The Application Of Science In Contextual Learning To Improve Students' Science Literacy

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ARTICLE INFO	ABSTRACT
	This study aims to analyse the effectiveness of science applications in contextual learning in improving students' science literacy. This study uses a quantitative approach with a single group pretest and posttest design on eighth grade students of junior high schools in urban areas. Data were collected through science literacy tests based on literacy competency indicators, learning implementation observation sheets, and documentation. Data analysis techniques were performed using descriptive analysis, calculation of learning outcome improvement, and mean difference tests. The results showed that the application of science-based contextual learning was able to significantly optimise students' science literacy, especially in the competencies of explaining scientific phenomena, designing and evaluating scientific investigations, and interpreting scientific data and evidence. Learning that integrates real-life contexts, local knowledge, and problem solving has been proven to make the learning process more meaningful and optimise student engagement. These findings indicate that science application-based contextual learning is effective as a strategy for improving science literacy in science learning.

1. Introduction

Scientific literacy is a crucial prerequisite for students to be able to understand natural phenomena, make evidence-based decisions, and respond to various global issues such as health, the environment, and sustainability in a rational and responsible manner (OECD, 2023), (Kelp et al., 2023). However, various studies show that Indonesian students' science literacy achievements are still relatively low, especially in the competency of relating scientific concepts to real-life contexts. This condition indicates that science learning has not fully encouraged students to apply scientific knowledge meaningfully, thus requiring learning innovations oriented towards strengthening science literacy.

A number of studies reveal that one of the causes of low science literacy is the dominance of conventional learning approaches that emphasize memorization of concepts and provide little space

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for contextual problem solving (Oktarina et al., 2023) (Pala & Başıbüyük, 2023). This type of learning tends to make it difficult for students to understand the relevance of science in everyday life. As an alternative solution, contextual learning (Contextual Teaching and Learning) is considered relevant because it emphasises the connection between scientific concepts and real-life situations faced by students, making learning more meaningful and applicable (Fensham, 2012) (Safnowandi, 2021).

Various empirical studies indicate that contextual learning that integrates science applications through Problem-Based Learning, ethnoscience, and socio-scientific issues can optimise students' competence in explaining scientific phenomena, designing and evaluating scientific investigations, and interpreting data and evidence scientifically (Hadiprayitno & Sukri, 2024) (R. Puspita, 2023), (Siombone et al., 2024). In addition, the development of contextual learning media such as e-modules, big books, and pop-up books based on local wisdom has also been reported to be effective in optimising student engagement and understanding of scientific concepts (Suryanti & Widodo, 2023), (Hidayah et al., 2024).

Although these research results show the great potential of contextual learning, further studies are needed to systematically examine how science applications in contextual learning are implemented and how they contribute to improving students' science literacy. Therefore, this study was conducted with the aim of analyzing the effectiveness of science applications in contextual learning on improving students' science literacy. The results of this study are expected to provide an empirical and conceptual basis that strengthens the use of contextual learning as the main approach in science education, as well as a reference for educators and policy makers in developing science learning that is relevant, meaningful, and oriented towards strengthening science literacy.

Literature Review, Science literacy is a key competency in modern science education that emphasizes students' competence in understanding, using, and reflecting on scientific knowledge in various contexts of life. Conceptually, science literacy is not only related to the mastery of scientific concepts, but also includes scientific reasoning, evidence-based decision making, and an understanding of the role of science in society. The Programme for International Student Assessment (PISA) framework formulates scientific literacy into the competencies of explaining scientific phenomena, designing and evaluating scientific investigations, and interpreting scientific data and evidence.

This framework emphasises that science literacy must be developed through learning that enables students to relate scientific concepts to real-life situations and everyday issues.
One approach relevant to the development of science literacy is contextual teaching and learning. Contextual teaching and learning views learning as a constructive process that occurs when students relate new knowledge to their experiences and life contexts. This approach developed as a critique of science learning that is detached from students' realities and tends to be oriented towards memorising concepts. Theoretically, contextual learning is based on constructivism, which emphasises the active role of students in building understanding through interaction with the environment, authentic problems, and social discourse.

The main characteristics of contextual learning include the use of real-world contexts, active student involvement in problem solving, and the integration of social, cultural, and environmental issues in science learning. Previous research shows that context-based learning can optimise conceptual understanding and higher-order thinking skills, including critical thinking and scientific argumentation. Contextual learning also allows students to view science as a tool for understanding and responding to real issues, rather than merely a collection of abstract concepts.

The application of science in contextual learning is a strategic means of bridging theoretical concepts with empirical reality. The integration of everyday phenomena, socio-scientific issues, and local wisdom in science learning has been proven to optimise the relevance and meaningfulness of

learning. Various research results show that the application of approaches such as Problem-Based Learning, Project-Based Learning, ethnoscience-based learning, and the use of digital media and technology in a contextual framework have a positive impact on students' science literacy. These approaches encourage students to develop investigative, reasoning, and application competencies in science in an authentic manner.

However, a number of studies have also identified challenges in the implementation of contextual learning, particularly related to educator competencies, limitations in contextual teaching materials, and gaps in learning facilities. Curriculum changes have not always been accompanied by changes in classroom learning practices, so that contextual approaches are often not implemented optimally. Therefore, there is a need to develop systematic science application-based learning models and learning media that are appropriate for student characteristics.

Based on the theoretical review and previous research findings, it can be concluded that science application-based contextual learning has a strong theoretical foundation and significant empirical potential to optimise students' science literacy. However, further research is needed to empirically examine the effectiveness of implementing science application-based contextual learning in the context of science education in secondary schools. This review forms the basis and justification for this study.

2. Methodology

This study applied a quantitative approach with a quasi-experimental research method using a One Group Pretest–Posttest design. This design involved a group of students who were first given a pretest, then received treatment in the form of contextual learning based on science applications, and subsequently given a posttest to identify improvements in science literacy. The choice of this research design was based on the objective of analyzing changes in students' science literacy competencies before and after the treatment was given, even though this design has limitations in controlling the influence of external variables.

The research population consisted of junior high school students. The research sample was determined using purposive sampling and consisted of 48 eighth-grade students from two junior high schools in the 2024/2025 academic year. The sample selection considered student readiness, the availability of technology-based learning support facilities, school willingness, and initial academic competency uniformity. Students who did not consistently participate in learning were excluded from the research sample.

The independent variable in this study was science application-based contextual learning, while students' science literacy served as the dependent variable. Science literacy is measured by referring to the Programme for International Student Assessment (PISA) framework, which covers three main competencies, namely the ability to explain scientific phenomena, design and evaluate scientific investigations, and interpret scientific data and evidence.

The research instrument is a science literacy test adapted from PISA questions and tailored to the Indonesian context. The test consists of 30 multiple-choice and essay questions. The validity of the instrument was assessed through expert judgement by science education lecturers and science teachers, with a content validity index of 0.89 and Cronbach's alpha reliability of 0.82. In addition, observation sheets were used to assess the implementation of contextual learning, and documentation and brief interviews were used as supporting data.

The study was conducted over eight weeks. In the first week, a pretest was conducted, followed by the implementation of science application-based contextual learning for six weeks through hybrid learning. The learning was designed in stages: relating, experiencing, applying, cooperating, and transferring. At the end of the activity, students were given a posttest to measure their improvement

in science literacy. The data were analyzed using descriptive and inferential statistics. Prerequisite tests included the Kolmogorov–Smirnov normality test and the Levene homogeneity test. Improvements in science literacy were analyzed using N-Gain values, while hypothesis testing was conducted using a paired sample t-test or Wilcoxon test if the data were not normally distributed. All statistical analyses were performed using SPSS version 25.0 software.

3. Results

Improving Student Science Literacy

The implementation of contextual learning in science applications shows a significant improvement in student science literacy. Based on the results of the study, students who participated in learning with a contextual approach showed progress in three aspects of science literacy competence according to the PISA framework, namely: (1) explaining scientific phenomena with an average achievement of 86.3%, (2) designing and evaluating scientific investigations at 86.7%, and (3) interpreting data and evidence scientifically at 84.3% (Purbaningrum et al., 2024).

Contextual learning that links science material to everyday life has been proven to make learning more meaningful and relevant to students. When educators are able to connect science concepts to real-life situations experienced by students, they can see the connection between the knowledge they learn and their daily lives (Hidayah et al., 2024). This approach allows students to develop a deeper understanding of science concepts and apply them in different contexts.

Effectiveness of Context-Based Learning Models

Research on the development of context-based teaching materials has shown very positive results. The e-modules and big books developed based on contextual learning were validated by experts as highly feasible, with a validation percentage of 92-94% (D. Puspita & Sari, 2024). Field trial results show that students responded very well to contextual learning media, with satisfaction levels reaching 96-99%.

The effectiveness of contextual learning is also evident from the improvement in student learning outcomes. Analysis using the N-Gain test shows an increase in science literacy competence in the moderate to high category after the implementation of contextual learning. A total of 22 out of 30 students (73.3%) showed good progress, 5 students (16.7%) were in the moderate category, and only 3 students (10%) were still in the poor category (Novita & Ulinnuha, 2024).

Ethnoscience and Local Wisdom-Based Learning

The integration of the ethnoscience approach into contextual learning has a significant impact on students' science literacy. The Read, Explore, and Apply (REA) learning model based on ethnoscience enables students to connect scientific knowledge with their daily lives, thereby promoting an overall improvement in science literacy (Wahyuni et al., 2021), (Kotimah et al., 2024)(Khairiyah et al., 2026).

Learning that integrates the local cultural context makes the learning material more relatable and easier for students to understand. The ethnoscience approach helps students develop a deeper appreciation for nature and apply scientific principles in their daily lives (Nisa et al., 2015), (Dewi et al., 2021). Students can conduct direct observations, identify scientific issues, explain natural phenomena, and draw conclusions about environmental conditions and changes caused by human activities.

Discussion

The Urgency of Contextual Learning in Optimizing Science Literacy

Low science literacy in Indonesia poses a significant challenge in science education. The 2022 PISA results show that although Indonesia has experienced an increase in literacy and numeracy, students' science literacy competencies still require serious attention (OECD, 2023). One of the main

factors causing low science literacy is textual and less contextual learning, which is not connected to students' daily lives.

Science learning in Indonesia is still dominated by a theoretical approach, while the procedural and mechanical aspects of science remain weak. Students are not taught to optimally conclude scientific phenomena, analyze, and think creatively. Knowledge about science is also rarely linked to local and global contexts, which results in students losing interest in understanding scientific phenomena more deeply (Cahyana, 2024). As a result, attitudes towards science and natural phenomena are low, and only a few young people are interested in studying science.

The Advantages of Contextual Learning in Science Applications

Contextual learning has several fundamental advantages in optimizing students' science literacy. First, learning becomes more meaningful and relevant because the subject matter is linked to real-life situations experienced by students (Tari & Rosana, 2019), (Maynastiti et al., 2020). Second, contextual learning is able to develop students' science literacy through the integration of scientific concepts with everyday life, which facilitates deep and practical understanding.

The contextual approach to science learning allows students to not only learn scientific facts, but also develop critical thinking, problem-solving, and collaboration skills in the scientific thinking process (Sahabuddin et al., 2023). Effective 21st-century learning must integrate scientific literacy so that students are better prepared to face future challenges, whether in the context of education, the world of work, or everyday life.

Integration of Innovative Learning Approaches

The combination of contextual learning with innovative learning approaches such as Problem-Based Learning (PBL), scientific inquiry learning, and STEM approaches has proven effective in optimizing science literacy. The contextual-based PBL model encourages students to actively research, investigate, and evaluate problem-solving processes, which indirectly optimizes their interest and motivation to learn (Suginem, 2021), (Najib et al., 2023).

Socio-Scientific Issues Based Learning (SSIBL) also makes an important contribution to building science literacy that is contextual to people's lives. SSIBL encourages students to conduct scientific investigations into social issues related to science and to make ethical and responsible decisions and actions (Amos & Levinson, 2019). The integration of biological concepts with real-world social science issues, such as unhealthy eating patterns and the mukbang trend phenomenon, equips students with the competence to manage healthy eating patterns and develop critical thinking skills.

The Role of Contextual-Based Learning Media

The development of contextual-based learning media such as e-modules, big books, and pop-up books contributes positively to improving science literacy High-quality learning media must have credibility by involving real experiences and examples from the students' environment (Damayanti et al., 2024), (Agustin & Razi, 2023). E-books that can provide real experiences have been proven to optimize student understanding.

Innovative learning media that integrate local wisdom can serve as effective teaching materials, especially in the era of Society 5.0, as they are in line with the competencies needed in the 21st century (Sonia et al., 2024). By integrating local issues, e-books can become contextual teaching materials that help optimize enthusiasm for natural resource conservation (Khalel et al., 2023).

Stages of Implementing Science Literacy in Contextual Learning

The implementation of science literacy in contextual learning can be carried out through several strategic stages. The contact stage begins with an introduction to various issues or problems developing in society and an exploration of events occurring in the learners' surroundings. These issues can be sourced from news reports, articles, or the students' direct experiences. Next, the topics raised are linked to the learning material so that learners understand the relevance and urgency of

the material to be studied. The curiosity stage is characterized by questions designed to stimulate learners' curiosity. These questions relate to issues or problems that have been discussed previously, and to answer them, learners need to understand the learning material. This approach encourages learners to play an active role in seeking information and building knowledge independently.

4. Conclusions

This study concludes that the application of contextual learning based on science applications can optimize students' science literacy in a meaningful way. Learning that links scientific concepts to real-life contexts encourages students to understand scientific phenomena more deeply, develop investigative skills, and interpret data and evidence logically. The integration of innovative learning approaches and the use of contextual media relevant to the students' environment and culture makes the learning process more meaningful and problem-solving oriented. These findings emphasize the importance of contextual learning as a key strategy in science education to address the challenge of low science literacy. Further research is recommended to involve experimental designs with control groups, broader sample coverage, and long-term impact measurements to obtain a more comprehensive understanding. Practically, the results of this study convey the message that strengthening science literacy is not enough through mastery of concepts alone, but must be built through contextual, reflective learning experiences that are relevant to the realities of students' lives.

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