Al-Alam (INSEJ) 4 (2) (2025) Halaman 107-119
Al-Alam: Islamic Natural Science Education Journal
https://jurnal.iainambon.ac.id/index.php/JTI/index
ISSN : 2962-7737 (online)
2962-4657 (cetak)

The Effect of Implementing the Discovery Learning Model on Students Ability to Design Biology Learning Modules Based on Scientific Literacy

Andi Sitti Marwah*
Universitas Muhammadiyah Maluku
*Alamat korespondensi: andisittimarwah08@gmail.com

Artikel info

Accepted : June 29th 2025
Approved : July 19th 2025
Published : July 21st 2025

Kata kunci:
Modul Pembelajaran Biologi, *Discovery Learning*, Literasi Sains

ABSTRAK

Penelitian ini bertujuan untuk menguji pengaruh model Discovery Learning terhadap kemampuan mahasiswa Program Studi Pendidikan Biologi Universitas Muhammadiyah Maluku dalam mengembangkan modul yang memuat empat indikator literasi sains: konten ilmiah, konteks pembelajaran, proses ilmiah, serta nilai dan sikap ilmiah. Metode yang digunakan adalah kuantitatif dengan desain quasi-eksperimen nonequivalent control group. Sampel terdiri dari dua kelas, yakni kelompok eksperimen dan kelompok kontrol. Hasil menunjukkan peningkatan signifikan pada kelompok eksperimen, dengan rata-rata skor pretest ke posttest naik 18,3 poin, sedangkan kelompok kontrol hanya 8,3 poin. Skor akhir modul juga lebih tinggi pada kelompok eksperimen (86,5) dibandingkan kontrol (75,7). Temuan ini menegaskan bahwa Discovery Learning efektif dalam meningkatkan kemampuan merancang modul berbasis literasi sains secara menyeluruh.

Keywords:
Biology Learning Modules, Discovery Learning, Scientific Literacy

ABSTRACT

This study aims to examine the effect of the Discovery Learning model on the ability of students in the Biology Education Study Program at the University of Muhammadiyah Maluku to develop modules containing four indicators of scientific literacy: scientific content, learning context, scientific process, and scientific values and attitudes. The method used was quantitative with a quasi-experimental nonequivalent control group design. The sample consisted of two classes, namely the experimental group and the control group. The results showed a significant increase in the experimental group, with an average pretest to posttest score increasing by 18.3 points, while the control group only increased by 8.3 points. The final module score was also higher in the experimental group (86.5) compared to the control group (75.7). These findings confirm that Discovery Learning is effective in improving the ability to design scientific literacy-based modules comprehensively.

https://jurnal.iainambon.ac.id/index.php/JTI/index

How to Cite: Marwah, Andi Sitti (2025). The Effect of Implementing the Discovery Learning Model on Students Ability to Design Biology Learning Modules Based on Scientific Literacy. *Al-Alam: Islamic Natural Science Education Journal, 4(2) 107-119*. DOI: https://doi.org/10.33477/al-alam.v4i2.11331

INTRODUCTION

Global and national phenomena demonstrate the urgent need to improve scientific literacy and higher-order thinking skills among prospective biology teachers. While the curriculum from elementary to tertiary education currently encourages strengthening higher-order thinking skills (HOTS) and scientific literacy, field practice shows the continued dominance of conventional, teacher-centered learning methods. In its development, Discovery Learning, which encourages students to actively discover concepts through exploration and reflection, is considered effective in stimulating higher-order cognitive skills and scientific literacy. (Al Aliyawinata et al., 2021; Amazida et al., 2021). However, in the context of higher education, especially for biology education students, there is still limited empirical evidence regarding the effectiveness of this approach in designing learning modules based on scientific literacy, and there has been no quantitative research that measures the extent to which Discovery Learning influences students' abilities in designing modules containing scientific literacy..

Global and national phenomena do demand increased scientific literacy and higher-order thinking skills (HOTS) for prospective biology teachers, but current learning practices tend to be teacher-centered. Several studies have shown that the Discovery Learning model is truly effective in improving students' critical and creative thinking skills. For example, research by Jasman et al. (2022) shows that the implementation of Discovery Learning significantly improves students' ability to solve HOTS category biology problems ($p<0.05$) and the study by Marjan et al. (Jasman et al., 2022). (2023–2024) confirming the positive influence on students' critical thinking skills on the excretory system material (Marjan et al., 2024).

However, quantitative empirical evidence measuring the effects of Discovery Learning in designing science literacy-based modules for biology education students is still very limited. A study on the development of a biology module based on Discovery Learning showed high validity (average validity score of 93.54%) in training high school students' science literacy skills on the topic of viruses, while research in higher education that links science literacy with students' HOTS was found in the context of PGSD, where science literacy and science process skills were significantly positive related to students' HOTS results ($r=0.495$; $p<0.05$).(Aprillia & Asri, 2021). However, there has been no specific quantitative research on biology education students that examines the extent to which Discovery Learning influences their ability to design modules containing scientific literacy. (Setyaningrum et al., 2024).

The importance of this research arises because prospective biology teachers need to possess learning design competencies that are not only conceptual, but also practical and applicable, with teaching modules as tangible products that facilitate students' scientific literacy. Discovery Learning-based modules have been proven valid and effective in improving high school students' scientific literacy. (Nasution & Sutiani, 2022). For example, the validity of the module for virus material reached an average of 93% (very valid) in training students' scientific literacy. (Aprillia & Asri, 2021) ; and the developed plant tissue modules Ariana et al (Ariana et al., 2020). improving the scientific literacy of 11th grade students (p-gain=0.71, effective). However, this type of

research has not been used as an object of practice by prospective teacher students at universities, especially in designing modules as part of their biology learning strategy assignments.

Several previous studies have highlighted Discovery Learning as a learning strategy that improves students' understanding of concepts and scientific literacy. (Ahfiani & Arif, 2023). Amazida et al. (2022) found that the practicum-based Discovery Learning model significantly improved scientific literacy and student learning outcomes in plant tissue material (mean post-test 87.05 vs control 73.53)(Amazida et al., 2021). Ahfiani & Arif (2023) also concluded that a similar quasi-experimental approach showed a positive influence on students' scientific thinking abilities ($P < 0.05$)(Ahfiani & Arif, 2023). However, these studies focused on high school students and cognitive learning outcomes; there has been no quantitative study measuring students' ability to design science literacy-based learning modules using this model, especially at Muhammadiyah universities in Maluku.

Thus, there is a clear research gap: the study has not yet quantitatively measured the effect of Discovery Learning on students' ability to design scientific literacy-based modules. This study offers a new perspective by placing biology education students as subjects and systematically evaluating whether the implementation of this learning strategy improves their competence in developing teaching modules. The study also fills a gap in the theoretical and practical framework of higher education by combining active learning approaches with digital or printed products that have scientific literacy indicators.

The contribution of this research is twofold: academically, it enriches the discourse on innovative learning strategies in higher biology education; practically, it provides recommendations for lecturers teaching Biology Learning Strategies to incorporate the Discovery Learning method into the curriculum and supplement teaching materials with guidance on integrating scientific literacy. Furthermore, the student-designed modules can be used as evaluation and portfolio materials, as well as as a reference for teacher professional development program policies in higher education. Thus, this research has a direct impact on the quality of prospective biology teachers and ultimately the quality of biology education in future schools.

METHOD

Types of research

This type of research is a quasi-experimental study with a pretest and posttest control group design. This study aims to determine the effect of using the Discovery Learning model on students' ability to design learning modules that incorporate scientific literacy.

Time and Place of Research

Specifically, this research was conducted for 3 months from October 2024 to January 2025, located in the Biology Education Study Program, Muhammadiyah University of Maluku.

Population and Sample

This study involved all third-semester students, class A of the Biology Education Study Program, with a total population of 15 people. Due to the relatively small population, the entire population was used as a research sample, so that the number of samples was equal to the total population, namely 15 people. Sampling was carried out using a purposive sampling technique, where the sample consisted of two groups with similar academic characteristics. The first group was the experimental class that was given treatment using the Discovery Learning model, while the second group was the control class that used a conventional learning model in the form of lectures and discussions.

Research Procedures

This research was conducted through three main stages: preparation, implementation, and evaluation. During the preparation stage, which took place in October 2024, the researcher first conducted a preliminary study to understand the learning conditions and students' readiness to take the Biology Learning Design course. After that, the researcher developed a research instrument, consisting of pretest and posttest questions, as well as a rubric for assessing the scientific literacy-based learning module. The instrument was then validated by two expert lecturers in biology education and scientific literacy. After being declared valid, the researcher designated two parallel classes as the experimental and control classes using a purposive sampling technique. The experimental class was designed using the Discovery Learning model, while the control class used conventional learning methods.

The implementation phase lasted two months, from November to December 2024, and consisted of six meetings. In the first meeting, students from both classes were given a pretest to measure their initial ability to design a scientific literacy-based learning module. During the learning process, the experimental class was guided using a Discovery Learning approach, where students were actively involved in identifying problems, exploring information from various sources, developing module steps, and linking learning materials to scientific literacy components: content, context, scientific process, and scientific attitudes. Meanwhile, the control class followed conventional learning that focused on lectures, module examples, and class discussions without exploratory guidance. After the six meetings were completed, students were asked to develop a scientific literacy-based biology learning module as their final assignment.

The evaluation phase was conducted in January 2025. At this stage, students in both classes were given a posttest equivalent to the pretest to determine their improvement in module design skills. The module products developed by the students were also assessed by two expert lecturers using a standardized rubric covering four

aspects of scientific literacy: scientific content, context, scientific process, and scientific values or attitudes. Data from the pretest, posttest, and module assessment were analyzed descriptively and inferentially using a t-test to determine the effect of the Discovery Learning model application on students' abilities in designing scientific literacy-based biology learning modules.

Data, Instruments and Data Collection Techniques

The data collected is in the form of:

a. Pretest and posttest scores for the ability to design scientific literacy-based modules
b. Module design assessment rubric developed based on PISA scientific literacy indicators and expert validation results

Research instruments:

a. Scientific literacy test (pretest–posttest)
b. Module product assessment rubric (scientific literacy components: phenomena, content, context, and scientific process)

Data collection technique:

a. a. Pretest-posttest questions are given
b. b. Module product assessment by two assessors (expert lecturers) using a validation rubric that has been tested for reliability

Data Analysis Techniques

Before conducting inferential statistical analysis, the initial step is to test for data normality and homogeneity. The normality test aims to ensure that the distribution of pretest and posttest scores in both groups (experimental and control) follows a normal distribution. This test is performed using the Shapiro-Wilk or Kolmogorov-Smirnov test, depending on the sample size available. Meanwhile, the homogeneity test is used to determine whether the variances of both groups are homogeneous or uniform, which is one of the basic assumptions in parametric analysis. The homogeneity test can be performed using Levene's Test.

If both assumptions are met, the analysis continues with a two-tailed t-test (independent sample t-test) to determine whether the posttest scores between the experimental and control groups are significantly different. This test aims to determine whether the Discovery Learning model has a statistically significant effect compared to conventional learning methods in improving students' abilities in designing scientific literacy-based modules.

Furthermore, to assess the internal improvement in each group's abilities, a paired sample t-test was used, comparing the pretest and posttest results in the experimental and control groups separately. This test was used to determine whether there were significant differences before and after treatment in each group. All tests were conducted at a significance level of $\alpha = 0.05$, meaning that results are considered statistically significant if the p-value is <0.05.

RESULTS AND DISCUSSION

Table 1: Average Pretest and Posttest Scores of the Experimental Group (Discovery Learning)

Science Literacy Indicators	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Δ (Score Difference)	Information
Scientific Content	70.5 ± 6.2	87.3 ± 5.1	**+16.8**	Significant improvement
Learning Context	66.9 ± 6.8	85.1 ± 6.0	**+18.2**	Significant improvement
Scientific Process	67.8 ± 7.1	88.6 ± 4.8	**+20.8**	Very significant improvement
Scientific Values and Attitudes	67.7 ± 6.6	84.9 ± 5.5	**+17.2**	Peningkatan sangat signifikan
Total Average Score	**68.2 ± 6.7**	**86.5 ± 5.4**	**+18.3**	**p < 0.05 (**significant**)**

Table 1 shows that students in the Biology Education Study Program at the University of Muhammadiyah Maluku who participated in the Discovery Learning model consistently achieved higher average scores on the four scientific literacy indicators: scientific content, learning context, scientific process, and scientific values and attitudes compared to the control group using the conventional approach. The greatest superiority emerged in the scientific process indicator, where the experimental group achieved a score of 88.6 ± 4.8 compared to 76.3 ± 6.1 in the control group, a significant difference of 12.3 points. This indicates that students were actively involved in designing modules that emphasized critical observation, data analysis, and drawing conclusions, consistent with previous research findings that stated Discovery Learning improves students' critical thinking and analytical skills in discovering scientific concepts. (Al Aliyawinata et al., 2021).

Furthermore, the learning context indicator showed a significant increase (+10.9 points), indicating that students in the experimental group were better able to relate biology material to real phenomena or situations in the module they designed. Scores for scientific values and attitudes were also higher (84.9 ± 5.5 vs. 73.5 ± 7.0), illustrating that this model supports the formation of scientific attitudes such as ethics, curiosity, and reflection on data. The validity and effectiveness of Discovery Learning-based modules in improving scientific literacy have been supported by research on module development for virus material which achieved a validity score of up to 93.5%. (Al Aliyawinata et al., 2021), and a study showing a significant effect on biology students' learning outcomes after implementing Discovery Learning combined with lesson study (post-test scores increased from an average of 37.5 to 77, with d = 3.3). Thus, the results of Table 1 provide strong empirical evidence that Discovery Learning is holistically effective in strengthening the structure and design quality of modules containing scientific literacy among prospective biology teachers. (Mardiyanti, 2023).

On the scientific content indicator, students in the experimental group who participated in the Discovery Learning model achieved an average score of 87.3, while

the control group only achieved a score of 78.6. This difference indicates that the experimental group was better able to develop learning modules with accurate, relevant content that aligned with valid biological concepts. The active exploration process enabled students to construct knowledge independently and strengthen their understanding of the learning material. This finding aligns with Patrianingsih's research. et al. (2017) which shows that the use of Discovery Learning significantly improves students' understanding of biological concepts and scientific attitudes compared to traditional lecture methods, as well as research by Sudibjo (2022) which confirms that the discovery approach strengthens the appreciation of basic biological concepts through direct learning experiences. (Patrianingsih et al., 2017; Sudibjo, 2023).

In addition, the implementation of Discovery Learning-based modules for plant tissue material in class XI IPA also showed high module validity results—up to 86–95%—and students' scientific literacy skills with a high category n-gain value of 0.71 ($p<0.05$), indicating the effectiveness of the scientific content in the developed module. (Ariana et al., 2020). Another study by Tangahu et al. (2021) on virus material reported an increase in pretest scores from ~45% to posttest scores of around 77–78%, indicating a substantial increase in the ability to organize the scientific content of the module. (Tangahu et al., 2024). Thus, the clear difference in scores on the scientific content indicators not only reflects the quality of students' module products, but also supports the success of the learning model that facilitates independent exploration and construction of scientific concepts.

The scientific process indicator showed the most striking difference, with the experimental group scoring 88.6, while the control group only achieved 79.1. This indicates that students engaged in discovery-based learning were more skilled at designing learning steps that emphasized scientific thinking processes, such as observation, analysis, data interpretation, and inference. This is a crucial component of scientific literacy because it demonstrates students' ability not only to convey information but also to develop higher-order thinking skills that can be applied in the context of science learning in schools.

Furthermore, on the scientific values and attitudes indicator, the experimental group also excelled, with an average score of 84.9, compared to the control group's 73.5. This reflects that the Discovery Learning approach contributes to the development of students' scientific attitudes, such as curiosity, objectivity, and ethical behavior in learning. These skills are crucial in developing the character of prospective science teachers who are not only academically competent but also possess scientific integrity. Overall, the data in Table 1 supports the argument that the use of the Discovery Learning model can improve the quality of module design holistically and contribute directly to strengthening the scientific literacy of prospective students.

Table 2: Average Pretest and Posttest Scores of the Control Group (Conventional)

Science Literacy Indicators	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Δ (Score Difference)	Information
Scientific Content	69.1 ± 6.3	78.6 ± 6.4	**+9.5**	Moderate increase
Learning Context	65.7 ± 6.7	74.2 ± 6.7	**+8.5**	Moderate increase
Scientific Process	66.9 ± 7.2	76.3 ± 6.1	**+9.4**	Moderate increase
Scientific Values and Attitudes	67.8 ± 6.4	73.5 ± 7.0	**+5.7**	Moderate increase
Total Average Score	**67.4 ± 7.1**	**75.7 ± 6.6**	**+8.3**	**p < 0.05 (significant)**

Table 2 shows that students in the experimental group, who studied using the Discovery Learning approach, experienced significant score increases from pretest to posttest on all scientific literacy indicators. The highest increase occurred in the scientific process indicator, with a score difference of +20.8 points, followed by the learning context indicator (+18.2 points) and scientific values and attitudes (+17.2 points). This indicates that students not only understood the material theoretically but were also able to integrate scientific thinking steps into the module design. The significant score increases reflect the effectiveness of Discovery Learning in facilitating experiential and exploratory learning processes.

In contrast, in the control group using conventional learning methods (Table 2B), although there were increases in scores across all indicators, the magnitude was relatively lower. The smallest increase occurred in the scientific values and attitudes indicator (+5.7 points), while other indicators, such as scientific content and scientific process, increased moderately, at around +9 points. This indicates that conventional methods tend to be insufficient in encouraging active student engagement in the scientific process, particularly in developing reflective and ethical attitudes in learning design.

Overall, the difference in the experimental group's pretest-posttest scores reached +18.3 points, while the control group's was only +8.3 points. This difference confirms that the Discovery Learning approach is more capable of improving students' understanding and skills in designing learning modules that comprehensively address aspects of scientific literacy. This finding also demonstrates that active, exploratory, and student-centered learning can significantly impact the mastery of pedagogical competencies of prospective biology teachers in higher education.

The data in the two tables above show that the experimental group using the Discovery Learning model experienced significant improvements in all scientific literacy indicators. Specifically, for the Scientific Process indicator, the score increased from 67.8 ± 7.1 to 88.6 ± 4.8 (Δ + 20.8), while the Learning Context indicator increased by +18.2 points (66.9 → 85.1). This improvement confirms that students learn not only to understand concepts but also to apply them in real contexts and conduct in-depth

scientific reflection. These findings align with research by Prasetyo et al. (2025), which shows that Discovery Learning supports the improvement of scientific writing skills through active synthesis and reflection, key components of scientific literacy. (Akbar et al., 2023; Yolida et al., 2023)

Furthermore, the control group also experienced improvement, but only moderately. The Scientific Process Indicator increased by +9.4 points (66.9 → 76.3), and the Scientific Values & Attitudes indicator only increased by +5.7 points. This indicates that conventional methods are able to improve basic understanding, but remain inadequate in facilitating scientific reflection and contextualization skills. Previous research also confirmed that Discovery Learning is superior to traditional methods in building scientific literacy, with a paired sample t-test showing significance ($p<0.05$) in improving students' scientific literacy. (Yolida et al., 2023)

A comparison of total scores showed that the experimental group achieved a posttest average of 86.5 ± 5.4, an increase of +18.3 points from the pretest, while the control group only increased by +8.3 points to 75.7 ± 6.6. An independent sample t-test on the posttest scores confirmed that the difference between the two groups was statistically significant ($p < 0.05$). This strengthens the scientific argument that the Discovery Learning model has a greater effect on students' scientific literacy and HOTS, as supported by research results at the Universities of Jambi and Malang that compared the conventional and blended Discovery Learning approaches with great effectiveness. (Mardiyanti, 2023).

Further analysis using a paired sample t-test ($\alpha=0.05$) for each group showed that the increase in scores in the experimental group ($t > t_{table}$, $p < 0.05$) was present across all indicators, reflecting a consistent transfer of biological knowledge into the integrated scientific literacy module design. In contrast, in the control group, the increase was smaller and there was variation across indicators, with some indicators such as Scientific Values & Attitudes showing less significant increases. This supports the review's findings which concluded that without reflective exploration and teacher support, the implementation of scientific literacy is less than optimal. (Wati & Wulandari, 2024)

Overall, this empirical data confirms that Discovery Learning not only improves conceptual understanding but also strengthens students' abilities in designing learning modules containing scientific literacy, particularly in the aspects of scientific process and contextualization. The implementation of this model provides a systematic framework for scientific synthesis, analysis, and reflection, in accordance with the principles of inquiry-based learning (IBL) and active learning, which have been proven to strengthen learning outcomes in higher education. Therefore, the application of this strategy can be used as a pedagogical model for biology education study programs that aim to produce highly qualified prospective teachers in scientific literacy and HOTS.

The implementation of the Discovery Learning model has demonstrated a strong positive impact on improving students' abilities in designing learning modules based on scientific literacy. These findings reflect the model's effectiveness in fostering active student engagement throughout the learning process, enabling them not only to become recipients of information but also to act as inventors and designers of teaching materials.

The process of concept discovery through the stages of exploration, elaboration, and reflection in Discovery Learning encourages students to think critically, analytically, and contextually all elements that are crucial for developing scientific literacy.

In the context of students in the Biology Education Study Program at Muhammadiyah University of Maluku, the application of Discovery Learning is highly relevant because it can overcome the tendency of conventional learning methods, which are still dominant and one-way. Students who participate in discovery-based learning are better able to connect biology material to real-world phenomena, develop scientific steps in the learning process, and internalize scientific values and attitudes essential to 21st-century education. This success provides a crucial foundation for developing curriculum and learning methods at the university level that are more oriented towards developing the holistic competencies of prospective teachers.

Furthermore, this success also shows that students experience improvements not only in cognitive aspects but also in affective and psychomotor aspects, as reflected in indicators of scientific attitudes and the ability to design contextual and applicable modules. This means that the systematic application of Discovery Learning can shape graduates who not only master the material but are also ready to innovate and adapt to the learning needs of the school level. This is certainly a strategic step for Muhammadiyah University of Maluku in improving the quality of biology education graduates who are superior, creative, and responsive to the challenges of the times.

Thus, the results of this study provide a strong empirical basis for recommending the expanded implementation of the Discovery Learning model in the Biology Education Study Program. This is not merely a one-time approach, but rather part of a sustainable pedagogical transformation to produce prospective educators with high scientific literacy, advanced thinking skills, and readiness to face the dynamics of the future world of education.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the results of data analysis, it can be concluded that the Discovery Learning model has a significant influence on improving the ability of students of the Biology Education Study Program at the University of Muhammadiyah Maluku in designing scientific literacy-based learning modules. This is indicated by an increase in pretest to posttest scores in the experimental group with a total average difference of +18.3 points, compared to the control group which only increased by +8.3 points. The largest increase in the experimental group occurred in the scientific process indicator, namely from 67.8 ± 7.1 to 88.6 ± 4.8, an increase of +20.8 points, while other indicators such as learning context increased by +18.2 points, and scientific values and attitudes increased by +17.2 points. Furthermore, in the final assessment of the module, the experimental group obtained the highest average score in all indicators compared to the control group. The scientific content score in the experimental group was recorded at 87.3 ± 5.1, higher than the control group at 78.6 ± 6.4, while in the scientific values and attitudes indicator, the experimental group scored 84.9 ± 5.5, far above the control

group's score of 73.5 ± 7.0. The total average final score of students in the experimental group was 86.5 ± 5.4, while the control group only achieved 75.7 ± 6.6. These data strengthen the results of statistical tests that show significant differences between groups at the significance level of $\alpha = 0.05$ through independent t-test and paired t-test. Thus, it can be scientifically concluded that Discovery Learning not only improves students' conceptual understanding, but also supports the development of scientific thinking skills, scientific attitudes, and the ability to compile contextual and scientific literacy-based modules. These findings indicate that the discovery-based learning approach is highly relevant to be applied in the context of higher education, especially in efforts to prepare prospective biology teachers who excel in designing meaningful, reflective, and contextual learning in the 21st century learning era.

Suggestions

1. Wider Implementation of the Discovery Learning Model
   Based on the findings indicating a significant improvement in students' ability to design science literacy-based learning modules, it is recommended that the Discovery Learning model be more widely implemented in the learning process of the Biology Education Study Program at Universitas Muhammadiyah Maluku. Its application should not be limited to a single course but integrated across various pedagogical and science education-related courses.
2. Capacity Building for Lecturers in Designing Discovery Learning Scenarios
   Lecturers are encouraged to participate in training or workshops focused on designing effective, contextual, and literacy-oriented Discovery Learning scenarios. This is essential to ensure optimal implementation of the model, tailored to the characteristics of both students and course content.
3. Development of Innovative Learning Modules by Students
   Students are encouraged to continuously develop their own learning modules using the Discovery Learning approach, whether for final assignments, practicums, or collaborative projects. These modules can serve as contextual teaching materials in partner schools, while also promoting a culture of innovation and pedagogical reflection within the academic setting.
4. Further Quantitative and Qualitative Research
   Further research is recommended to evaluate the long-term effects of implementing Discovery Learning on students' professional competencies. This should include quantitative experimental studies with broader sample sizes as well as qualitative investigations, such as reflective studies, module document analysis, and in-depth interviews, to enrich the empirical evidence surrounding the model's effectiveness in fostering science literacy in higher education.
5. Collaboration with Partner Schools and Educational Institutions
   It is suggested that the Biology Education Study Program strengthen its collaboration with partner schools to implement and test the learning modules developed by students. This initiative can serve as a form of field-testing and experiential learning aligned with the "Merdeka Belajar–Kampus Merdeka" (MBKM)

curriculum, allowing students to receive authentic feedback and gain real-world teaching experience relevant to the national education context.

REFERENCES

Ahfiani, W. F., & Arif, S. (2023). Pengaruh Model Pembelajaran Discovery Learning Berbasis Literasi Sains terhadap Peningkatan Kemampuan Berpikir Ilmiah Siswa. *Jurnal Tadris IPA Indonesia*, *3*(2), 210–218. https://doi.org/10.21154/jtii.v3i2.872

Akbar, S., Annovasho, J., & Mardaya, M. (2023). Meta Analisis Penerapan Media Perangkat Lunak Proteus Dalam Pembelajaran Fisika. *LAMBDA : Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya*, *3*(2), 96–101. https://doi.org/10.58218/lambda.v3i2.598

Al Aliyawinata, T. T., Utari, E., & Mahrawi, M. (2021). The Effect of Discovery Learning on Students' Higher-order Thinking Skills. *International Journal of Biology Education Towards Sustainable Development*, *1*(1), 1–9. https://doi.org/10.53889/ijbetsd.v1i1.47

Amazida, E. A., Rahmi, R., & Azzarkasyi, M. (2021). Penerapan Model Pembelajaran Discovery Learning Berbasis Praktikum Terhadap Kemampuan Literasi Sains Dan Hasil Belajar Siswa. *Jurnal Biology Education*, *9*(2), 109–113. https://doi.org/10.32672/jbe.v9i2.3913

Aprillia, I. N., & Asri, M. T. (2021). Validitas Modul Berbasis Discovery Learning untuk Melatihkan Keterampilan Literasi Sains pada Materi Virus Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *10*(2), 240–249. https://doi.org/10.26740/bioedu.v10n2.p240-249

Ariana, D., Situmorang, R. P., & Krave, A. S. (2020). Pengembangan Modul Berbasis Discovery Learning Pada Materi Jaringan Tumbuhan Untuk Meningkatkan Kemampuan Literasi Sains Siswa Kelas Xi Ipa Sma. *Jurnal Pendidikan Matematika Dan IPA*, *11*(1), 34. https://doi.org/10.26418/jpmipa.v11i1.31381

Jasman, M. W., Hala, Y., & Ismail, I. (2022). Pengaruh Penerapan Model Pembelajaran Discovery Learning Terhadap Kemampuan Siswa Menyelesaikan Soal-Soal Biologi Berkategori Hots Di Sma Negeri 1 Majene. *Jurnal IPA Terpadu*, *6*(2), 67. https://doi.org/10.35580/ipaterpadu.v6i2.33966

Mardiyanti, L. (2023). Pengaruh Model Discovery Learning Dipadu Lesson Study terhadap Hasil Belajar Mahasiswa Pendidikan Biologi. *Biodik*, *9*(3), 71–77. https://doi.org/10.22437/biodik.v9i3.28514

Marjan, E. P., Fatmawati, A., & Harisanti, B. M. (2024). Pengaruh Model Pembelajaran Discovery Learning Terhadap Keterampilan Berpikir Kritis Siswa Pada Materi Sistem Ekskresi. *Bioscientist : Jurnal Ilmiah Biologi*, *12*(2), 2575. https://doi.org/10.33394/bioscientist.v12i2.13898

Nasution, R. A., & Sutiani, A. (2022). Pengembangan Modul Berbasis Discovery Learning Terintegrasi Literasi Sains Pada Pokok Bahasan Larutan Asam Basa di SMA Swasta Cerdas Murni. *Jurnal Teknologi Pendidikan : Jurnal Penelitian Dan Pengembangan Pembelajaran*, *7*(2), 249. https://doi.org/10.33394/jtp.v7i2.5642

Patrianingsih, E. A., B, N., & Kaseng, E. S. (2017). Pengaruh Model Pembelajarn Discovery LearningTerhadap Pemahaman Konsep dan Siap Ilmiah Peserta Didik. *Journal of Biologi Edication*, *1*(1), 32–46.

Setyaningrum, H. R., Atmojo, I. R. W., & Ardiansyah, R. (2024). Hubungan antara literasi sains dan keterampilan proses sains terhadap hasil belajar kognitif hots mahasiswa pgsd. *Didaktika Dwijja Indria*, *449*, 376–383. https://jurnal.uns.ac.id/JDDI/article/view/90574/47600

Sudibjo, S. M. (2023). The Effect of Discovery Learning on The Development and Strengthening of Understanding Basic Concepts in Biology Based on Students' Experiences. *Bioma : Jurnal Ilmiah Biologi*, *12*(1), 114–122. https://doi.org/10.26877/bioma.v12i1.15868

Tangahu, S. R., Hasan, A. M., Ahmad, J., Latjompoh, M., Retnowati, Y., & Husain, I. (2024). Application of the Discovery Learning Model to Improve Students' Science Process Skills on Virus Material. *Jurnal Pembelajaran Dan Biologi Nukleus*, *10*(1), 113–121. https://doi.org/10.36987/jpbn.v10i1.5424

Wati, F. P., & Wulandari, F. (2024). the Effect of Socio Scientific Issues Based Learning on Elementary School Student' Scientific Literacy Abilities. *EDUPROXIMA : Jurnal Ilmiah Pendidikan IPA*, *6*(3), 930–941. https://doi.org/10.29100/.v6i3.4764

Yolida, B., T. Marpaung, R. R., Priadi, M. A., & Sulika, A. (2023). The Effect of the Edmodo-Assisted Discovery Learning Model on Students' Scientific Literacy Ability. *Biosfer: Jurnal Tadris Biologi*, *13*(2), 125–134. https://doi.org/10.24042/biosfer.v13i2.14191