The Effect of Using E-modules in Biology Learning on Learning Outcomes of High School and University Students: Meta-Analysis

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Abstract

This study aims to determine the effect size (ES) of the application of e-modules in biology learning on student's learning outcomes. This study uses the type of meta-analysis research. The research sample consisted of 14 articles sourced from the results of article identification through *Google Scholar* and *Eric.* The research data were collected based on the reference of inclusion and exclusion criteria. Data analysis was conducted by calculating the ES value using *Cohen's d* formula. The results of data analysis showed that there were 14 articles divided into two levels of education, namely high school (9 articles) and university (5 articles) with a total average effect size score of 1,14 which means the effect size criteria are very large (VL). The ES average score for the high school level is 1,20 or very large (VL) ES average, while the ES average score for the university level is 1,02 or categorized as large (L) ES average. Therefore, it can be concluded that the effect size of the application of e-modules in biology learning has a significant impact on improving student learning outcomes.

Keywords: *E-modules, Biology, Student Learning Outcomes, Effect Size*

1. Introduction

Learning outcomes are abilities or competencies that involve three aspects, namely cognitive, affective, and psychomotor abilities. Learning outcomes are also used as a reference to assess how far students are in understanding the material presented (Imansari & Sunaryantiningsih, 2017). High and low student learning outcomes can be influenced by internal and external factors. Internal factors that affect student learning outcomes are physiological factors. Physiological factors describe a person's mental and physical condition. This factor is very important in helping students to remain in a stable condition in learning. External factors that affect student learning outcomes include parental environment, teacher competence, teacher communication, learning motivation, learning methods, and learning media (Jamil, 2017),

Learning media is one of the most important parts that support the success of a lesson. Learning materials can be delivered well and will be easier to understand with the help of learning media. Learning media will help students learn either independently or in groups which can improve learning outcomes and build students' critical thinking skills (Alfariez & Nadiah, 2023). In the current era of globalization, learning media is required to be more creative, innovative, and effective by developing technology-based learning media that can be used in an effort to improve student learning outcomes (Citra & Rosy, 2020).

Of the various technology-based learning media that are one of the learning supporters in the world of education that are able to attract special attention because of their potential to change the current traditional education paradigm are electronic modules or e-modules. E-modules are technology-based textbooks designed by teaching staff or teachers with the aim that students can learn independently under the guidance of the teacher in a systematic manner (Hunaidah et al., 2022). E-modules that not only contain text, but are supported by video, audio, and pictorial animations make e-modules more interesting and not boring. E-modules offer various features such as ease of navigation and users are facilitated by the display of images, video, audio, animation, and e-modules also allow immediate feedback (Rahmi et al., 2021).

Biology is often perceived as a subject that contains a lot of memorized text, abstract, and scientific words which then make students difficult and reduce their interest in learning (Maryanti & Kurniawan, 2018). The presence of e-modules with more supporting features can make learning biology more interesting and can help teachers visualize biological material which is often considered abstract. So e-modules are expected to be an interactive learning media that can improve concept understanding and student learning outcomes (Dewi & Lestari, 2020).

Some previous studies that tested the effectiveness of the use or application of e-modules in learning biology to improve student learning outcomes both at the high school and college levels showed positive results in the relationship between biology e-modules and student learning outcomes. Research conducted by Wulandari et al (2020) shows the results of increasing motivation and learning outcomes of grade X students in biology learning. In addition, development research as well as experiments to develop sigil software e-modules also show results that can improve student learning outcomes (Munandar et al., 2021). Both studies are also supported by research conducted by Rodiyah et al (2023) related to the development and influence of e-modules on reproductive system material in class XI students which shows the effectiveness of e-modules in improving student learning outcomes. Based on these studies, proves that the e-module media has a great influence in improving students' biology learning outcomes. Therefore, researchers are interested in testing the Effect Size of each experimental research related to the development and application of e-modules in learning biology on student learning outcomes at the high school and university levels.

2. Material and Method

This research uses the Meta-Analysis research model. Meta-analysis is research that explains a quantitative approach and is designed to review the results of previous research (Hartati, 2022). To achieve the research objectives, this study is based on two research questions as follows: 1) Whether the application of e-modules in learning biology in high schools and universities have a significant effect on student learning

outcomes?; 2) What is the percentage of the effect size of the application of e-modules in learning biology on the ability of student learning outcomes?

Research data searches were conducted using "Google Scholar" and "Eric" with the keywords "E-module" OR "Biology" OR "Student Learning Outcomes" OR "Paired t-test". The research data in the form of articles obtained through Google Scholar and Eric searches are selected based on the inclusion and exclusion criteria described in the table as follows:

Table 1. Inclusion and Exclusion Criteria

Criteria	Description
Inclusion	1. Articles with a publication year of the last 5 years (2020-2024) 2. SINTA-indexed journals (S1-S4) for Indonesian journals 3. Articles that use experimental or quasi-experimental research methods 4. Display paired t-test data 5. Articles with the scope of high school and university biology
Exclusion	1. Articles with publication year below 2020 2. Not indexed by SINTA or Scopus 3. Display half or none of the paired t-test data.

Data collection was carried out using the PRISMA method. PRISMA (Preferred Reporting items for Systematic Reviews and Meta-Analysis) has systematic stages, namely formulating (Identification), searching for literature systematically (screening), filtering or selecting articles deemed appropriate to the researcher's title (eligibility) and analyzing articles that have been selected (included) (Zarate et al., 2022). The articles that were successfully identified through the PRISMA method were then given an "F" code on each article. The following is the PRISMA diagram of the research data filtering process flow:
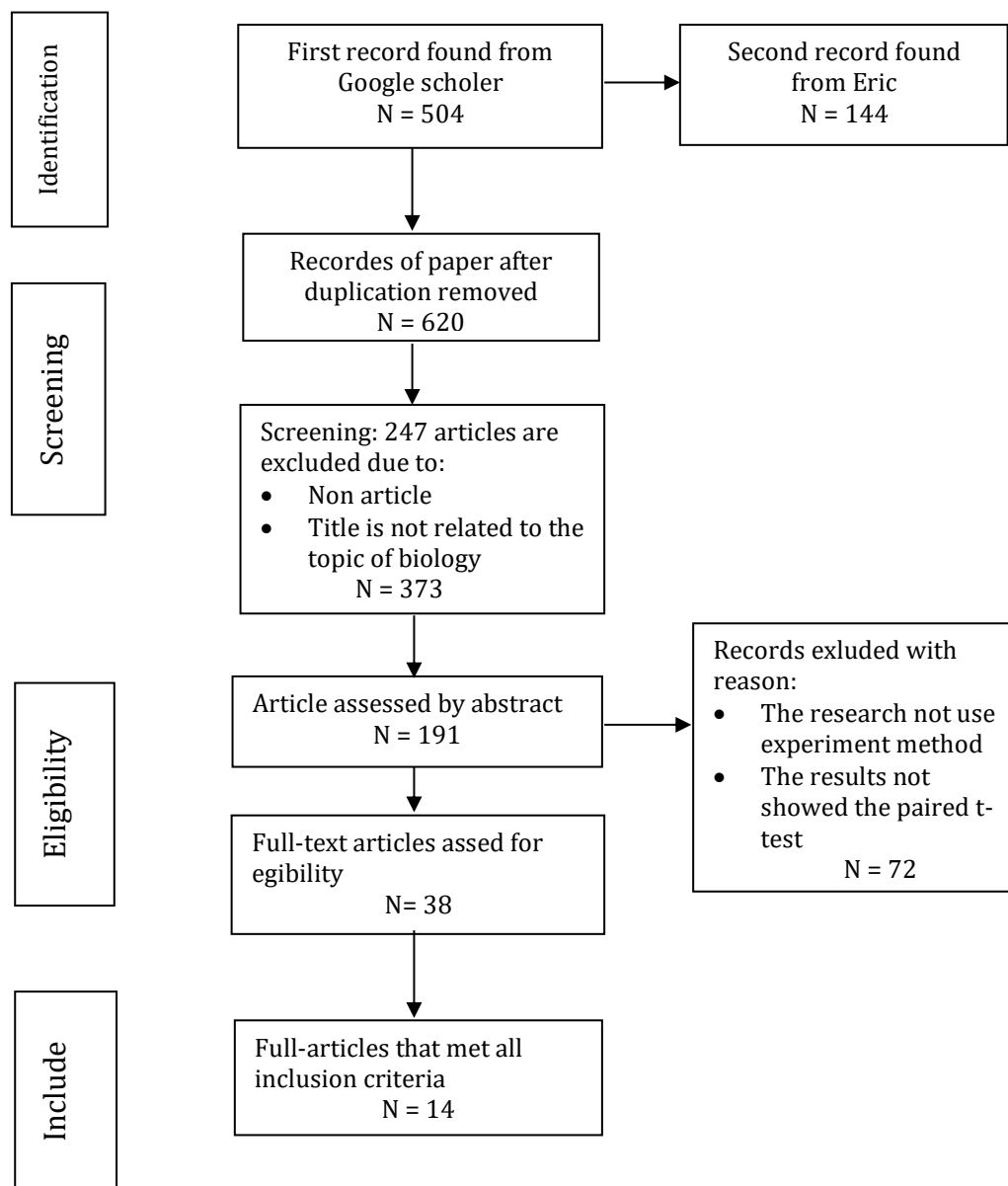
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┌─────────────┐     ┌──────────────────────┐          ┌──────────────────────┐
│             │     │  First record found  │          │  Second record found │
│Identification│    │   from Google scholer│ ───────→ │     from Eric        │
│             │     │      N = 504         │          │      N = 144         │
└─────────────┘     └──────────────────────┘          └──────────────────────┘
                               │
                               ▼
                    ┌──────────────────────┐
                    │  Recordes of paper   │
                    │  after duplication   │
┌─────────────┐     │      removed         │
│             │     │      N = 620         │
│  Screening  │     └──────────────────────┘
│             │                │
│             │                ▼
│             │     ┌──────────────────────┐
│             │     │ Screening: 247       │
│             │     │ articles are         │
└─────────────┘     │ excluded due to:     │
                    │ • Non article        │
                    │ • Title is not       │
                    │   related to the     │
                    │   topic of biology   │
                    │      N = 373         │
                    └──────────────────────┘
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                               ▼
┌─────────────┐     ┌──────────────────────┐          ┌──────────────────────┐
│             │     │ Article assessed by  │          │ Records exluded with │
│             │     │     abstract         │          │ reason:              │
│             │     │      N = 191         │ ───────→ │ • The research not use│
│ Eligibility │     └──────────────────────┘          │   experiment method  │
│             │                │                       │ • The results not    │
│             │                ▼                       │   showed the paired  │
│             │     ┌──────────────────────┐          │   t-test             │
│             │     │ Full-text articles   │          │      N = 72          │
└─────────────┘     │ assed for egibility  │          └──────────────────────┘
                    │      N= 38           │
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┌─────────────┐     ┌──────────────────────┐
│             │     │ Full-articles that   │
│   Include   │     │ met all inclusion    │
│             │     │ criteria             │
│             │     │      N = 14          │
└─────────────┘     └──────────────────────┘
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Figure 1. PRISMA diagram of research data collection

Analysis of research data using paired t-test data from each article using the cohen's d formula to determine the effect size of the application of e-modules on student learning outcomes in biology. The calculation of effect size uses Conhe's d formula which involves the difference in mean and standard deviation of the t-test results (Samo et al., 2023). The following Cohen's d formula was used to calculate the effect size of the 14 articles:

$$d = \frac{M_2 - M_1}{SD_{polled}}$$

Description:

d : the size of the effect size

M_1 : average of group 1 (control class)

M_2 : average of group 2 (experimental class)

SD_{polled}: combined standard deviation

The combined standard deviation value of the two groups was obtained using the following formula:

$$SD_{polled} = \sqrt{\frac{S_1^2 + S_2^2}{2}},$$

Description:

S_1^2 : control group variance

S_2^2 : experiment group variance

Furthermore, to determine the criteria of ES, the calculation results through Cohen's d formula are determined by following the following references:

Table 2. Effect Size Criteria

ES	Criteria
ES ≤ 0,15	Very small (VS)
0,15 < ES ≤ 0,40	Small (S)
0,40 < ES ≤ 0,75	Medium (M)
0,75 < ES ≤ 1,10	Large (L)
ES > 1,10	Very large (VL)

Source: Mayasari et al., (2022)

3. Results and Discussion

3.1. Results

Based on the results of searching and identifying articles through Google Scholar and Eric, 14 articles were obtained related to the effect of biology e-modules on the learning outcomes of high school and university students. The data from the effect size analysis of 14 articles are described in the following table:

Table 3. Effect size analysis in general

No	Code	Author, year	Level	Effect size (ES)	Criteria
1	F1	(Subhan, 2022)	High school	0,97	L
2	F2	(Lasala, 2023)	High school	1,25	VL
3	F3	(Delita et al., 2022)	Uni	0,96	L
4	F4	(Supratman et al., 2023)	High school	2,4	VL
5	F5	(Darmawulan et al., 2022)	Uni	0,40	S
6	F6	(Mulyaningsih & Mubarok, 2022)	High school	0,72	M
7	F7	(Maghfiroh et al., 2023)	High school	1,2	VL
8	F8	(Jimenez, 2020)	High school	0,57	M
9	F9	(Cruz & Mariana, 2023)	High school	1	L
10	F10	(Sumarmi et al., 2021)	Uni	2	VL
11	F11	(Sagita, 2021)	High school	1,9	VL
12	F12	(Masing & Aminatun, 2022)	High school	0,85	L
13	F13	(Sudarmika et al., 2024)	Uni	0,16	S
14	F14	(Koth et al., 2021)	Uni	1,58	VL
Total average effect size				**1,14**	**VL**

Based on the effect size analysis table above, the effect of e-modules in biology learning on student learning outcomes shows the highest value of 2.4 and is categorized in the criteria of very large (VL) influence or means that there is a very high influence between the application or use of e-modules in biology learning on student learning outcomes. The lowest effect size value is 0.16, which means that the effect of e-modules on student learning outcomes is small (S).

Table 3 Analysis of average effect size based on education level

Education level	Code	ES Average	Criteria
High school	F1	1,20	Very large (VL)
	F2		
	F4		
	F6		
	F7		
	F8		
	F9		
	F11		
	F12		
University	F3	1,02	Large (L)
	F5		
	F10		
	F13		
	F14		

Table 3 shows that the average value of ES at the high school education level is categorized as very large (VL) with an average effect size of 1,20. At the University level, the average value of ES is 1.02 and is categorized as large (L).

3.2. Discussion

Research related to the development of technology-based learning media is a topic that has been chosen by many researchers. One type of technology-based learning media that is in great demand by researchers is e-modules. Based on search data through PRISMA with the theme of biology e-modules, the number of research results reached 648 articles of various levels in the last five years. This proves that this research is currently the topic of choice among researchers in the field of education.

The application of e-modules in biology learning can affect student learning outcomes. Learning outcomes are the result of interpreting the relationship between a learning interaction and a teaching interaction (Delita et al., 2022). Learning outcomes also illustrate student success in taking a course of study. According to Bloom's taxonomy, learning outcomes can be divided into three, namely cognitive knowledge (understanding of concepts), affective (attitudes), and psychomotor (process skills) (Andriani & Rasto, 2019). Several researchers who researched to test the effectiveness of an e-module in learning biology on student learning outcomes showed mixed results.

Based on data analysis of the effect of e-modules in biology learning on student learning outcomes that have been tabulated in general table 2 shows a high average ES value between the two variables, namely the use of biology e-modules and student learning outcomes. Effect size is a natural representation of "how wrong" the null hypothesis is in quantitative terms or a measure between treatment and outcome (Hedges, 2008). ES analysis is carried out to determine the standardized difference

between the values or scores of the control and experimental groups. The ES score of a study can be done with several existing formulas, one of which is Cohen's d.

A total of 14 articles have been tested for effect size using cohen's d formula and show the highest ES result of 2.4 and is categorized as very large criteria (VL). Based on table 1 ES criteria, ES results are categorized as very large (VL) if the ES score is more than 1.10. There are 10 articles that show a large effect size score (4 articles) and very large (6 articles) which means that research on the use of e-modules in biology learning has a very significant positive effect on improving student learning outcomes, both at the high school and university levels. This is in line with Jeniffer's opinion that the application of technology-based learning media can increase student motivation and engagement, thereby also increasing student academic achievement (Harris et al., 2016).

Then, there are 2 articles that fall into the medium (M) criteria category with ES scores of 0.75 and 0.57. The calculation results with Cohen's d formula also show that there are 2 articles that have a small (S) ES score $(0.15 < ES \leq 0.40)$, namely 0.40 and 0.16. The small ES score indicates that the effect of e-modules in biology learning does not significantly improve student learning outcomes. However, the comparison of the number of articles that state a significant positive effect size of e-modules in learning biology on student learning outcomes is more than the articles that state medium or small effect size values.

This research focuses on biology topics at the high school and college or university levels. The results of the research data identification show that the use of e-modules in biology learning is more widely applied in high schools. Based on Table 3 analysis of the average ES based on the level of education, the results show that at the high school level, there are 9 articles collected with an average ES of 1.20 with very large (VL) criteria category. Meanwhile, at the university level, there were 5 articles with an average ES score of 1.02 with a large (L) criteria category. The average value of ES from both levels of education related to the effect of e-modules in biology learning on student learning outcomes proves that the effective use of technology-based learning media has succeeded in improving student learning outcomes at both levels.

The success of e-modules in improving student learning outcomes in biology learning is inseparable from the interactive nature of e-modules. E-modules are designed to display several features such as animated images, videos, audio, and text that can help visualize the contents of the module and make readers easily understand difficult material (Ricu Sidiq & Najuah, 2020). In addition, e-modules are also able to strengthen students' interest in learning independently and improve the quality of learning (Dewi & Lestari, 2020). Thus there is a positive reciprocal relationship between the use of e-modules and student learning outcomes. The results of the effect size analysis of 14 articles through Cohen's d formula prove that the use of e-modules in learning biology can significantly improve student learning outcomes.

Conclusion

Based on the Effect size analysis by calculating the mean and standard deviation values of 14 articles using cohen's d formula, the following conclusions can be drawn: 1). The application of e-modules in biology learning has a significant effect in improving student learning outcomes. 2). The ES score for the high school level is 1.20 and categorized in very large (VL) criteria, while the ES score for college or university level is 1.02 or categorized in large (L) criteria. Of the 14 articles collected, 2 articles had ES scores with small (S) criteria. However, overall the average effect size shows a positive influence of the application of e-modules in biology learning and increased student learning outcomes.

References

Alfariez, R., & Nadiah. (2023). Pengaruh Media Pembelajaran Terhadap Kemampuan Berpikir Kritis Siswa Smkn 71 Jakarta. Al Amin: Jurnal Kajian Ilmu Dan Budaya Islam, 6(1), 1–14.

Andriani, R., & Rasto, R. (2019). Motivasi belajar sebagai determinan hasil belajar siswa. Jurnal Pendidikan Manajemen Perkantoran, 4(1), 80. https://doi.org/10.17509/jpm.v4i1.14958

Citra, C. A., & Rosy, B. (2020). Keefektifan Penggunaan Media Pembelajaran Berbasis Game Edukasi Quizizz Terhadap Hasil Belajar Teknologi Perkantoran Siswa Kelas X SMK Ketintang Surabaya. Jurnal Pendidikan Administrasi Perkantoran (JPAP), 8(2), 261–272. https://doi.org/10.26740/jpap.v8n2.p261-272

Cruz, R. S., & Mariana, V. (2023). Effectiveness of constructivist e-learning module in General Biology. Sapienza: International Journal of Interdisciplinary Studies, 4(4), 1–15. https://doi.org/10.51798/sijis.v4i4.704

Darmawulan, N., Komariah, M., & Arifin, H. (2022). E-Module : Dengue Hemorrhagic Fever toward Knowledge and Learning Motivation among Nursing Students. Indonesian Nursing Journal of Education and Clinic (INJEC), 6(2016), 222–228. https://doi.org/10.24990/injecv6i2.471

Delita, F., Berutu, N., & Nofrion. (2022). ONLINE LEARNING : THE EFFECTS OF USING E-MODULES ON SELF-EFFICACY , MOTIVATION AND LEARNING OUTCOMES. Turkish Online Journal of Distance Education-TOJDE, 23(October), 93–107. https://doi.org/10.17718/tojde.1182760

Dewi, M. S. A., & Lestari, N. A. P. (2020). E-Modul Interaktif Berbasis Proyek Terhadap Hasil Belajar Siswa. Jurnal Imiah Pendidikan Dan Pembelajaran, 4(3), 433–441.

Harris, J. L., Al-Bataineh, M. T., & Al-Bataineh, A. (2016). One to One Technology and its Effect on Student Academic Achievement and Motivation. Contemporary Educational Technology, 7(4), 368–361. https://doi.org/10.30935/cedtech/6182

Hartati, N. (2022). Implementasi e-modul interaktif dalam meningkatkan motivasi dan

hasil belajar siswa pada pembelajaran biologi di SMA negeri 1 gondang. Jurnal Pendidikan Madrasah, 7(2), 173–184. https://doi.org/10.14421/jpm.2022.72.09

Hedges, L. V. (2008). What Are Effect Sizes and Why Do We Need Them? Child Development Perspectives, 2(3), 167–171. https://doi.org/10.1111/j.1750-8606.2008.00060.x

Hunaidah, M., Erniwati, E., & Mahdiannur, M. A. (2022). CinQASE E-module: Its Effectiveness to Improve Senior High School Students' Physics Learning Outcomes. Jurnal Penelitian Pendidikan IPA, 8(2), 641–648. https://doi.org/10.29303/jppipa.v8i2.1413

Imansari, N., & Sunaryantiningsih, I. (2017). Pengaruh Penggunaan E-Modul Interaktif Terhadap Hasil Belajar Mahasiswa pada Materi Kesehatan dan Keselamatan Kerja. VOLT : Jurnal Ilmiah Pendidikan Teknik Elektro, 2(1), 11. https://doi.org/10.30870/volt.v2i1.1478

Jamil, I. (2017). Faktor-Faktor Yang Mempengaruhi Prestasi Belajar Anak. Jurnal Ilmiah Pendidian Ana, 1(1), 22–30. https://doi.org/10.52960/jd.v2i1.90

Jimenez, E. C. (2020). Contextualized E-Learning Resource : A Tool for Stronger Academic Platform Contextualized E-Learning Resource : A Tool for Stronger Academic Platform. International Journal of Case Studies in Business, IT, and Education, 4(2), 110–116. https://doi.org/10.5281/zenodo.4018344

Koth, A. J., Focken, A. G., Lyden, E. R., & Yoachim, S. D. (2021). Effectiveness of an E-module at teaching novice learners critical thinking skills related to dentistry. Journal of Dental Education, 85(12), 1879–1888. https://doi.org/10.1002/jdd.12757

Lasala, N. J. (2023). Development and Validation of E-SelfIMo : E-Learning Self-Directed Interactive Module in Earth Science. Recoletos Multidisciplinary Research Journal, 11(1), 85–101. https://doi.org/10.32871/rmrj2311.01.0

Maghfiroh, M. S., Rahayu, E. S., & Widiatningrum, T. (2023). The Effectiveness of Using Mobile Learning-Based E-Plantbook with a Scientific Approach to Increase Student Learning Outcomes. Journal of Innovative Science Education, 12(37), 19–25. https://doi.org/10.15294/JISE.V11I1.60042

Maryanti, S., & Kurniawan, D. T. (2018). Pengembangan Media Pembelajaran Video Animasi Stop Motion Untuk Pembelajaran Biologi Dengan Aplikasi Picpac. Jurnal BIOEDUIN : Program Studi Pendidikan Biologi, 8(1), 26–33. https://doi.org/10.15575/bioeduin.v8i1.2922

Masing, F. A., & Aminatun, T. (2022). Developing an SSI-Based Learning Model of Android Module to Improve Critical Thingking Skills of Students. Jurnal Pembelajaran Dan Biologi Nukleus, 8(3), 673–685. https://doi.org/10.36987/jpbn.v8i3.3226

Mayasari, A., Asrizal, A., & Festiyed, F. (2022). Meta Analisis Pengaruh Media Pembelajaran Elektronik Terhadap Hasil Belajar Dan Pemahaman Konsep Siswa.

ORBITA: Jurnal Pendidikan Dan Ilmu Fisika, 8(1), 10. https://doi.org/10.31764/orbita.v8i1.7056

Mulyaningsih, U. Y., & Mubarok, I. (2022). Implementation of Multiple Representation-Based Fungi E-module on Students ' Cognitive Learning Outcomes and Writing Communication Skills. Journal of Biology Education, 11(3), 397–405. https://doi.org/10.15294/jbe.v11i3.60972

Munandar, R. R., Cahyani, R., & Fadilah, E. (2021). Pengembangan E-Modul Sigil Software Untuk Meningkatkan Hasil Belajar Siswa Di Masa Pandemi Covid-19. BIODIK, 7(4), 191–202. https://doi.org/10.22437/bio.v7i4.15204

Rahmi, E., Ibrahim, N., & Kusumawardani, D. (2021). Pengembangan Modul Online Sistem Belajar Terbuka Dan Jarak Jauh Untuk Meningkatkan Kualitas Pembelajaran Pada Program Studi Teknologi Pendidikan. Visipena, 12(1), 44–66. https://doi.org/10.46244/visipena.v12i1.1476

Ricu Sidiq, & Najuah. (2020). Pengembangan E-Modul Interaktif Berbasis Android pada Mata Kuliah Strategi Belajar Mengajar. Jurnal Pendidikan Sejarah, 9(1), 1–14. https://doi.org/10.21009/JPS.091.01

Rodiyah, S. R., Nirwana Anas, & Zulfiana Herni. (2023). Pengembangan E-Modul Biologi Materi Sistem Reproduksi Terintegrasi Paradigma Wahdatul 'Ulum Dalam Meningkatkan Hasil Belajar Siswa Kelas Xi Man Batubara. Jurnal Bionatural, 10(2), 176–186. https://doi.org/10.61290/bio.v10i2.725

Sagita, N. (2021). Development of Problem Based Learning (Pbl)-Based E-Module to Improve Critical Thinking Skills of Students In Biology Learning Class X Sman 1 Seberida Indragiri Hulu Regency. International Journal of Multidisciplinary Research and Analysis, 04(11), 1650–1654. https://doi.org/10.47191/ijmra/v4-i11-25

Samo, D. D., Ekowati, C. K., Soko, I. P., & Ngawas, K. R. (2023). Pengaruh penggunaan media pembelajaran matematika berbasis website terhadap peningkatan hasil belajar siswa: Meta-analisis. Jurnal Riset Pendidikan Matematika, 10(1), 89–101. https://doi.org/10.21831/jrpm.v10i1.49357

Subhan, A. (2022). Efektivitas Penggunaan PhET dalam Meningkatkan Hasil Belajar Ditinjau Dari Respon Pembelajaran Dan Keterampilan Saintifik. Jurnal Pendidikan Profesi Guru Madrasah, 2(3), 209–222. http://studentjournal.iaincurup.ac.id/index.php/skula

Sudarmika, P., Santyasa, I. W., Tegeh, I. M., & Sudarma, I. K. (2024). Development of Project-Based Flipped Learning Media to Achieve Nurse's Critical Thinking, Creative, and Spiritual Attitude. International Journal of Instruction, 17(2), 519–538. https://doi.org/10.29333/iji.2024.17229a

Sumarmi, Bachri, S., Irawan, L. Y., & Aliman, M. (2021). E-module in blended learning: Its impact on students' disaster preparedness and innovation in developing learning media. International Journal of Instruction, 14(4), 187–208.

https://doi.org/10.29333/iji.2021.14412a

Supratman, Noviat, W., & Hidayanti, N. (2023). Efektivitas E-Modul Berbasis Problem Based Learningterhadapliterasi Sains Sisw. Jurnal Ilmiah Wahana Pendidikan, 9(3), 623–631. https://doi.org/10.5281/zenodo.7635614

Wulandari, D. D., Adnyana, P. B., & Santiasa, I. M. P. A. (2020). Penerapan E-Modul Interaktif Terhadap Motivasi dan Hasil Belajar Siswa Pada Pembelajaran Biologi Kelas X. Jurnal Pendidikan Biologi Undiksha, 7(2), 66–80. https://ejournal.undiksha.ac.id/index.php/JJPB/index

Zarate, D., Stavropoulos, V., Ball, M., de Sena Collier, G., & Jacobson, N. C. (2022). Exploring the digital footprint of depression: a PRISMA systematic literature review of the empirical evidence. BMC Psychiatry, 22(1), 1–24. https://doi.org/10.1186/s12888-022-04013-y