International Journal of Education and Teaching Zone. Volume 4 (Issue 2): 16-06 (2025)
DOI: https://10.57092/ijetz.v4i2.418

THE JOURNAL OF IJETZ
(International Journal of Education and Teaching Zone)
P-ISSN: 2963-7899 I E-ISSN: 2830-7925
jurnal.yayasannurulyakin.sch.id/index.php/ijetz

# Validating a Pteridophyta Atlas Integrated with Local Wisdom for Enhancing Science Process Skills

**Afifah Mei Nuraini[1], Endang Susantini[1,2]*, Novita Kartika Indah[1], Nor Asniza Ishak[3]**
[1]Faculty of Mathematics and Natural Sciences, Surabaya State University, Surabaya, Indonesia
[2] EduSTEM Center, Surabaya State University, Surabaya, Indonesia
[3]Faculty of Education, Universiti Sains Malaysia, Malaysia

**Article History:**
Received: March 21, 2025
Revised: May 27, 2025
Accepted: June 08, 2025
Published: June 16, 2025

**Keywords:**
Atlas,
Local Wisdom,
Project Pteridophyta,
Science Process Skills,
Validity

***Correspondence Author:**
endangsusantini@unesa.ac.id

**Abstract:** Biology learning in schools is often theoretical and involves less direct exploration, so that students' science process skills have not developed optimally. This study aims to produce and test the validity of Atlas Pteridophyta based on Project-Based Learning (PjBL) and integrated with local wisdom of the community in the Tahura R. Soerjo area as a biology learning media to train science process skills. The method used in this research is Research and Development (R&D) with the 4D model (Define, Design, Develop, Disseminate). This atlas was developed through field exploration of local fern species that are utilized by the community in the context of culture, medicine, and food, then integrated in project-based activities. Validation was conducted by three validators, namely two lecturers of material and media experts to ensure the accuracy of the concept, and one biology teacher to assess the ease of use of the atlas. The validation used a questionnaire that assessed aspects of presentation, integration with PjBL, and relevance to science process skills. The validation results showed that the atlas had an excellent level of validity with an average score of 3.95; the aspect of integration with PjBL scored 3.92; and the aspect of science process skills scored 3.85. Although this atlas has not yet been implemented in schools, its use is planned in the pilot stage in one of the high schools in Jombang for grade 10 students. This research is still limited to expert validation and does not include effectiveness testing in the field so there is no comparison with other learning methods. Therefore, further research is needed to determine the impact of using the atlas on science process skills empirically. In conclusion, the PjBL-based Atlas of Pteridophyta is feasible to use as a contextual and exploration-based biology learning media. The integration of local wisdom also provides a more authentic learning experience and is relevant to the students' environment.

## INTRODUCTION

The Merdeka Curriculum in learning emphasizes the importance of mastering science process skills as the main basis. These skills include the abilities used by students to conduct scientific research in order to discover concepts, principles, or theories through the scientific thinking process (Defrianti et al., 2022; Mariyanti et al., 2023). In general, science process skills can be divided into two groups, namely basic process skills and integrated process skills (Fadillah et al., 2018; Santiawati et al., 2022). This research

focuses on developing basic science process skills, because these skills are an important initial stage before learners master more complex advanced skills.

Indicators of basic science process skills include: (1) observing, which is the ability to use the senses to collect information; (2) measuring, which is the use of measuring instruments to obtain quantitative data; (3) predicting, which is estimating results or events based on previous patterns or data; (4) classifying, which is grouping objects based on certain characteristics; (5) concluding, which is drawing conclusions from observations or experiments; and (6) communicating, which is conveying results and processes orally or in writing (Lianti et al., 2021). All of these indicators are in line with the learning outcomes in the Merdeka Curriculum, which requires students to be able to create solutions to problems that are relevant to local, national, and global issues, especially those related to understanding the diversity of living things and their role in the ecosystem (Kemendikbudristek, 2022). Therefore, it is important to provide learning media specifically designed to train basic science process skills in a local context, so the development of a project-based atlas that utilizes the potential of local wisdom is an innovative approach to science learning.

Basic science process skills play an important role in contextualized biology learning. These skills are the foundation that learners must have before they master more complex integrated science process skills at the next level of education (Gasila et al., 2019). Mastery of these basic skills allows learners to be actively involved in learning, develop a sense of responsibility, and build a systematic scientific mindset (Siswanto et al., 2018). In addition, science process skills are very important in helping students deal with various real problems that arise in everyday life and during the learning process (Astuti et al., 2018). In the context of this research, science process skills are the main target that is trained through project-based Atlas Pteridophyta media. This media is designed not only to deliver biological content visually and structurally, but also to encourage learners to actively explore, observe, classify, and infer information from the surrounding environment, especially through local wisdom-based projects.

Science process skills are considered important for students, but the reality of the field shows that most students are still relatively low. The results of Lepiyanto (2014) study showed that students' science process skills were still not optimal, especially in terms of classifying, predicting, and interpreting data caused by learning that was not oriented towards the scientific approach. The results of research by Kusumaningrum & Djukri (2016) also stated that the ability of students to science process skills was still low. The difficulties faced by students are mainly in the observation aspect. In line with Angelia et al (2022), in the observation aspect, students still have difficulty using relevant and sufficient facts based on observations. This phenomenon has a negative impact on students' learning achievement. Therefore, learning innovations are needed that encourage active participation of students and improve science process skills (Evendi et al., 2018).

One of the media innovations that can be used to train science process skills is atlas. Atlas is a visual learning media that contains a collection of images equipped with explanations of the material in it (Ales et al., 2017; Blain et al., 2023). The atlas developed in this study is the Atlas of Pteridophyta integrated with local wisdom, which contains

information about the diversity of ferns and their utilization by the people of the Tahura R. Soerjo area. The integration of local wisdom allows students to not only learn to recognize plant morphology and classification, but also relate it to the cultural context and local use (Kusuma et al., 2018). Through exploration activities using atlases, students are trained to observe the morphological characteristics of ferns, classify Pteridophyta species, measure plant parts using simple tools, communicate observations in the form of reports, and conclude findings scientifically. Thus, the atlas is not only a source of information, but also a tool to train basic science process skill indicators.

To maximize the effectiveness of the atlas in learning, the Project-Based Learning (PjBL) model is used. Based on the results of research conducted by Trifonia et al., (2024), it shows that the PjBL model is effective in improving students' science process skills in learning Pteridophyta, where experimental classes using the PjBL model through herbarium projects have higher science process skills than control classes. Activities in the herbarium project involve scientific activities such as observation, classification, documentation, and presentation, which contribute to strengthening learners' science process skills. PjBL encourages learners to be actively involved in real projects that focus on problem solving and field exploration (Misbah et al., 2024). This is in line with the opinion of Baho et al (2021) that the PjBL learning model is a learning model that uses projects (activities) as the core of learning. In the context of using an atlas, students are given a project to make a herbarium of ferns based on the specimens they find and identification with the help of an atlas. This process involves scientific skills from observation in the field to presentation of results, so it strongly supports the development of science process skills.

Herbarium is a collection of plant specimens that have been dried or preserved, and is generally used to help the process of identifying and classifying plants in botanical studies (Handayani et al., 2020). Apart from functioning as an identification tool, herbarium also acts as a form of ex-situ conservation to maintain the existence of plant diversity so that it remains sustainable (Syamsiah et al., 2020), as well as being an important learning resource in learning and biological research (Mertha et al., 2018). In the context of this research, the herbarium developed is based on local wisdom, by not only including scientific information such as scientific names and morphological characteristics, but also adding data related to local names and traditional uses owned by the surrounding community for these plants. This integration is done through extracting information directly from local communities, especially regarding the use of ferns as traditional medicines, food ingredients, or cultural symbols. Thus, this local wisdom-based herbarium not only enriches biology learning content contextually, but also encourages students to better understand the importance of conserving biodiversity as well as local culture (Tomi et al., 2024).

One example of the application of local wisdom in the utilization of ferns is the Raden Soerjo Forest Park (Tahura) area in East Java. Tahura R. Soerjo is an area rich in biodiversity, including Pteridophtyta (Fatma et al., 2017). The community around Tahura has long utilized Pteridophtyta, such as *Selaginella wildenovii* which is used as a medicine for shortness of breath and *Cyathea latebrosa* to increase plant fertility (Sari et al., 2016).

This traditional use reflects the local wisdom that is still sustainable and can be used as an authentic learning resource that is relevant to the lives of students (Khaerunnisa et al., 2018; Saidah et al., 2019). Therefore, Pteridophyta was chosen as the focus in the development of the learning atlas because it has high ecological, economic and cultural values.

The atlas developed in this study not only presents scientific information about the structure and classification of ferns, but also contains local wisdom information, such as local names of plants, their use in community traditions, and management practices carried out for generations. The integration of local wisdom is done through field exploration and interviews with local communities, then included in each specimen description in the atlas as part of the learning narrative. The novelty of this research lies in the combination of local data-based visual media, project approach, and local wisdom, resulting in learning media that is not only scientific and contextual, but also builds students' awareness of the importance of biodiversity conservation and local cultural values. Based on this background, this study aims to produce and test the validity of a project-based Atlas of Pteridophtyta integrated with the local wisdom of the Tahura R. Soerjo area community.

## METHOD

The type of research used in this study is research and development (R&D) which aims to produce a product in the form of a project-based Pteridophyta atlas integrated with the local wisdom of the Tahura R. Soerjo area community. The development model used is the 4D model (Define, Design, Develop, Disseminate) (Zidan et al., 2023). The Four-D (4D) development model was chosen in this study because it has simpler stages and is arranged in detail and systematically (Hidayati et al., 2023). In the define stage, a needs analysis was conducted through literature studies and initial field observations. The design stage includes designing atlas content that combines fern structure and classification material with local wisdom information, such as local names, traditional uses, and processing methods obtained through interviews with the community. The develop stage focuses on the validation of the atlas by experts. The disseminate stage is planned in the form of publication.

The type of research data uses qualitative data analysis and quantitative data. Qualitative data were obtained from interviews with local people who know the traditional use of ferns. To maintain the validity and reliability of qualitative data, source triangulation and validation by ethnobotanists were conducted (Juniartin, 2023; Sandi et al., 2024). Quantitative data were obtained from the assessment of validation sheets filled out by biologists who have backgrounds in accordance with the fields of media development and plant biology. The validation process of the atlas product was carried out after the development stage was completed, using a validation sheet instrument that was prepared based on three main aspects: (1) quality of media presentation (2) integration with the Project-Based Learning (PjBL) approach, and (3) relevance to science process skills indicators. The assessment used a four-level Likert scale. The scores obtained were then analyzed descriptively quantitatively to determine the level of validity based on the average

score and its interpretation category. The validity criteria were determined by matching the average percentage of the total validity score, as in Table 1.

**Table 1** Likert Scale

| Likert Scale | Criteria |
|---|---|
| 4 | Very valid |
| 3 | Valid |
| 2 | Less valid |
| 1 | Not alid |

To determine the validity of the atlas learning media by experts, the average score is calculated. The average rating was calculated using the formula in Figure 1·

$$Average\ score = \frac{\Sigma validator\ score}{\Sigma question\ X\ \Sigma\ validate}$$

**Figure 1.** Average score calculation formula

Categorization of the validation instrument scores by experts/validators presented in the following Table 2.

**Table 2** Eligibility Criteria

| Interval Score | Criteria |
|---|---|
| 3,26 < x > 4,00 | Very valid |
| 2,52 < x > 3,25 | Valid |
| 1,76 < x > 2,50 | Less valid |
| 1,00 < x > 1,75 | Not valid (total revision) |

The atlas learning media product is declared valid/worthy if it obtains an average score of more than 2.50. If the average score obtained is more than 3.25 to 4.00, then the product is declared very valid/fit for use without significant revision. Conversely, if the product obtained an average score of less than or equal to 2.50, it was declared invalid/feasible (Pamuraja et al., 2022).

## RESULT AND DISCUSSION

This research produced a PjBL-based Atlas of Pteridophtyta integrated with the local wisdom of the local community of Tahura R. Soerjo Wonosalam Jombang East Java as a learning medium for Kingdom Plantae. Atlas is produced in printed form. The stages of making Atlas Pteridophyta media are as follows:

### *Define Stage*

At this stage, the researcher determines the product to be developed based on the results of the needs analysis and learning context. An initial analysis was conducted on the characteristics of learners, which was obtained through informal interviews with biology teachers and observations of the learning process in the classroom. From the results of the analysis, it is known that most students understand the material more easily through direct learning experiences and tend to be less interested if only presented with material through lectures or passive discussions. They need teaching materials that are contextual, visual

and allow real exploration of the surrounding environment (Indarti et al., 2017). However, learning models that are still dominated by conventional methods have not been able to accommodate this need optimally.

The second analysis is the curriculum, where what is used is the Merdeka Curriculum, which emphasizes project-based learning and strengthening science process skills. In learning Kingdom Plantae material, students are required not only to understand the structure and classification of ferns, but also to be able to apply process skills(Meishanti et al., 2020). To answer these needs, the product developed is a project-based Pteridophyta atlas integrated with local wisdom. This atlas not only presents visual and informative material, but also directs students to conduct real exploration through a project to make herbarium from local ferns. In this project, learners are asked to identify fern specimens, document morphological characteristics, record utilization based on local information, and compile a structured final report.

The third analysis is learning media, which reveals that there is no Pteridophyta atlas available that integrates scientific information with local wisdom. Tahura R. Soerjo Wonosalam-Jombang, East Java is an area with high fern diversity, but its utilization by the local community has not been documented in teaching materials. Therefore, a PjBL-based Atlas of Pteridophyta integrated with local wisdom was developed that does not only present scientific information and is reinforced by local wisdom narratives in the form of local names of plants and traditional uses obtained through interviews with local communities. Assessment of the project was carried out using an authentic assessment rubric that included aspects of: (1) accuracy of specimen identification, (2) completeness of scientific and local information collected, (3) technical skills in herbarium preservation and presentation, and (4) students' ability to present project results.

***Design Stage***

The design stage is the initial design and creation of the Pteridophyta Atlas based on the results of data collection at the define stage. The design process begins with sorting visual and descriptive documentation of ferns from exploration. The photos were then selected and adjusted with data from community interviews, such as the use of *S. wildenovii* as a medicine for shortness of breath and *C. latebrosa* as a plant fertilizer (Sari et al., 2016). The information is then integrated into the description of each specimen in the atlas, so that students not only learn the biological aspects, but also the meaning and cultural value of the plant.

The atlas was designed using the Canva application and organized into three main sections: opening, core, and closing (Kusuma et al., 2018). The opening section contains the cover page, preface, instructions for use, table of contents, and list of images. The core component contains introductory material about Pteridophyta, an image gallery of specimens that have been utilized by the community, and a project activity sheet for making Pteridophyta dry herbarium. In this project, learners are invited to collect fern specimens from the surrounding environment, dry and preserve the plants, perform identification with the help of an atlas, and compile herbarium data sheets that include scientific names, local names, morphological characteristics, habitats, and traditional uses.

Through this activity, learners practice science process skills such as observing the shape of leaves and stems, classifying based on reproductive structures, measuring leaf length or plant height, and communicating and summarizing their findings in a project report. Each stage of the project directly trains basic science process skills, namely observation, classification, measurement, inference, and scientific communication. The concluding section of the atlas includes a bibliography and glossary of terms to strengthen learners' understanding of the scientific and local terms used.

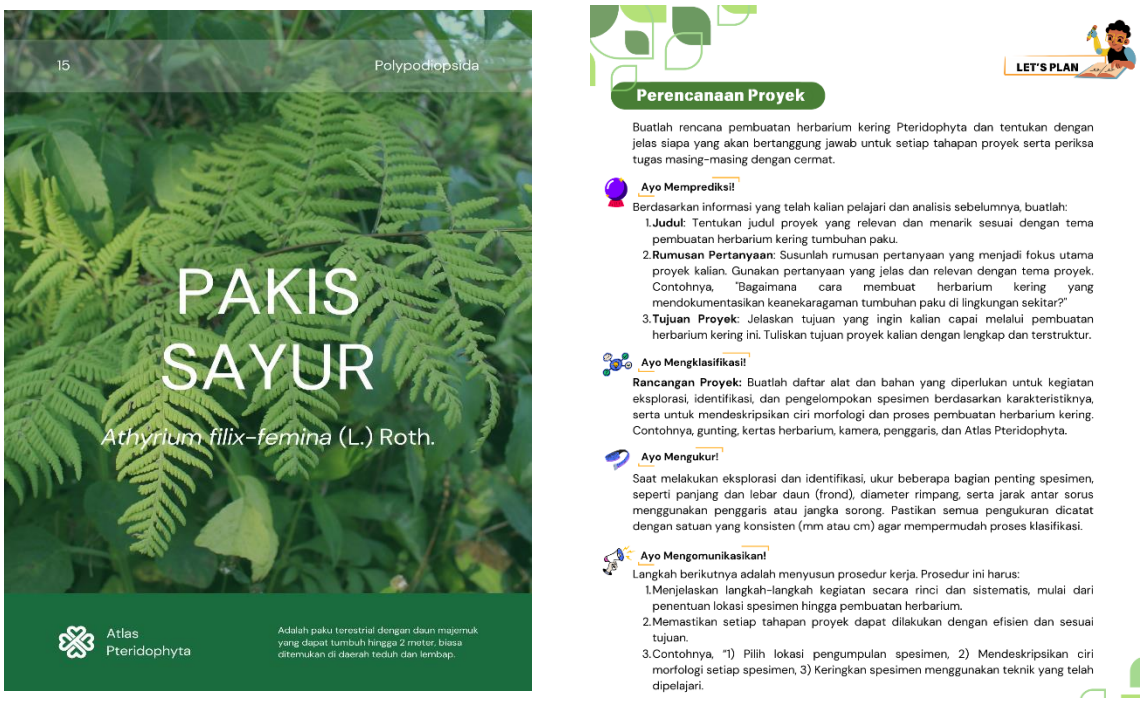

(a) (b)

**Figure 2.** Part of the Pteridophyta Atlas based on PjBL integrated with local wisdom: a) Atlas Cover; b) Atlas User Guide

The cover presented in Figure 2a exemplifies a professional and visually arresting design for the Pteridophyta Atlas. It masterfully integrates detailed botanical illustrations of regionally significant fern species within a harmonious and aesthetically balanced layout. Employing a natural palette dominated by verdant greens complemented by earthy tones, alongside clear and elegant typography, the cover instantly conveys the atlas's scientific authority while evoking a profound connection to the local environment. Subtly embedded motifs or symbols thoughtfully reflect the integration of local wisdom, reinforcing the project's cultural grounding. Beyond its immediate visual appeal, this professionally executed cover serves as a powerful first point of engagement, effectively communicating the atlas's purpose and its foundation in Project-based Learning (PjBL). The overall design projects an image of credibility, rich informational value, and strong contextual relevance to place-based education.

Complementing the cover, Figure 2b showcases the professionally designed User Guide section, distinguished by its exceptional clarity and usability. It features a clean,

systematic layout incorporating intuitive navigation elements such as step-by-step instructions, supportive visuals, and easily recognizable icons. This meticulous design guides educators and learners alike in maximizing the atlas's potential within PjBL activities. A well-defined information hierarchy utilizing headings, subheadings, bullet points, and explanatory graphics ensures rapid accessibility and comprehension of the guide's content. Crucially, this section forms the vital bridge between the atlas's rich scientific content, the active learning principles of PjBL, and the embedded local wisdom. It provides a practical framework for users to translate the atlas's resources into tangible, locally relevant projects. The guide's professional structure and pedagogical design significantly enhance the overall educational value of the atlas, transforming it from a mere reference into an effective, self-contained learning tool.




(c) (d)

**Figure 3.** Part of the Pteridophyta Atlas based on PjBL integrated with local wisdom: c) Images of plants utilized by the local community; d) Project that trains science process skills

Atlas is a learning media dominated by complete visual images accompanied by concise instructions and descriptions. This media is very effective in being used as an independent learning resource or teacher companion in classical learning, because it presents information systematically, concretely, and is easy to understand (Kusuma et al., 2018). According to Permatasari (2018), the use of atlases makes it easier for students to remember and understand the material because it is able to visualize abstract concepts in real terms, such as the shape of plant morphology, habitat, and reproductive structure. In addition, atlases are considered fun by students because they present attractive colors and an arrangement of information that is not boring (Putri et al., 2021). Putri & Wulandari (2020) and Biswas et al (2025) added that the advantages of atlas media lie in the

practicality of presentation, simplicity of format, and visual appeal that can arouse interest in learning.

In the context of learning, atlases can be used as a tool in plant identification activities, for example when students are asked to match real specimens of ferns with pictures and descriptions of their morphology in the atlas. This trains observation and classification skills. In addition, learners can record the habitat of origin and utilization of plants based on the data in the atlas, which hones the skills of classifying information and drawing conclusions (inference). By filling in the project activity sheets in the atlas, learners also get used to recording data, measuring leaf length, comparing species with each other, and communicating observations in writing - all of which are part of science process skills. Therefore, this atlas is not only a medium of information, but also a means of direct practice to train the scientific thinking process contextually

**Development Stage**

The develop phase is the product development phase of Atlas Pteridophyta which is then validated by experts. Validation was carried out by three validators: two expert lecturers from the UNESA Biology Education Masters Study Program who have expertise in the field of biology and ethnobotany learning media development, and one high school biology teacher who assessed the readability and ease of use of the atlas in the classroom. The validation process used a validation sheet instrument that covered three main aspects: (1) the quality of the media display, (2) the integration of the content with the PjBL model and local wisdom, and (3) the connection of the material with the indicators of science process skills. The summary of the validation results can be seen in

**Figure 4**.

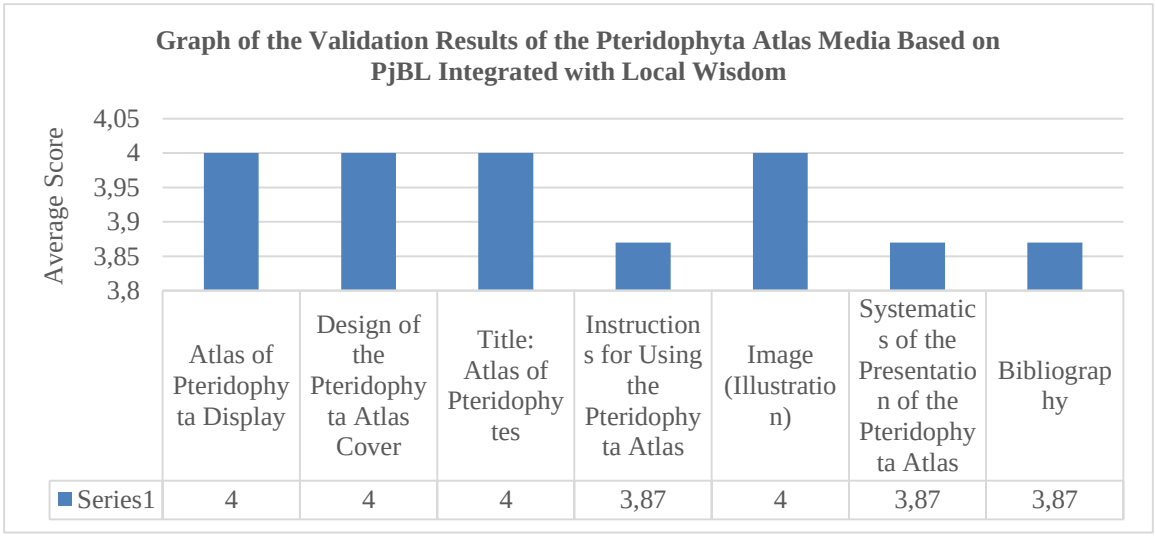



**Figure 4.** Results of the Pteridophyta Atlas Validation

Figure 3 is a graph of the validation results of the project-based Atlas of Pteridophyta integrated with local wisdom. Based on the graph, it can be seen that three main aspects, namely the appearance of the atlas, the cover design, and the title of the atlas obtained a perfect score of 4.00, indicating a "very good" assessment from the validator. The image

and illustration aspects also obtained a maximum score of 4.00, indicating that the visualization in the atlas is considered interesting, informative, and supports the understanding of the material. Meanwhile, aspects of instructions for use, systematic presentation, and bibliography scored 3.87, which is still included in the "very good" category, although lower than other aspects. These scores indicate a decent validation of the Atlas as a learning medium that highlights its effectiveness and suitability for educational purposes. A more detailed description can be seen in Figure 3, which shows the assessment indicators per section.

**Table 3.** Expert validation results of the Pteridophyta Atlas based on PjBL integrated with local wisdom of the Tahura R. Soerjo community to train science process skills

| Indicator | Average | Category |
|---|---|---|
| Atlas of Pteridophyta Display | | |
| 1) Visually appealing | 4 | Very valid |
| 2) Good color variation | 4 | Very valid |
| 3) Easy to use | 4 | Very valid |
| 4) Easy-to-read letters | 4 | Very valid |
| Average Presentation Display | 4 | Very valid |
| Design of the Pteridophyta Atlas Cover | | |
| 1) Attractive cover | 4 | Very valid |
| 2) Relevant images | 4 | Very valid |
| 3) Font size as appropriate | 4 | Very valid |
| 4) The combination of colors and illustrations is good. | 4 | Very valid |
| Average Presentation Cover Design | 4 | Very valid |
| Title: Atlas of Pteridophytes | | |
| 1) According to the material | 4 | Very valid |
| 2) Representing the contents of the atlas | 4 | Very valid |
| 3) Brief, concise, clear | 4 | Very valid |
| 4) Easy to read | 4 | Very valid |
| Average Presentation Title | 4 | Very valid |
| Instructions for Using the Pteridophyta Atlas | | |
| 1) Instructions are included | 4 | Very valid |
| 2) Easy to understand | 3,5 | Very valid |
| 3) Clear and concise sentences | 4 | Very valid |
| 4) Procedures according to activities | 4 | Very valid |
| Instructions for Using the Average Presentation | 3,87 | Very valid |
| Image (Illustration) | | |
| 1) Attractive illustration | 4 | Very valid |
| 2) Clear illustration | 4 | Very valid |
| 3) Illustration according to the main topic | 4 | Very valid |
| 4) The illustration contains meaning or significance | 4 | Very valid |
| Image (Illustration) Average Presentation | 4 | Very valid |
| Systematics of the Presentation of the Pteridophyta Atlas | | |
| 1) The atlas is arranged in order (information, questions, activities, practice, exercises) | 4 | Very valid |
| 2) Activities in the atlas are systematically organized (from fundamental questions to project evaluation) | 4 | Very valid |
| 3) The components in the atlas are interconnected. | 4 | Very valid |
| 4) Atlas has a feature that connects the PJBL model with process skills. | 3.5 | Very valid |
| Systematics of Average Presentation Delivery | 3,87 | Very valid |
| Bibliography | | |
| 1) Writing according to the correct rules | 4 | Very valid |
| 2) Using at least 10 references | 4 | Very valid |

| Indicator | Average | Category |
|---|---|---|
| 3) According to the citation used | 4 | Very valid |
| 4) Consistent in writing | 3,5 | Very valid |
| Average Presentation Bibliography | 3,87 | Very valid |
| Overall Average Media Atlas Pteridophyta | 3,95 | Very valid |

Overall validity score The Pteridophtyta Atlas received an average presentation feasibility score of 3.95, which falls into the Very Valid category, indicating that this atlas meets good quality standards as a learning resource and is suitable for implementation in the teaching and learning process. This satisfactory validation result provides confidence that the atlas can be an innovative solution to help students understand the concept of Pteridophtyta more easily. Based on the research conducted by Muwaffaqoh & Pratiwi (2018), the developed atlas is very helpful in understanding the morphology of plants in the school environment. With very high scores in all aspects, the Pteridophyta Atlas has great potential to be used as an effective learning resource in project-based Biology education.

Furthermore, the high validity score obtained indicates that the project-based Pteridophyta Atlas integrated with local wisdom has successfully combined modern visualization with a strong pedagogical approach, creating an interactive, engaging, and contextually relevant learning media. Although the atlas overall received the category of "very valid," the validation results indicate that the atlas "can be used with revisions," which suggests that there are minor aspects that need to be improved to achieve optimal quality. This is in line with Warsita (2019) opinion, which states that the development of educational products is a repetitive process and requires continuous revisions to achieve optimal quality. Based on the validator's feedback, the three main revisions are: (1) usage instructions, which were initially less operational and needed clarification to be easily understood by teachers and students; (2) the addition of conservation status information on fern specimens, so that students understand the importance of biodiversity preservation; and (3) strengthening scientific citations that support the local wisdom section, to enhance the validity of the traditional information presented in the atlas.

The validation process of the project-based Atlas Pteridophtyta is also conducted to assess the quality and suitability of this media in supporting project-based learning. The validation process was carried out by providing the product, and the instrument used was a validation questionnaire consisting of 6 aspects, namely Determination of fundamental questions, Project planning, Project implementation schedule, Teacher monitoring and project progress, Project reporting, presentation, and publication, as well as Process and project outcome evaluation. The highest score on the instrument is 4 "Very Good" and the lowest score is 1 "Very Poor".

**Table 4.** Expert validation results for the Project Based Learning (PjBL) based Pteridophyta Atlas

| Indicator | Average | Category |
|---|---|---|
| Determination of fundamental questions | | |
| 1) Atlas contains questions related to projects in daily life. | 3,5 | Very valid |
| Project planning | | |
| 1) The project implementation procedure is clearly written. | 4 | Very valid |

| Indicator | Average | Category |
|---|---|---|
| Project implementation schedule<br>1) Atlas provides a timeline activity sheet | 4 | Very valid |
| Monitoring the progress and development of the project<br>1) The atlas contains the process of project work and guidance. | 4 | Very valid |
| Reports, presentations, and project publications<br>1) Atlas guides students in the preparation and presentation of reports. | 4 | Very valid |
| Evaluation of the project process and results<br>1) Atlas provides evaluation questions to assess students' knowledge. | 4 | Very valid |
| Overall average of the Project Based Learning Atlas Pteridophyta content | 3,92 | Very valid |

Based on Table 4, the results of the analysis of the aspects of project planning, schedule preparation, monitoring, reporting, and evaluation get an average score of 4 which is included in the very valid category. This shows that Atlas Pteridophtyta has met the eligibility standards as a learning resource in project-based learning (PjBL). However, the aspect of determining the fundamental question scored 3.5, slightly lower than the other aspects. This indicates that although the atlas has provided relevant questions, the questions have not fully aroused learners' curiosity or stimulated their critical thinking on real problems in the surrounding environment. To overcome this, improvements were made by providing questions that were more open, challenging, and directly related to local issues, such as “How do local people use ferns in traditional medicine, and what impact does this have on the conservation of these species?”. Overall, the validation obtained indicates that the PjBL-based Atlas of Pteridophtyta is a very valid and feasible media for use in learning, especially in the fern herbarium making project. This is in line with the research by Sari et al (2020), which states that the PjBL-based learning media developed falls into the very valid category with an average score of 3.59 from expert validators.

Learning with the PjBL model allows students to be active in every stage of the project, from identifying ferns, collecting specimens, processing them into herbariums, to analyzing and presenting the results. PjBL provides a learning experience based on exploration and research, thereby enhancing students' process skills, including observation, classification, and communication of research results. In the context of the herbarium project, the PjBL model has proven to be more effective compared to the Direct Instructions (DI) method. Research by Natasya et al (2025) shows that students who use PjBL in herbarium creation have a higher accuracy level in identifying and describing specimens compared to students who learn using DI. This is supported by research by Jalinus et al (2017) which sexplains that PjBL allows students to manage information independently, collaborate in groups, and systematically design and evaluate products. Furthermore, they are also more aware of the importance of conservation and biodiversity sustainability, as this project encourages direct exploration of specimens in the surrounding environment.

Learning with the PjBL Model allows students to be active in the entire project process, from identifying ferns, collecting specimens, to presenting the results. PjBL encourages science process skills such as observation, classification, and communication,

and can be tailored to the different needs of students through role distribution and step-by-step work guidelines (Pirdaus, 2024). In the herbarium project, PjBL helps students overcome identification difficulties by directly comparing field specimens and references in an atlas. Research by Natasya et al (2025) shows that students who use PjBL in herbarium creation have a higher accuracy level in identifying and describing specimens compared to students who learn using DI. This is supported by research by Jalinus et al (2017), which explains that PjBL allows students to manage information independently, collaborate in groups, and systematically design and evaluate products. Additionally, they are also more aware of the importance of conservation and biodiversity sustainability, as this project encourages direct exploration of specimens in the surrounding environment.

Furthermore, the validation results of the PjBL-based Pteridophyta Atlas indicate that this media has a very good level of validity in training students' science process skills. Based on the validation questionnaire covering six main aspects, the analysis results show that the Atlas Pteridophtyta is effective in facilitating students to observe, classify, measure, predict, communicate, and conclude, which are basic science process skills in biology learning.

**Table 5.** Expert validation results of the Pteridophyta Atlas based on PjBL integrated with the local wisdom of the Tahura R. Soerjo community to train Science Process Skills

| Indicator | Average | Category |
|---|---|---|
| Atlas Pteridophtyta reflects observation indicators. | | |
| 1) Encouraging students to use their senses to obtain information | 3,5 | Very valid |
| 2) Encouraging students to observe the morphological characteristics of Pteridophyta | 4 | Very valid |
| Indicator Observing Average Presentation | 3,75 | Very valid |
| Atlas Pteridophtyta reflects indicators for classification | | |
| 1) Encouraging the recording of observation results | 4 | Very valid |
| 2) Encouraging the search for differences and similarities in the characteristics of Pteridophyta | 3,5 | Very valid |
| 3) Encouraging the identification of Pteridophyta classification | 4 | Very valid |
| Indicator Classifying Average Presentation | 3,83 | Very valid |
| Atlas Pteridophtyta reflects the indicator measuring | | |
| 1) Encouraging the selection of appropriate measurement units | 3,5 | Very valid |
| 2) Encouraging the use of measuring instruments in observations | 3,5 | Very valid |
| Indicator Measuring Average Presentation | 3,5 | Very valid |
| Atlas Pteridophtyta reflects predictive indicators. | | |
| 1) Encouraging students to predict the results of observations | 4 | Very valid |
| 2) Encouraging students to express possibilities before they are observed | 4 | Very valid |
| Indicator Predicts Average Presentation | 4 | Very valid |
| Atlas Pteridophtyta reflects indicators of communication | | |
| 1) Encouraging the presentation of observations on Pteridophyta | 4 | Very valid |
| 2) Encourage consultation with the teacher to overcome obstacles | 4 | Very valid |
| Indicator Communicating Average Presentation | 4 | Very valid |
| Atlas Pteridophtyta reflects the concluding indicators. | | |
| 1) Encouraging students to draw conclusions and evaluate the results of their observations | 4 | Very valid |
| Overall Average Atlas of Pteridophyta for Training Science Process Skills | 3,85 | Very valid |

Project-based learning (PjBL) in the creation of a dry herbarium of Pteridophyta aims to train students' science process skills, such as observation, classification, prediction, measurement, conclusion, and communication. One of the instruments used in this project is the Pteridophtyta Atlas, which has been validated to measure the extent to which it can support those skills. Based on the validation results in Tabele 5, it shows that the PjBL-based Pteridophyta Atlas has a very good level of validity in training science process skills, with an average score of 3.85. All indicators of science process skills received a "Very Valid" category, with a minimum score of 3.5. This atlas is effectively used in project activities, such as observing the morphology of ferns, measuring specimen sizes, classifying based on morphological characteristics, and compiling and presenting observation reports. Visualization of local specimens, complete with scientific names, local names, conservation status, and narratives of local wisdom, makes learning more concrete and contextual. Research by Amanda et al (2023) shows that project-based methods have been proven to significantly enhance science process skills. This model helps students understand concepts through direct experience, enhances active participation in learning, and develops skills in observing, classifying, predicting, and concluding. In line with the research conducted by Ginting et al (2024), PjBL has also been proven to make students more active, creative, capable of working together in groups, building knowledge individually, and effectively developing science process skills.

The Atlas of Pteridophyta not only presents information about various types of ferns but is also equipped with various interactive features that support project-based learning in a more structured and engaging manner. Features such as Let's Science, Let's Plan, Let's Task, Let's Check, and Let's Try are designed to gradually and systematically train scientific process skills. For example, when collecting fern plant specimens, students can use Let's Science as a guide to observe morphology, record the shape and texture of leaves, the shape and position of sori, and growth patterns, thereby training their observation and scientific recording skills. In the project planning stage, the Let’s Plan feature helps students outline work steps, determine tools and materials, and set activity schedules, which trains skills in communicating, classifying, and predicting. During the process, Let’s Check provides activity monitoring, while Let’s Taste encourages students to communicate their findings. At the end of the project, the Let’s Try feature guides students to analyze the process and results of their findings, as well as draw conclusions from what they have done. These features are also designed to be flexible and adaptive, so they can be tailored to the different needs of students. For example, students with a visual inclination can focus more on using illustrations and observation templates, while kinesthetic students can be active in the collection and creation of herbariums.

The Pteridophyta atlas based on PjBL integrated with the local wisdom of the Tahura R. Soerjo community has several advantages that support contextual and meaningful biology learning. First, this atlas presents data on the diversity and utilization of ferns visually, accompanied by detailed images and morphological descriptions. This makes it easier for students to perform identification, classification, and observation. These skills are important considering that many students still have difficulty observing objects accurately (Angelia et al., 2022). Second, the atlas serves as a practical supplement and a

confirmation medium during identification, for example, when the original specimens are difficult to find or distinguish. In the learning practice, teachers can guide students to observe ferns around the school or urban forests, then match them with images and information in the atlas for verification of their types and uses. This has proven to be effective, as demonstrated by Wahyudi et al (2024) who reported an increase in the average scores of students after using the atlas as teaching material. The third advantage is the integration with the PjBL model, which encourages the strengthening of science process skills through herbarium-making projects, such as observing, measuring, documenting, and concluding field findings. The uniqueness of this atlas lies in its integration with the local wisdom of the Tahura R. Soerjo community. This integration enhances the relevance of learning because students not only study biological concepts but also relate them to local life and culture, thereby fostering ecological awareness and a sense of ownership towards the surrounding environment (Maduriana & Gata, 2021). This is in line with the views of Sahtoni et al (2017) and Widarti et al (2020) that PjBL empowers students to acquire knowledge through real experiences.

***Dissimination Stage***

The PjBL-based Atlas of Pteridophyta learning media integrated with local wisdom is planned to be disseminated through digital platforms to expand user utilization and access. One of the main dissemination strategies is to share the atlas in digital format through Google Drive, the link of which will be shared through various social media such as TikTok, Instagram, and other learning platforms. This approach was chosen because it can reach a wider audience quickly, flexibly and without geographical limitations. This strategy allows a solution to the independent utilization of learning media by teachers and learners from various regions.

## CONCLUSION

Based on the research results, a project-based Pteridophyta Atlas integrated with the local wisdom of the Tahura R. Soerjo community has been developed and validated. The validation results show that this atlas has a very high level of validity, with an overall average score of 3.95 (Very Valid category). Validity in the PjBL model aspect received a score of 3.92, while the aspect of science process skills reached a score of 3.85, indicating that this atlas is effective in training students' science process skills. Overall, this atlas is deemed feasible and has the potential to serve as an innovative learning medium that not only strengthens students' understanding of the diversity of Pteridophyta but also encourages project-based scientific exploration and awareness of biological conservation and local culture. However, since the research is still limited to the expert validation stage, further studies are needed to test the effectiveness of the atlas in real implementation across various educational units. Future development of the atlas could include the addition of supporting features, such as evaluative quizzes, field exploration videos, and reflective worksheets to enhance student engagement. Additionally, there is a need to raise teachers' awareness about the importance of project-based learning, as well as to strengthen the collaboration between teachers and students in using the atlas optimally.

## REFERENCES


Ales, L., Bellofatto, A. A., & Wang, J. J. (2017). Taxing Atlas: Executive Compensation, Firm Size, and Their Impact on Optimal Top Income Tax Rates. *Review of Economic Dynamics*, *26*(2017), 62–90. https://doi.org/10.1016/j.red.2017.02.007

Amanda, N. G., Biru, L. T., & Suryani, D. I. (2023). Pengaruh Model Pembelajaran Project Based Learning terhadap Keterampilan Proses Sains pada Ta Makanan di Sekitarmu Kelas VIII. *PENDIPA Journal of Science Education*, *7*(2), 168–177. https://doi.org/10.33369/pendipa.7.2.168-177

Angelia, Y., Supeno, S., & Suparti, S. (2022). Keterampilan Proses Sains Siswa Sekolah Dasar dalam Pembelajaran IPA Menggunakan Model Pembelajaran Inkuiri. *Jurnal Basicedu*, *6*(5), 8296–8303. https://doi.org/10.31004/basicedu.v6i5.3692

Astuti, S., Danial, M., & Anwar, M. (2018). Pengembangan LKPD Berbasis PBL (Problem Based Learning) Untuk Meningkatkan Keterampilan Berpikir Kritis Peserta Didik Pada Materi Kesetimbangan Kimia. *Chemistry Education Review (CER), Pend. Kimia PPs UNM*, *1*(2), 90–114. https://ojs.unm.ac.id/CER/article/view/5614/0

Biswas, S. A., Ahmad, H., Bormon, S., Rimon, Sohag, S. R., & Akhi, A. B. (2025). Money Plant Disease Atlas: A Comprehensive Dataset For Fisease Classification In Ornamental Horticulture. *Data in Brief*, *58*, 1–13. https://doi.org/10.1016/j.dib.2024.111216

Giacobini, P., Gitton, Y., & Chédotal, A. (2023). A Tridimensional Atlas Of The Developing Human Head. *Cell Resource*, *186*(26), 5910-5924.e17. https://doi.org/10.1016/j.cell.2023.11.013

Defrianti, D., & Iskandar, I. (2022). The Mastery of Teacher Emotional Intelligence Facing 21st Century Learning. *International Journal of Education and Teaching Zone*, *1*(1), 50–59. https://doi.org/10.57092/ijetz.v1i1.28

Evendi, Susantini, E., Wasis, W., & Prahani, B. K. (2018). Improving Students' Scientific Asking Skills through the Implementation of Question Webs Based Learning Model. *Journal of Physics: Conference Series*, *1108*(1–7). https://doi.org/10.1088/1742-6596/1108/1/012037

Fadillah, E. N., & Angraini, E. (2018). Pengembangan Modul Praktikum Genetika Berbasis Keterampilan Proses Sains Untuk Mahasiswa Program Studi Pendidikan Biologi. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, *3*(01), 34–42. https://doi.org/10.33503/ebio.v3i01.77

Ginting, W. B., Fatmi, N., Sakdiah, H., Ginting, F. W., & Ayunda, D. S. (2024). Pengaruh Model Pembelajaran Project Based Learning Berbantuan Modul Terhadap Peningkatan Keterampilan Proses Sains Pada Materi Kemagnetan. *Journal on Education*, *6*(4), 19137–19146. https://doi.org/10.31004/joe.v6i4.5907

Handayani, T. T., Sumardi, S., & Ekowati, C. N. (2020). Pelatihan Pembuatan Herbarium Sebagai Pengayaan Media Pembelajaran Ipa-Biologi Bagi Guru Smp Mgmp Ipa Di Kecamatan Way Tenong Kabupaten Lampung Barat. *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat Dan Corporate Social Responsibility (PKM-CSR)*, *3*, 806–809. https://doi.org/10.37695/pkmcsr.v3i0.852

Hidayati, R. A., & Taqwa, M. R. A. (2023). Computer Based Recitation Program Development With Feed Back in Newton's Law Topic. *IJETZ: International Journal of Education and Teaching Zone*, *2*(1), 113–129. https://doi.org/10.57092/ijetz.v2i1.49

Indarti, & Purwantoyo, E. (2017). Keefektifan Project Based Learning dengan Observasi pada Materi Keanekaragaman Tumbuhan Tingkat Tinggi. *Journal of Biology Education*, *6*(2), 187–194. https://doi.org/10.15294/jbe.v6i2.19321

Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students. *Advances in Social Science, Education and Humanities Research*, *102*, 251–256. https://doi.org/10.2991/ictvt-17.2017.43

Juniartin. (2023). Validitas Modul Etnobiologi Berbasis Etnobotani Masyarakat Ternate. *Bionatural*, *10*(1), 98–104. https://doi.org/10.61290/bio.v10i1

Kemendikbudristek BSKAP. (2022). Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan, Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 008/H/KR/2022. In *Kemendikbudristek* (Issue 021). https://kurikulum.kemdikbud.go.id/file/1692927593_manage_file.pdf

Khaerunnisa, E., & Pamungkas, A. S. (2018). Pengembangan Instrumen Kecakapan Matematis Dalam Konteks Kearifan Lokal Budaya Banten Pada Materi Bangun Ruang Sisi Datar. *Kreano: Jurnal Matematika Kreatif-Inovatif*, *9*(1), 17–27. https://doi.org/10.15294/kreano.v9i1.11210

Kusuma, R., Rohman, F., & Syamsuri, I. (2018). Pengembangan Atlas Keanekaragaman Hayati Berbasis Potensi Lokal untuk SMK Jurusan Pertanian. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *3*(3), 296–301. http://journal.um.ac.id/index.php/jptpp/

Kusumaningrum, S., & Djukri, D. (2016). Pengembangan Perangkat Pembelajaran Model Project Based Learning (PjBL) untuk Meningkatkan Keterampilan Proses Sains dan Kreativitas. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 241–251. https://doi.org/10.21831/jipi.v2i2.5557

Lepiyanto, A. (2014). Analisis Keterampilan Proses Sains Pada Pembelajaran Berbasis Praktikum. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *5*(2), 156–162. https://doi.org/10.24127/bioedukasi.v5i2.795

Lianti, Y., & Zuhra, F. (2021). Upaya Meningktkan Keterampilan Proses Sains Siswa Pada Materi Perpindahan Kalor Melalui Model Pembelajaran Problem Based Learning. *Bioscientist: Jurnal Ilmiah Biologi*, *8*(2), 20–26. http://www.jfkip.umuslim.ac.id/index.php/jupendas/article/view/721

Maduriana, I. M., & Gata, I. W. (2021). Integrasi Pendidikan Biologi dalam Konservasi Lembu Putih Taro Berbasis Kearifan Lokal. *Jurnal Pedagogi Dan Pembelajaran*, *4*(3), 450. https://doi.org/10.23887/jp2.v4i3.41349

Mariyanti, N., Sulistri, E., & Anitra, R. (2023). Pengaruh Model Inkuiri Terbimbing Berbasis Lingkungan Terhadap Keterampilan Proses Sains Siswa Kelas V dalam Pembelajaran IPA di SDN 12 Singkawang. *CENDEKIA: Jurnal Ilmu Sosial, Bahasa, Dan Pendidikan*, *3*(4), 198–208. https://doi.org/10.55606/cendikia.v3i4.2034

Meishanti, O. P. Y., Sholihah, F. N., & Dari, N. S. U. (2020). Implementasi Discovery Learning Dengan Praktikum Kingdom Plantae Untuk Melatih Keterampilan Proses Di MA Unggulan Kh. Abd. Wahab Hasbulloh Tambakberas Jombang. *Jurnal Biologi Dan Pembelajarannya (JB&P)*, *7*(2), 68–75. https://doi.org/10.29407/jbp.v7i2.15200

Mertha, I. G., Idrus, A. Al, Ilhamdi, M. L., & Zulkifli. (2018). Pelatihan Teknik Pembuatan Herbarium Kering Dan Identifikasi Tumbuhan Berbasis Lingkungan Sekolah di SMAN 4 Mataram. *Jurnal Pendidikan Dan Pengabdian Masyarakat*, *1*(1), 82–87. https://doi.org/10.29303/jppm.v1i1.498

Misbah, Adha, A., Segalerba, G., & Nova Kafrita. (2024). Analysis of Student Concept Mastery Using the Project Based Learning Model Seen from Parents' Work. *International Journal of Education and Teaching Zone*, *3*(2), 210–223. https://doi.org/10.57092/ijetz.v3i2.251

Muwaffaqoh, D., & Pratiwi, R. P. (2018). Pengembangan Atlas struktur Morfologi dan Anatomi Daun Tumbuhan Pesisir Sebagai Sumber Belajar Biologi. *Bioedu: Berkala Ilmiah Pendidikan Biologi*, *7*(2), 330–337. https://ejournal.unesa.ac.id/index.php/bioedu/article/view/28791

Natasya, D. F., Daningsih, E., & Yuniarti, A. (2025). The Use Of Fern Herbarium As A Project And Learning Material In Project-based learning To Improve Learning Outcome. *Bio_Inoved: Jurnal Biologi-Inovasi Pendidikan*, *7*(1), 80–90. https://ppjp.ulm.ac.id/journal/index.php/bino/article/view/20826

Pamuraja, B. E., Halidjah, S., & Ghasya, D. A. V. (2022). Pengembangan Media Pembelajaran Berbasis Web Subtema Bagaimana Tubuh Mengolah Makanan Kelas V Sekolah Dasar. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa (JPPK)*, *11*(3), 1–11. https://doi.org/10.26418/jppk.v11i3.53418

Permatasari, A. L. (2018). Atlas Sosial Ekonomi Daerah Rawan Bencana Gunungapi Merapi. *Media Komunikasi Geografi*, *19*(1), 76. https://doi.org/10.23887/mkg.v19i1.13906

Pirdaus, P. (2024). Project-Based Learning Model Increases Student Creativity and Learning Outcomes in Pancasila and Citizenship Education Learning. *Journal of Education Research and Evaluation*, *8*(1), 173–182. https://doi.org/10.23887/jere.v8i1.73525

Putri, D. D., & Wulandari, T. S. H. (2020). Uji Validitas Atlas Biologi Berbasis Problem Solving pada Materi Organisasi Kehidupan untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas VII. *SNasPPM: Prosiding Seminar Nasional Penelitian Dan Pengabdian Masyarakat*, *5*(2), 238–243. http://prosiding.unirow.ac.id/index.php/SNasPPM/article/download/419/410.

Putri, R. A., Susantini, E., & Taufikurohmah, T. (2021). The Results Presentation of The Test Plants As A Natural Indicator of The Test Compounds of The Acid-Base Balance In the Teaching Materials of The Atlas to Train Scientific Reasoning Students. *IJORER : International Journal of Recent Educational Research*, *2*(3), 354–364. https://doi.org/10.46245/ijorer.v2i3.116

Sahtoni, S., Suyatna, A., & Manurung, P. (2017). Implementation Of Student's Worksheet

Based On Project Based Learning (pjbl) To Foster Student's Creativity. *International Journal of Science and Applied Science: Conference Series*, *2*(1), 329–338. https://doi.org/10.20961/ijsascs.v2i1.16738

Saidah, K., & Damariswara, R. (2019). Pengembangan Bahan Ajar Materi Dongeng Berbasis Kearifan Lokal Jawa Timur Bagi Siswa Kelas III SD. *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran*, *9*(1), 73. https://doi.org/10.25273/pe.v9i1.4320

Sandi, F. M., Rahayu, H. M., & Sunandar, A. (2024). Etnobotani Tanaman Aromatik Suku Melayu Sambas Sebagai Sumber Belajar Kontekstual Biologi SMA. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *10*(4), 728–742. https://online-journal.unja.ac.id/biodik/article/view/38636

Santiawati, S., Yasir, M., Hidayati, Y., & Hadi, W. P. (2022). Analisis Keterampilan Proses Sains Siswa Smp Negeri 2 Burneh. *Natural Science Education Research*, *4*(3), 222–230. https://doi.org/10.21107/nser.v4i3.8435

Sari, L., Taufina, T., & Fachruddin, F. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) dengan Menggunakan Model PJBL di Sekolah Dasar. *Jurnal Basicedu*, *4*(4), 813–820. https://doi.org/10.31004/basicedu.v4i4.434

Sari, T. E., Hudha, A. M., & Poncojari, W. (2016). Biodiversitas Dan Kearifan Lokal Tumbuhan Paku Pada Masyarakat Di Kawasan Taman Hutan Raya Raden Soerjo Cangar Kota Batu. *Prosiding Seminar Nasional II 2016, Kerjasama Prodi Pendidikan Biologi FKIP Dengan Pusat Studi Lingkungan Dan Kependudukan (PSLK) Universitas Muhammadiya Malang*, 1003–1009. https://eprints.umm.ac.id/id/eprint/4735

Siswanto, J., Susantini, E., & Jatmiko, B. (2018). Multi-representation Based on Scientific Investigation for Enhancing Students' Representation Skills. *Journal of Physics: Conference Series*, *983*(1), 1–7. https://doi.org/10.1088/1742-6596/983/1/012034

Syamsiah, S., Nurhayati, B., & Hiola, S. F. (2020). Pemanfaatan spesimen herbarium sebagai media pembelajaran bagi Guru-Guru IPA/Biologi di Kabupaten Enrekang. *Jurnal Dedikasi*, *22*(1), 99–103. https://doi.org/10.26858/dedikasi.v22i1.13831

Tomi, D., Suraya, E., Aprianto, R., Sastria, E., & Leoni, L. (2024). Designing Student Worksheets Based on Local Wisdom Using a Detailed Learning Model Integrated Discovery Learning on Biodiversity Material. *International Journal of Education and Teaching Zone*, *3*(3), 1–10. https://doi.org/10.57092/ijetz.v3i3.310

Trifonia, I., Trisianawati, E., & Herditiya. (2024). Penerapan Model Project Based Learning Melalui Herbarium Book Materi Pterydophyta Terhadap Kreativitas Peserta Didik Kelas X SMA Karya Sekadau. *JBIOENDRA: Jurnal Pendidikan Biologi*, *02*(02), 319–328. https://journal.unwira.ac.id/index.php/JBIOEDRA/article/view/3833

Wahyudi, Y., Ana, Widiaty, I., & Yulia, C. (2024). Identifikasi Pendekatan Project Based Learning dalam Konteks Pembelajaran di Pendidikan Vokasional : Analisis Bibliometrik Identification of Project-Based Learning Approaches in the Context of Vocational Education : A Bibliometric Analysis. *JPP: Jurnal Penelitian Pendidikan*, *24*(3), 421–451. https://doi.org/10.17509/jpp.v24i3.80405

Warsita, B. (2019). Evaluasi Media Pembelajaran Sebagai Pengendalian Kualitas. *Jurnal Teknodik*, *17*(1), 438–447. http://dx.doi.org/10.32550/teknodik.v17i4.581

Widarti, H. R., Rokhim, D. A., & Syafruddin, A. B. (2020). The Development of Electrolysis Cell Teaching Material Based on Stem-PjBL Aproach Assisted by Learning Video: A Need Analysis. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 309–318. https://doi.org/10.15294/jpii.v9i3.25199

Zidan, A., Mahardika, I. K., & Subiki. (2023). Content Accuracy and Recency of TPACK-Based Physics Textbooks on Work and Energy Materials to Improve Science Literacy of High School Students. *International Journal of Education and Teaching Zone*, *2*(3), 501–5011. https://doi.org/10.57092/ijetz.v2i3.132