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The Hypothetic OMIRE Learning Model to Improve The Scientific Literacy of Prospective Science Teachers

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ABSTRACT

Objective: Prospective science teachers must have good scientific literacy skills as critical agents in developing future generations' scientific literacy. However, the scientific literacy skills of prospective science teachers in Indonesia still need to improve. This research tries to formulate the OMIRE learning model to increase the scientific literacy of prospective science teachers. **Method:** The method used is a literature study with a qualitative research type. **Results:** The hypothetical OMIRE learning model synthesizes inquiry-based learning models and culture-based learning models to develop the scientific literacy of prospective science teachers. This model is based on several learning theories, including constructivism, Piaget's cognitive development theory, Vygotsky's social constructivist theory, Ausuble's meaningful learning, Bruner's discovery learning, Novak's concept map (mind map), information processing theory, collateral learning theory, boundary crossing metaphor culture, and scientific reconstruction. The hypothetical OMIRE learning model consists of five phases: Observation (O), Mind Mapping (M), Investigation (I), Reconstruction (R), and Evaluation (E). **Novelty:** The hypothetical OMIRE learning model can develop the scientific literacy of prospective science teachers. Further research needs to be conducted to test the validity, practicality, and effectiveness of the OMIRE learning model in improving the scientific literacy of prospective science teachers.

INTRODUCTION

Various complex problems that negatively impact the rapid development of science and technology in this era of globalization require people to master several life skills. Scientific literacy is one of the 21st-century skills identified by the World Economic Forum (2015) as critically needed for survival. Scientific literacy is more focused on applying knowledge and skills in various situations to make decisions and solve problems in everyday life (Husamah et al., 2022; Sholahuddin et al., 2021). OECD (2019) defines scientific literacy as a skill possessed by reflective citizens to engage in issues and ideas related to science. Although there is no universally accepted definition of scientific literacy (Wang et al., 2024), in essence, scientific literacy refers more to what scientific knowledge people must master to live more effectively and responsibly. A person's level of scientific literacy is indicated by their ability to (a) explain phenomena scientifically, (b) evaluate and design scientific investigations, and interpret data and evidence scientifically (OECD, 2019).

It is very important to master scientific literacy (Pahrudin et al., 2019; Ploj Virtič, 2022). Someone who masters scientific literacy well will have a more significant opportunity to adapt (Adnan et al., 2021), be more effective in making personal decisions (Ploj Virtič, 2022), and be able to solve problems in everyday life

(Sholahuddin et al., 2021). Baltikian et al. (2024) stated that scientific literacy is a top priority because of the increasing importance of scientific literacy in this dynamic world. Because a country's progress is determined mainly by its citizens' scientific literacy level, scientific literacy has become.
The main goal of various science education reforms in various countries (Cansiz & Cansiz, 2019; Chang et al., 2024; Dewi et al., 2021; Forbes et al., 2020; Wiyarsi et al., 2021). However, the scientific literacy achievements of Indonesian students still need to improve (Adnan et al., 2021; Sholahuddin et al., 2021). As a tool for evaluating the quality of education systems worldwide (AlAli & Wardat, 2024), PISA reports that Indonesian students' scientific literacy achievements are consistently below the average score (Salahuddin et al., 2021). The latest PISA 2022 data shows that the scientific literacy achievements of Indonesian students have decreased even though their rankings are stated to have increased.

Several factors are causing the low scientific literacy achievements of Indonesian students. One of them is the teacher factor. It cannot be denied that teachers are the dominant factor causing Indonesian students' low scientific literacy achievements. This is closely related to the role of teachers as key agents in promoting, implementing, and teaching scientific literacy to students at school (Adnan et al., 2021; Al Sultan et al., 2021). Ideally, science teachers should have high scientific literacy (Dewi et al., 2019). As producers of science teachers, universities must be able to equip their students with good scientific literacy skills.

However, various empirical studies regarding the scientific literacy profile of prospective science teachers in various regions in Indonesia show that the scientific literacy achievements of prospective science teachers still need to be higher (Pahrudin et al., 2019; Suryati et al., 2020). The low scientific literacy achievements of prospective science teachers indicate that the science learning process still needs to improve, namely only focusing on aspects of scientific literacy content knowledge and students' low understanding of science concepts (Suryati et al., 2020). The learning model implemented so far has yet to develop students' scientific literacy ultimately. Using inappropriate learning models results in students' scientific literacy needing to be adequately trained. Improving the quality of science learning is very important. One way is to develop an innovative science learning model that can better develop prospective science teachers' scientific literacy than existing learning models.

Several learning models are indicated to develop students' scientific literacy. The inquiry-based learning model is known as the best solution for increasing scientific literacy (Adnan et al., 2021; Husamah et al., 2022; Romero-Ariza et al., 2020; Wang et al., 2022). Increased scientific literacy occurs because, in the inquiry-based learning model, students have extensive opportunities to discuss and argue their scientific ideas (Fadly et al., 2022), and it is the main way scientists practice carrying out scientific evaluations and drawing scientific conclusions (Ješková et al., 2022; Wiyarsi et al., 2021). PISA, in the field of science itself, underlines the importance of using inquiry-based learning models to equip students with scientific literacy competencies so that they are willing to engage in reasoned discourse about science and technology in the future (Kang, 2022). Unfortunately, the inquiry-based learning model still has weaknesses in increasing students' scientific literacy. This is closely related to the characteristics of the inquiry-based learning model itself, which places greater emphasis on depth of understanding with limited topics so that it is not in line with scientific literacy assessment, which requires a broad understanding of topics (Mcconney et al., 2014).

The National Research Council (1996) revealed that the low success of science learning was caused by underutilizing the socio-cultural context in science learning. This is in line with findings from Purnawati (2024), who stated that one of the causes of students' low scientific literacy achievements is that students need to transmit scientific situations and knowledge at school to their real-life cultural experiences or vice versa. Thus, culture-based science learning can bridge the gap between traditional knowledge systems and scientific methodology (Verawati & Wahyudi, 2024). Authentic science offers a rich and authentic context for science learning that has the potential to attract interest and increase students' learning motivation (Dewi et al., 2019; Parmin et al., 2022; Zidny et al., 2020; Zidny & Eilks, 2022). Indigenous science is indigenous knowledge based on the culture and perspectives of indigenous peoples (Zidny & Eilks, 2020). Elaborating on indigenous science in science classrooms has the potential to build meaningful and contextual learning (Yani et al., 2021). Several empirical studies show that culture-based science learning can increase scientific literacy (Dewi et al., 2021; Heliawati et al., 2022; Yuliana et al., 2021; Zidny & Eilks, 2022). However, culture-based science learning still has limitations in developing students' scientific literacy, especially regarding time management, excellent preparation from lectures, and the incompatibility of learning materials with external exams.

Facts in the classroom show that no learning model has been developed to facilitate the development of students' scientific literacy. To overcome this gap, developing innovative science learning models is very important. The innovative science learning model being developed can overcome weaknesses and adopt the advantages of previously existing learning models to be more effective in increasing the scientific literacy of prospective science teacher students.

One alternative learning model designed to overcome this gap is the OMIRE learning model, which improves students' overall scientific literacy. OMIRE is an acronym for the five phases of the model syntax, namely observation (O), mind-mapping (M), InvestigationInvestigation (I), reconstruction (R), and evaluation (E). The OMIRE learning model synthesizes the inquiry-based and culture-based learning models by adopting the advantages and reducing the weaknesses of the two learning models. The essence of the hypothetical OMIRE learning model is the packaging of science learning in an integrated cultural context to increase the scientific literacy of prospective science teachers.

Through activities such as observing cultural phenomena, compiling mind maps to organize students' initial knowledge, conducting investigations using various methods, reconstructing indigenous science into scientific science, and evaluating and reflecting on the science learning process that has been carried out, it is believed that researchers can facilitate the development of scientific literacy indicators so that they can improve the scientific literacy of prospective science teacher students better than the learning models that have been applied previously. Based on this background, the research problem is formulated: How is the development of a hypothetical OMIRE learning model to increase the scientific literacy of prospective science teachers? The development of the hypothetical OMIRE learning model includes (1) a chronology of the formation of the OMIRE learning model; (2) characteristics and novelty of the hypothetical OMIRE learning model; and (3) logical theoretical rationale in designing the OMIRE learning model. The research aims to develop a hypothetical OMIRE learning model to increase the scientific literacy of prospective science teachers.

RESEARCH METHOD

This research is qualitative and uses a literature study approach. It aims to develop a hypothetical learning model to improve the scientific literacy of prospective science teachers. This literature study adopts Randolph's (2009) and consists of several stages: problem formulation, data collection, data evaluation, data analysis and interpretation, and public presentation. The research flowchart is shown in Figure 1.

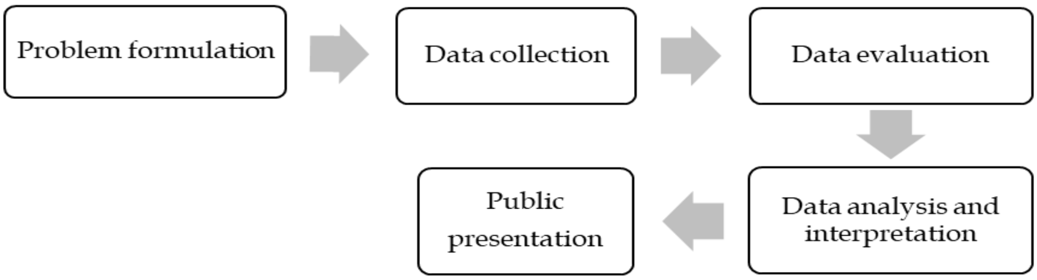

Figure 1. Research flowchart.

The problem formulation stage begins by analyzing the need to develop an innovative science learning model that will better increase the scientific literacy of prospective science teachers than existing and previously implemented learning models. At this stage, questions are also formulated regarding the chronology of the model formation, the characteristics and novelty of the innovative science learning model that will be developed, and the logical theoretical rationale for designing the OMIRE learning model.

The data collection stage was carried out by searching for articles and books relevant to scientific literacy, learning theories that underlie the development of scientific literacy, and learning models that can facilitate the development of students' scientific literacy. The data evaluation stage is done by selecting proper, good-quality literature and the main focus of the research. Critical empirical and theoretical studies are carried out at this stage by organizing and categorizing literature that can improve every aspect of scientific literacy.

The data analysis and interpretation stage was completed by building a conceptual framework for developing a hypothetical OMIRE learning model. A critical and in-depth study found that the hypothetical OMIRE learning model was developed by synthesizing inquiry and culture-based learning models. This section also describes the chronology of the formation of the hypothetical OMIRE learning model syntax and the indicators of scientific literacy that can be developed in each phase of the model syntax.

The public presentation stage presented the characteristics and novelty of the hypothetical OMIRE learning model developed in this research. At this stage, critical arguments were also put forward about how observation activities (O), mind-mapping (M), investigations using various methods (I), science reconstruction (R), and evaluation (E) can develop scientific literacy indicators that can increase students' scientific literacy better than previously existing learning models.

RESULTS AND DISCUSSION

Results

Scientific Literacy

Scientific literacy has various meanings and dynamics. Scientific literacy is a broad concept encompassing many important educational themes that have historically changed. Scientific literacy is applying scientific knowledge based on appropriate evidence, especially relevant to daily life and careers, in solving problems and making responsible decisions. Scientific literacy is a person's ability to apply knowledge and skills in various situations. Scientific literacy is understanding science and its application in solving real societal problems (Sholahuddin et al., 2021).

Robert (2007) states that there are two visions of scientific literacy, namely Vision I, which focuses more on understanding main scientific concepts, principles, and facts, and Vision II, which places greater emphasis on the use of knowledge in situations that individuals face in their daily lives as citizens. PISA 2015/2018 defines scientific literacy as the skill to participate in scientific issues and ideas as a reflective citizen. Scientific literacy refers to the scientific knowledge people must master to live more effectively and be responsible. So, the currently developing understanding of scientific literacy refers more to Vision II of scientific literacy. Personal and social contexts are critical in motivating increased scientific literacy, so science learning should be carried out based on context, not by identifying important content. The scientific literacy indicators in this research refer to three scientific literacy competencies according to PISA 2015/2018, including (a) explaining phenomena scientifically, (b) evaluating and designing scientific investigations, and interpreting data and evidence scientifically (OCED, 2018).

Learning Models that Can Develop Scientific Literacy

Inquiry-based Learning Model

Inquiry-based learning is based on constructivism, where students actively construct knowledge through investigation. In inquiry-based learning, students actively participate in an authentic research cycle (Meulenbroeks et al., 2024). The syntax of the inquiry-based learning model consists of (a) drawing attention and presenting a problem (phenomenon), (b) formulating a hypothesis, (c) collecting data to prove the hypothesis, (d) formulating an explanation, and (e) reflecting on the situation/process thinking (Arends, 2015). Several empirical studies show the effectiveness of inquiry-based learning models in increasing scientific literacy (Adnan et al., 2021; Husamah et al., 2022; Romero-Ariza et al., 2020; Wang et al., 2022). Inquiry-based learning is also a strong positive predictor of student achievement and interest. Apart from having several strengths, the inquiry-based learning model also has several areas for improvement, as shown in Table 1, so this learning model has not been able to optimally increase students' scientific literacy.

Table 1. Strengths and weaknesses of the inquiry-based learning model.

Aspect	The Inquiry-based Learning Model
Strengths	In inquiry-based learning: 1. Students are given ample opportunities to discuss/argue their scientific ideas (Fadly et al., 2022); 2. Students practice evaluating and drawing scientific conclusions (Ješková et al., 2022; Wiyarsi et al., 2021); 3. Students' critical thinking, scientific processing, and problem-solving skills are well developed. These skills are closely related to scientific literacy and 4. Students are involved in reasoned discourse about science and technology (Kang, 2022).
Weaknesses	1. Inquiry-based learning does not readily provide time and space to cover the entire content due to dense curriculum content, assessment

Aspect	The Inquiry-based Learning Model
	procedures that may not be appropriate to inquiry-based learning, and limited laboratory resources that limit inquiry design (Romero-Ariza et al., 2020; Strat & Jegstad, 2022); 2. In inquiry-based laboratories, students often experience frustration, failure, and excessive workload; 3. Not all students have sufficient knowledge/ability to engage meaningfully in inquiry-based learning (Wang et al., 2022); 4. Inquiry-based learning places greater emphasis on depth of understanding with limited topics so that it is not in line with scientific literacy assessment, which requires a broad understanding of topics; 5. Open inquiry shows a negative relationship with scientific literacy (Aditomo & Klieme, 2020; Kang, 2022; Wang et al., 2022); 6. The many choices that students face during assignments with open inquiry-based learning cause them to be overwhelmed, making it difficult to achieve the expected competencies (Meulenbroeks et al., 2024) and 7. Students often face challenges completing complex inquiry tasks, especially in applying multivariable reasoning and building scientific explanations (Teig, 2024).

Culture-based Learning Model

One of the general issues in science education is increasing students' motivation and interest in learning. The rich and authentic context found in culture has the potential to increase student interest and learning achievement (Dewi et al., 2019; Dewi et al., 2021; Parmin et al., 2022; Zidny et al., 2020; Zidny & Eilks, 2022). The elaboration of indigenous science found in cultural and scientific phenomena in science classrooms can potentially build meaningful and contextual learning (Yani et al., 2021). Science learning with an ethnoscience approach is contextual learning that can bridge the process of discovering concepts and contexts in science learning (Lasmana, 2024). Indigenous science contains various concepts, principles, and scientific knowledge that still need to be formalized, so they need to be formalized and reconstructed into scientific science. The reconstruction of indigenous science can be interpreted as a rearrangement of concepts found in indigenous science that have been transcribed into scientific science.

The syntax of the culture-based learning model, according to Suastra (2005), consists of four phases, namely: (1) identifying students' knowledge, (2) conducting investigations from various perspectives, (3) reflecting, and (4) evaluating the process. Several empirical studies have shown that culture-based learning can increase students' scientific literacy (Dewi et al., 2021; Heliawati et al., 2022; Yuliana et al., 2021; Zidny & Eilks, 2022). Although many empirical studies show the effectiveness of culture-based learning in increasing scientific literacy, it also has several weaknesses, as shown in Table 2.

Table 2. Strengths and weaknesses of culture-based learning models.

Aspect	The Culture-based Learning Model
Strengths	With culture-based learning: 1. Science learning becomes more holistic, engaging, and relevant to students' daily lives (Parmin et al., 2022; Zidny et al., 2020; Zidny & Eilks, 2022); 2. Science concepts become more accessible to understand, and retention

Aspect	The Culture-based Learning Model
	of new concepts takes longer (Yuliana et al., 2021); 3. Can create a positive attitude in students toward science (Ramdiah et al., 2020) and care for the environment/nature conservation (Lubis et al., 2022; Parmin et al., 2022; Zidny & Eilks, 2022); and 4. Science learning integrated with local community knowledge allows students to interact with scientific inquiry, increasing their scientific literacy (Uslan et al., 2024).
Weaknesses	1. Science educators are more familiar with scientific science than natural science, and educators need adequate competence because it requires extra time and learning strategies; 2. Time management problems, more excellent preparation by teachers, inappropriateness with external examinations, and 3. Lecturers face challenges integrating local wisdom in science learning, including identifying and selecting appropriate local knowledge, adapting curricular materials, and training educators to effectively combine traditional wisdom with scientific principles (Verawati & Wahyudi, 2024).

Discussion

The development of the hypothetical OMIRE learning model to improve the scientific literacy of prospective science teachers is divided into three main parts: the chronology of its formation, its characteristics and novelty, and the logical theoretical rationale for designing it.

The Hypothetical OMIRE Learning Model to Increase The Scientific Literacy

The hypothetical OMIRE learning model synthesizes an inquiry-based learning model with characteristics emphasizing depth of understanding but limited topics and a culture-based science learning model offering rich and authentic topics to attract students' interest and learning motivation. Synthesis is carried out by adopting the strengths and reducing the weaknesses of the two models to produce an innovative hypothetical learning model that can improve the scientific literacy of prospective science teachers. The hypothetical model developed is called the OMIRE learning model, which is an acronym for its syntax phases: Observation (O), Mind–Mapping (M), InvestigationInvestigation (I), Reconstruction (R), and Evaluation (E). The chronology of the formation of the OMIRE learning model is shown in Figure 2.

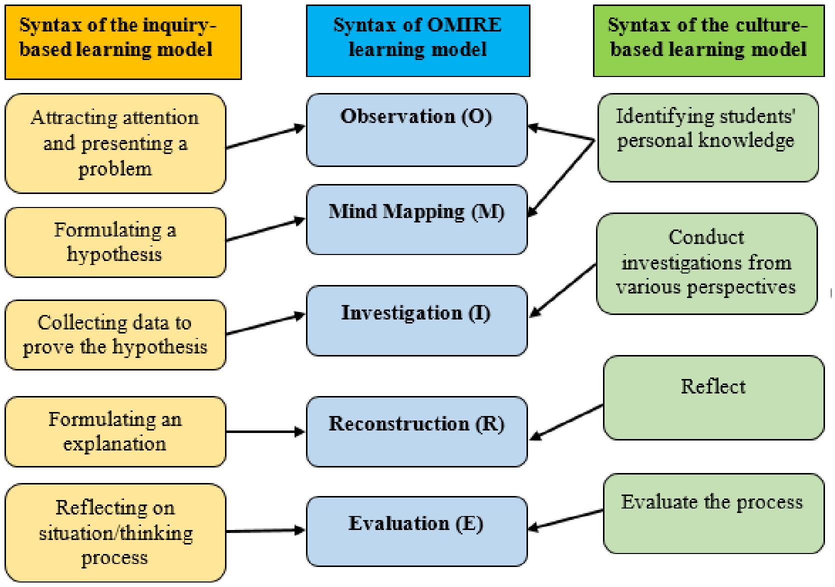

Figure 2. The chronology of the formation of the OMIRE learning model.

Figure 2 shows that each phase of the OMIRE learning model is a synthesis of the inquiry-based learning model phase and the culture-based model, contributing to students' scientific literacy development. The observation phase (O) in the OMIRE learning model is related to attracting attention, presenting problems in the inquiry-based learning mode, and identifying students' knowledge in the culture-based learning model. Increasing interest in learning at the initial stage of learning is significant because it presents an exciting and relevant cultural phenomenon. The mind-mapping (M) phase is related to the hypothesis formulation phase in the inquiry-based learning model and the identification phase of students' knowledge in the culture-based learning model, which is then mapped as mind mapping. Hypothesis preparation must be done to provide direction for further investigation. These two phases increase students' scientific literacy, especially in scientifically explaining phenomena.

The investigation phase (I) relates to collecting data on the inquiry-based learning model and the investigation phase from various perspectives on the culture-based learning model. Testing the truth of the hypothesis in the inquiry-based learning model can be done through investigative activities to obtain data supporting the hypothesis. The Investigation was carried out in a multidisciplinary and multiperspective manner using several methods: literature review, direct observation of the object of study, interviews with community leaders, and experiments. The reconstruction phase (R) is related to the phase of formulating explanations in the inquiry-based learning model and the reflection phase in the culture-based learning model. The indigelous science and scientific science data collected in the investigation phase is organized and analyzed, and science reconstruction is carried out. The evaluation phase (E) is related to reflecting on the situation (thinking process) in the inquiry-based learning model and the process evaluation phase in the culture-based learning model. The results of scientific investigations and reconstructions are presented by the presenting group and responded to by other groups in class discussions. At this stage, evaluation and reflection activities occur during the learning process. The investigation, reconstruction, and evaluation phases improve the three indicators of scientific literacy: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting scientific data and evidence.

Characteristics and Novelty of the Hypothetical OMIRE Learning Model

The essence of the hypothetical OMIRE learning model is the packaging of science learning in an integrated cultural context to increase the scientific literacy of prospective science teachers. The hypothetical OMIRE learning model has several characteristics, namely, including a specific learning model to increase scientific literacy, an integrated science approach, the result of a synthesis of inquiry-based learning models and culture-based learning models, and is based on several constructivist learning theories, theories Piaget's cognitive development, Vygotsky's social constructivist theory, Ausuble's meaningful learning, Bruner's discovery learning, Novak's concept maps (mind maps), information processing theory, collateral learning theory, cultural boundary crossing metaphors, and science reconstruction.

Some of the novelties of this hypothetical OMIRE learning model are: (1) Science learning is carried out in an integrated manner by analyzing a cultural phenomenon in a multiperspective (indigenous science and scientific perspective) and multidisciplinary (Physics, Chemistry, and Biology) so that science learning becomes more holistic and meaningful; (2) Because the cultural phenomenon studied is a broad topic, the preparation of hypotheses is carried out in the form of a mind map to organize the scientific concepts contained in the cultural phenomenon; (3) The Investigation was carried out using four methods, namely: literature study, experiments, direct observation, and interviews with community leaders; (4) Science reconstruction is a unique phase of this model which aims to build new knowledge through students' active role during the learning process through activities of reconstructing or translating indigenous science into scientific science. Evaluation and reflection are carried out at the end of the learning process.

Logical Theoretical Rationale in Designing the OMIRE Learning Model

Based on the chronology of the formation of the OMIRE model, the researchers concluded that to improve the scientific literacy of prospective science teachers as a whole, several activities must be carried out: (1) observation of cultural phenomena, (2) preparation of hypotheses in the form of mind-mapping, (3) investigations using several methods, (4) reconstruction of scientific data from investigations, and (5) evaluation and reflection on the learning process. The rationality of the sequence of phases of the OMIRE learning model developed is based on researchers' arguments, theoretical studies, and empirical studies. The explanation of each phase is as follows.

Observation Phase (O)

This phase aims to attract students' interest in learning by presenting cultural phenomena that are interesting and relevant to students' daily lives. Indigenous science found in culture offers a rich and authentic context so that it can attract students' interest (Zidny & Eilks, 2020) so that it has a positive impact on learning perceptions and achievements (Kang & Keinonen, 2018; Zidny & Eilks, 2020, 2022). Interest is part of intrinsic motivation. Motivation is initiating and maintaining goal-directed academic activities (Alqawasmi et al., 2024). Vygotsky emphasized the importance of cultural and social context in science learning. Lecturers explore students' initial knowledge by asking questions related to these cultural phenomena so that a connection occurs between new knowledge and students' initial knowledge so that meaningful learning occurs (Adnan et al., 2021). This is in line with Ausuble's theory of meaningful learning that meaningful learning occurs when new concepts are linked to previously existing relevant concepts, and Piaget's theory of cognitive development, which states that assimilation occurs when students use pre-existing schemas to understand new information so that the new information will be easier to understand and last longer in the student's cognitive structure (Slavin, 2018). In culture-based learning, students learn through local culture and relate it to scientific concepts so that they can increase their scientific literacy (Citra et al., 2021; Heliawati et al., 2022; Yuliana et al., 2021; Zidny & Eilks, 2022). Explaining scientific phenomena indicates scientific literacy that can be developed in the observation phase.

Mind Mapping Phase (M)

This phase aims to develop hypotheses in mind mapping related to indigenous and scientific science concepts found in cultural phenomena. Organizing concepts in the form of mind mapping needs to be done because the cultural phenomenon presented is a broad topic (Zidny & Eilks, 2020) and is holistic, which can be analyzed multidisciplinary (Physics, Chemistry, and Biology) and multiperspective (native science perspective and scientific science). In this phase, the lecturer divides students into several heterogeneous groups based on cooperative learning principles. Learning in group settings is based on Vygotsky's social constructivist theory, which emphasizes the role of social context in knowledge construction, where social interaction can accelerate students' cognitive development (Arends, 2015). According to Piaget's cognitive theory, social interactions can build knowledge by organizing, assimilating, and accommodating new information in their cognitive structures. Through mind-mapping activities, students can develop scientific literacy, especially in indicators, to explain phenomena scientifically.

Investigation Phase (I)

This phase explores and collects data to prove hypotheses through investigative activities from genuine science and scientific perspectives. The investigation was carried out using four methods: literature review, experimentation, observation of the object of study, and interviews with community figures. Bruner emphasized that authentic learning is carried out through discovery (Arends, 2015). The investigative phase refers to Dewey's pedagogy in that lecturers engage students in problem-solving projects and help them investigate important social and intellectual issues (Arends, 2015). The ability to carry out scientific investigations is the primary goal of science education because students can experience and appreciate the essence of science (Kim, 2024). In this phase, the lecturer acts as a “cultural broker” who attempts to facilitate the crossing of cultural borders that students experience in science classes by providing the scaffolding the student group needs. Scaffolding determines the success of learning (Forbes et al., 2020).

Investigation through literature review can improve students' skills in reading comprehension, processing information from various sources, and problem-solving. The ability to transmit conceptual understanding and appropriately interpret and evaluate texts regarding scientific concepts is closely related to scientific literacy. Several empirical studies show that students' scientific literacy can be improved by interacting directly with learning resources (Yuliana et al., 2021), for example, by direct observation activities at study sites and in-depth interviews with community leaders (Suprapto et al., 2021). Investigation is also closely related to scientific experiments in finding the truth of hypotheses (Parmin et al., 2022), which involves identifying variables (independent, dependent, and control variables) (Ješková et al., 2022). This phase can develop the three indicators of scientific literacy.

Reconstruction Phase (R)
This phase aims to organize, analyze investigative data, and reconstruct indigenous science into scientific science. Science reconstruction means rearranging or translating indigenous science into scientific science (Suprapto et al., 2021). Indigenous science contained in local wisdom can be explained and understood scientifically (Nuangchalerm et al., 2022). Through science reconstruction activities, students can develop critical thinking, solve problems holistically (Zidny & Eilks, 2020), and understand how to apply scientific concepts to local community wisdom (Suprapto et al., 2021). The reconstruction phase begins with organizing the investigation data, distinguishing between indigenous science that can be explained scientifically and indigenous science that cannot. This science reconstruction phase can develop the three indicators of scientific literacy.

Evaluation Phase (E)
This phase aims to evaluate and reflect on the learning process that has been carried out. Reflective thinking is one of the principles of constructivist learning that can increase students' scientific literacy (Adnan et al., 2021). The evaluation phase begins by allowing one group of students to present the results of their scientific investigation and reconstruction and continues with class discussion. Through class discussions, students will be trained to convey ideas and opinions supported by facts and scientific evidence (Fadly et al., 2022). Providing ample opportunities for students to discuss and debate their scientific ideas can hone students' scientific literacy. Utilizing local potential as a learning resource can increase student activity in class discussions and explain occurring phenomena (Yani et al., 2021). This phase ends with giving a test, carried out independently by students to deepen their' concepts. This evaluation phase can develop the three indicators of scientific literacy.

CONCLUSION

Fundamental Finding: There is a need to develop innovative science learning models based on preliminary studies to improve the scientific literacy of prospective science teachers. The OMIRE learning model is designed to increase the scientific literacy of prospective science teachers. The OMIRE learning model consists of five phases, namely: observation (O), mind mapping (M), investigation (I), reconstruction (R), and evaluation (E). **Implication:** The OMIRE learning model can be applied to improve students' overall scientific literacy at various levels of education. **Limitation:** The OMIRE learning model is still hypothetical, so further research must be conducted to test the validity, practicality, and effectiveness of the OMIRE learning model for increasing the scientific literacy of prospective science teachers. **Future Research:** The OMIRE learning model can be applied at primary and secondary education levels with different cultural contexts. Future researchers who want to apply the OMIRE learning model must adapt it to their students' cognitive development level.

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REFERENCES

Aditomo, A., & Klieme, E. (2020). Forms of inquiry-based science instruction and their relations with learning outcomes: evidence from high and low-performing education systems. *International Journal of Science Education*, *42*(4). https://doi.org/10.1080/09500693.2020.1716093

Adnan, Mulbar, U., Sugiarti, & Bahri, A. (2021). Scientific literacy skills of students: Problem of biology teaching in junior high school in South Sulawesi, Indonesia. *International Journal of Instruction*, *14*(3), 847–860. https://doi.org/10.29333/iji.2021.14349a

Al Sultan, A., Henson, H., & Lickteig, D. (2021). Assessing preservice elementary teachers' conceptual understanding of scientific literacy. *Teaching and Teacher Education*, *102,* 1-10. https://doi.org/10.1016/j.tate.2021.103327

AlAli, R., & Wardat, Y. (2024). Low PISA performance students: Factors, perceptions, and improvement strategies. *International Journal of Religion*, *5*(9), 334–348. https://doi.org/10.61707/nve8gj33

Alqawasmi, A., Alsalhi, N. R., & Al Qatawneh, S. S. (2024). The influence of utilizing inquiry-based learninstrategy on science accomplishment of primary students' stage. *International Journal of Interactive Mobile Technologies*, *18*(5), 62–76. https://doi.org/10.3991/ijim.v18i05.47011

Arends, R. (2015). *Learning to teach (tenth edition).* McGraw-Hill Education.

Baltikian, M., Kärkkäinen, S., & Kukkonen, J. (2024). Assessment of scientific literacy levels among secondary school students in Lebanon: Exploring gender-based differences. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(3), 23-40. https://doi.org/10.29333/ejmste/14279

Cansiz, M., & Cansiz, N. (2019). Reconceptualizing and field testing the scientific literacy framework by exploring the aspect of scientific literacy in Turkish science curriculum. *Journal of Baltic Science Education*, *18*(5), 681–691. https://doi.org/10.33225/jbse/19.18.681

Chang, T. C., Lyu, Y. M., Wu, H. C., & Min, K. W. (2024). Introduction of taiwanese literacy-oriented science curriculum and development of an aligned scientific literacy assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(1), 1-15. https://doi.org/10.29333/ejmste/13930

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Dewi, Citra Ayu, Erna, M., Martini, Haris, I., & Kundera, I. N. (2021). Effect of contextual collaborative learning based ethnoscience to increase student's scientific literacy ability. *Journal of Turkish Science Education*, *18*(3), 525–541. https://doi.org/10.36681/tused.2021.88

Fadly, D., Rahayu, S., Dasna, I. W., & Yahmin, Y. (2022). The effectiveness of a SOIE strategy using socio-scientific issues on students chemical literacy. *International Journal of Instruction*, *15*(1), 237–258. https://doi.org/10.29333/iji.2022.15114a

Forbes, C. T., Neumann, K., & Schiepe-Tiska, A. (2020). Patterns of inquiry-based science instruction and student science achievement in PISA 2015. *International Journal of Science Education*, *42*(5), 1-23. https://doi.org/10.1080/09500693.2020.1730017

Heliawati, L., Lidiawati, L., Adriansyah, P. N. A., & Herlina, E. (2022). Ethnochemistry-based adobe flash learning media using indigenous knowledge to improve students' scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 271–281. https://doi.org/10.15294/jpii.v11i2.34859

Husamah, H., Suwono, H., Nur, H., & Dharmawan, A. (2022). The development and validation of environmental literacy instrument based on spirituality for prospective science teachers.

Eurasia Journal of Mathematics, Science and Technology Education, *18*(12), 112-125. https://doi.org/10.29333/EJMSTE/12732

Ješková, Z., Lukáč, S., Šnajder, Ľ., Guniš, J., Klein, D., & Kireš, M. (2022). Active learning in STEM education with regard to the development of inquiry skills. *Education Sciences*, *12*(10), 1-12. https://doi.org/10.3390/educsci12100686

Kang, J. (2022). Interrelationship between inquiry-based learning and instructional quality in predicting science literacy. *Research in Science Education*, *52*(1), 1-10. https://doi.org/10.1007/s11165-020-09946-6

Kang, J., & Keinonen, T. (2018). The effect of student-centered approaches on students' interest and achievement in science: Relevant topic-based, open and guided inquiry-based, and discussion-based approaches. *Research in Science Education*, *48*(4), 110-122. https://doi.org/10.1007/s11165-016-9590-2

Kim, S. (2024). Development of an inquiry activity model emphasizing the representation of primary science textbooks. *Journal of Baltic Science Education*, 23(2), 315–330. https://doi.org/10.33225/jbse/24.23.315

Lasmana, O. (2024). Exploring local wisdom through project-based learning: A case study of the application of ethnoscience models. *Chelonian Conservation And Biology*, *19*(1), 1–8.

Lubis, S. P. W., Suryadarma, I. G. P., Paidi, & Yanto, B. E. (2022). The effectiveness of problem-based learning with local wisdom oriented to socio-scientific issues. *International Journal of Instruction*, *15*(2), 1-11. https://doi.org/10.29333/iji.2022.15225a

Mcconney, A., Oliver, M. C., Woods-Mcconney, A., Schibeci, R., & Maor, D. (2014). Inquiry, engagement, and literacy in science: a retrospective, cross-national analysis using PISA 2006. *Science Education*, *98*(6), 963–980. https://doi.org/10.1002/sce.21135

Meulenbroeks, R., van Rijn, R., & Reijerkerk, M. (2024). Fostering secondary school science students' intrinsic motivation by inquiry-based learning. *Research in Science Education*, *54*(3), 339–358. https://doi.org/10.1007/s11165-023-10139-0

NRC. (1996). *National science education standards*. National Academies Press.

Nuangchalerm, P., El Islami, R. A. Z., & Prasertsang, P. (2022). Science attitude on environmental conservation of thai and indonesian novice science teacher students. *International Journal of STEM Education for Sustainability*, *2*(2), 148–155. https://doi.org/10.53889/ijses.v2i2.62

OCED. (2018). PISA 2018 for development assessment and analytical framework. *OECD Publishing*. https://www.oecd.org/education/pisa-2018-assessment-and-analytical-framework-b25efab8-en.htm

OECD. (2019). PISA 2018 assessment and analytical framework. *OECD Publishing*.

Pahrudin, A., Irwandani, Triyana, E., Oktarisa, Y., & Anwar, C. (2019). The analysis of pre-service physics teachers in scientific literacy: Focus on the competence and knowledge aspects. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 52–62. https://doi.org/10.15294/jpii.v8i1.15728

Parmin, P., Savitri, E. N., Khusniati, M., & El Islami, R. A. Z. (2022). The prospective science teachers' skills in reconstructing indigenous knowledge of local culture on breast milk using pare (Momordica charantia). *International Journal of Educational Research Open*, *3*, 10-21. https://doi.org/10.1016/j.ijedro.2022.100193

Ploj Virtič, M. (2022). Teaching science & technology: components of scientific literacy and insight into the steps of research. *International Journal of Science Education*, *44*(12), 1916–1931. https://doi.org/10.1080/09500693.2022.2105414

Purnawati, R. (2024). Scientific literacy by incorporating local terms and sociocultural phenomena into science teaching-learning process. *PROJECT*, *7*(2), 433–448.

Ramdiah, S., Abidinsyah, A., Royani, M., Husamah, H., & Fauzi, A. (2020). South kalimantan local wisdom-based biology learning model. *European Journal of Educational Research*, *9*(2), 639-645. https://doi.org/10.12973/eu-jer.9.2.639

Randolph, J. J. (2009). A guide to writing the dissertation literature review. *Practical Assessment,* *Research and Evaluation*, *14*(13), 1-22.

Roberts, D. A. (2007). Scientific literacy / science literacy. *Handbook of Research on Science Education*, 729–780.

Romero-Ariza, M., Quesada, A., Abril, A. M., Sorensen, P., & Oliver, M. C. (2020). Highly recommended and poorly used: English and spanish science teachers' views of inquiry-based learning (IBL) and its enactment. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(1), 1–16. https://doi.org/10.29333/ejmste/109658

Sholahuddin, A., Susilowati, E., Prahani, B. K., & Erman, E. (2021). Using a cognitive style-based learning strategy to improve students' environmental knowledge and scientific literacy. *International Journal of Instruction*, *14*(4), 791–808. https://doi.org/10.29333/iji.2021.14445a

Slavin, R. E. (2018). *Educational psychology : Theory and practice.* Pearson.

Strat, T. T. S., & Jegstad, K. M. (2022). Norwegian teacher educators' reflections on inquiry-based teaching and learning in science teacher education. *Journal of Science Teacher Education,* 1-11. https://doi.org/10.1080/1046560X.2022.2125623

Suprapto, N., Prahani, B., & Deta, U. (2021). Research trend on ethnoscience through bibliometric analysis (2011-2020) and the contribution of indonesia. *Library Philosophy and Practice (e-Journal)*, 1-23.

Suryati, S., Yusran, K., Asma, N., Hendrawani, & Sri, R. (2020). Identification of science literacy competency of chemistry teacher candidate. *Jurnal Zarah*, *8*(1), 50–55.

Teig, N. (2024). Uncovering student strategies for solving scientific inquiry tasks: Insights from student process data in PISA. *Research in Science Education*, *54*(2), 205–224. https://doi.org/10.1007/s11165-023-10134-5

Uslan, Abdullah, N., Imami, M. K. W., & Aiman, U. (2024). The effectiveness of the local knowledge-based module (LKBM) to improve students' scientific literacy and thinking skills. *Jurnal Pendidikan IPA Indonesia*, *13*(1), 147–161. https://doi.org/10.15294/jpii.v13i1.47561

Verawati, N. N. S. P., & Wahyudi, W. (2024). Raising the issue of local wisdom in science learning and its impact on increasing students' scientific literacy. *International Journal of Ethnoscience and Technology in Education*, *1*(1), 42-51. https://doi.org/10.33394/ijete.v1i1.10881

Wang, H. H., Hong, Z. R., She, H. C., Smith, T. J., Fielding, J., & Lin, H. shyang. (2022). The role of structured inquiry, open inquiry, and epistemological beliefs in developing secondary students' scientific and mathematical literacies. *International Journal of STEM Education*, *9*(1), 1-11. https://doi.org/10.1186/s40594-022-00329-z

Wang, L., Yuan, Y., & Wang, G. (2024). The construction of civil scientific literacy in china from the perspective of science education. *Science and Education*, *33*(1), 249–269. https://doi.org/10.1007/s11191-022-00367-7

WEF. (2015). *New Vision for Education: Unlocking the Potencial of Technology*. World Economic Forum.

Wiyarsi, A., Prodjosantoso, A. K., & Nugraheni, A. R. E. (2021). Promoting students' scientific habits of mind and chemical literacy using the context of socio-scientific issues on the inquiry learning. *Frontiers in Education*, *6*, 1-11. https://doi.org/10.3389/feduc.2021.660495

Yani, A., Amin, M., Rohman, F., Suarsini, E., & Rijal, M. (2021). Pre-service biology teacher's perception on local environment problems as contextual learning resources. *International Journal of Evaluation and Research in Education*, *10*(3), 768–780. https://doi.org/10.11591/ijere.v10i3.21091

Yuliana, I., Cahyono, M. E., Widodo, W., & Irwanto, I. (2021). The effect of ethnoscience-themed picture books embedded within contextbased learning on students' scientific literacy. *Eurasian Journal of Educational Research*, *2021*(92), 317–334. https://doi.org/10.14689/ejer.2021.92.16

Zidny, R., & Eilks, I. (2020). Integrating perspectives from indigenous knowledge and Western science in secondary and higher chemistry learning to contribute to sustainability education. *Sustainable Chemistry and Pharmacy*, *16*, 1-12. https://doi.org/10.1016/j.scp.2020.100229

Zidny, R., & Eilks, I. (2022). Learning about pesticide use adapted from ethnoscience as a contribution to green and sustainable chemistry education. *Education Sciences*, *12*(4), 23-35. https://doi.org/10.3390/educsci12040227

Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science and Education*, *29*(1), 145–185. https://doi.org/10.1007/s11191-019-00100-x

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