Journal of Engineering Science and Technology
Vol. 20, No. 6 (2025) 2126 - 2153

CONTEXTUAL FLUID MECHANICS IN A DIGITAL MODULE THROUGH PROJECT-BASED LEARNING WITH SCIENCE, ENVIRONMENT, TECHNOLOGY, AND SOCIETY APPROACH INTEGRATED WITH KAYUH BAIMBAI VALUES TO SUPPORT SUSTAINABLE DEVELOPMENT GOALS (SDGS)

SARAH MIRIAM[1], DEWI DEWANTARA[1,*], SRI HARTINI[1], NURUL HIKMAH[1], S. SUJITO[2], MUSTIKA WATI[1], AXMADJANOV DONIYOR BAXTIYOR[3]

[1]Universitas Lambung Mangkurat, Banjarmasin, Indonesia
[2]Universitas Negeri Malang, Malang, Indonesia
[3]Chirchik State Pedagogical University, Chirchik, Uzbekistan
*Corresponding Author: dewantara_pfis@ulm.ac.id

Abstract

This study aimed to improve students' scientific literacy on static fluid concepts by developing a contextual digital module that integrates project-based learning with the science-environment-technology-society approach and *kayuh baimbai* values. A quasi-experimental posttest-only control design compared a class using the module with a class taught conventionally, using a validated learning outcome test and appropriate parametric or non-parametric analyses. Learners in the experimental class outperformed the control and achieved a large practical impact on literacy competencies. The module elevates understanding because projects require learners to connect pressure, buoyancy, and hydraulic principles with local flood realities, collaborate in culturally grounded teams, and justify designs with evidence. The work provides an implementable resource for physics teachers, advances culturally responsive science pedagogy, and supports disaster resilience by guiding students to design feasible floating and hydraulic solutions for riverine communities. It strengthens communication, creativity, and reflective evaluation during project presentations. This study supports current issues in sustainable development goals (SDGs).

Keywords: Fluid concepts, *Kayuh baimbai*, Project-based learning (PjBL), Science environment technology and society (SETS), Science literacy.

1. Introduction

Literacy is an essential competency in 21st-century education, encompassing not only an understanding of scientific concepts but also the ability to think critically and apply knowledge in real-life contexts. Many reports regarding this literacy have been well-documented (Table 1). It is foundational for enabling students to evaluate information, solve problems, and make informed decisions related to science, environment, technology, and society.

However, Indonesian students consistently rank low in international assessments such as the programme for international student assessment (PISA). Between 2006 and 2015, Indonesia's scores ranged from 382 to 403 [1], with a score of 396 in 2018 [2-4], and declined further to 383 in 2022, a figure still considered low by global standards. These results indicate ongoing challenges in students' abilities to comprehend, evaluate, and apply scientific knowledge for problem-solving [5].

Contributing factors include limitations in curriculum design, learning models, infrastructure, and learning resources that do not align with the competencies required in modern science education [6, 7]. The low scientific literacy level also undermines students' environmental awareness and understanding of local socio-scientific issues, both of which are vital in preparing a competitive generation for the future [8].

Table 1. Previous studies regarding literacy.

No.	Title	Ref.
1	The impact of project-based learning (PjBL) on students' motivation and learning outcomes: A literature review	[9]
2	Utilization of YouTube videos during online learning to increase literacy in English for middle school students	[10]
3	Lyrics of kawih tanah sunda by Koko Koswara as a media for learning cultural literacy for students in junior high school	[11]
4	Implementation of the school literacy movement before teaching and learning activities at middle school	[12]
5	Efforts to improve young generation problem solving in the era of globalization using six thinking hats analysed with SPSS: Solving literacy, read, and hoax	[13]
6	Integrating generative artificial intelligence (AI)-based multimodal learning in education to enhance literacy aligned with sustainable development goals (SDGs)	[14]
7	Student development: Implementation of water rocket media as a project-based learning tool to improve the literacy of junior high school students during the pandemic	[15]
8	Community extension: Literacy and numeracy enhancement program for alternative learning system and out-of-school youth learners	[16]
9	Socialization of digital literacy in compiling a balanced healthy menu to members of POKJA III the PKK Movement Team of Purwakarta Regency	[17]
10	Literacy program for elementary school students about inclusive education in recognizing children with special needs	[18]
11	Strengthening literacy in children with special needs during courageous learning with family support in learning during a pandemic	[19]

At the school level, contextual implementation remains limited. Preliminary interviews with physics teachers at a public senior high school in Banjarmasin revealed that students' science literacy has never been formally assessed. Teachers expressed difficulty in applying innovative pedagogies due to students' limited conceptual understanding, especially in physics.

Moreover, their skills in processing information and solving higher-order thinking problems remain weak, and their interest in physics is notably lower than in other sciences like biology. Physics instruction continues to rely heavily on conventional methods, with minimal integration of interdisciplinary approaches or local values. For example, the science-environment-technology-society approach has not yet been applied in physics classes, nor has local wisdom (particularly *kayuh baimbai*, a cultural value from South Kalimantan symbolizing cooperation and collective progress) been incorporated into teaching strategies.

Although project-based learning (PjBL) has been used in some cases [20], it is often limited to simple activities such as producing short videos. Research has shown that PjBL improves creativity and collaboration [21, 22], that the science-environment-technology-society approach makes science more relevant to students' lives [23], and that *kayuh baimbai* can foster values of teamwork and mutual respect [24]. However, studies that combine these three dimensions into a unified and contextualized instructional design (particularly for fluid mechanics) are still lacking.

This study seeks to address that gap by developing a contextual digital module that integrates PjBL, the science-environment-technology-society approach, and *kayuh baimbai* values in the teaching of static fluid concepts. A quasi-experimental posttest-only control group design involving 54 Grade 11 students was employed to examine the effectiveness of the module.

The novelty of this study lies in three main contributions. First, it merges project-based learning with the science-environment-technology-society approach into a digital module, a combination rarely explored in physics education. Second, it embeds local wisdom (*kayuh baimbai*) to strengthen the cultural relevance and character education aspect of science learning. Third, it focuses on improving students' literacy in the area of static fluid mechanics, a topic student often finds conceptually difficult. These innovations are expected to contribute both to theoretical developments in science education and to practical instructional strategies that support meaningful, collaborative, and sustainable learning.

2. Literature Review

2.1. Science literacy

Scientific literacy refers to an individual's ability to understand, communicate, and apply scientific knowledge to solve problems, thereby fostering positive attitudes and environmental awareness [25]. Etymologically, the term originates from the Latin words *literatus* (literate) and *scientia* (knowledge), emphasizing both comprehension and intellectual engagement with scientific information [26]. In its broader sense, scientific literacy also encompasses the capacity to understand the interrelationships among science, technology, society, culture, and the environment [27]. The primary objective of scientific literacy in education is not merely to train future scientists, but to equip students with the cognitive tools necessary for informed decision-making that impact both their present and future lives [28].

In an era marked by rapid technological and informational advancement, scientific literacy has become increasingly vital. It enables students to tackle everyday challenges and make reasoned choices based on their understanding of scientific principles [29, 30]. As a core 21st-century competency, it requires the ability to interact meaningfully with knowledge and data.

Scientific literacy comprises four key aspects: context, knowledge, competence, and attitudes. This study focuses specifically on the competence aspect, which involves the mental processes used to respond to questions and resolve scientific problems. These processes include explaining scientific phenomena, designing, and evaluating scientific investigations, and interpreting data and evidence.

Table 2 presents a comprehensive framework of the dimensions and sub-components of scientific literacy that should be prioritized in the learning process. Various factors contribute to the low levels of scientific literacy among students, such as the use of ineffective textbooks, persistent misconceptions, non-contextual learning practices, poor reading habits, unsupportive learning environments, inadequate infrastructure, limited teacher capacity, and weak school governance [31].

Addressing these challenges requires the implementation of contextually appropriate instructional strategies that integrate scientific content with relevant social, technological, and environmental issues. Such integration is essential for fostering students' critical thinking, scientific reasoning, and problem-solving skills. In light of these factors, adopting a structured, multi-dimensional approach to scientific literacy development is both necessary and urgent.

2.2. Fluid

The hydrological configuration renders the region highly susceptible to seasonal flooding, particularly during the rainy season when intense rainfall causes rivers to overflow. These floods may last for several days or even weeks, yet local communities continue their daily activities through various adaptive strategies. Notably, flood-resistant infrastructure such as floating restaurants, buildings equipped with hydraulic jack systems, and automated water pumps have been developed to accommodate fluctuating water levels. These adaptations can be examined through the lens of fluid statics, encompassing principles such as pressure, hydrostatic pressure, Pascal’s Law, and Archimedes’ Principle. Understanding these concepts is essential for designing stable, safe, and environmentally responsive structures that can function even under extreme hydrological conditions.

Density is a fundamental concept in fluid mechanics, representing the ratio of mass to volume and indicating how compact a substance is. In the case of the Barito River, the presence of mud and sediments increases the density of water compared to clean water. This higher density significantly impacts buoyancy and must be accounted for in the engineering of floating structures, such as restaurants, which need to remain stable under dynamic loads, including people, furniture, and flood debris.

Table 2. Dimensions and indicators of scientific literacy.

Dimension	Type	Competence/sub-competence	Description/indicator
Science competence	Explaining phenomena scientifically	Identifying, generating, applying, and evaluating explanations for natural and technological phenomena	Applying scientific knowledge; explaining implications of scientific understanding in real-world contexts
	Designing and evaluating scientific investigations & interpreting data	Designing and assessing investigations; interpreting and drawing conclusions from data	Interpreting data representations accurately; evaluating relative merits of findings
	Using scientific information for decision-making	Researching, evaluating, and applying scientific claims and evidence	Making informed decisions based on scientific arguments and benefits in various contexts
Science knowledge	Content	Understanding core concepts in physics, chemistry, biology, and earth science	Applying content knowledge to solve real-life science problems
Science context	Procedural	Familiarity with scientific methods and procedures	Using standard scientific methods to collect and validate data
	Epistemic	Understanding how scientific knowledge is constructed and justified	Recognizing the nature of science as a discipline and evaluating the basis of scientific claims
	Personal	Applying science in personal and family life	Solving daily life problems using scientific reasoning
	Social	Applying science within community and societal issues	Addressing local and regional challenges through scientific understanding
	Global	Applying science to global challenges	Relating science to health, environment, resources, and technological advancements across countries

Pascal's Law further informs the design of hydraulic systems used in adaptive architecture. This law states that pressure applied to a confined fluid is transmitted equally in all directions. In practical terms, certain structures in South Kalimantan are built on lightweight concrete foundations supported by hydraulic jacks. When floodwaters rise, sensors activate hydraulic pumps that transfer fluid into enclosed chambers beneath the foundation, enabling a uniform and vertical lifting of the entire structure. This mechanism minimizes water damage while preserving building integrity.

Figure 1 illustrates the principle of buoyancy as described by Archimedes' Law, which is foundational in explaining how floating restaurants maintain equilibrium on river surfaces. According to Archimedes law: *"A body wholly or partially submerged in a fluid experience an upward buoyant force equal in magnitude to the weight of the fluid displaced by the body"*.

This principle underlies the engineering of pontoons or floating platforms, which displace sufficient water to support the weight of the entire structure, ensuring both floatation and stability, even under varying fluid densities.

For instance, the floats or pontoons used for floating restaurants on the Barito River displace a large volume of water, generating sufficient buoyant force to support the weight of the building along with its occupants and equipment during floods.

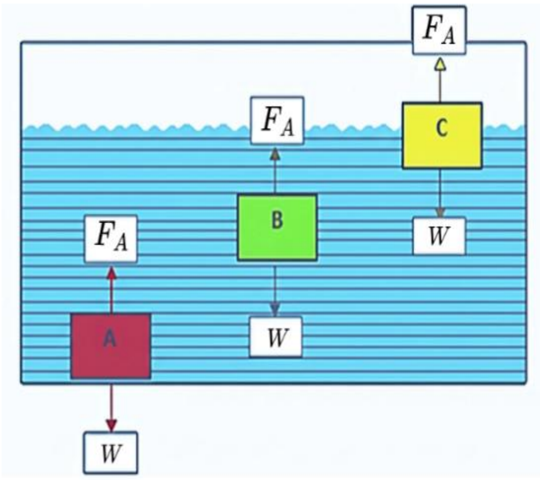

Fig. 1. Conditions of buoyancy: Sinking, neutral buoyancy, rising, and floating [32].

2.3. Science, environment, technology, and society (SETS) with project-based learning (PjBL)

The SETS approach serves as a comprehensive pedagogical framework that integrates scientific content with environmental issues, technological developments, and societal needs [23]. This approach goes beyond mastery of scientific concepts by emphasizing their real-world applications, encouraging students to consider not only the technological utility of science but also its social and environmental consequences [33-37]. Empirical studies have shown that SETS-based e-modules increase student engagement and yield positive learning responses, highlighting the model's relevance in improving science literacy.

Scientific literacy, a core 21st-century competency, requires students to analyse and solve real-life phenomena by connecting scientific knowledge to environmental, technological, and social contexts [38, 39]. The implementation of SETS fosters higher-order thinking skills (HOTS), encouraging students to become critical thinkers and active learners who can relate abstract science concepts to practical societal challenges [40-43]. The model is also grounded in seven key pedagogical principles: constructivism, inquiry, questioning, learning community, modelling, reflection, and authentic assessment [44].

One of the distinctive strengths of SETS lies in its meaningful learning process, which progresses through five sequential stages: (i) identifying contextual societal problems, (ii) forming concepts through exploration and discussion, (iii) applying concepts in daily life, (iv) reinforcing concepts to address misconceptions, and (v) conducting assessments across cognitive, affective, and psychomotor domains [45]. These stages enable students not only to master scientific content but also to develop collaboration, creativity, and social awareness by engaging with real-world problems.

When integrated with PjBL, the SETS approach provides a synergistic learning experience that further enhances students' engagement and understanding. PjBL centres on student-led project design, implementation, and presentation, offering tangible outcomes and authentic learning processes. In this context, Table 3 presents a comparative overview of SETS, PjBL, and their integrated model (SETS-PjBL), emphasizing their individual characteristics and the added value of their combination. The integration empowers students to apply scientific concepts in solving complex problems that are not only technical but also environmental and societal in nature. As a result, this blended approach fosters scientific literacy, innovation, and awareness of community-cantered issues through collaborative, project-driven learning experiences.

2.4. *Kayuh baimbai* character

Local wisdom plays an essential role in shaping educational values and moral development. One notable example from Banjarmasin is the cultural philosophy of *kayuh baimbai*, which originates from the region's rich river-based heritage. Literally meaning "rowing together in harmony," this value symbolizes unity, solidarity, cooperation, and mutual support toward achieving shared goals. Rooted in everyday river life, *kayuh baimbai* reflects a collective mindset that prioritizes teamwork and communal responsibility. It is for this reason that the phrase has been adopted as the official motto of Banjarmasin City [46, 47].

In the context of education, *kayuh baimbai* embodies values that resonate strongly with collaborative learning and character formation. These include respect for others' opinions, commitment to group cohesion, and active participation in shared tasks. Such values align closely with the Pancasila Student Profile, particularly in the dimensions of collaboration (gotong royong), faith in God Almighty, and creativity [24]. Integrating *kayuh baimbai* into classroom instruction not only enhances the relevance of local culture but also reinforces national character values, making learning more holistic and culturally grounded.

Table 4 presents the relationship between *kayuh baimbai* values and the dimensions, elements, and sub-elements of the Pancasila Student Profile. It highlights how this cultural principle supports teamwork, shared communication, spiritual development, and creative expression in alignment with national education goals.

Table 3. Comparison of SETS, PjBL, and their integration.

Aspect	SETS	PjBL	SETS-PjBL integration
Focus	Integrates science, environment, technology, and society to connect learning with real-life contexts	Emphasizes student-cantered projects to solve authentic problems and produce tangible outcomes	Combines the SETS framework with PjBL to apply science concepts through projects addressing real-world social, environmental, and technological issues
Learning approach	Constructivist, inquiry-based, reflective, with authentic assessment	Experiential, problem-solving, collaborative, and iterative through project phases	Inquiry-based, constructivist, and project-oriented; promotes active engagement, critical thinking, and reflection
Student role	Connects science to societal and environmental applications	Designs, implements, and presents projects; collaborates in teams	Applies science in addressing real-world issues through project work; engages in teamwork, creativity, and reflection
Teacher role	Facilitator guiding inquiry and cross-disciplinary connections	Facilitator and mentor during project development	Guides students in integrating SETS principles into project-based activities and supports metacognitive reflection
Learning outcomes	Higher-order thinking, science literacy, environmental and social awareness	Collaboration, creativity, problem-solving, communication, and project management	Science literacy, real-world problem-solving, collaboration, creativity, environmental and social responsibility
Assessment	Authentic assessment of cognitive, affective, and psychomotor domains	Evaluates project quality, process, teamwork, and presentation	Blended assessment model that includes concept mastery, project quality, and integration of SETS principles in student-led projects and team reflection

Table 4. Dimensions, elements, and sub-elements of the Pancasila student profile related to the values of *kayuh baimbai.*

Dimension	Element	Sub-element	Action
Collaboration (gotong royong)	Collaboration	Teamwork	Completing tasks through building teams and managing cooperation to achieve common goals aligned with predetermined targets
	Communication for shared goals	Accepting others' opinions	Actively listening to understand and analyse information, emotions, ideas, and concerns, and using various strategies to reach shared goals
	Social coordination	Maintaining group cohesion	Aligning and sustaining individual and group actions for consistency and accountability in achieving group goals
Faith in God Almighty	Religious morality	Knowing and loving God Almighty	Applying an understanding of divine attributes in personal and social worship practices
Creativity	Producing original works and actions	Contributing ideas or opinions	Exploring and expressing thoughts and feelings in the form of actions or products, while evaluating their impact on self and environment

3. Method

This study employed a quantitative approach using a quasi-experimental posttest-only control group design. The participants consisted of 54 eleventh-grade students from a public senior high school in Banjarmasin. The students were divided into two groups: an experimental class and a control class, each comprising 27 students. The experimental group received instruction through a contextual e-module integrating PjBL and the SETS approach, while the control group was taught using conventional methods. The primary instrument used to collect data was a learning outcome test designed to evaluate the effectiveness of the developed e-module in enhancing students' scientific literacy.

Data analysis was conducted in several stages. First, a normality test was performed using the Shapiro-Wilk test, as the sample size in each group was less than 50. Data are considered normally distributed when the significance value exceeds 0.05 and not normally distributed when the value is less than 0.05. In cases where the assumption of normality was not met, non-parametric statistical procedures were applied to test the hypotheses.

Second, hypothesis testing was carried out by comparing the obtained significance values using the Asymptotic Significance (2-tailed) criterion. A significance value greater than 0.05 indicated acceptance of the null hypothesis (H_0), while a value below 0.05 led to the acceptance of the alternative hypothesis (H_a). The hypotheses formulated for this study were as follows:

(i) H_0: The e-module has no significant effect on students' scientific literacy.

(ii) H_a: The e-module has a significant effect on students' scientific literacy.

Finally, the magnitude of the treatment effect was assessed using Cohen's d. This measure provides an effect size classification to interpret the practical significance of the findings. A Cohen's d value of ≥ 0.80 is considered a large effect, values between 0.50 and 0.79 indicate a medium effect, and values between 0.20 and 0.49 are categorized as a small effect.

4. Results and Discussion

4.1. Overview of findings and cultural-technological adaptation

The improvement in students' scientific literacy regarding fluid mechanics concepts indicates that the integration of the SETS approach with PjBL, supported by *kayuh baimbai* values, is effective in bridging the gap between abstract physics theory and the real-life context of South Kalimantan. This combination promotes contextual learning, encouraging students to engage with content that reflects their cultural and environmental surroundings. The incorporation of Banjar local wisdom into educational design enhances the relevance and authenticity of learning experiences [7]. Furthermore, local values such as *wasaka* and *kayuh baimbai* not only foster community identity but also cultivate students' innovation skills, enabling them to devise practical solutions that benefit local society [48]. As such, the developed module serves not merely as a medium for instruction, but as a transformative tool for preparing students to respond meaningfully to environmental and societal challenges in their communities.

Figure 2 illustrates a prominent cultural-technological adaptation: a floating stall (*warung terapung*) commonly found in riverine communities. This structure applies the concept of buoyancy using pontoons as its stabilizing system. From a physics perspective, the design adheres to Archimedes' Principle, which posits that any object wholly or partially submerged in a fluid experiences a buoyant force equal to the weight of the fluid displaced. In the case of a floating house or stall, airtight pontoons-typically cylindrical or rectangular in shape-are installed beneath the platform. These pontoons displace water, generating an upward buoyant force that allows the structure to remain afloat and stable, even under varying loads.

4.2. Application of fluid principles in local context

In floating house structures, pontoons serve as the primary support systems that enable the house to remain afloat and stable on the water's surface. From a physics standpoint, this design is governed by Archimedes' Principle, which states that any object wholly or partially submerged in a fluid experience an upward buoyant force equal to the weight of the displaced fluid. In practice, pontoons-typically constructed in the form of airtight cylindrical or rectangular blocks-are mounted beneath the structure. When submerged, they displace water, thereby producing an upward buoyant force (F_a) that supports the weight of the structure.

Fig. 2. Illustration of a floating food stall using pontoons as a buoyancy system.

At the same time, the total weight of the house and its contents exert a downward force defined as W = mg. For the house to float stably, the condition $F_a \geq W$ must be satisfied. If $F_a > W$, the structure floats with part of the pontoon above the waterline. If $F_a = W$, the house is in equilibrium, typically with the pontoon partially submerged. However, if $F_a < W$, the pontoon cannot support the load, and the structure will sink. Thus, the design of the pontoons must consider the total mass of the building, occupants, and furnishings to ensure that the submerged volume generates sufficient buoyant force

In addition to force magnitude, the distribution of pontoons also plays a critical role in maintaining stability. Even placement beneath the structure ensures that the centre of buoyancy aligns with the centre of gravity, reducing the risk of tilting. This is comparable to the wide hull design in boats, which promotes balance and structural integrity on water surfaces. Consequently, pontoons function not only as flotation devices but also as stability mechanisms, ensuring safety and habitability in water-based environments.

Another fluid principle applied by students is hydrostatic pressure, which proved especially relevant in the design of stilt houses in flood-prone and swampy regions. Hydrostatic pressure increases with depth and acts in all directions. Its distribution must be carefully analysed in designing house pillars to ensure structural resistance against lateral forces from floodwater [49]. In South Kalimantan, where stilt houses are common, such knowledge bridges fluid mechanics and civil engineering by incorporating scientific reasoning into the selection of materials, depth of embedment, and lateral stability.

Archimedes' Principle also became a focal point in the construction of floating restaurant prototypes. Since buoyant force is proportional to the volume of displaced fluid, students learned to calculate necessary platform dimensions based on total building load and variations in water density. For example, the Barito River (known for its muddy and silt-laden water) has a higher density than clean water. This difference impacts buoyant force and thus affects the structural design of floating platforms. Understanding such variability reinforces the importance of localized knowledge in scientific literacy [48].

Pascal's Law, which explains the uniform transmission of pressure in confined fluids, was applied in student-designed hydraulic jack prototypes. These devices demonstrated how pressure applied at one point in a fluid system is distributed evenly throughout, allowing students to lift model buildings using simple piston mechanisms [50]. The activity linked theoretical understanding with real-world problem-solving, especially for flood mitigation in regions like South Kalimantan.

The principle of capillarity further expanded students' insight into water filtration and distribution. Through this concept, they explored how water moves through narrow pores in soil or fabric via capillary action. Students applied this understanding to design rudimentary filtration systems that could support clean water access during flood events [51]. Such low-cost, community-based solutions illustrate how fluid concepts can be transformed into meaningful technological innovations through the lens of science literacy.

4.3. Alignment: Project-based learning, the science–environment–technology–society approach, and *kayuh baimbai* values

The alignment between scientific literacy competencies, PjBL, the SETS approach, and *kayuh baimbai* values is detailed in Table 5. This framework illustrates how fluid mechanics concepts can be translated into collaborative engineering tasks rooted in cultural context. The integration of *kayuh baimbai* enriches PjBL-SETS instruction by aligning local wisdom (emphasizing cooperation, mutual responsibility, and social coordination) with project-based scientific practices such as inquiry, analysis, and real-world application.

The research was implemented over three meetings, each designed to guide students through the engineering application of static fluid principles. In the first meeting, students were introduced to the essential question: *how can fluid mechanics be used to design flood-resilient structures in river and swamp environments?* This question was grounded in real data from flood-prone areas in South Kalimantan. Students then identified real-world engineering problems, such as building stability under hydrostatic pressure or buoyant force optimization for floating restaurants. This initial phase trained students to explain scientific phenomena while simultaneously approaching fluid mechanics from an applied design perspective.

In the second meeting, students developed technical designs and created digital posters to present their proposed solutions. They translated theoretical knowledge (such as buoyant force calculations and pressure transmission in hydraulic systems) into visual and functional designs. This phase emphasized technical communication and modelling, akin to engineering practice.

In the third meeting, students compiled reports and presented their design outcomes. The reporting process simulated authentic scientific and engineering documentation, reinforcing the integration of theory, data interpretation, and justification of design choices. Students were required to demonstrate not only scientific accuracy but also relevance to local needs and feasibility of implementation.

Table 5. Framework linking science literacy, PjBL, the SETS approach, and *Kayuh Baimbai* values.

Dimension	Science literacy competencies	PjBL syntax	SETS approach	*Kayuh baimbai* values
Explaining phenomena scientifically	Recognize, apply, and evaluate scientific explanations for natural/technological problems	Start with the essential question; design the project	Link science content to environmental and societal issues	Collaboration in designing solutions for shared problems (e.g., stability of swamp houses and floating restaurants)
Evaluating and designing inquiry	Plan and assess investigations; interpret data and evidence critically	Create a schedule; monitor project progress	Integrate technology in designing and testing solutions	Teamwork, coordination, and maintaining group cohesion in collaborative project activities
Interpreting data and evidence	Interpret data in multiple forms and draw conclusions	Assess the outcome	Connect data with local contexts (e.g., water pressure, buoyancy, hydraulic systems)	Communication toward common goals, valuing others' opinions, and social coordination
Using information for decision-making	Evaluate evidence and communicate scientific claims for practical decision-making	Evaluate the experience	Emphasize societal relevance and practical design for riverside communities	*Gotong royong* and shared responsibility in reflecting on results for collective benefit
Knowledge dimension	Static fluid concepts (pressure, buoyancy, Pascal's Law), procedures for modelling and measurement, epistemic skills	Integrated across all six PjBL syntaxes	Real-world relevance through integration of science, environment, technology, and society	Innovation, creativity, and community participation guided by local wisdom

In the third meeting, students compiled reports and presented their design outcomes. The reporting process simulated authentic scientific and engineering documentation, reinforcing the integration of theory, data interpretation, and justification of design choices. Students were required to demonstrate not only scientific accuracy but also relevance to local needs and feasibility of implementation.

To initiate this process, teachers presented the contextual problem of annual floods using real-world media and data. Rather than treating this as a mere trigger, the scenario was framed as a case study in applied fluid mechanics. Students explored scientific-technical questions such as:

(i) Why do structurally sound buildings collapse during floods?

(ii) How does pressure vary with fluid depth and density?

(iii) How can static fluid principles be used to engineer resilient floating structures?

This framing shifted physics learning from abstract computation to real-life engineering simulation. Students assumed the role of problem solvers and innovators, exploring science through the lens of local infrastructural and environmental challenges. Teachers further supported this by raising provocative guiding questions (for example, whether water only wet or also pushes) and by motivating students to think critically and creatively about how fluid principles could lead to functional designs like flood-proof *warung terapung*.

Learning objectives were clearly outlined and aligned with scientific, technological, and cultural dimensions. In the Physics Understanding element, objectives emphasized cooperative learning, application of static fluid principles to real challenges, and development of design ideas for flood-resistant structures. This addressed the science literacy indicator of explaining scientific phenomena and reflected the *kayuh baimbai* values of community collaboration and coordinated action.

In the Process Skills element, objectives focused on producing digital posters that visually communicated problem-solving strategies grounded in fluid mechanics. Science literacy indicators included evaluating investigations and interpreting evidence. Corresponding *kayuh baimbai* values included creativity, open communication, and team-based role distribution.

Finally, students compiled reports and orally presented their work. These activities supported science literacy indicators related to the use of scientific information in decision-making and evaluating design quality. Socially, students practiced cohesion, mutual respect, and public speaking responsibility, embodying the *kayuh baimbai* character values throughout the learning process.

The outcomes demonstrate that the developed PjBL–SETS e-module functioned not only as a tool for improving scientific literacy but also as a technological design platform. It enabled students to:

(i) Apply static fluid principles (e.g., pressure, Pascal's Law, buoyancy) in engineering design,

(ii) Model and interpret data to evaluate feasibility,

(iii) Create innovative and locally relevant solutions for real community needs.

These results affirm that the integration of PjBL and the SETS approach, when reinforced by *kayuh baimbai*, strengthens both scientific reasoning and technological innovation skills essential for solving context-specific societal and environmental problems.

4.4. Assessment instruments and tasks

Table 6 demonstrates how each stage of the PjBL syntax corresponds directly to specific science literacy indicators. This alignment reinforces the pedagogical strength of PjBL as a structured instructional model that integrates conceptual understanding with real-life application. Beyond building knowledge, the model cultivates 21st-century competencies such as critical thinking, communication, collaboration, and problem-solving.

Table 6. Relationship between project-based learning syntax and science literacy indicators.

PjBL Syntax	Description of learning activities	Science literacy indicators
Start with the essential question	The teacher introduces contextual problems (e.g., flood-prone floating restaurants). Students identify challenges and explore facts.	Explaining scientific phenomena through recognition, generation, and application of explanations and solutions.
Design a plan for the project	Students work collaboratively to design solutions applying static fluid principles.	Designing and evaluating scientific investigations and applying knowledge in practical contexts.
Create a schedule	Teams outline timelines for investigation, data collection, and poster/report development.	Organizing the application of scientific information systematically for decision-making and planning.
Monitor project progress	Teachers guide and monitor discussion and task progress (e.g., poster drafts, hydraulic prototype ideas).	Interpreting data and evidence, and refining strategies through feedback.
Assess the outcome	Students present digital posters or physical prototypes with fluid mechanics solutions.	Communicating scientific ideas and evaluating real-world benefits of science applications.
Evaluate the experience	Teams reflect on collaboration, processes, and outcomes of learning activities.	Investigating and evaluating the use of science for decision-making and real-life actions.

To evaluate the impact of the PjBL–SETS e-module integrated with *Kayuh Baimbai* values, a set of assessment instruments was developed, aligned to specific scientific literacy indicators. Table 7 summarizes the sample test items and their targeted competencies. These instruments assess more than content recall; they are designed to measure students' ability to apply scientific knowledge to contextual problems related to static fluids, simulating real-world engineering challenges in flood-prone environments.

To verify the effectiveness of the treatment, normality and significance testing were conducted. Table 8 presents the Shapiro-Wilk test results. The data for the experimental class were normally distributed ($p = 0.111$), whereas the control class data were not ($p = 0.001$). This difference necessitated the use of non-parametric analysis.

Subsequently, the Mann-Whitney U test was employed to determine the significance of differences in posttest performance (Table 9). The test yielded a U value of 25.000 and a p-value of 0.000, indicating a statistically significant difference between the experimental and control groups. This result supports the conclusion that the intervention had a meaningful impact on students' scientific literacy.

Table 7. Scientific literacy instruments and static fluid applications.

Scientific Literacy Indicator	Question
Explaining scientific phenomena	Apply the concept of hydrostatic pressure to explain how fluid depth and density affect pressure at the base of a floating restaurant (use data from 1–3 m depths).
Explaining scientific phenomena	Evaluate the claim: "All restaurants float safely on rivers if placed on large plastic drums." Is this true? Justify with scientific reasoning.
Designing and evaluating scientific inquiry	Propose a safer floating restaurant design using fluid pressure data and Archimedes' Principle.
Designing inquiry & interpreting data	Based on Pascal's Law, calculate the force on a large piston if 80 N is applied to a small piston (A_1 = 5 cm², A_2 = 100 cm²). Can this lift a 1200 N structure?
Using science for decision-making	Design a flood-resistant restaurant with an automatic hydraulic lift system. Explain its real-world advantages and limitations.

Table 8. Normality test of students' posttest data (Shapiro–Wilk).

Class	Statistic	df	Sig.	Conclusion
Experimental	0.938	27	0.111	Normally distributed
Control	0.832	27	0.001	Not normally distributed

Table 9. Mann–Whitney u test results.

Test Statistics	Value	Conclusion
Mann-Whitney U	25.000	H_0 rejected, H_a accepted
Asymp. Sig. (2-tailed)	0.000	Significant difference between the two groups

The implications of these findings are substantial. The experimental class (exposed to contextual and project-based learning enriched with cultural values) achieved higher conceptual mastery and demonstrated greater ability to translate static fluid equations into design calculations. The N-gain in the experimental group reached 0.72 (high category), while the control group scored 0.49 (moderate). This further reinforces the notion that meaningful science learning occurs when abstract principles are embedded in culturally relevant, community-driven problem-solving contexts.

4.5. Process skills and communication outcomes

To measure students' process skills, the study assessed their ability to produce informative digital posters, compiled structured reports, and presented findings effectively. Table 10 presents the achievement scores for these objectives in the experimental class. The data show that students performed in the high category across all process indicators. These results confirm that the integration of technological design tasks within the PjBL-SETS framework successfully nurtured students' scientific communication, teamwork, and reflective reporting skills, essential components of 21st-century science education.

Table 10. Achievement of learning objectives in process skills (experimental class).

Learning objective	Score	Category
Create an informative and attractive digital poster based on static fluid principles	100	High
Compile a simple, clear, and structured report (worksheet) describing the poster-making process	76	High
Communicate the results of the digital poster in an informative and engaging manner	100	High
Average	**92**	**High**

4.6. Scientific literacy achievement

Further statistical analysis was conducted using an independent sample t-test to determine differences between the experimental and control classes. As shown in Table 11, the significance value was less than 0.05, indicating a statistically significant difference in scientific literacy scores. Students in the experimental group outperformed their peers, especially in the domain of explaining scientific phenomena and applying scientific information in decision-making.

This result suggests that engaging students in engineering-oriented problem-solving, such as designing floating restaurants, not only strengthens conceptual mastery but also enhances their ability to transfer knowledge into real-world contexts.

Table 11. Learning achievement results on the aspect of scientific literacy indicators.

No.	Scientific Literacy Indicator	Control	Category	Exp.	Category
1	Explaining phenomena scientifically	34	Medium	73.7	High
2	Designing and evaluating investigations, interpreting data and scientific evidence critically	39.2	Medium	58.1	Medium
3	Using scientific information for decision-making and action	12.4	Low	56.9	Medium
	Average	**28.5**	**Low**	**62.9**	**Medium**

Note: Exp = Experimental.

These findings provide several important insights:

(i) Scientific Literacy Enhancement-Students demonstrated the ability to explain real-world flood phenomena using hydrostatic pressure, Pascal's Law, and Archimedes' Principle, which are foundational for applied fluid mechanics in engineering.

(ii) Technological Application-Learners successfully translated equations into design specifications, such as calculating pontoon volume and material requirements to ensure buoyant stability.

(iii) Societal Relevance-Framing tasks around flood mitigation in South Kalimantan connected abstract science to urgent community needs, showcasing the role of physics in disaster resilience.

(iv) Cultural Integration-*Kayuh Baimbai* values reinforced collaborative planning and implementation, aligning indigenous cultural practices with modern engineering design methodologies.

Altogether, these findings validate the function of the PjBL–SETS e-module as not only an instructional resource but also a platform for scientific-technological innovation grounded in local wisdom and environmental responsiveness.

4.7. Contextual case assessment: Floating restaurants

Table 12 outlines an assessment item that contextualizes the application of Archimedes' Principle within the phenomenon of floating restaurants on the Banjarmasin River. This case-based evaluation enabled students to analyse real conditions, assess claims critically, and propose engineering solutions based on static fluid principles.

Table 12. Assessment of floating restaurant context based on static fluid concepts.

Component	Content
Context	Along the banks of the Banjarmasin River, floating restaurants are built on rafts supported by plastic drums that act as flotation devices. According to Archimedes' Law, these drums generate a buoyant force equal to the weight of the displaced water. However, some floating restaurants nearly sink due to incorrect estimation of weight and buoyant capacity. Understanding density, volume, and buoyant force is therefore crucial in the design of stable floating structures.
Learning objective	Students are able to develop solution ideas based on static fluid concepts in the context of designing a flood-resistant restaurant.
Science literacy dimension	Explaining Scientific Phenomena
Assessment item	**Cognitive Level: C6** Evaluate the following claim: "All restaurants can float safely on the river as long as they are placed on large plastic drums." After evaluating, design a safer floating restaurant idea based on static fluid concepts.
Answer key	**Claim Evaluation**: The statement is not always true; flotation depends on balancing the building's total weight with the buoyant force. Drums must be large and durable, placed symmetrically to ensure balance. River conditions (depth, current) must also be considered. **Design Idea**: Use multiple large drums placed evenly under the platform. Select lightweight, durable materials. Elevate the structure above the water surface. Add anchors or ropes. Ensure all drums are watertight and regularly inspected to prevent sinking.

This assessment measures students' abilities to connect abstract scientific principles to tangible community problems. By engaging with culturally relevant cases, learners were encouraged to apply their scientific reasoning at higher cognitive levels (C6), particularly in designing practical, safe, and sustainable structures. The integration of local context, engineering relevance, and scientific accuracy ensures that science learning extends beyond classrooms, into community-oriented innovation and resilience-building.

4.8. Scientific literacy indicator analysis

This study measured students' scientific literacy through achievement scores based on three core indicators drawn from the scientific literacy framework. The assessment was conducted using post-test results from both the experimental class, taught using a PjBL module integrated with *kayuh baimbai* values and the SETS approach, and the control class, which received conventional instruction. The learning outcomes for each indicator were analysed to evaluate the effectiveness of the developed e-module in fostering students' scientific literacy competencies. These results are reflected in Table 10.

According to the data, the control class attained an overall average score of 28.5, categorized as low, whereas the experimental class scored 62.9, categorized as medium. On the first indicator, explaining scientific phenomena, the control group reached a medium-level score of 34, while the experimental group showed a substantial improvement with a score of 73.7, categorized as high. These findings indicate that students exposed to the e-module were better able to connect fluid statics principles with real-world flooding scenarios. Their responses typically demonstrated a coherent understanding of the relationship among fluid depth, density, and hydrostatic pressure, supported by logical and quantitative explanations.

For the second indicator, designing and evaluating scientific investigations and interpreting evidence critically, the control group scored 39.2 (medium), while the experimental group achieved 58.1 (also medium). Although the experimental class outperformed the control, the achievement level remained moderate. This outcome suggests that while the PjBL strategy fostered improvement, students' higher-order scientific reasoning was not yet fully optimized. Since the project output emphasized the creation of digital posters rather than direct experimentation, opportunities for engaging in authentic investigative processes and critical data interpretation were limited. Nonetheless, several students proposed innovative solutions-such as the use of hydraulic jacks or pontoons for flood-resistant floating restaurants-demonstrating the potential of contextual project work to cultivate design-based thinking.

Figure 3 illustrates the application of Archimedes' Principle in the design of floating structures. It includes a conceptual diagram showing the interaction between buoyant force and gravitational weight, and a real-life representation of a house supported by pontoons on a river. This figure reflects students' understanding of the principle as applied to the stabilization of floating architecture.

The third indicator, *investigating, evaluating, and using scientific information for decision-making and action*, recorded the lowest achievement across both groups. The control class scored only 12.4 (low), while the experimental group improved to 56.9 (medium). This aligns with teacher observations that decision-making and reflective thinking remain among the most challenging areas for students. Despite the use of PjBL to encourage independent thinking, many students still preferred to follow structured instructions rather than critically evaluate new information. Nevertheless, a subset of the experimental class showed promise by applying Pascal's Law in their hydraulic design proposals, highlighting the potential of contextual learning to strengthen practical decision-making when scaffolded with scientific reasoning.

Overall, these findings support the conclusion that integrating scientific concepts with technological design in a culturally rooted, project-based framework significantly enhances scientific literacy. The PjBL–SETS e-module effectively bridged theoretical knowledge with real-world application, helping students not only to comprehend static fluid principles but also to utilize them in addressing community-relevant environmental issues such as flooding. This pedagogical model aligns physics instruction with the broader goals of education for sustainable development and local resilience building.

(a) (b)

Fig. 3. Application of Archimedes' principle in floating structures: (a) Diagram of buoyant force and weight acting on the floating house, and (b) Floating house supported by pontoons on the river.

4.9. Relevance to sustainable development goals (SDGs)

The findings and framework of this study are directly aligned with several targets of the United Nations SDGs, especially in the domains of education, innovation, community resilience, and environmental sustainability. The integration of the SETS approach, PjBL, and *kayuh baimbai* values supports multiple SDGs in the following ways:

(i) SDG 4: Quality Education. By promoting scientific literacy, critical thinking, and culturally responsive pedagogy, the developed e-module advances inclusive and equitable quality education. Students are empowered to apply physics concepts to solve authentic problems, making learning more meaningful and relevant to their lives.

(ii) SDG 9: Industry, Innovation, and Infrastructure. Through engineering-oriented tasks such as designing floating structures, students are introduced to innovation in infrastructure adapted to flood-prone regions. This nurtures creativity and problem-solving as foundational skills for future STEM careers.

(iii) SDG 11: Sustainable Cities and Communities. The contextual learning activities address the urgent need for flood-resilient infrastructure in South Kalimantan. Students contribute ideas that could inform local adaptation strategies, reflecting the goal of building inclusive, safe, and sustainable communities.

(iv) SDG 13: Climate Action. As climate change intensifies flood risks, this study encourages students to engage in climate-responsive design thinking. By applying fluid statics to mitigate disaster impacts, the project instils environmental awareness and a proactive attitude toward local climate adaptation.

(v) SDG 17: Partnerships for the Goals. The integration of local cultural values (*Kayuh* Baimbai) into science education exemplifies a localized partnership model between indigenous knowledge and global education goals. It promotes cooperation across domains-science, culture, education, and community development.

In sum, the developed PjBL–SETS module serves as a practical educational intervention that not only enhances academic outcomes but also cultivates a generation of learners equipped to contribute to sustainable development. By embedding SDG principles into physics education, this study offers a scalable model for linking classroom instruction to global and local challenges in a meaningful, contextualized manner. This study adds new information regarding SDGs, as reported elsewhere (Table 13).

Table 13. Previous studies on SDGs.

No.	Title	Ref.
1	Sustainable development goals (SDGs) in engineering education: Definitions, research trends, bibliometric insights, and strategic approaches	[52]
2	Sustainable packaging: Bioplastics as a low-carbon future step for the SDGs	[53]
3	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting SDGs	[54]
4	HIRADC for workplace safety in manufacturing: A risk-control framework and bibliometric review to support SDGs	[55]
5	Techno-economic analysis of production ecobrick from plastic waste to support SDGs	[56]
6	Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia’s green tourism policy and the SDGs	[57]
7	Definition and role of sustainable materials in reaching global SDGs completed with bibliometric analysis	[58]
8	Bibliometric insight into materials research trends and innovation to support SDGs	[59]
9	Physical adaptation of college students in high-altitude training to support SDGs	[60]
10	Enhancing job satisfaction through HRIS and communication: A commitment-based approach to SDGs	[61]
11	Enhancing innovative thinking through theory-based instructional model to support SDGs	[62]

Table 13 (Continue). Previous studies on SDGs.

No.	Title	Ref.
12	Influence of self-efficacy on affective learning outcomes in social studies education toward achieving SDGs	[63]
13	Enhancing occupational identity and self-efficacy through self-education in art/design aligned with SDGs	[64]
14	Integrating generative AI-based multimodal learning in education to enhance literacy aligned with SDGs	[65]
15	Dataset on Sulawesi schools and cultural implications to support SDGs	[66]
16	Enhancing professional readiness in vocational education aligned with SDGs	[67]
17	School feeding program and SDGs in education: Linking food security to learning outcomes	[68]
18	Influence of eco-friendly packaging on consumer interest to meet SDGs	[69]
19	SDG 12 implementation through lemon commodities and waste reduction	[70]
20	Mediterranean diet patterns and sustainability to support SDGs	[71]
21	Education on food diversification through infographic to improve SDGs	[73]
22	Safe food treatment technology to achieve SDG zero hunger and optimal health	[73]
23	Student awareness of sustainable diet and carbon footprint reduction to support SDGs 2030	[74]

5. Conclusion

This study concludes that integrating the SETS approach with PjBL and *Kayuh Baimbai* values significantly enhances students' scientific literacy in the context of static fluid concepts. The developed e-module effectively bridged theoretical knowledge with real-world flood-related challenges in South Kalimantan, enabling students to explain scientific phenomena, evaluate investigations, and apply scientific reasoning in technological design. Beyond improving academic performance, the module fostered cultural relevance, engineering innovation, and collaborative problem-solving, demonstrating that localized, contextual, and project-driven learning can support sustainable science education and community-based resilience.

Acknowledgment

We thank Universitas Lambung Mangkurat, which funded this research through a competitive grant with contract number 1886/UN8.2/PG/2025.

References

1. Hidayah, N.; Rusilowati, A.; and Masturi, M. (2019). Analisis profil kemampuan literasi sains siswa SMP/MTs di Kabupaten Pati. *Phenomenon*: *Jurnal Pendidikan MIPA*, 9(1), 36-47.
2. Hardinata, A.; Simanjuntak, M.P.; Djulia, E.; Purba, S.K.; Siregar, K.J.; and Lubis, G.D.U. (2023). Level of scientific literacy ability of middle school

students in Medan based on framework PISA 2018. *Indonesian Science Education Research*, 5(2), 251-263.

3. Ichsan, I.; Suharyat, Y.; Santosa, T.A.; and Satria, E. (2023). Effectiveness of STEM-based learning in teaching 21st century skills in Generation Z students in science learning: A meta-analysis. *Jurnal Penelitian Pendidikan IPA*, 9(1), 150-166.
4. Santosa, T.A.; Suhaimi, S.; and Aprilsia, S. (2022). Analisis Pendekatan Saintifik dalam Pembelajaran IPA selama Pandemi Covid-19 di Sekolah Dasar. *Jurnal Didika*: *Wahana Ilmiah Pendidikan Dasar*, 8(1), 92-101.
5. Suryati, S.; Surningsih; and Mashami, R.A. (2022). Pengembangan e-modul interaktif reaksi redoks dan elektrokimia berbasis nature of science untuk penumbuhan literasi sains siswa. *Reflection Journal*, 2(1), 26-33.
6. Jufrida, J.; Basuki, F.R.; Pangestu, M.D.; and Prasetya, N.A.D. (2019). Analisis faktor yang mempengaruhi hasil belajar IPA dan literasi sains di SMP Negeri 1 Muaro Jambi. *EduFisika*: *Jurnal Pendidikan Fisika*, 4(2), 31-38.
7. Agustin, S.; Asrizal, A.; and Festiyed, F. (2021). Analisis effect size pengaruh bahan ajar IPA bermuatan literasi sains terhadap hasil belajar siswa SMP/MTs. *Jurnal IPA dan Pembelajaran IPA*, 5(2), 125-137.
8. Ibrahim, I.M.; Suryadi, K.; Darmawan, C.; and Nurbayani, S. (2024). Examining climate change issues for improving cross-generation awareness in 21st century agenda: A bibliometric approach. *ASEAN Journal for Science Education*, 3(2), 173-182.
9. Pratiwi, D.T.; Zahratunnisa, F.; and Rahmawan, S. (2025). The impact of project-based learning (PjBL) on students' motivation and learning outcomes: A literature review. *ASEAN Journal for Science Education*, 4(1), 53-58.
10. Sutanto, K.I.H.; Muktiarni, M.; and Mupita, J. (2022). Utilization of YouTube videos during online learning to increase literacy in English for middle school students. *ASEAN Journal of Educational Research and Technology*, 1(1), 47-52.
11. Muliawati, E.S.; and Maryanti, R. (2022). Lyrics of kawih tanah sunda by koko koswara as a media for learning cultural literacy for students in junior high school. *ASEAN Journal of Educational Research and Technology*, 1(2), 133-138.
12. Anjani, A.I.; and Maryanti, R. (2023). Implementation of the school literacy movement before teaching and learning activities at middle school. *ASEAN Journal of Educational Research and Technology*, 2(2), 75-84.
13. Theron, J.; Richardo, E.; Sutedjo, M.; and Syarifudin, M. (2024). Efforts to improve young generation problem solving in the era of globalization using six thinking hats analyzed with SPSS: Solving literacy, read, and hoax. *ASEAN Journal of Educational Research and Technology*, 3(2), 171-176.
14. Nurjamin, A.; Nurjamin, L.R.; Fajriah, Y.N.; Nurjamin, A.K.; and Firdaus, H.A. (2026). Integrating generative artificial intelligence (AI)-based multimodal learning in education to enhance literacy aligned with Sustainable Development Goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(1), 71-88.
15. Putra, R.D.; and Sakti, A.W. (2022). Student development: Implementation of water rocket media as a project-based learning tool to improve the literacy of junior high school students during the pandemic. *ASEAN Journal for Science Education*, 1(1), 1-8.

16. Arciosa, R.M.; Perfecio, J.; and Cerado, E.C. (2022). Community extension: Literacy and numeracy enhancement program for alternative learning system and out-of-school youth learners. *ASEAN Journal for Science Education*, 1(2), 75-80.
17. Hidayat, A.Z.; and Nandiyanto, A.B.D. (2022). Socialization of digital literacy in compiling a balanced healthy menu to members of POKJA III the PKK Movement Team of Purwakarta Regency. *ASEAN Journal of Community Service and Education*, 1(1), 77-82.
18. Faddillah, R.N.; Nandiyanto, A.B.D.; and Bilad, M.R. (2022). Literacy program for elementary school students about inclusive education in recognizing children with special needs. *ASEAN Journal of Community and Special Needs Education*, 1(1), 1-8.
19. Fitri, S.D.; Muktiarni, M.; and Mupita, J. (2022). Strengthening literacy in children with special needs during courageous learning with family support in learning during a pandemic. *ASEAN Journal of Community and Special Needs Education*, 1(1), 29-36.
20. Hartini, S.; Khairiyah, N.; Wati, M.; Dewantara, D.; Zainuddin, Z.; Ismail, I.; Saehana, S.; and Abdul Rahman, N.F.A. (2024). Student's science literacy skill through implementation of integrating teaching modules with SETS approach on renewable energy topics. *Journal of Engineering Science and Technology*, 19(5), 1693-1715.
21. Khotimah, H.; and Suhirman, R. (2020). Pengaruh model pembelajaran project based learning terhadap kreatifitas berpikir dan literasi sains siswa SMAN 1 gerung tahun 2018/2019. *Spin*, 2(1), 13-26.
22. Melindayani, S. (2022). Pengaruh model pembelajaran berbasis proyek terhadap kemampuan literasi sains materi IPA siswa kelas V SD Telkom Makassar. *Jurnal Handayani*, 13(1), 1-13.
23. Siagian, G.; Santosa, T.A.; Festiyed, F.; and Yerimadesi, Y. (2023). The effect of ethnoscience-based science environment technology society (SETS) learning model in learning physics and biology. *Jurnal Ilmiah Pendidikan Fisika*, 7(2), 342.
24. Hasani, N.L.; Hartini, S.; and An'nur, S. (2019). Meningkatkan keterampilan proses sains dan karakter kayuh baimbai. *Jurnal Ilmiah Pendidikan Fisika*, 3(2), 65-76.
25. Dewantari, N.; and Singgih, S. (2020). Penerapan literasi sains dalam pembelajaran IPA. *Indonesian Journal of Natural Science Education*, 3(2), 366-371.
26. Laugksch, R.C. (2000). Scientific literacy: A conceptual overview. *Science Education*, 84(1), 71-94.
27. Wardhana, S.; Nabilah, S.; Dewitasari, A.P.; and Hidayah, R. (2022). E-modul interaktif berbasis nature of science (NoS) perkembangan teori atom guna meningkatkan level kognitif literasi sains peserta didik. *UNESA Journal of Chemical Education*, 11(1), 34-43.
28. Ramli, M.; Susanti, B.H.; and Yohana, M.P. (2022). Indonesian students' scientific literacy in Islamic junior high school. *International Journal of STEM Education for Sustainability*, 2(1), 53-65.

29. Muzijah, R.; Wati, M.; and Mahtari, S. (2020). Pengembangan e-modul menggunakan aplikasi Exe-Learning untuk melatih literasi sains. *Jurnal Ilmiah Pendidikan Fisika*, 4(2), 89.
30. Khikmah, N.L.; and Susantini, E. (2019). Kelayakan lembar kegiatan peserta didik (LKPD) literasi sains pada materi sistem pencernaan untuk melatihkan keterampilan berpikir kritis peserta didik. *BioEdu*: *Berkala Ilmiah Pendidikan Biologi*, 8(3), 112-119.
31. Suparya, I.K.; Suastra, I.W.; and Arnyana, I.B. (2022). Rendahnya literasi sains: Faktor penyebab dan alternatif solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, 9(1), 153-166.
32. Mutmainah, I. (2016). Rancang bangun perangkat eksperimen hukum archimedes untuk MTs LB/A Yaketunis kelas VIII. *Jurnal Pendidikan Inklusi*, 3(2), 237-251.
33. Dewantara, D.; Wati, M.; Hartini, S.; Haryandi, S.; Fajariah, I.; Syifa, N.A.; and Fitri, M.R. (2024). Analysis of item response theory in science literacy assessment containing local wisdom and Pancasila student profile. *Tarbiyah*: *Jurnal Ilmiah Kependidikan*, 13(2), 229-243.
34. Ardianti, S.D.; Susilo, S.; and Kurniasih, D. (2020). Effectiveness of digital heat teaching materials based on science, environment, technology, society (SETS) to improve science literacy of junior high school students. *Journal of Innovative Science Education*, 9(1), 13-20.
35. Setiawan, A.; Nuryani, N.; and Hidayat, T. (2019). Application of LKS vision of science, environment, technology, and society (SETS) in science learning to improve students' scientific literacy of MTs. *Journal of Innovative Science Education*, 8(1), 60-67.
36. Mawaddah, R.; Susanti, R.; and Rahmawati, E. (2022). The development of e-worksheet based on SETS (science, environment, technology, and society) to improve students' scientific literacy skills. *BioEdu*: *Journal of Biology Education*, 11(3), 489-497.
37. Brownell, S.E.; and Tanner, K.D. (2023). Developing science literacy in students and society: Theory, research, and practice. *Journal of Microbiology & Biology Education*, 24(2), 1-9.
38. Kapici, H.O.; and Costu, F. (2023). Investigating the effects of different laboratory environments on gifted students' conceptual knowledge and science process skills. *Turkish Journal of Education*, 12(2), 94-105.
39. Ozer, S.; Kiray, S.A.; and Cardak, O. (2021). Science teacher candidates' views about science-technology-society-environment relations. *Eurasian Journal of Educational Research*, 2021(91), 83-104.
40. Çınar, S.; and Çepni, S. (2021). The impact of science teaching based on Science-Technology-Society (STS) approach to elementary school students. *Educational Policy Analysis and Strategic Research*, 16(4), 198-217.
41. Acut, D.; and Antonio, R. (2023). Effectiveness of Science-Technology-Society (STS) approach on students' learning outcomes in science education: Evidence from a meta-analysis. *Journal of Technology and Science Education*, 13(3), 1-23.
42. Susilowati, E.; and Widyastuti, I. (2022). Meta-analysis: The effectiveness of using socio-scientific issues on science literacy and students' higher-order

thinking ability in science learning. *Jurnal Pendidikan IPA Indonesia*, 11(4), 529-546.

43. Witdiya, T.; Supriadi, G.; Supriatin, A.; and Annovasho, J. (2023). The effect of STEAM learning on improving each indicator of students' creative thinking in physics learning. *Jurnal Ilmiah Pendidikan Fisika*, 7(1), 42.
44. Zahro, M. (2019). Pendekatan pembelajaran kontekstual: Teori dan praktik. *Jurnal Pendidikan dan Pembelajaran*, 26(2), 123-135.
45. Azzahra, A.; Sunaryo; and Budi, E. (2022). Pengembangan e-modul interaktif berbasis pendekatan SETS (science, environment, technology, and society) menggunakan program Lectora Inspire pada materi sumber energi terbarukan kelas XII SMA. *Jurnal Pendidikan Sains dan Teknologi*, 10(1), 73-80.
46. Trisna, B.N. (2019). Pendidikan 4.0: Perubahan paradigma dan penguatan kearifan lokal dalam pembelajaran matematika. *Math Didactic*: *Jurnal Pendidikan Matematika*, 5(1), 83-92.
47. Lismawati. (2022). Representasi kearifan lokal dan filosofi dalam syair lagu Banjar. *Jurnal Pendidikan dan Pembelajaran*, 6(2), 123-135.
48. Surawardi, S.; and Zuhriah, F. (2023). Aspek sosial pendidikan dalam kearifan lokal budaya kayuh baimbai di Kalimantan Selatan. *Al-Falah*: *Jurnal Ilmiah Keislaman dan Kemasyarakatan*, 23(1), 43-53.
49. Zhou, Z.; Yang, H.; Wang, X.C.; and Zhang, Q.F. (2016). Fractured rock mass hydraulic fracturing under hydrodynamic and hydrostatic pressure joint action. *Journal of Central South University*, 23(10), 2695-2704.
50. Maryanti, R.; Hufad, A.; Sunardi, S.; and Nandiyanto, A.B.D. (2022). Teaching on Pascal's Law: The use of experimental videos of hydraulic concepts from everyday products in the learning process for students with special needs and vocational school students. *Journal of Engineering Education Transformations,* 35(Special Issue 2), 96-101.
51. Zhao, Z.; Luo, Z.; Sun, H.; Li, H.; Liu, Q.; and Liu, H. (2023). Capillary rise in layered soils. *Applied Sciences*, 13(6), 3374.
52. Ragadhita, R.; Fiandini, M.; Al Husaeni, D.N.; and Nandiyanto, A.B.D. (2026). Sustainable development goals (SDGs) in engineering education: Definitions, research trends, bibliometric insights, and strategic approaches. *Indonesian Journal of Science and Technology*, 11(1), 1-26.
53. Basnur, J.; Putra, M.F.F.; Jayusman, S.V.A.; and Zulhilmi, Z. (2024). Sustainable packaging: Bioplastics as a low-carbon future step for the sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, 3(1), 51-58.
54. Sesrita, A.; Adri, H.T.; Suherman, I.; Rasmitadila, R.; and Fanani, M.Z. (2025). Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis. *ASEAN Journal for Science and Engineering in Materials*, 4(2), 245-266.
55. Henny, H.; Budi, A.H.S.; Andriyansyah, M.; Ar Rozzak, M.R.; Baru, M.M.; and Masek, A. (2025). Hazard identification, risk assessment, and determining control (HIRADC) for workplace safety in manufacturing industry: A risk-control framework complete with bibliometric literature review analysis to

support sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, 4(2), 267-284.

56. Syahrudin, D.; Roestamy, M.; Fauziah, R.S.P.; Rahmawati, R.; Pratidina, G.; Purnamasari, I.; Muhtar, S.; and Salbiah, E. (2026). Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, 5(1), 9-16.
57. Apriliani, A.; Waahyudin, C.; Ramdani, F.T.; Martin, A.Y.; Syahrudin, D.; Hernawan, D.; and Salbiah, E. (2026). Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, 5(1), 17-36.
58. Ragadhita, R.; Nandiyanto, A.B.D.; Farobie, O.; Kurniawan, T.; and Bilad, M.R. (2026). Definition and role of sustainable materials in reaching global sustainable development goals (SDGs) completed with bibliometric analysis. *ASEAN Journal for Science and Engineering in Materials*, 5(1), 53-100.
59. Al-Obaidi, A.S.M. (2026). The Journal of Engineering, Science and Technology (JESTEC): A bibliometric insight into materials research trends and innovation to support sustainable development goals (SDGs). *ASEAN Journal for Science and Engineering in Materials*, 5(1), 101-122.
60. Xing, G.; Chano, J.; Thadanatthaphak, Y.; and Wu, C.C. (2025). Physical adaptation of college students in high-altitude training: Empirical findings and curriculum development insights to support sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(2), 215-236.
61. Imaniyati, N.; Ratnasari, C.D.; and Adman, A. (2025). Enhancing job satisfaction through human resource information systems and communication: A commitment-based approach to achieve sustainable development goals (SDGs) in education-oriented organizations. *ASEAN Journal of Educational Research and Technology*, 4(2), 237-254.
62. Di, R.; Sawangboon, T.; and Chano, J. (2025). Enhancing innovative thinking through a theory-based instructional model in design education to support sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(3), 311-332.
63. Wiyanarti, E.; and Nurjannah, A.N. (2026). Influence of self-efficacy on affective learning outcomes in social studies education toward achieving sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(1), 1-18.
64. Yu, X.; Chano, J.; and Wongsaphan, M. (2026). Enhancing occupational identity and self-efficacy through a self-education model in art and design education aligned with sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(1), 19-46.
65. Nurjamin, A.; Nurjamin, L.R.; Fajriah, Y.N.; Nurjamin, A.K.; and Firdaus, H.A. (2026). Integrating generative artificial intelligence (AI)-based multimodal learning in education to enhance literacy aligned with sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(1), 71-88.

66. Abduh, A.; Achmad, S.F.; Syam, C.; Samad, S.; Arham, M.; Mustafa, M.; and Pandang, A. (2026). Dataset on the number of schools, teachers, and students in Sulawesi, Indonesia: Kindergarten, primary, junior, senior high, vocational, and Islamic boarding schools with educational access, quality, and cultural implications to solve challenges and strategies in education management and support sustainable development goals (SDGs). *ASEAN Journal of Educational Research and Technology*, 4(1), 89-116.
67. Khamdamovna, K.S. (2025). Enhancing professional readiness in vocational education through an integrative approach aligned with the sustainable development goals (SDGs). *ASEAN Journal for Science Education*, 4(2), 143-154.
68. Ximenes, S.M. (2025). School feeding program and sustainable development goals (SDGs) in education: Linking food security to learning outcomes in Timor-Leste. *ASEAN Journal for Science Education*, 4(2), 155-168.
69. Haq, M.R.I.; Nurhaliza, D.V.; Rahmat, L.N.; and Ruchiat, R.N.A. (2024). The influence of environmentally friendly packaging on consumer interest in implementing zero waste in the food industry to meet sustainable development goals (SDGs) needs. *ASEAN Journal of Economic and Economic Education*, 3(2), 111-116.
70. Maulana, I.; Asran, M.A.; and Ash-Habi, R.M. (2023). Implementation of sustainable development goals (SDGs) no. 12: Responsible production and consumption by optimizing lemon commodities and community empowerment to reduce household waste. *ASEAN Journal of Community Service and Education*, 2(2), 141-146.
71. Nurnabila, A.T.; Basnur, J.; Rismayani, R.; Ramadhani, S.; and Zulhilmi, Z. (2023). Analysis of the application of mediterranean diet patterns on sustainability to support the achievement of sustainable development goals (SDGs): Zero hunger, good health and well beings, responsible consumption, and production. *ASEAN Journal of Agricultural and Food Engineering*, 2(2), 105-112.
72. Awalussillmi, I.; Febriyana, K.R.; Padilah, N.; and Saadah, N.A. (2023). Efforts to improve sustainable development goals (SDGs) through education on diversification of food using infographic: Animal and vegetable protein. *ASEAN Journal of Agriculture and Food Engineering*, 2(2), 113-120.
73. Rahmah, F.A.; Nurlaela, N.; Anugrah, R.; and Putri, Y.A.R. (2024). Safe food treatment technology: The key to realizing the sustainable development goals (SDGs) zero hunger and optimal health. *ASEAN Journal of Agricultural and Food Engineering*, 3(1), 57-66.
74. Keisyafa, A.; Sunarya, D.N.; Aghniya, S.M.; and Maula, S.P. (2024). Analysis of student's awareness of sustainable diet in reducing carbon footprint to support sustainable development goals (SDGs) 2030. *ASEAN Journal of Agricultural and Food Engineering*, 3(1), 67-74.