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How does Learning Differentiate with The Socio-Scientific Issue (SSI) Climate Change Improving Environmental Literacy?

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ABSTRACT

Climate change is a complex global problem that requires understanding and action from students. Natural and Social Sciences projects can integrate climate change learning with social and scientific contexts. The preliminary study show that students do not yet have the environmental literacy skills needed to support science and technology projects learning. It also shows that students have difficulty understanding the concept of climate change and its implications for the environment. This research aims to determine the effect of differentiated learning with SSI to increase students ' understanding of climate change. The research method used is mixed methods research using the Exploratory Sequential Mixed Methods Design method. The research results show that implementing climate change differentiation learning with SSI can improve students ' environmental literacy skills. The results of the one-way ANOVA test have a significance value of <0.05, where there is an increase after implementing differentiation learning. The findings of this research can integrate climate change learning with social and scientific contexts. SSI can help students understand complex issues that have significant social and scientific impact. This can motivate students to take action to overcome problems as an aspect of environmental literacy skills.

Introduction

The demands of the 21st century in the world of education must be able to produce human resources who have complete competencies which are the main competencies that students must have in order to be able to take part in real life in the 21st century (Mardhiyah, 2021). In addition, it is shown that every learner must have the ability to think critically, solve problems, communicate, and work together in a loaded environment (Prayogi & Estetika, 2019). The Science and Society Project (IPAS Project) is a new thing in the material and all learning tools in the current independent curriculum. However, many teachers in this science project have difficulty in carrying out the project-based teaching process because the science project itself is a new subject that combines physics, chemistry, biology, and social sciences (Tanti, 2022). There is a relationship between the IPAS Project and environmental

literacy, including the learning outcomes that must be achieved by students must understand, overcome, and contribute to solutions to environmental problems around us (Maesaroh *et al*, 2021; Permana *et al*., 2023).

Students' lack of environmental literacy is usually caused by not having an adequate understanding of environmental issues that are happening in the world. They may not be aware of the negative impacts that climate change, deforestation, pollution, and other environmental problems can produce. Most of the students are more focused on technology, consumption, and indoor activities than interacting with nature (Kirana *et al*., 2022). Students' lack of motivation or awareness about the importance of environmental literacy can also be an obstacle and feel that there is no positive impact of understanding environmental issues and they feel that the existing issues are irrelevant to daily life, so that it becomes one of the losses of motivation to learn (Khozin *et al*., 2020).

Based on the results of the preliminary study by reviewing the results of the integrated environmental action attitude questionnaire, the environmental literacy skills of 36 students in class X Visual Communication Design 3 are not fully aware of the environment, this is evidenced by the low average questionnaire score that does not meet the minimum criteria standards. Students are used to memorizing material with the cognitive level still at C1 to C3 only. Educators and curriculum policymakers must be able to create project-based learning models that can support students to attract students to real-world problems (Şaşmazören *et al*., 2022)

A learning method that emphasizes the use of social and scientific contexts in science learning using the Socio-scientific Issues (SSI) approach (Montgomery *et al*., 2022). This is because in its implementation, students are given the opportunity to investigate complex social issues with a scientific approach, so that they can develop a deeper understanding of these issues (Klaver *et al*., 2023). Socio scientific Issues (SSI) approach has strong relevance to the subjects of the IPAS Project.

This is because there is a strong connection between social and scientific issues, which fits with the IPAS Project approach which emphasizes science learning through research projects (Putra, 2022). SSI encourages students to be actively involved in research and discussions on social and environmental issues (Fihani *et al*., 2021). SSI can be used as a learning method in the Science and Technology Project to increase students' understanding of environmental issues (Khozin *et al*., 2020).

However, in some situations, students in learning always encounter learning obstacles including not understanding environmental issues, limited scientific knowledge, difficulties in data analysis, or motivation problems (Kirana *et al*., 2022). If someone has environmental literacy, they will understand and comprehend the importance of their environment. They will use critical thinking to solve problems, make decisions for improvement, and take responsible action to overcome environmental problems (Farida & Hadiansah, 2018). It must be understood that the ultimate goal of environmental education is to make students environmentally literate. This is because environmental literacy intersects with scientific literacy. Knowledge, cognitive skills, attitudes and environmentally responsible behavior are components of environmental literacy that can be used to evaluate a person's level of environmental literacy (Nasution, 2016). Learning differentiation in the curriculum independent give color separately in the learning process moment, this in line with Ki Hajar Dewantara's philosophy stated that Education provides demands to all form owned conditions child (Pitaloka & Arsanti, 2022).

The activities carried out in differentiated learning describe the process of modifying students' learning experiences, so that all aspects of the learning process are in accordance with the needs and basic characteristics of individual students. (Mumpuniarti *et al*., 2020.) The results of the analysis of a number of relevant articles and the results of preliminary studies showed that several discussion topics had not been integrated with each other and certain aspects had not received adequate exploration, including lack of research that specifically explores integration between Socio-scientific approaches Issues (SSI) and Natural and Social Sciences learning (IPAS) with a focus on skills development students' environmental literacy. Although it has been mentioned that Socio-scientific Issues (SSI) can help prepare students to face global environmental challenges in the future, and that science learning provides opportunities for students to think and investigate objects and phenomena (Atabey & Topcu, 2020), this gap lies in the lack of research that specifically explores how integration between Socio-scientific Issues (SSI) and IPAS can effectively improve environmental literacy skills and students' understanding of environmental issues holistically with apply learning customized differentiation with ability participant educate .

This study combines differentiated learning that pays attention to the individual needs and abilities of students with an SSI approach that focuses on social and scientific issues that are relevant to contextual learning that has a direct impact on students' environment. The learning process that pays attention to content differentiation, process differentiation and product differentiation (Danuri, 2023).

Climate change issues that often occur around students' environment are often ignored by them because of their indifference to the impacts that will occur. Therefore, this study emphasizes more on environmental literacy skills using a socio-scientific approach in learning, especially in science project courses with differentiated learning that emphasizes students' ability to understand, analyze, and take action on environmental problems based on scientific knowledge that they already understand. This is because previous studies have only examined one aspect and are not contextual and only focus on critical thinking skills (Fihani *et al*., 2021).

Meanwhile, the purpose of this study is to identify how applied differentiated learning can facilitate the diverse learning needs of students, especially in improving environmental literacy skills. The socio-scientific approach is very relevant to environmental literacy skills. The relationship between social scientific issues topics in the Science Project learning. This is the basis for researchers to solve the problems found, both in the ability to understand, analyze data, and motivation problems experienced by students in the midst of various increasingly pressing environmental challenges, such as climate change and pollution crises, environmental literacy skills become very crucial. Students must have knowledge and understanding of environmental issues so that they can increase their concern, awareness and actions that must be taken towards environmental issues.

Method

Approach research to be done using mixed methods research with method Exploratory Sequential Mixed Methods Design that combines elements qualitative and quantitative in One study for understand a phenomenon with more comprehensive. Design method This occurs where researchers start with explore qualitative data and analyze it, in stage first, then collect quantitative data as study stage second (Dawadi *et al*., 2021). The research approach that will be carried out uses mixed methods research with the Exploratory Sequential Mixed Methods Design method which combines qualitative and quantitative elements in one study

to understand a phenomenon more comprehensively. This design method occurs where researchers start by exploring qualitative data and analyzing it, in the first stage, then collecting quantitative data as the second research stage (Dawadi *et al*., 2021). The data was analyzed using one-way ANOVA test statistics to see whether the hypothesis was accepted or rejected on the quantitative data produced (Sutisna, 2020). Overview of Mixed Method Exploratory Sequential Mixed Methods Design presented in Figure 1 below.

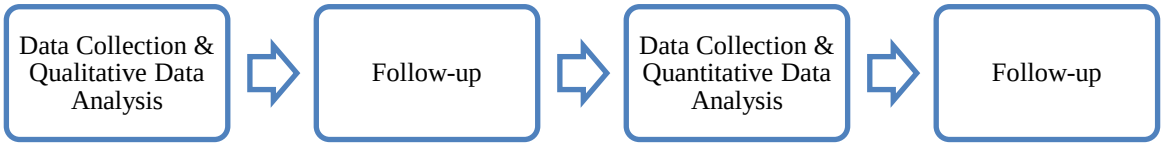

Figure 1. Exploratory Design Stage Sequential Mixed Design Methods (Avianti, 2022)

Election sample done with purposive sampling method was chosen as technique taking customized samples with need research in progress learning participant educate will categorized into 3 types sample that is category ability participant educate high, medium, and low. Implementation instrument customized research with selected method presented in table 1 below.

Table 1. Analysis Data

Target	Technique	Information
Issue phenomenon theme	Statement	Qualitative Data
Conceptual exploration relevant to the issue	Structured statement questionnaire	Qualitative Data
literacy results regarding issues	Structured statement questionnaire	Quantitative Data
Logical and illogical follow-up to issue analysis	Customized questions with 3 categories ability participant educate	Quantitative Data

The instrument used for data collection was a questionnaire compiled according to environmental literacy indicators to test environmental knowledge, cognitive skills, environmental care attitudes and behavior towards the environment (Hariyadi *et al*., 2021) presented in Table 2.

Table 2. Environmental Literacy Indicators

No	Environmental Literacy Indicators	Environmental Literacy Sub-Indicators
1	Environmental Knowledge	Knowledge about the environment (climate change)
2	Skills	Issue identification
		Analysis of causes, impacts and environmental changes
3	Attitude	Attitude of appreciation towards the environment
		Attitude of concern towards the environment
		Sensitivity towards the environment
4	Behavior	Responsible for the environment

The data obtained from the total questionnaire amounted to 40 consisting of 10 statements regarding environmental knowledge, 10 statements regarding skills, 10 statements regarding environmental care attitudes and 10 statements regarding environmental behavior. Research respondents were asked to fill in the answer alternatives strongly agree or always to disagree or never with a score of 4 to 1 according to the questionnaire statement (Putra *et al*., 2021)

Results and Discussion

Research result in a way qualitative started with find theme phenomenon moderate issue become conversation in society. Participant educate take phenomenon disaster nature in the area Garut and Bandung caused by changes climate among them phenomenon wind nipple

pickaxe, wind large, and landslides occurred in both area the with very close in time. Then participant educate explore draft change prevailing climate from phenomenon the. At stage here, participants educate own high enthusiasm and can explore Alone difference phenomena that occur and easier in understand concepts contained in phenomena issues discussed. As for Next, participants educate do evaluation ability literacy environment with results listed in table 3.

Table 3. Results of Quantitative Data Analysis Literacy Environment

Statistics	Results	Information
Normality Test	Sig > 0.05	Normally distributed
Homogeneity Test	Sig < 0.05	No Homogeneous
One Way Anova Test	Sig < 0.05	There is difference

Initial testing using the prerequisite test showed that the data was normally distributed, then continued with parametric statistical tests using One Way Anova Test Interpretation. Results of ANOVA analysis one track show that there is significant difference between literacy environment students on the third category learning ($F (2, 87) = 12.45$, $p < 0.01$). Tukey's post hoc test showed that literacy environment students in categories ability high (M=86.20) in total significant taller compared to with category ability medium (M=80.29) and category ability low (M=74.80). Research result This show that learning differentiation science project with SSI approach to change climate effective in increase literacy environment student. The SSI approach is possible student for connect draft science with issues relevant social, such as change climate (Atabey & Topcu, 2020). This matter can increase motivation and engagement student in study, as well help they develop more understanding deep about issues environment (Nurwidodo *et al*., 2020). Learning differentiation with notice ability Study students are also proven effective in increase literacy environment. Students in categories ability tall can finish more projects complex and challenging, so they obtain more understanding deep about material learning. Students in categories ability medium and low get more support and guidance Lots from the teacher, so they can reach results optimal learning (Rosyidah & Subekti, 2023). Steps taken in the SSI approach facilitates indicator skills think critical and literacy environment participant integrated education in learning differentiation listed in Table 4.

Table 4. Learning Differentiation with SSI

Socio Scientific Issues (Marks, 2014)	Literacy Environment (Ida Farida, 2017)	Learning Applied differentiation
Identify scientific issues (Predict) Explaining scientific issues (Explain) Using scientific evidence (Observe)	Knowledge (Climate Change) Attitude (Plan Investigation Issue) Competency (Identification and Analysis issue)	**Tall:** Student requested For Work in group for develop solution innovative for overcome change climate in Indonesia. Solution must realistic, yes implemented and sustainable **Currently:** Student requested for discuss dilemma ethics environment related surroundings with change climate from the video shown. **Low:** Student Practice knowledge that has been owned about change climate from events in the area West Java.

Socio Scientific Issues (Marks, 2014)	Literacy Environment (Ida Farida, 2017)	Learning Applied differentiation
Act Continue (Extend)	Behavior (Action to environment as commitment actual	**Tall:** Student do test tool temperature sensor detector, humidity air and distance Arduino uno from a place by group, compare between results from the detector. **Currently:** Project poster design about change climate in educate public in mitigation disaster natural **Low:** Testing knowledge past online quiz in give example action simple as can be done every day, like save energy and reduce use plastic.

Students have increased environmental literacy skills after implementing differentiated learning processes by categorizing students into three groups, namely high, medium, and intermediate groups. This group division is based on a diagnostic assessment of students' initial knowledge of climate change. The following is a graph of the overall percentage of students' environmental literacy based on environmental literacy indicator categories.

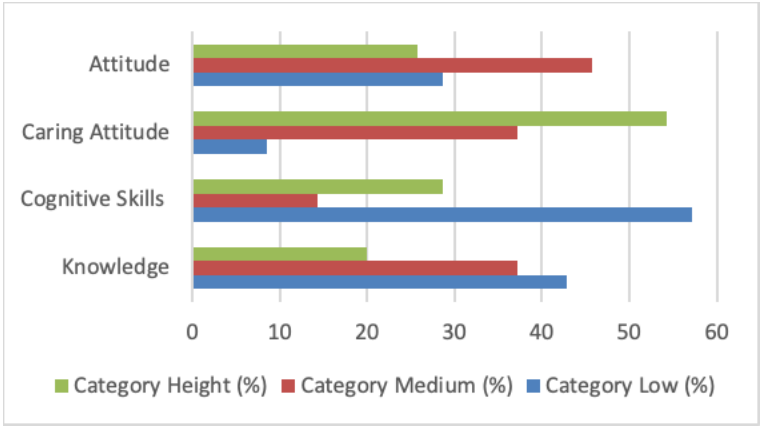

Figure 2. Percentage of Environmental Literacy of Students based on Indicators

Overall results can be seen from the high attitude of caring for the environment even though they have low knowledge. Although this can be influenced by environmental knowledge and environmental care attitudes, there is a weak relationship between environmental knowledge and environmental care attitudes). In addition, the environmental care attitude of students who have a high percentage is also influenced by factors of experience and interaction with the environment also plays a very important role in influencing environmental care attitudes, while in environmental behavior indicators that are in the moderate category, this can be influenced by environmental knowledge, because environmental knowledge and environmental behavior have a high relationship (Fang *et al*., 2023). Environmental knowledge that can influence a person's concern for the environment, this can be used as a reference to increase environmental knowledge so that it becomes a basis for a person to maintain the sustainability of nature and solve environmental problems (Spínola, 2021)

Conclusion

Learning differentiation science project with SSI approach to change climate is effective strategy for increase literacy environment student. Approach This can increase literacy environment as well as connect draft science with issues relevant social proven with exists improvement literacy environment participant educate with average value results three category participant education (M=80.43). Learning differentiation with notice ability Study students are also proven effective in increase literacy environment.

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