriate to students' daily lives. Apart from that, the social problem of flooding can actually be claimed as a disaster that is characteristic of a particular region, which can be called the local wisdom of a region. This actually becomes local wisdom in negative reviews. This is contrary to research conducted by Maulida (2022), Muhardini et al. (2023), and Wadi et al. (2023), which states that local wisdom is the potential of a region. This takes the form of regional specialties, traditional games, batik, or other cultures. Flood events are a negative potential for certain areas. In this research, flooding conditions students to have scientific literacy that leads to the context of science, seen from the shape of objects and the properties of liquid objects. The hope is that by understanding the concept of flooding, students can determine actions related to this concept. For example, floods are a form of liquid matter. In the process of evacuating objects, we must use waterproof objects, for example plastic.

In the thought construction syntax, students process data obtained from observations about flood problems through video shows, reading materials and activities facilitated in the LKPD. After that, students examine and construct the knowledge they have and relate it to the scientific concepts that underlie the problem of flooding contextually. This activity conditions students to be scientifically literate, seen from the aspect of interpreting evidence and data. In line with what Sururuddin et al. (2023) said , this analysis activity is an activity that equips students to think critically and leads to 4C skills (critical thinking, creative, collaboration and communication). This is in line with the 4Cs presented by Khoiri et al. (2021); Winaryati & Hidayat (2020). In this research, students' critical thinking is formed when they are active through LKPD. This LKPD provides students with the experience of constructing thoughts through meaningful learning activities. They were directed to make a poster containing a moral message that could address the problem of flooding. The process of making this poster goes through critical, analytical and creative thinking stages.

In the reflective interpretation syntax, students use it to interpret, think purposefully and continuously and make decisions on the flood issues that have been studied. Students provide opinions, ideas or theoretical views on the issue of flooding, namely about why floods occur, what causes them, what solutions to overcome them, and how we can prevent them. After that, students are directed by the teacher to make a persuasive decision based on moral and ethical values. In this activity,

students are directed to create persuasive posters that can influence other people to have a good attitude towards flood problems. This interpretation process is also used to reflect on students themselves. This reflection conditions students to explore what has been done regarding flood prevention measures, what will be done if a flood occurs, and how we can behave and have good ethics if a flood occurs. This conditions students to be scientifically literate in terms of the scientific process, namely analyzing, interpreting and drawing conclusions. In this research, the expected conclusion is constructive thinking and behavior that can address the problem of flooding.

Authentic assessment syntax is carried out by teachers by providing authentic assessments to measure the extent of student learning progress in studying the material topics that have been presented. Authentic assessment is carried out by collecting data based on real activities carried out by students when learning. The three aspects assessed are the level of scientific literacy, presentation of products that have been developed such as infographics, posters or other products, and product assessment. This form of assessment contains the results of students' self-reflection while they are studying, so that they will be able to digest, appreciate and reflect on the issues they have studied. In this research, authentic assessment was carried out in 3 aspects: scientific literacy assessment, poster assessment, and Pancasila student profile assessment. As stated by Dewi et al. (2023), that science and science learning in the independent curriculum is still implemented by cultivating the Pancasila student profile. The Pancasila student profile pays attention to the formation of student character which is the accompanying impact in this research. The expected morals and ethics are one of the characters that are instilled in students after studying through the IPAS learning based on SSI model. However, in the learning that is carried out, students' morals and ethics when facing problems cannot be seen directly, because it requires a long period of time to monitor them. Thus, it is recommended that after implementing the SSI-based science model, students' morals and ethics need to be monitored and truly assessed so that when they actually face science problems in the social environment, they can really be applied.

Conclusion

This research produces a framework for IPAS learning model based on SSI model which has components: objectives, syntax, social system, reaction principle, supporting system, instructional impact, and accompanying impact. Constructively, this model framework has a validity of 99.2 % (very valid) and a learning tool of 96.5% (very valid). In terms of practicality, this model has a score of 86% (very practical category) for implementation in elementary school level learning. This learning model also has an effectiveness of 0.538 (medium category) in strengthening elementary school students' scientific literacy. Thus, this model is suitable to be applied at other elementary school levels in a wider scope, by paying attention to several things, such as careful planning in terms of infrastructure or time management. It is also recommended that it is necessary to monitor student morals and ethics after this learning model is implemented.

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Author Contributions

Anatri Desstya (author 1) was in charge of coordinating the entire research process and writing scientific articles, Ika Candra and Fitri Puji R (authors 2 and 3) were developing the needs analysis questionnaire, Yulia MH and Honest UK.

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Conflicts of Interest

The authors declare no conflict of interest.

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