Journal Of Biology Education Research (JBER)
Vol 6(1) 2025 | ISSN: 2774-7859
DOI: 10.55215/jber.v6.i1.24

https://journal.unpak.ac.id/index.php/jber

Development of Research-Based Modules in Hydroponic Learning

Mellisa[1*], Laili Rahmi, Yeyendra, Yandri Waltriandi, Anggun Puspita Sari

[1]Universitas Islam Riau, Pekanbaru, Indonesia

**Email:* mellisabio@edu.uir.ac.id

Received: 15 Januari 2025 Revised: 15 Maret 2025 Accepted: 25 Maret 2025

Abstract

Hydroponics is an increasingly popular cultivation method due to its land and water use efficiency. To support students' understanding in this field, a research-based learning module is needed to ensure that the material presented is relevant and evidence-based. An interactive and research-based learning module can enhance students' conceptual understanding and skills in effectively applying hydroponic techniques. This study aims to develop a hydroponic module based on research results. This study utilizes the ADDIE model in the module development phase, students' needs and curriculum requirements were identified to align the module content with learning objectives. The design phase involved structuring the module by integrating recent research findings in hydroponics, selecting appropriate instructional strategies, and incorporating interactive elements. In the development phase, the module was created with interactive features and media to enhance engagement and comprehension. The implementation phase included pilot testing with students to gather feedback on usability and effectiveness. Finally, in the evaluation phase, expert validation and student assessments were conducted to measure the module's validity and effectiveness. Trials and validation were conducted by experts, including media specialists, subject matter experts, and hydroponic practitioners, to ensure the module met quality standards. Validation results indicated that the developed module was categorized as highly valid. Additionally, based on student assessments, the module received in the "good" category, demonstrating its suitability for hydroponics courses. These findings suggest that the research-based hydroponics module is an effective learning resource for students, providing both theoretical knowledge and practical applications in hydroponics education.

Keywords: development; education; hydroponic; modules

INTRODUCTION

The increasingly advanced and modern era of globalization demands an increase in the quality and relevance of education because the progress of a nation is highly dependent on high-quality human resources (Giawa, 2023). In order to adapt to the times, the education system in Indonesia has undergone various curriculum changes aimed at improving students' adaptability to future challenges, such as globalization, environmental problems, advances in information technology, and the convergence of science and technology (Mellisa & Saputri, 2023). Therefore, education does not only focus on delivering academic knowledge but also on developing soft skills so that students can become competent individuals and compete globally (Zulaiha & Kusuma, 2020). In the Industrial Revolution 4.0 era, education, especially in science learning, is responsible for forming intelligent, accountable, and adaptive individuals to technological developments (Aryana, 2018). One important aspect of improving the quality of learning is the use of effective learning media. Learning media is a tool in the teaching and learning process to enhance students' understanding of the material (Ambri & Arsih, 2023).

According to Arsyad (2016), educators need to have sufficient knowledge of learning media because media is an integral part of the educational process that contributes to achieving learning goals. In addition, innovative learning media can generate learning motivation, improve critical thinking skills, and present information more systematically and attractively (Mellisa & Fitri, 2022). One way to improve the effectiveness of science learning is to develop teaching materials that are appropriate to the needs of students and integrate Information and Communication Technology (ICT) in biology learning (Nurdyansyah, 2018). The use of technology-based teaching materials can create a more interactive and interesting learning environment. Teaching materials can be written learning resources, such as books, modules, and worksheets, or digital forms, like interactive simulations and learning videos (Giawa, 2023). With proper design, teaching materials can help students understand complex concepts more efficiently, improve critical thinking skills, and encourage independent problem-solving (Azhar et al., 2024). The integration of ICT in teaching materials also provides wider access to valid and scientific learning resources, so that it can increase the effectiveness of learning and the readiness of students to face the challenges of the digital era (Taufik *et al*., 2024; Handoyo & Kamal, 2025).

One field of science relevant to the development of technology-based teaching materials is hydroponics, a method of cultivating plants without soil using nutrient solutions. Hydroponics has an important role in supporting environmental sustainability and food security in the modern era. However, based on the analysis of initial research, it was found that in hydroponic learning, students still rely on PowerPoint presentation media and references from blogs that have not been validated in compiling assignments or practicum reports. In addition, the hydroponic practices carried out by students are still limited to the available practicum guides, without any deeper and scientifically based learning resources. Therefore, this study aims to develop a hydroponic module based on research results so that students have more valid, systematic, and scientifically based learning resources. With this module, it is hoped that hydroponic learning will be more effective and able to improve students' understanding of the concept and application of hydroponics in everyday life.

METHOD

The ADDIE model is a key component in the systems approach to learning development and instructional design procedures. This model, which is widely used in instructional design, offers a systematic framework consisting of five core stages: Analysis, Design, Development, Implementation, and Evaluation (Suryani & Khoiriyah, 2018; Mellisa *et al.*, 2023). The ADDIE stages applied in this study are presented in Figure 1. Each phase plays an important role in ensuring the development of effective and efficient teaching materials according to educational needs.

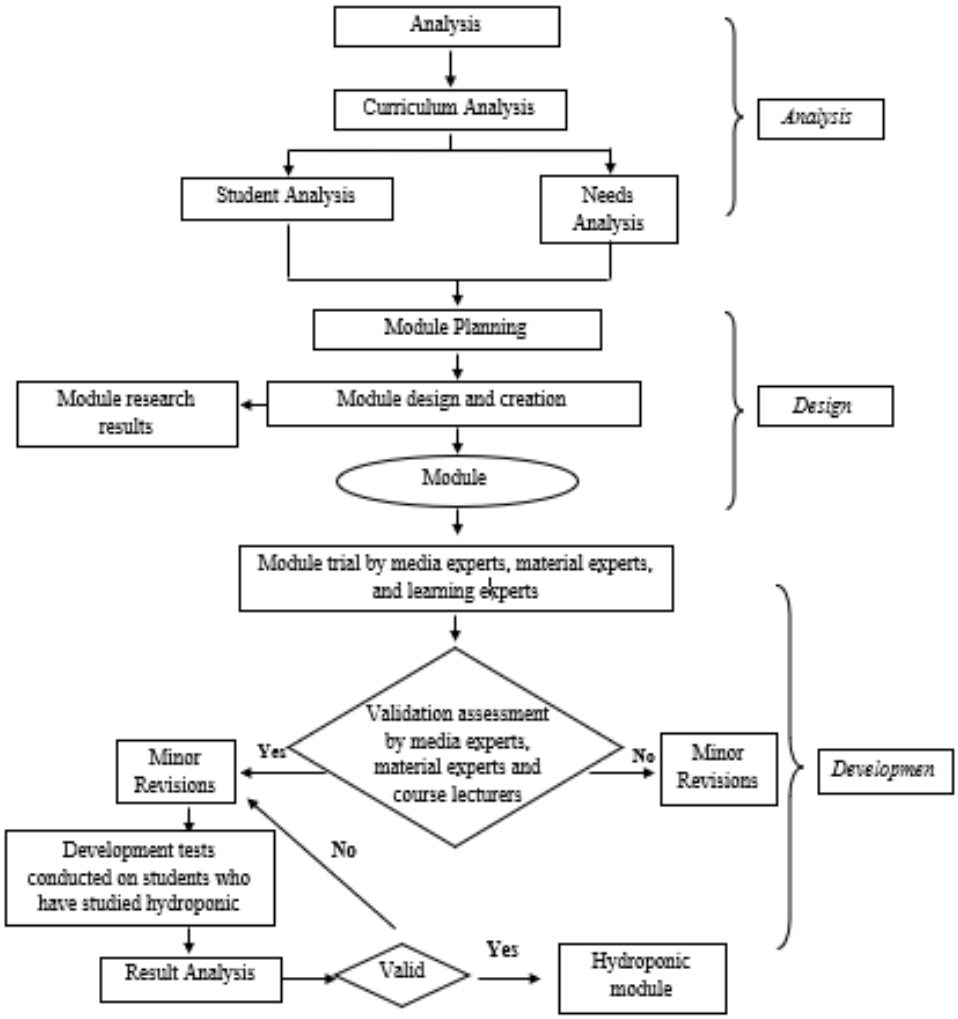

Figure 1. ADDIE Stages (Analysis to Development)
Source: (Mellisa & Yanda, 2019)

The analysis stage includes curriculum analysis, needs analysis, and student analysis. This stage determines relevant materials, student needs, and the current curriculum (Mellisa *et al*., 2023). Furthermore, the design stage includes planning, designing, and creating modules. The development stage includes validation by media experts, material experts, learning experts, and course lecturers. The validated modules are tested on students who have studied hydroponic material. The instruments used to collect data include validation sheets and student response questionnaires. The data analysis technique used is the Likert Scale method. The implementation stage in this study was carried out by applying the module that had been developed in hydroponic learning. Students used this module in learning activities independently and in group discussions. Learning activities included understanding the basic concepts of hydroponics, applying hydroponic methods in laboratory practice, and compiling reports based on the experiment results.

The evaluation stage aims to measure the effectiveness of the developed module. Evaluation is carried out in two forms, namely formative and summative evaluation. Formative evaluation is carried out during the module development process by collecting feedback from students and lecturers for further improvement. A summative assessment is carried out after the implementation of the module by

measuring the increase in student understanding using tests and analyzing student responses to the module. With this approach, the hydroponic module based on research results can be tested for its effectiveness in improving student understanding and critical thinking skills in hydroponics.

$$V = \frac{TSe}{TSh} x100\%$$

Information:
V = media validation
TSe = Total score achieved
TSh = Total maximum expected score

After the results of each validation test are known, to obtain conclusions from all the validity results of each expert, teacher and student, they can be adjusted or confirmed with validity criteria such as table 1.

Table 1. Validity criteria from validators and product assessment results by teachers

No.	Percentage Scale (%)	Criteria
1.	85.0-100	Very valid, can be used without any correction
2.	70.0-85	Quite valid, can be used but needs minor improvements
3.	50.01-70	Less valid, needs major improvement
4.	01.00-50	Invalid, cannot be used

(Akbar, 2013)

Meanwhile, the results of calculating student responses are entered into categories and these criteria can be seen in table 2.

Table 2. Criteria for percentage results of student response questionnaire

No.	Percentage Scale (%)	Criteria
1.	85.01-100	Very well
2.	75.01-85	Good
3.	60.01-75	Pretty good
4.	55.01-60	Not good
5.	≤55	Very bad

(Akbar, 2013)

RESULT AND DISCUSSION

This study focuses on the design and development stage of the ADDIE (*Analysis to Development*) model. In the design stage, this study involves planning and designing the module to be developed as part of the learning system. This process includes designing the structure, content, and interactive features of the module. The first step in the design stage is to detail the module structure by including the curriculum analysis, needs analysis, and student analysis that have been done previously. Then, this study involves content planning, where materials relevant to the learning objectives are integrated into the module. This design includes the selection of teaching methods, interactive strategies, and how information is presented to facilitate student understanding. After the design stage is completed, this research enters the development stage. At this stage, the material and design of the module that has been designed are validated by several validators, namely material experts, media experts and learning experts. Module validation is accompanied by suggestions and input from the validators, including several words that are still *typography* , adding plant image captions to the research results section, and avoiding the use of pointers in writing the contents of the module. The validity test aims to see the validity of the module from the aspects of the components of content feasibility, presentation, language and graphics (Fauziah *et al* ., 2023) . The results of the validity test can be seen in table 3 below.

Table 3. Validation results by experts (media experts, material experts and learning experts)

No	Validators	Rated aspect	Average Percentage (%)	Criteria
1	Media expert	Graphics	87	Very valid
2	Subject matter expert	Content Eligibility	95	Very valid
3	Learning Expert	Presentation eligibility	93	Very valid
		Language	92	Very valid
Average percentage			**92**	**Very valid**

Based on the validation results that have been carried out, it can be concluded that the hydroponic module based on research results that have been developed is included in the very valid category with an average percentage of 92%. This high level of validity indicates that the module has met quality standards in various important aspects, including the appropriateness of content, language, presentation, and graphics (Nurfitri *et al*., 2022). Regarding the appropriateness of content, this module has been designed according to scientific and pedagogical principles relevant to hydroponic learning. The material presented covers basic concepts to practical applications based on the latest research, thus providing in-depth and evidence-based insights for students. The accuracy and completeness of the information in this module have also been verified by experts in their fields, ensuring that the content presented has high academic validity.

In terms of language, this module uses clear, straightforward language and is in accordance with academic and pedagogical rules. The use of technical terms in hydroponics has been adjusted to students' level of understanding, thus helping them understand the concept without experiencing difficulties due to ambiguity or overly complex terms. Meanwhile, in terms of presentation, this module is designed with a systematic and easy-to-understand structure. The material is arranged hierarchically, from basic concepts, hydroponic principles, to applications and research-based case studies. The presence of illustrations, graphs, and diagrams supporting theoretical explanations further clarify the concepts presented, so students can connect theory with practice more effectively. From the graphic aspect, this module has been developed with an attractive and ergonomic visual design, paying attention to layout, color selection, and the use of relevant images to increase attractiveness and readability. The module design also adopts the user-friendliness principle, so students can easily navigate the content without experiencing difficulties. By meeting quality standards in these four aspects, this module is considered worthy of being implemented in the learning process as the leading learning resource for students taking hydroponics courses. Using this research-based module is expected to improve students' understanding of the concept and application of hydroponics and encourage their critical and analytical thinking skills in studying and applying research-based hydroponic techniques.

In addition, this module also has the potential to increase the effectiveness of learning because it provides a more interactive approach and is based on the latest scientific developments in hydroponics. In addition, using this module is expected to improve students' understanding of the concept of hydroponics in more depth because the material presented is based on the latest research and is arranged systematically (Sari *et al* ., 2024). The implementation of this module also has the potential to support the development of innovative learning methods that are more interactive and research-based, so that students can gain a more meaningful and applicable learning experience in the field of hydroponics (Purnomo *et al* ., 2024; Suryani *et al* ., 2024). After the validity test was conducted, the next stage was a limited trial of students who had taken the hydroponics course. This stage aims to see students' responses to the hydroponics module based on the research results that have been developed. This student response questionnaire includes four assessed aspects: appearance, language, material, and benefits. The results of student responses to the hydroponics module based on research results can be seen in Table 4 below.

Table 4. Results of student responses to the hydroponics module based on research results

No	Rated aspect	Average Percentage (%)	Criteria
1	Appearance	87	Very good
2	Language	82	Good
3	Material	83	Good
4	Benefit	82	Good
	Average percentage	**83**	**Good**

Based on the results of the student response questionnaire, it can be concluded that the hydroponic module based on research results that have been developed is included in the good category, with an average percentage of 83%. The high level of positive responses from students reflects that this module has been able to meet their learning needs in various aspects, such as completeness of the material, readability, and ease of understanding the concept of hydroponics (Puspitasari *et al*., 2023). In terms of the completeness of the material, students considered that this module provides comprehensive information, starting from the basic concepts of hydroponics, the working principles of the hydroponic system, and the latest research-based application techniques. The systematic presentation of the material allows students to understand the relationship between theory and practice to develop analytical thinking skills in applying hydroponic techniques effectively (AJ *et al.*, 2024).

Regarding readability, this module is designed with communicative language and is in accordance with students' level of understanding. The use of technical terms in hydroponics has been explained scientifically so that students can easily understand the concepts presented. A clear presentation structure, systematic use of subtitles, and support for illustrations and graphics also contribute to improving the readability of this module. In addition, this module is considered to make it easier for students to understand the concept of hydroponics systematically. With research-based explanations, students get theory and can see how hydroponic principles are applied in various real case studies. This helps them build a deeper understanding and encourages critical thinking in analyzing and solving problems in the field of hydroponics.

The existence of this module also provides benefits in terms of providing more structured learning resources. Students have access to materials developed in a focused and evidence-based manner to increase the effectiveness of their learning process. In addition, this module can be a primary reference for students who want to study hydroponics in more depth or are interested in research in modern agriculture. In the future, this module can still be improved based on input from students and other users. Periodic evaluation of the effectiveness of the module and integration with technology-based learning innovations can be carried out to further improve its quality. Thus, this module is expected to continue to improve the quality of education in modern agriculture, especially in equipping students with knowledge and skills relevant to current developments in agricultural technology. A module is a teaching material designed to help students learn independently, with or without teacher guidance (Setiabudi *et al* ., 2022; Pertiwi *et al* ., 2023; Famulaqih & Lukman, 2024). The module contains essential components of teaching materials that are systematically arranged using clear and easy-to-understand language so that students can access them according to their level of knowledge (Ambri & Arsih, 2023). Using modules in learning allows students to understand the material more flexibly, without relying on a facilitator. In addition, the module-based learning process can increase the efficiency, effectiveness, and relevance of learning because students can adjust the pace of learning to their needs and abilities (Lestari & Parmiti, 2020; Imran *et al* ., 2021). As a structured and complete teaching material device, modules also create a more systematic and directed learning experience so that learning objectives can be achieved optimally (Pratiwi *et al* ., 2017; Maharcika *et al*. , 2021).

In addition to the validation and trial results, several challenges were faced during this module's development. One of the main challenges is the content preparation process, which must be adjusted to the level of student understanding so that the material presented is not too difficult or too easy. In addition, the preparation of the visual design and module layout is also a challenge because it must be adjusted to

good graphic rules to make it more attractive and easy to understand. The solution implemented to overcome these challenges is to involve media experts in designing the module design so that the visual appearance is more attractive and in accordance with the principles of instructional design. In addition, in compiling the material, a readability test was carried out to ensure students could easily understand the language used in the module.

CONCLUSION

Based on the research results, the hydroponic module is classified as very valid, with an average percentage of 92%, indicating its suitability for testing on hydroponic course students. In addition, this module received an average of 83% in the good category, so it can be used in learning. This research is useful for the global community, especially for future researchers because this module needs to be tested on a wider scale with students from various study programs for further development. Further research can also explore integrating digital technology to improve learning effectiveness. In addition, this module has the potential to be applied in learning urban agriculture and sustainable agricultural systems. It can be initiate the global sustainable agricultural system and give benefit to the Nation.

REFERENCES

AJ, P. W. S., Dharmono, D., & Kaspul, K. (2024). Development of a Popular Scientific Book about Pulai Population Structure (Alstonia scholaris) in the Lake Sari Embun Region, South Kalimantan. *Journal Of Biology Education Research (JBER)*, *5*(1), 10–20. https://doi.org/10.55215/jber.v5i1.9689

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. PT. Remaja Rosdakarua Offset.

Ambri, G. N. U. A., & Arsih, F. (2023). Pengembangan Modul Pembelajaran Biologi Bernuansa Emotional Spiritual Quotient (ESQ) Pada Materi Sistem Koordinasi Untuk Siswa Kelas XI. *YASIN : Jurnal Pendidikan Dan Sosial Budaya*, *3*(1), 106–115. https://doi.org/10.58578/yasin.v3i1.870

Aryana, I. B. P. (2018). Pembelajaran Sains di Era Reviolusi Industri 4.0. *Prosiding Seminar Nasional MIPA*, 8.

Azhar, A. (2013). *Media Pembelajaran*. PT. Raja Grafindo Persada.

Famulaqih, S., & Lukman, A. (2024). Pengembangan Bahan Ajar Modul Pembelajaran. *Karakter: Jurnal Riset Ilmu Pendidikan Islam*, *1*(2), 1–12.

Fauziah, N., Oktariani, O., & Rahmawati, R. (2023). Pengembangan E-Modul Belajar dan Pembelajaran Bernuansa Hasil Riset Kependidikan. *Edukatif : Jurnal Ilmu Pendidikan*, *5*(1), 308–315. https://doi.org/10.31004/edukatif.v5i1.4484

Giawa, I. P. (2023). Pengembangan Modul Sistem Fotosintesis Pada Tumbuhan Kelas VIII Untuk Siswa SMP Negeri 2 Lolomatua. *FAGURU : Jurnal Ilmiah Mahasiswa Keguruan*, *2*(1). https://doi.org/https://doi.org/10.57094/faguru.v2i1.645

Handoyo, T., & Kamal, R. (2025). Pengembangan Bahan Ajar Berbasis Multimedia. *Harmoni Pendidikan: Jurnal Ilmu Pendidikan*, *2*(1), 230–250.

Imran, A., Amini, R., & Fitria, Y. (2021). Pengembangan Modul Pembelajaran IPA Berbasis Model Learning Cycle 5E di Sekolah Dasar. *Jurnal Basicedu*, *5*(1), 343–349. https://doi.org/https://doi.org/10.31004/basicedu.v5i1.691 Jurnal

Lestari, H. D., & Parmiti, D. P. (2020). Pengembangan E-Modul IPA Bermuatan Tes Online untuk Meningkatkan Hasil Belajar. *Journal of Education Technology*, *4*(1), 73–79. https://doi.org/https://doi.org/10.23887/jet.v4i1.24095

Maharcika, A. A. M., Suarni, N. K., & Gunamantha, I. M. (2021). Pengembangan Modul Elektronik (e-Modul) Berbasis Flipbook Maker Untuk Subtema Pekerjaan di Sekitarku Kelas IV SM/MI. *PENDASI : Jurnal Pendidikan Dasar Indonesia*, *5*(2), 165–174. https://doi.org/https://doi.org/10.23887/jurnal_pendas.v5i2.240

Mellisa, Chairun, N., & Saputri, D. (2023). Developing a video-animated learning media of the human skeletal system using Powtoon. *Research and Development in Education (RaDEn)*, *3*(1), 1–15.

https://doi.org/10.22219/raden.v3i1.23315
Mellisa, M., & Fitri, I. (2022). Pengembangan Media Pembelajaran Berbasis Video dengan Menerapkan Sistem Hidroponik pada Materi Pertumbuhan dan Perkembangan di SMA/MA Kota Pekanbaru. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(3), 4070–4081. https://doi.org/10.31004/edukatif.v4i3.2771
Mellisa, M., Nissa, C., & Saputri, D. (2023). Developing a video-animated learning media of the human skeletal system using Powtoon. *Research and Development in Education (RaDEn)*, *3*(1), 1–15. https://doi.org/10.22219/raden.v3i1.23315
Mellisa, M., & Saputri, D. (2023). Development of interactive e-books in tissue culture learning for class xi science. *Biosfer*, *16*(2), 272–285. https://doi.org/10.21009/biosferjpb.27811
Mellisa, M., & Yanda, Y. D. (2019). Developing audio-visual learning media based on video documentary on tissue culture explant of Dendrobium bigibbum. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *5*(3), 379–386. https://doi.org/10.22219/jpbi.v5i3.9993
Nurdyansyah, N. (2018). Pengembangan Bahan Ajar Modul Ilmu Pengetahuan Alambagi Siswa Kelas IV Sekolah Dasar. *Universitas Muhammadiyah Sidoarjo*.
Nurfitri, Y., Retnowati, R., & Awaludin, M. T. (2022). Development of Digital Pocket Book for Disaster Mitigation Materials Coronavirus Disease 2019 (COVID-19) to Increase Student Resilience to Disasters. *Journal Of Biology Education Research (JBER)*, *3*(1), 11–22. https://doi.org/10.55215/jber.v3i1.3651
Pertiwi, P. D., Novaliyosi, N., Nindiasari, H., & Sukirwan, S. (2023). Analisis kesiapan guru matematika dalam implementasi kurikulum merdeka. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, *6*(3), 1717–1726.
Pratiwi, P. H., Hidayah, N., & Martiana, A. (2017). Pengembangan Modul Matakuliah Penilaian Pembelajaran Sosiologi Berorientasi HOTS. *Jurnal Cakrawala Pendidikan*, *36*(2), 201–209. https://doi.org/10.21831/cp.v36i2.13123
Purnomo, P. E. A., Agustini, K., & Sudatha, I. G. W. (2024). Peran Flipbook Sebagai Media Pembelajaran Inovatif Dalam Pembelajaran Abad 21. *Jurnal Riset Dan Inovasi Pembelajaran*, *4*(3), 2001–2015.
Puspitasari, D., Sutjihati, S., & Suhardi, E. (2023). Development of E-Leaflet Based Learning Media to Improve Student Learning Outcomes in Excretion System Materials. *Journal Of Biology Education Research (JBER)*, *4*(1), 9–16. https://doi.org/10.55215/jber.v4i1.3748
Sari, H. D., Riandi, R., & Surtikanti, H. K. (2024). Bahan Ajar Digital Bermuatan Potensi Lokal Untuk Meningkatkan Pemahaman Konsep dan Motivasi Belajar Pada Materi Bioteknologi Konvensional. *Jurnal Basicedu*, *8*(1), 263–276.
Setiabudi, A. A., Octaria, D., & Fuadiah, N. F. (2022). Desain E-Modul Berbasis Problem Based Learning pada Materi Program Linear untuk Siswa Kelas XI SMA. *Mathema: Jurnal Pendidikan Matematika*, *4*(1), 27–38.
Suryani, E., & Khoiriyah, I. S. A. (2018). Pemanfaatan E-book sebagai Sumber Belajar Mandiri bagi Siswa SMA/SMK/MA. *International Journal of Community Service Learning*. https://doi.org/10.23887/ijcsl.v2i3.15422
Suryani, E., Nurfathurrahmah, N., & Herman, H. (2024). Pengembangan E-Modul Biologi Berbasis Model Pembelajaran Project Based Learning untuk Siswa SMP. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *4*(4), 789–797.
Taufik, T., Imansyah, M. N., Rayhan, M., & Jainab, U. (2024). Pelatihan Pembuatan Bahan Ajar Berbasis Digital dalam Mendukung Implementasi Kurikulum Merdeka Belajar. *Prima Abdika: Jurnal Pengabdian Masyarakat*, *4*(4), 700–710.
Zulaiha, F., & Kusuma, D. (2020). Pengembangan Modul Berbasis STEM untuk Siswa SMP. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(2), 246–255. https://doi.org/10.29303/jpft.v6i2.2182