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Development of a PjBL-Based Science Project Teaching Module on the Material of Living Things and Their Environment to Improve Students' Scientific Literacy State Vocational School 1 Modoinding

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Abstract

This study aims to develop a Project Based Learning (PjBL) based Science Project module on the subject of living things and their environment that meets the criteria of validity, practicality, and effectiveness and is able to improve students' scientific literacy. This study is a research and development (R&D) using the ADDIE model which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The study was conducted at SMK Negeri 1 Modoinding. The results of the study indicate that the PjBL-based Science Project module developed meets the criteria of very validity based on the assessment of material experts and media experts. The module also received positive responses from teachers and students so that it is included in the category of very practical for use in learning. In addition, the application of the module is able to support the implementation of project-based learning well and contribute to improving students' scientific literacy. In conclusion, the PjBL-based Science Project module on the subject of living things and their environment developed through the ADDIE model is suitable for use in learning because it meets the criteria of validity, practicality, and effectiveness and can improve students' scientific literacy.

1. INTRODUCTION

1.1. Background of the Problem

The Natural and Social Sciences (IPAS) Project subject in the Independent Curriculum is designed to provide more meaningful learning experiences through project-based activities relevant to students' lives. Learning focuses not only on mastering concepts but also on the ability to conduct investigations, think critically, collaborate, and demonstrate environmental awareness.

The local context of Living Things and their environment is an important aspect in the Science Project learning because it can strengthen students' connection with Living Things and the environment around Modoinding, as a center for horticultural agriculture in North Sulawesi.

Organic waste generated from agricultural activities has great potential as a contextual learning resource. Students can learn about the interactions of living things, the role of decomposers, the material cycle, and how waste can be processed into something more useful.

Based on initial observations in the odd semester of the 2025/2026 academic year, the Science Project learning process at SMK Negeri 1 Modoinding has not fully utilized its environmental potential. The project modules used are still general and do not incorporate local issues such as horticultural vegetable waste as part of the learning activities. However, the use of local contexts has been proven to improve conceptual understanding and build students' scientific literacy. Harisna and Sutarto (2020) stated that an environment-based learning approach significantly improves scientific literacy skills and student engagement in the learning process.

Scientific literacy is an essential 21st-century competency that requires students to understand scientific concepts. Scientific literacy encompasses not only mastery of ecological knowledge but also the ability to think critically, interpret data, and make decisions based on scientific evidence.

Developing project modules is one solution for providing more structured, directed, and contextual learning. A good module can guide students in conducting investigations, collecting data, analyzing information, and solving environmental problems, both independently and in groups. Project-based learning also provides opportunities for students to produce work that has real value for the surrounding environment.

Recent studies suggest that project-based learning with an environmental context can significantly improve students' scientific literacy. A study by Rusly, Toge, and Tualeka (2025) reported that the implementation of a project-based learning model that raised coastal environmental issues succeeded in significantly improving students' scientific literacy skills through their involvement in projects relevant to the surrounding environment. This evidence strengthens the point that project modules developed with local contexts such as horticultural vegetable waste have great potential in building the scientific literacy of students at SMK 1 Modoinding.

Based on the learning needs of the school and previous research findings, developing a project module integrated with the local context of Modoinding is crucial. This module is expected to help students engage in project-based learning while developing a deeper understanding of ecological concepts. Furthermore, this module is expected to improve students' scientific literacy through real-life, collaborative, and life-relevant activities.and them.

1.2 Problem Identification

Based on the research background, several problems can be identified as follows:

1. The Science Project Learning on the material Living Things and Their Environment at SMK Negeri 1 Modoinding has not fully

utilized the potential of the surrounding environment as a contextual learning resource.
2. The abundant horticultural vegetable waste available in the school and community environment has not been optimally utilized as a learning medium in the Science Project.
3. The teaching materials used in science project learning are still limited and do not yet take the form of project modules that are arranged systematically.
4. The IPAS Project Module that integrates ecological concepts with organic waste management activities is not yet available and has not been developed in a planned manner.
5. The ongoing Science Project learning has not optimally supported the improvement of students' scientific literacy.
6. The level of feasibility of the IPAS Project module, both in terms of validity, practicality, and effectiveness, has never been tested empirically.

1.3 Problem Definition

In order for the research to be more focused and in-depth, this research is limited to the following:

1. The research focused on developing a Science Project module on the subject of Living Things and Their Environment by utilizing horticultural vegetable waste as a learning context.
2. The research is limited to testing the feasibility of the module, which includes aspects of validity, practicality, and effectiveness of the module developed.
3. The research was limited to measuring the scientific literacy of class X students of SMK Negeri 1 Modoinding after participating in learning using the developed Science Project module.

1.4 Problem Formulation

Based on the problem limitations, the problem formulation in this research is:

1. How is the development of the Science Project module on the material Living Things and Their Environment by utilizing horticultural vegetable waste using the ADDIE model?
2. What is the level of validity, practicality, and effectiveness of the developed IPAS Project module?
3. Can the use of the developed Science Project module improve the scientific literacy of class X students at SMK Negeri 1 Modoinding?

1.5 Research Objectives

In accordance with the problem formulation above, the objectives of this research are:

1. Developing a Science Project module on the subject of Living Things and Their Environment by utilizing horticultural vegetable waste using the ADDIE model.
2. Measuring the level of validity, practicality, and effectiveness of the developed IPAS Project module.
3. Improving the scientific literacy of class X students of SMK Negeri 1 Modoinding through the use of the developed Science Project module.

2. LITERATURE REVIEW

2.1 Science and Technology Project Subjects in the Independent Curriculum

The Natural and Social Sciences (IPAS) Project subject is one of the innovations in the Independent Curriculum designed to provide cross-disciplinary learning experiences through project-oriented activities. The Independent Curriculum emphasizes that students need to be given the opportunity to “learn through direct experience so that they are able to connect knowledge to real life” (Kemendikbudristek, 2025). Thus, the IPAS Project becomes a forum for strengthening 21st-century skills while facilitating more contextual and meaningful learning.

At the vocational high school level, the topic of Living Things and Their Environment is

a key theme in the Science Project. This theme encompasses the concepts of ecosystems, biodiversity, interactions between living things, material cycles, and contemporary environmental issues such as waste management and ecological sustainability. This learning provides students with the opportunity to think scientifically and solve problems related to their surroundings.

2.2 Living Things and Their Environment

The subject of Living Things and Their Environment encompasses an understanding of the reciprocal relationship between organisms and their environment. Ecology, as a scientific field, emphasizes the importance of balance within ecosystems. Krebs (2014) states that "ecology is the scientific study of the interactions that determine the distribution and abundance of organisms." This statement emphasizes that the interactions of living things are at the heart of ecology, including the processes of decomposition, energy flow, and material recycling within ecosystems.

In the context of learning at SMK Negeri 1 Modoinding, ecology material is highly relevant because students live in a horticultural agricultural area. This allows them to directly observe how vegetable waste plays a role in the decomposition process and how it affects soil quality and the surrounding ecosystem.

2.3 Horticultural Vegetable Waste in the Context of Learning

Horticultural crops grow and thrive in Modoinding District, leading to its designation as an agropolitan development area. Various horticultural commodities have been marketed regionally, nationally, and internationally, significantly increasing community income and welfare, while also positively impacting efforts to increase regional revenue (Lihiang, Sasinggala, and Butarbutar, 2022).

Horticultural vegetable waste is the remaining harvested produce or unused plant parts, such as wilted leaves, stems, outer cabbage, damaged vegetables, or vegetables that do not meet market standards. In horticultural centers, this waste can reach significant amounts daily. If not managed properly, this waste has the potential to cause environmental problems such as unpleasant odors, increased fly populations, and methane gas production from anaerobic decomposition.

Vegetable waste also holds significant potential as a contextual learning material. Numerous studies have shown that organic waste management can be a means of developing students' scientific literacy. Furthermore, horticultural plants have the appropriate texture and nutrient content for composting, making them suitable for use in project activities to observe the decomposition process, the role of microorganisms, and the transformation of matter. Using local waste allows students to see the direct results of waste processing activities and recognize the importance of environmentally friendly practices in their daily lives.

2.4 Project Based Learning (PjBL)

*Project-Based Learning*is a learning approach where students acquire knowledge and skills by working on collaborative projects with fellow group members under the guidance and direction of teachers and involving complex questions, problem solving, and tangible results (Pontoh, et al., 2024). According to Restika Wijayanti (2025), PjBL is a learning approach that emphasizes the active involvement of students through real projects that are relevant to everyday life.

PjBL syntax is a systematic step in implementing project-based learning. Based on research fromMuhibbullah, Alviani, Natasya, Rahmadini, and Trilisiana (2024), PjBL syntax includes several stages, namely: 1. Determining Basic Questions, 2: Creating a Project Design, 3: Preparing a Project Implementation Schedule, 4: Monitoring Project Implementation Progress, 5: Assessment of Results, 6: Evaluation of the Project and Project Results

The PjBL model has several key characteristics: student-centered learning, project-based learning, real-world or contextual problem-based learning, investigation and exploration, product creation, and collaboration among students. These characteristics demonstrate that PjBL is not only outcome-oriented but also a meaningful and authentic learning process (Wijayanti, 2025).

Some of the advantages of the PjBL model include increasing student engagement and motivation, developing critical thinking and problem-solving skills, enhancing creativity and collaboration, helping students understand concepts more deeply, and connecting learning to real life. Research shows that the implementation of PjBL can significantly improve students' learning outcomes and critical thinking skills.(Selasmawati and Lidyasari, 2023). Reflecting on students' experiences in completing a project and finding new breakthroughs to create better and more efficient innovations. Furthermore, the use of appropriate and good teaching materials in the form of Student Worksheets (LKPD) with a PjBL model greatly supports the learning process, thereby improving student learning outcomes (Surya et al., 2024).

Despite its many advantages, PjBL also has several limitations, including requiring a relatively longer time, careful planning, not all students are active in groups, requiring teacher preparedness in managing learning, and relatively complex learning evaluation. Furthermore, PjBL implementation often faces obstacles in project planning and classroom management if not supported by proper preparation (Muhibbullah, Alviani, Natasya, Rahmadini, and Trilisiana, 2024).

2.5 Teaching Modules in Science Learning

A teaching module is a systematically and independently compiled instructional material oriented toward achieving specific competencies. A good module must meet the appropriateness of content, presentation, language, and design. In the context of the Independent Curriculum, modules contain not only material but also exploration activities, reflection, formative assessment, and learning products.

Modules are an important tool to support project-based learning because they can guide the steps, facilitate scientific investigations, and provide space for recording findings. In the context of this research, the developed teaching module will integrate ecological theory with horticultural vegetable waste processing activities, providing students with a contextual learning experience.

2.6 ADDIE Development Model

The ADDIE model is a learning development model consisting of five main stages: analysis, design, development, implementation, and evaluation. Each stage in this model is interrelated and can be repeated to produce optimal learning products. The analysis stage is carried out to identify learning needs, student characteristics, and problems that occur in the field. The design stage focuses on designing the module structure, learning objectives, and learning strategies to be used. The development stage is the process of creating learning products according to the predetermined design. Next, the implementation stage is carried out by testing the product on students, and the final stage, evaluation, aims to assess the product's quality and make necessary improvements.

The ADDIE model is widely used in the development of learning media and modules because it provides systematic guidance and allows for revisions at each stage of development (Silitonga, Hastuti, Thohiri, and Pulungan, 2022). The application of the ADDIE model in learning has been proven to increase learning effectiveness because each stage is designed to ensure a match between student needs and the product being developed.

2.7 Scientific Literacy

Scientific literacy is an individual's ability to understand scientific concepts and use that knowledge to explain phenomena, solve problems, and make decisions related to everyday life. Scientific literacy focuses not only on conceptual mastery but also encompasses critical thinking skills, data interpretation, and the application of science in real-world contexts.

Scientific literacy is a crucial competency in learning because it plays a role in shaping students who are capable of facing various global challenges based on science and technology. This aligns with findings that scientific literacy is a key indicator of 21st-century skills and is a focus of international assessments such as PISA (Ariani, D., Isnaeni, W., Djuniadi, Ani Rusilowati, A., and Sukaesih, S., 2025).

The scientific literacy indicators in this study refer to the scientific literacy framework developed in the context of international

assessment and science education research, which includes:

1. Scientific knowledge
   The ability to understand scientific concepts, principles, and facts related to living things and their environment.
2. Scientific competence
   The ability to explain scientific phenomena, design investigations, and interpret scientific data and evidence.
3. Context of science applications (science in context)
   The ability to relate scientific concepts to real problems in everyday life.
4. Scientific attitude
   Attitude of caring for the environment, curiosity, and responsibility in the use of scientific knowledge.

Scientific literacy is also closely related to students' critical thinking skills, where increasing scientific literacy contributes significantly to analytical and evaluation skills in science learning (Risahadi and Akbar, 2024).Scientific literacy encompasses students' ability to understand, analyze, and apply scientific concepts in real-life contexts, including ecological issues related to living things and the environment. Improving scientific literacy in learning this material enables students not only to master ecological knowledge but also to think critically scientifically and make evidence-based decisions relevant to their environmental challenges, such as pollution and ecosystem change. Research by Fajarwati, Windayani, and Susilawati (2025) shows a positive relationship between scientific literacy and students' critical thinking skills and self-awareness in learning about environmental pollution, so that scientific literacy plays an important role in shaping scientific attitudes and students' readiness to face the environmental challenges of the 21st century.

2.8 Relevance of Horticultural Waste in Science and Technology Projects

Utilizing horticultural waste in the Science and Environmental Sciences (IPAS) project supports contextual learning that aligns with the characteristics of the Modoinding area. This waste can be processed into compost, liquid organic fertilizer, or simple research materials. Activities such as measuring the compost temperature, observing microorganisms, or monitoring physical changes in the waste can be part of the IPAS project.

The project-based learning model that uses waste as a learning medium has been proven to be effective in increasing students' scientific literacy, especially in the aspects of scientific thinking skills and conceptual understanding, as shown by Sulastri, Siska, Widya, Muliani, and Setiawan (2025) in research on the influence of the Project Based Learning model on organic waste processing projects on scientific literacy.

2.9 Relevant Research

Various empirical studies have shown that the use of learning modules based on environmental issues and local contexts can improve students' scientific literacy, including conceptual understanding and scientific thinking skills. Research by Putri, Hariyadi, and Mudakir (2023) reported that the development of a STEM-based learning module on environmental pollution significantly improved students' scientific literacy and critical thinking skills through their active involvement in contextual projects addressing environmental issues. Furthermore, Ardithayasa, Gading, and Widiana (2022) also found that Project-Based Learning (PjBL)-based learning modules were effective in improving students' scientific literacy and problem-solving skills in plant growth, which is relevant to understanding the relationship between living things and their environment.Research by Afifah, Agustina, Sukmawardani, and Kurniati (2025) stated that the implementation of PjBL based on real contexts such as material processing activities or environmental phenomena has been proven to be able to improve students' understanding of concepts and scientific literacy skills.Thus, this empirical evidence strengthens that a project-based learning approach that includes environmental issues or contexts can significantly improve students' scientific literacy skills.

2.10 Framework of Thinking

The framework of thinking in this study begins with the problem of low scientific literacy

of students and the suboptimal learning of the Science Project, encouraging the need to develop contextual learning modules. The Science Project module was developed by utilizing horticultural vegetable waste through the ADDIE model. The developed module was then tested for validity, practicality, and effectiveness. Modules that meet these three criteria are expected to be able to improve the scientific literacy of class X students of SMK Negeri 1 Modoinding. The framework of thinking in this study can be seen in the following figure.

Figure 2.1 Thinking Framework Chart

3. Research Methods

3.1 Type and Design of Research

This research is research and development (R&D) which uses the ADDIE model as a module development framework.

The experimental design used isA pre-experimental study using a One Group Pretest–Posttest Design, a research design involving one group of subjects who are given treatment and measured before and after the treatment. This design is used to determine changes in student abilities after using the developed module. The research design pattern is described as follows:

O1 X O2

Information:

- O1 : pretest (initial test)
- X : treatment (learning using the IPAS Project module)
- O2 : posttest (final test)

3.2 Research Procedures Using the ADDIE Model

1) Analysis

This stage includes: analysis of student needs, analysis of the Grade X Science Project curriculum, identification of learning problems, analysis of student characteristics at SMK Negeri 1 Modoinding, and analysis of the local context in the form of horticultural vegetable waste.

Needs analysis is carried out through teacher interviews, classroom observations, and review of learning documents.

2) Design

Activities at this stage include: preparing the module structure, selecting material on Living Things and Their Environment, designing project activities based on horticultural waste, preparing validation instruments, practicality, and scientific literacy tests, determining indicators and learning flows.

3) Development

This stage includes: preparation of a complete module draft, development of project activities, internal revision, expert validation (materials, learning media), validity calculations, limited trials on 9 students to see the understanding of the module flow, language suitability, and completeness of project activities.

Feedback from validators and students in the limited trial phase was used to revise the module before the field test.

4) Implementation (Field Test)

The module was implemented in the experimental class to measure effectiveness. Activities at this stage included: implementing the project according to the module, observing the module's implementation, administering pretests and posttests, and documenting the learning process.

5) Evaluation

Evaluation consists of formative evaluation (each ADDIE stage) and summative evaluation (validity, practicality, and effectiveness test results). At this stage, final revisions are made to produce a ready-to-use module.

3.3 Location and Time of Research

The research was conducted at SMK Negeri 1 Modoinding, South Minahasa Regency, North Sulawesi.

The research period took place in the even semester of the 2025/2026 academic year, covering all stages of ADDIE up to the field test.

3.4 Subjects and Sampling Techniques

1) Research Subjects

- Subjects in the limited trial stage: 9 class X students.
- Subjects in the field test stage: 20 class X students.

2) Sampling Technique

The sampling technique used purposive sampling, namely class selection based on the considerations of science teachers and similarities in class characteristics (Fraenkel, Wallen, and Hyun, 2018).

3.5 Data Types and Data Sources

1. Module Validity Data → comes from expert validator assessments.
2. Module Practicality Data → comes from teacher and student responses.
3. Module Effectiveness Data → comes from the science literacy pretest and posttest.
4. Project Observation Data → results of monitoring module implementation.
5. Context Data → results of observations and studies of school documents.

3.6 Data Collection Techniques

1) Module Validity
   Collected through validation sheet expert (learning materials and media).
2) Practicality of the Module
   Obtained through teacher and student response questionnaires after limited trials and field tests.
3) Module Effectiveness
   Measured using a science literacy test given before and after learning.

3.7 Research Instruments

The research instruments used in developing this teaching module were systematically developed, adhering to the principles of validity, practicality, and effectiveness, which are indicators of the quality of a learning product. The instruments used included validation sheets from subject matter and media experts, questionnaires on teacher and student practicality, observation sheets on learning implementation, and a scientific literacy test. The instruments were developed based on the research objectives, the characteristics of the Project-Based Learning (PjBL) model, and the scientific literacy indicators being measured.

The development of instruments in this study refers to scientific literacy indicators which include: (1) the ability to explain scientific phenomena, (2) the ability to design and evaluate scientific investigations, (3) the ability to interpret scientific data and evidence, (4) the ability to relate science to real life contexts, and (5) scientific attitude towards the environment.

The instruments used in this study consist of:

1. Expert and Media Validation Instruments

Validation instruments were used to assess the module's suitability in terms of learning materials and media. Validation was conducted by material experts and media experts.

a. Material Expert Validation Instrument

This instrument is used to assess the suitability of the material content with learning outcomes, conceptual accuracy, material depth, and relevance to the PjBL model.

In addition, this instrument has been developed by adding aspects of scientific literacy which include: The ability of the material to facilitate students to explain scientific phenomena, the ability of the material to encourage students to design scientific investigations, the ability of the material to train students to interpret data, the relevance of the material to real-life contexts, the strength of scientific attitudes and environmental awareness.

Assessment uses a 1–4 Likert scale.

b. Media Expert Validation Instrument

This instrument is used to assess aspects of appearance, readability, presentation, interactivity, and technical quality of the media.

This instrument was also developed by including indicators of scientific literacy, namely: Media supports understanding of scientific phenomena through visualization, media facilitates data analysis (tables/graphs), media encourages critical

thinking skills, media raises contextual issues based on the environment

2. Practicality Questionnaire

The practicality questionnaire was used to determine the ease of use of the module by teachers and students in the learning process.

a. Teacher Practicality Questionnaire

This instrument covers aspects of ease of use, timeliness, learning implementation, usefulness, and usability of the module.

To support the measurement of scientific literacy, this questionnaire also includes: The module's ability to help students explain scientific phenomena, the module's ability to facilitate investigative activities, the module's ability to train project data analysis, and the module's ability to improve students' critical thinking.

b. Student Practicality Questionnaire

This instrument is used to determine students' responses to the use of modules in learning.

The aspects of scientific literacy that are measured include: Students' ability to understand and explain environmental problems, the ability to conduct experiments or scientific activities, the ability to read and understand observational data, and increasing concern for the environment.

3. Learning Implementation Observation Instrument

Observation instruments are used to observe the implementation of Project-Based Learning (PjBL)-based learning during the learning process.

Observations are carried out based on the PjBL syntax which includes: Determining basic questions, project planning, scheduling, project implementation and monitoring, testing results and evaluating experience.

In addition, this observation instrument also integrates scientific literacy indicators, namely: Students' ability to explain scientific phenomena, students' ability to design and carry out investigations, students' ability to collect and analyze data, and students' ability to draw conclusions based on scientific evidence.

4. Science Literacy Test Instrument

The test instrument was used to measure the level of scientific literacy of students before and after learning using the Science Project module.

The tests used are pretest and posttest in the form of multiple choice questions which are arranged based on scientific literacy indicators.

The test grid includes: Explaining scientific phenomena, evaluating and designing scientific investigations, interpreting scientific data and evidence, and relating science concepts to real-life contexts.

The test instrument was designed based on the material "Living Things and Their Environment" with the context of processing organic waste into liquid organic fertilizer (POC).

3.8 Data Analysis Techniques

3.8.1 Module Validity Analysis

Validity is calculated using the formula:

$$PK=\frac{SP}{ST}\ x\ 100\%$$

with:

- PK = percentage of validity,
- SP = score obtained,
- ST = Total score.

If a teaching module has a validity level of more than 70%, then the teaching module can be declared valid, if more than 85% meets the criteria for very valid (Zakiyah, Maimunah, and Suanto, 2024).

3.8.2 Analysis of Module Practicality

Practicality is analyzed using descriptive statistical techniques in the form of percentages:

$$Kepraktisan\ (\%)=\frac{Skor\ diperoleh}{Skor\ maksimum}\ x\ 100\%$$

Practicality categories according to Riduwan in Rahmadina (2023):

- 80–100%: very practical
- 60–80%: practical
- 40–60%: quite practical
- 20-40%: less practical
- 0-20%: not practical

3.8.3 Module Effectiveness Analysis (N-Gain)

The effectiveness of the module is measured using Normalized Gain (N-Gain):

$$N\text{-}Gain = \frac{(posttest\text{-}pretest)}{(100\text{-}pretest)}$$

Gain categories (Hake, 1999):

- $g \geq 0.70 \rightarrow$ high
- $0.30 \leq g < 0.70 \rightarrow$ moderate
- $g < 0.30 \rightarrow$ low

4. Results and Discussion

4.1 Research Results

This research is a development research (Research and Development) that aims to produce a Science Project module based on Project Based Learning (PjBL) on the material of Living Things and Their Environment to improve the scientific literacy of class X students of SMK Negeri 1 Modoinding. The development model used in this research is the ADDIE model which consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

The product developed is a Science Project teaching module that utilizes the local context of horticultural vegetable waste as a contextual learning resource. The module was developed to help students understand ecological concepts, organic waste processing, and hone their scientific literacy skills through a project activity involving the production of liquid organic fertilizer (POC).

4.2 Module Development Stages Using the ADDIE Model

4.2.1 Analysis Stage (Analysis)

The analysis stage was carried out to identify learning needs, student characteristics, school conditions, and problems that occurred in the Science Project learning at SMK Negeri 1 Modoinding.

Based on initial observations and interviews with teachers, it was found that the Science Project learning on the topic of Living Things and Their Environment still does not fully utilize the surrounding environment as a contextual learning resource. Learning tends to use general teaching materials and does not integrate the local potential of the Modoinding area, which is known as a horticultural agricultural area. Furthermore, students still experience difficulties in understanding ecological concepts in depth because the learning is more theory-oriented. Scientific investigation activities and real-life projects are also still limited, so students' scientific literacy skills have not developed optimally.

The results of the needs analysis show that students require teaching materials that are: Contextual to everyday life; Encourage active student involvement; Include scientific experiments and investigations; Support project-based learning; and Help students understand real-world environmental problems.

Based on the analysis, the researchers developed a PjBL-based Science and Technology Project module utilizing horticultural vegetable waste as a learning context. The vegetable waste context was chosen because it is closely related to the lives of students in Modoinding. Organic waste from daily agricultural production is used as the main ingredient in a liquid organic fertilizer (POC) production project. Through this activity, students not only learn ecological concepts but also learn to conduct scientific investigations, collect data, analyze observations, and draw evidence-based conclusions.

4.2.2 Design Stage (Designing)

The design stage involves drafting a teaching module based on the results of the needs analysis. At this stage, researchers begin to determine the module structure, learning design, project activities, teaching materials, student worksheets (LKPD), assessments, and scientific literacy indicators to be developed.

The module is designed using the Project Based Learning (PjBL) model which consists of the following stages: 1. Determining basic questions; 2. Designing project planning; 3. Preparing a project schedule; 4. Monitoring project implementation; 5. Testing project results; and 6. Evaluating learning experiences.

The material developed is focused on the topic of Living Things and Their Environment with the main activity being a project to make liquid organic fertilizer from horticultural vegetable waste.

The module structure consists of: 1. Module identity; 2. Learning outcomes; 3. Learning objectives; 4. Meaningful understanding; 5. Leading questions; 6. Teaching materials; 7. Learning steps; 8. Student worksheet; 9. Assessment instruments; and 10. Learning reflection.

At this stage, researchers also developed scientific literacy indicators that were integrated into each learning activity, namely: 1. Explaining scientific phenomena; 2. Designing scientific investigations; 3. Collecting and interpreting scientific data; 4. Connecting scientific concepts with environmental contexts; and .5. Drawing evidence-based conclusions.

In addition to the teaching module, researchers also designed LKPD which guides students in carrying out project activities in stages, starting from identifying problems to preparing project results reports.

4.2.3 Development Stage

The development stage is carried out by compiling a complete module product based on the design that has been made. The resulting products include: 1. Science Project teaching module; 2. Teaching materials; 3. Project-based student worksheets; 4. Expert validation instruments; 5. Learning observation instruments; 6. Teacher and student practicality questionnaires; and 7. Pre-test and post-test questions.

After the product has been developed, the module is validated by material experts and media experts to determine the level of product feasibility before being tested in the field.

4.3 Product Validation Results

4.3.1 Results of Material Expert Validation

Validation by material experts was conducted to assess the suitability of the module content, conceptual accuracy, material depth, relevance to the PjBL model, and integration of scientific literacy. The expert who validated the material was Prof. Dr. Herry Sumampouw, M.Pd., a Professor in the Biology Department of FMIPAK UNIMA. Based on the validation results, the module obtained a total score of 83 out of a maximum score of 88 with a percentage of 94.32%. These results indicate that the module is in the “Very Valid” category.

The results of the material expert assessment can be seen in the following table.

Table 4.1 Results of Material Expert Validation

Assessment Aspects	Score	Maximum Score
Material Suitability	15	16
Truth and Depth of Matter	14	16
Material Updates	11	12
Presentation of Material	12	12
Compliance with PjBL	12	12
Science Literacy	19	20
Total	83	88

The percentage of material expert validation is calculated using the formula:

Percentage = (Score obtained / Maximum score) × 100%

Percentage = (83/88) × 100%

Percentage = 94.32%

The validation results show that the module is very appropriate to the learning outcomes of the Science Project and is able to integrate scientific literacy indicators in real learning activities.

The material experts provided several suggestions for improvement, including: 1. Improving the formulation of learning objectives according to suggestions; 2. Question language; and 3. Drawing conclusions towards HOTS.

Although there are still some parts that need to be improved, overall the module is declared suitable for use with revisions.

4.3.2 Media Expert Validation Results

Media expert validation was conducted to assess the quality of the module's display, readability, media presentation, interactivity, technical quality, and support for scientific literacy. The expert who conducted the media validation was Prof. Dr. Meike Paat, M.Pd as a Professor of the Biology Department of FMIPAK

UNIMA. Based on the validation results, the module obtained a total score of 77 out of a maximum score of 88 with a percentage of 87.50%. These results indicate that the module is included in the "Very Valid" category.

Table 4.2 Media Expert Validation Results

Assessment Aspects	Score	Maximum Score
Visual Display	14	16
Legibility	12	12
Media Presentation	11	12
Interactivity	10	12
Appropriateness to Learning	11	12
Technical Quality	6	8
Science Literacy Support	13	16
Total	77	88

The media expert validation percentage is calculated as follows:

Percentage = (77/88) × 100%

Percentage = 87.50%

The assessment results show that the module has an attractive, systematic, easy-to-understand appearance and is able to support project-based learning.

Media experts also provided several suggestions for improvement, namely: 1. The font size in certain sections needs to be reduced; 2. The background image should be adjusted so that it does not interfere with the visualization of the main text; and 3. Certain sections of the text do not need to be marked with striking colors.

Based on the validation results of material experts and media experts, the module was declared valid and suitable for use in learning.

4.4 Implementation Stage

The implementation stage was carried out through limited trials and field trials in class X of SMK Negeri 1 Modoinding.

The trial was conducted to determine: 1. The practicality of the module; 23. The implementation of learning; 3. The response of teachers and students; and 4. The effectiveness of the module in improving scientific literacy.

4.4.1 Results of Teacher Practicality Test

The practicality of the module by teachers was assessed using a questionnaire consisting of several aspects, namely: 1. Ease of use; 2. Timeliness; 3. Implementation of learning; 4. Usefulness; 5. Usability; and 6. Scientific literacy.

Based on the results of the teacher questionnaire, most aspects received high scores. Teachers assessed that the module was easy to use in learning and able to support the implementation of project-based learning. In terms of scientific literacy, both teachers gave the maximum score for the module's ability to help students explain environmental phenomena, conduct investigations, and analyze project data. However, teachers still gave lower scores for the aspects of timeliness and flexibility of module use. This is because project-based learning requires a relatively longer time than regular learning. In general, the results of the teacher assessments showed that the module was in the "Very Practical" category with an average practicality percentage of 90.48%.

4.4.2 Results of Student Practicality Test in Limited Trial

A limited trial was conducted on nine students to determine their initial response to the module. The questionnaire results showed an average practicality percentage of 89.71%, categorized as "Very Practical."

Students stated that: 1. The module was easy to understand; 2. The project activities were interesting to do; 3. The student worksheets helped them understand the work steps; 4. Learning was more active and not boring; and 5. The project activities made them understand environmental issues better.

In terms of scientific literacy, students responded positively to observation, data analysis, and conclusion-making activities. However, some students still experienced difficulties analyzing observation results and drawing data-based conclusions.

4.4.3 Results of Student Practicality Test in Field Trial

After revisions based on the results of a limited trial, the module was then tested on a field scale involving 20 students. The results of the field trial showed an average practicality percentage of 91.47%, categorized as "Very Practical." Most students responded positively to the use of the module. Students felt that project-based learning made them more active, easier to understand the material, and more motivated to learn. The aspects with the highest scores were the indicators of scientific literacy and student involvement in project activities. This indicates that the module is able to encourage students to carry out scientific activities directly. In addition, students also appeared more enthusiastic when conducting experiments making liquid organic fertilizer because the activity was directly related to their surrounding environment.

4.5 Results of Observations on Learning Implementation

Learning observations were conducted to determine the implementation of the PjBL model and student activities during the learning process. Observations were conducted by two observers using learning observation instruments. The results showed that all stages of project-based learning were implemented well. In the introductory activities, the teacher was able to open the lesson effectively, conduct apperception, convey learning objectives, and relate the material to real life situations.

In the core activities, the teacher successfully implemented Project Based Learning syntax, starting from determining fundamental questions to evaluating learning experiences. Students were seen actively during the project activities. They worked together in groups, carried out practices according to procedures, collected observational data, and discussed project results. Observers also assessed that indicators of scientific literacy had emerged in the learning process. Students were able to: Explain environmental problems; Design experimental steps; Collect data systematically; Analyze observational results; and Draw conclusions based on data.

However, some groups still found students experiencing difficulties analyzing data and developing solutions to challenges encountered during the project. Overall, the learning process was categorized as very good.

4.6 Module Effectiveness Results

The effectiveness of the module was measured through pre-test and post-test results to determine the improvement in students' scientific literacy after using the PjBL-based Science Project module. Twenty students took the test. The pre-test and post-test results are shown in the following table.

Table 4.3 Results of Students' Pre-test and Post-test

No	Information	Mark
1	Total pre-test scores	765
2	Pre-test average	38.25
3	Total post-test scores	1610
4	Post-test average	80.50
5	Minimum Competency (KKM)	70

The data shows that the average student score increased significantly after using the module. The average pre-test score of 38.25 indicated that students' initial scientific literacy skills were still low. After participating in the project-based module, the average post-test score increased to 80.50, exceeding the minimum competency criteria (KKM) of 70.

To determine the level of improvement in student learning outcomes more accurately, researchers calculated the N-Gain value according to the formula used in Chapter III.

The N-Gain formula used is:

$$N\text{-}Gain = \frac{(posttest\text{-}pretest)}{(100\text{-}pretest)}$$

The effectiveness of using the module in overall learning in the class can be determined by calculating the average N-Gain value, by adding up all the N-Gain scores from 20 students and

dividing it by 20. Based on the pre-test and post-test data, the total N-Gain score for all students is14.13. If this number is divided by 20, the average N-Gain value will be 0.71 which isin the high category. These results indicate that the Project-Based Learning (PBL) Science Project module is highly effective in improving students' scientific literacy. This improvement in learning outcomes occurs because students not only receive theoretical material but also engage directly in scientific investigations through a liquid organic fertilizer production project.
Through these activities, students learn to: 1. Identify environmental problems; 2. Conduct direct observations; 3. Collect experimental data; 4. Analyze changes that occur during fermentation; and 5. Draw conclusions based on observational data.

In addition to improving grades, changes were also evident in student learning activities. During the lesson, students appeared more active in asking questions, discussing, making observations, and connecting science concepts to environmental issues around them.

Thus, it can be concluded that the PjBL-based Science Project module developed is effective for use in learning to improve the scientific literacy skills of class X students at SMK Negeri 1 Modoinding.

4.7 Evaluation Stage

The evaluation stage is carried out at each stage of module development. The evaluation aims to correct product deficiencies so that the resulting module is more suitable for use. Several revisions made based on the results of expert validation and trials include: 1. Improvement of the formulation of learning objectives according to suggestions; 2. Question language; 3. Drawing conclusions towards HOTS; 4. The font size in certain sections needs to be reduced; 5. Setting the background image so as not to interfere with the visualization of the main text; and 7. Certain sections of the text do not need to be marked with striking colors.

The revision was made so that the module would be easier to understand, more interesting, and more effective for use in learning.

4.2 Discussion

4.2.1 Development of PjBL-Based Science and Technology Project Modules

This research successfully developed a Project Based Learning (PBL) Science Project module on the subject of Living Things and Their Environment by utilizing horticultural vegetable waste as a learning context. The module development was carried out using the ADDIE model consisting of the stages of analysis, design, development, implementation, and evaluation. The use of the ADDIE model helps researchers develop products systematically and directed. The developed module is designed to provide a contextual learning experience through project activities for making liquid organic fertilizer. Learning not only emphasizes mastery of concepts, but also the ability of students to conduct scientific investigations and solve environmental problems.

The research results show that the use of local context has a positive influence on student engagement in learning. Students appear to understand the material more easily because the problems studied are directly related to their daily lives. This finding aligns with the opinion of the Ministry of Education, Culture, Research, and Technology (2022), which states that learning in the Independent Curriculum needs to provide contextual and meaningful learning experiences. Furthermore, the use of horticultural waste as a learning resource also supports real-life ecological learning. Students can directly observe the process of organic material decomposition, physical changes during fermentation, and the relationship between waste management and the environment. This aligns with Krebs' (2014) opinion, which emphasizes that ecology studies the relationship between organisms and their environment.

4.2.2 Validity of the IPAS Project Module

The validation results from the material experts were 94.32%, and the validation results from the media experts were 87.50%. Both results indicate that the module is in the very valid category.
The high validation value indicates that the module has fulfilled the following aspects: 1.

Suitability of the material; 2. Conceptual accuracy; 3. Learning presentation; 4. Suitability with PjBL syntax; 5. Media readability; and 6. Integration of scientific literacy.

The module was also deemed capable of facilitating project-based learning activities through investigation, observation, data collection, and analysis of experimental results. In terms of scientific literacy, the module scored very high because scientific literacy indicators were integrated into every stage of the learning process. Students are not only asked to understand the theory, but are also trained to: 1. Identify environmental problems; 2. Formulate hypotheses; 3. Conduct experiments; 4. Collect data; 5. Analyze observation results; and 6. Draw evidence-based conclusions.

The results of this study support previous research which states that project-based learning is able to improve students' scientific thinking skills and scientific literacy.

4.2.3 Practicality of the Science Project Module

The results of the teacher and student practicality test indicate that the module is categorized as very practical. Teachers considered the module easy to use and helpful in implementing project-based learning. The module was also considered capable of increasing student engagement in learning activities. Meanwhile, students responded positively to the module's appearance, project activities, worksheets (LKPD), and experimental activities. The high level of practicality indicates that the module can be used well in real-life learning situations in schools. However, several obstacles were still encountered during the implementation of the learning process. One of these was time constraints because the project activities require a fairly lengthy process of observation and analysis. In addition, some students still needed guidance when compiling data analysis and drawing scientific conclusions. However, overall, the module has helped students learn more actively, collaboratively, and independently.

4.2.4 Effectiveness of Modules on Scientific Literacy

The results of the study indicate that the use of the PjBL-based Science Project module effectively improved students' scientific literacy. This is evident in the increase in the average pre-test score from 38.25 to 80.50 in the post-test. The improved learning outcomes indicate that project-based learning can help students understand the concepts of ecology and organic waste management more deeply. This aligns with the results of research conducted bySurya, et al., 2024) stated that there was an influence of the implementation of the project-based learning model on student learning outcomes.

During the learning process, students are directly involved in scientific activities such as: 1. Observing changes during fermentation; 2. Collecting observation data; 3. Analyzing the changes that occur; 4. Discussing the results of experiments; and 5.

Draw conclusions based on data.

These activities help students develop scientific literacy skills, especially in the aspects of explaining scientific phenomena, designing investigations, and interpreting data.

The findings of this study align with those of Harisna and Sutarto (2020), who stated that environmental-based learning can improve scientific literacy skills and student engagement. These findings also support the research of Rusly, Toge, and Tualeka (2025), who demonstrated that project-based learning within an environmental context can significantly improve scientific literacy skills. Furthermore, these findings reinforce the opinion of Fajarwati, Windayani, and Susilawati (2025) that scientific literacy is closely related to critical thinking skills and student awareness of environmental issues. Through the organic waste processing project, students not only gain theoretical knowledge but also understand the importance of environmental protection through concrete actions.

5. Conclusion and Suggestions

5.1 Conclusion

Based on the results of research and development of the Science Project module based on Project Based Learning (PjBL) on the material

Living Things and Their Environment to improve the scientific literacy of class X students of SMK Negeri 1 Modoinding, the following conclusions can be drawn.

1. Development of PjBL-Based Science and Technology Project Modules
   A Project-Based Learning (PBL) Science Project Module on Living Things and Their Environment was successfully developed using the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation. The developed module utilizes horticultural vegetable waste as a learning context through a liquid organic fertilizer (POC) production project. The use of this local context makes learning more meaningful, contextual, and relevant to students' lives.

2. Validity, Practicality, and Effectiveness of the PjBL-Based Science and Technology Project Module
   The validation results from material experts and learning media experts indicate that the module is in the “Very Valid” category. Based on these validation results, it can be concluded that the developed PjBL-based Science and Technology Project module has met the valid criteria and is suitable for use in learning.
   The results of the teacher's practicality test and the results of the student's practicality test in the limited trial and field trials indicate that the module is in the "Very Practical" category. Thus, it can be concluded that the developed PjBL-based Science Project module has a very good level of practicality.
   Based on the learning outcomes of students, it shows that the Science Project module based on Project Based Learning is very effective in improving students' scientific literacy.

3. Improving Scientific Literacy
   The N-Gain calculation yielded a value of 0.71, categorized as high. These results indicate that the use of the module has a positive impact on improving students' scientific literacy skills.
   Improvements in scientific literacy can be seen in students' abilities in:
   1. Explain environmental phenomena;
   2. Designing investigative activities;
   3. Collecting observation data;
   4. Analyze and interpret data; and
   5. Draw conclusions based on scientific evidence.

   Through project-based learning, students not only learn theoretical concepts but also gain hands-on experience in conducting scientific activities through organic waste processing projects. Thus, it can be concluded that the PjBL-based Science Project module is effective in improving the scientific literacy of class X students of SMK Negeri 1 Modoinding.

5.2 Suggestions

Based on the results of the research that has been conducted, the researcher provides several suggestions as follows.

1. For Teachers
   Teachers are advised to utilize project-based learning more effectively in science project learning because it can increase student engagement and scientific literacy. Teachers are also expected to utilize the surrounding environment as a contextual learning resource to make learning more meaningful. Furthermore, teachers need to provide more intensive guidance to students when analyzing data and drawing scientific conclusions.
2. For Schools
   Schools are expected to support project-based learning by providing adequate facilities and supporting resources. Schools can also encourage the use of the surrounding environment as part of contextual learning that supports the Independent Curriculum.
3. For Further Researchers
   Future researchers are advised to develop project-based learning modules for other subjects with broader coverage. Further research can also be conducted over a longer period of time to allow for more in-depth analysis of project results and observation processes. Furthermore, further research could develop project-based digital learning media integrated with scientific literacy.
4. For Students
   Students are expected to be more active in scientific investigations and utilize project-

based learning experiences to foster environmental awareness. They are also expected to apply the knowledge they gain in their daily lives, particularly in organic waste management and environmental conservation.

BIBLIOGRAPHY

Afifah, SN, Agustina, TW, Sukmawardani, Y., and Kurniati, T. (2025). From Regular to Revolutionary: Science Literacy in PJBL-STREAM-Based Fermentation Learning. Journal of Biology Learning Innovation, 6(2): 1-11.

Ariani, D., Isnaeni, W., Djuniadi, Rusilowati, A., and Sukaesih, S. (2025). Systematic Literature Review: Research Trends on PISA-Oriented High School Students' Science Literacy in Indonesia for the Period 2016-2025. Journal of Mathematics and Natural Sciences Education, 15(4): 1771-1782

FF, I W., Gading, I K., and Widiana, I W. (2022). Project Based Learning Modules to Improve Scientific Literacy and Problem-Solving Skills. Journal for Lesson and Learning Studies, 5(2): 316-325.

Fajarwati, L., Windayani, N., and Susilawati, W. (2025). The Relationship between Scientific Literacy and Critical Thinking with Students' Self-Awareness on Environmental Pollution Material. BIOEDUIN Journal, 15(1): 1–9.

Fraenkel, J.R., Wallen, N.E., and Hyun, H. (2018).How to Design and Evaluate Research in Education (8th ed.). San Francisco: McGraw-Hill Education.

Hake, RR (1999).Analyzing Change/Gain Scores. American Educational Research Association, 1–4. http://www.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf

Harisna, R., and Sutarto, J. (2020). Effectiveness of Environmental Based Thematic Learning Tools (EBTLT) in Improving the Science Literacy Skills. Journal of Primary Education, 9(5), 554–561.

Ministry of Education, Culture, Research, and Technology. (2025).Learning and Assessment Guide, Revised Edition. https://repositori.kemendikdasmen.go.id/33290/1/Panduan%20Pembelajaran%20Asesmen.pdf

Krebs, CJ (2014).Ecology: The Experimental Analysis of Distribution and Abundance (6th ed.). Pearson.

Lihiang, A., Sasinggala, M., and Butarbutar, RR (2022). Identification of Horticultural Plant Diversity in Modoinding District, South Minahasa Regency, North Sulawesi Province. BIOMA: MAKASSAR BIOLOGY JOURNAL, 7(2): 44-50

Muhibbullah, MM, Alviani, VZ, Natasya, D., Rahmadini, AR, and Trilisiana, N. (2024). Analysis of the Suitability of Project Based Learning Syntax Implementation in the Learning Process. Epistema, 5(1): 42-57.

Pontoh, MM, Paat, M., Harahap, F., and Rungkat, JA (2024). The Effect of Project Based Learning Model on Students' Creative Thinking Skills at SMP Negeri 6 Tondano. SOSCIED, 7(1)

Putri, RN, Hariyadi, S., and Mudakir, I. (2023). Development of a STEM-Based Learning Module on Environmental Pollution to Improve Students' Science Literacy and Critical Thinking Skills. BioShell Journal, 12(2), 111–119.

Rahmadina, DO (2023). Development of Learning Media Using Contextually Integrated Islamic Google Sites Web on Circle Material. Thesis. Riau: UIN SUSKA Riau

Risahadi, PN, and Akbar, B. (2024). The Relationship between Scientific Literacy Skills and Critical Thinking Skills in Science in Grade 4 Elementary School Students. Educational Publication, 14(3): 238-242.

Rusly, N., Toge, S., and Tualeka, E. (2025). The Effect of Coastal Environment-Based Project-Based Learning Model on the Science Literacy Skills of Elementary School Students at SD Negeri 127 in South Halmahera. International Journal of Education, Information Technology, and Others, 8(2), 27–32.

Sari, IN, Angraeni, L., Kurniasih, D., and Nurussaniah. (2024). Effectiveness of Guided Inquiry-Based Worksheets in Improving Science Process Skills on Vibrations and Waves Materials. Kappa Journal, 8(3): 534-540.

Selasmawati, and Lidyasari, AT (2023). Project-Based Learning (PjBL) Learning Model in Improving Critical Thinking Abilities in Elementary Schools to Support 21st Century Learning. Journal of Science Education Research, 9(11): 1165–1170.

Silitonga, AI, Hastuti, P., Thohiri, R., and Pulungan, AF (2022). Implementation of the ADDIE Model in the Development of Case Method-Based E-Module. SISFO: Scientific Journal of Information Systems, 6(2): 101-126.

Sulastri, Siska, D., Widya, Muliani, and Setiawan, T. (2025). The Effect of Project Based Learning (PjBL) Model in Organic Waste Processing Project on Students' Science Literacy. Kappa Journal, 9(1): 143-148.

Surya, E., Poluakan C., Rungkat J., and Rogahang, M. (2024). Implementation of the Project Based Learning Model on Student Learning Outcomes in the Human Circulatory System. SOSCIED, 7(1)

Wijayanti, R. (2025). Application of Project Based Learning (PjBL) Model in Improving Writing Skills in Indonesian Language Learning. Bima Journal, 3(1): 63-80.

Zakiyah, MA, Maimunah, and Suanto, E. (2024). Validity of SQ3R-Based Teaching Modules to Facilitate Mathematical Communication Skills. Math-UMB.EDU Journal, 11(3): 209-221.

Yapanto, L. M., Wibowo, M., Anwar, K., Panggabean, D., Wahyudi, H., & Sudarmo, A. P. (2025). Valuation of Fisheries Resource Utilization in Coral Reef Ecosystems of the Thousand Islands National Park. In *International Conference on Multidisciplinary Academic Studies* (Vol. 3, pp. 244-248).