



Development of Bioinformatics Based E-Magazine for Medical Biotechnology Learning: a Case Study of *In Silico* Research Project

Muhammad Abdul Irhas Ihwanul Muslimin, Muhammad Iqbal Filayani

Program Studi Pendidikan Biologi, Fakultas Tarbiyah dan Ilmu Keguruan,
UIN Sayyid Ali Rahmatullah Tulungagung

*Email: muhammadabdulirhas.uinsatu@gmail.com

Article Information	ABSTRAK
Submitted: 15 – 06 – 2025 Accepted: 27 – 10 – 2025 Published: 31 – 10 – 2025	Perkembangan teknologi berdampak pada digitalisasi di berbagai bidang, termasuk pendidikan. Di pendidikan tinggi, mahasiswa dituntut menguasai teknologi sesuai bidang keahliannya. Salah satu penerapan IPTEK mahasiswa biologi adalah bioinformatika, yang dapat diintegrasikan ke dalam pembelajaran bioteknologi kedokteran melalui media yang relevan. Penelitian ini bertujuan untuk mengembangkan <i>e-magazine</i> berbasis bioinformatika sebagai pendukung pembelajaran bioteknologi kedokteran. Metode yang digunakan yaitu <i>Research and Development</i> (R&D) dengan model ADDIE (<i>Analyze, Design, Development, Implementation, Evaluation</i>). Analisis kebutuhan melibatkan 66 mahasiswa dengan hasil 100% menyatakan setuju apabila dikembangkan <i>e-magazine</i> bioinformatika. Desain <i>e-magazine</i> dikembangkan dengan mensubstitusi hasil penelitian <i>in silico</i> senyawa daun kelor terhadap kanker paru-paru. Validasi ahli menunjukkan kelayakan sebesar 91,25% (materi) dan 85,7% (media) dengan kategori sangat valid. Penilaian kepraktisan pengguna menghasilkan rata-rata 89,8% (sangat praktis). Sedangkan uji efektivitas menghasilkan N-Gain rata-rata 0,9 (pemahaman sedang) dengan persentase 59,71% (cukup efektif). Sehingga <i>e-magazine</i> bioinformatika dapat dinyatakan layak, praktis, dan efektif untuk pembelajaran bioteknologi kedokteran. Kata kunci: Pengembangan; Bioinformatika; Bioteknologi; <i>E-Magazine</i>; <i>In silico</i>.
Publisher	ABSTRACT
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang	<i>The rapid development of technology has led to digitalization in various fields, including education. In higher education, students are required to master technology according to their field of expertise. One of the technological applications for biology students is bioinformatics, which can be integrated into medical biotechnology learning through relevant media. This study aims to develop a bioinformatics-based e-magazine as a supporting medium for medical biotechnology learning. The research employed a Research and Development (R&D) method using the ADDIE model (Analyze, Design, Development, Implementation, Evaluation). The needs analysis involved 66 students, with all participants (100%) agreeing on the importance of developing a bioinformatics e-magazine. The e-magazine design was developed by incorporating the in silico research results of Moringa oleifera leaf compounds as potential agents against lung cancer. Expert validation showed feasibility scores of 91.25% (material) and 85.7% (media), both categorized as very valid. The practicality assessment by users</i>

obtained an average score of 89.8% (very practical). Meanwhile, the effectiveness test yielded an average N-Gain score of 0.9 (medium improvement) with an N-Gain percentage of 59.71% (fairly effective). Therefore, the bioinformatics e-magazine can be categorized as feasible, practical, and effective to support medical biotechnology learning.

Keywords: *Bioinformatics; Biotechnology; Development; E-Magazine; In silico.*

Copyright ©2025, Bioeduca: Journal of Biology Education

INTRODUCTION

The rapid advancement of technology has driven digitalization across various sectors, including education. In the educational domain, technology plays an essential role in supporting the application of scientific knowledge (Rahadian, 2017). The acceleration of technological development has created demands on all parties involved in education. Both educators and students are expected to adapt to, keep up with, and utilize technological advancements. Consequently, technology can serve as a facility to support more effective and efficient learning processes (Perdani & Azka, 2019)

At the higher education level, technology has already been integrated into learning processes. This integration aims to equip students with knowledge and skills in science and technology to support the implementation of the independent learning curriculum. Moreover, the use of technology in higher education environments is expected to foster interactive, dynamic, and relevant learning experiences tailored to students' increasingly diverse needs (Amirudin, 2021). According to Fanani, based on the Indonesian National Qualifications Framework (KKNI), students are positioned at level 6. This means they must be capable of applying their skills in their respective fields by utilizing technology to solve problems and adapt to various situations (Fanani, 2020).

One form of science and technology implementation in higher education is modern biology learning through the field of bioinformatics. Bioinformatics is an interdisciplinary field that integrates biology, computer science, statistics, and informatics engineering. Bioinformatics enables the analysis of biological data on a large scale (Lesk, 2019), making research and data processing more manageable. However, the integration of bioinformatics into biology education in higher education has not yet been optimized, particularly in education-based study programs (Syita et al., 2025). A preliminary survey of students in the Biology Education Program at the State Islamic University of Sayyid Ali Rahmatullah Tulungagung showed that 33.3% of 66 respondents were unfamiliar with bioinformatics. One contributing factor is the absence of bioinformatics courses in the curriculum. Therefore, introducing bioinformatics to students requires incorporating bioinformatics content into relevant courses, such as Introduction to Biotechnology in the topic of health and medical biotechnology.

Biotechnology is a discipline that applies biological science and technology. It serves as a bridge for students to learn science and technology in biological research

(Amin, 2016). Integrating bioinformatics into biotechnology learning can provide students with knowledge of how information technology is used to process biological data (A. P. P. Sari et al., 2017). One alternative for presenting bioinformatics in biotechnology studies is through the use of e-magazine. E-magazine were chosen because they can deliver informative, interactive, visually engaging, and easily accessible learning content (Putri et al., 2017). With modern and flexible designs, e-magazines offer a refreshing learning experience, reducing students' boredom during lessons (Srikandi et al., 2019).

Moreover, the developed e-magazine does not only introduce bioinformatics concepts in biotechnology, but also includes examples of bioinformatics based biotechnology research through *in silico* studies. This *in silico* research component was selected based on students' preferences in a preliminary survey. The results indicated that students expect innovative and applicable learning media, one of which is the inclusion of a mini research project accompanied by research tutorials. The selected *in silico* project focuses on studying the bioactive compounds of *Moringa oleifera* leaves as potential treatment agents for lung cancer. Through the e-magazine, students not only learn about bioinformatics tools and databases but also explore the potential of local natural resources for research in medical biotechnology, such as drug discovery using *in silico* methods. Therefore, this study aims to develop an innovative and applicable learning media in the form of a bioinformatics-based e-magazine for learning biotechnology in the context of health and medicine.

METHODS

This study employed a Research and Development (R&D) conducted from January to May 2025 at State Islamic University of Sayyid Ali Rahmatullah Tulungagung. This research used the ADDIE model, which consists of five stages are Analyze, Design, Develop, Implement, and Evaluate (Sugiyono, 2006). Data collection techniques included observation, questionnaires, tests, documentation, and literature studies. In the Analyze stage, observations were conducted to analyze the curriculum, Semester Learning Plan, and identify students' needs. The Design stage involved arranging the structure, content, and layout (storyboard) of the bioinformatics e-magazine by integrating *in silico* research findings on the bioactive compounds of *Moringa oleifera* leaves against lung cancer. The Development stage covered the validation product's process by material and media experts through questionnaires. In the Implementation stage, the e-magazine was tested on 27 biology education students using *pre-test* and *post-test* to assess understanding and effectiveness. In the Evaluation stage, involved revising the product and assessing each development phase based on validator feedback. The data were analyzed qualitatively based on feedback from validators and users, and quantitatively using validation and practicality scores on a five point Likert scale. Furthermore, the *pre-test* and *post-test* data were statistically analyzed using SPSS 23 including normality test and significance test (paired sample *t*-test or Wilcoxon test), while the N-Gain

score was used to measure students' improvement and the product's effectiveness (Sukarelawan et al., 2024).

$$\text{Feasibility (K)} = \frac{\text{Obtained Score}}{\text{Maximum Score}} \times 100\%$$

Table 1. Percentage Scale Guidelines for Product Feasibility (Riduwan, 2007)

Percentage (%)	Criteria
81%-100%	Very Feasible
61%-80%	Feasible
41%-60%	Fairly Feasible
21%-40%	Less Feasible
0%-20%	Not Feasible

Table 2. Percentage Scale Guidelines for Product Practicality (Husein IM & Rusimamto, 2019)

Percentage (%)	Criteria
82%-100%	Very Practical
63%-81%	Practical
44%-62%	Less Practical
25%-43%	Impractical

Table 3. Normalized Gain Criteria (Sukarelawan et al., 2024)

N-Gain Score	Criteria
$0.70 \leq g \leq 1.00$	High
$0.30 \leq g < 0.70$	Medium
$0.00 < g < 0.30$	Low
$g = 1.00$	No Improvement
$-1.00 \leq g \leq 0.00$	Decrease

Table 4. Criteria for Determining The Level of Effectiveness (Sukarelawan et al., 2024)

N-Gain Score	Criteria
<40	Ineffective
40-55	Less effective
56-75	Fairly effective
>76	effective

RESULT AND DISCUSSIONS

In this study, the product produced is an e-magazine. The selection of this product was based on the result of a questionnaire distributed to sixty six respondents. The e-magazine is an innovation of printed media that has been transformed into an electronic display. Essentially, the function of an e-magazine and a printed magazine is the same, namely to present actual and up-to-date information. However, both have different physical forms while printed magazines are paper-based, e-magazines are digital and can only be accessed using electronic devices (Putri et al., 2017). Nevertheless, the use of e-magazines has expanded into various fields, one of which is education. E-magazines in the field of education are utilized as innovative and engaging learning media. The informative nature of e-magazines can

create an active learning environment because e-magazines can be equipped with various features such as visual images, videos, and others, allowing learning to take place interactively (Rohmah et al., 2020). The development of the e-magazine according to the ADDIE model is described in the following stages.

Analyze Stage

At the analysis stage, two main steps were carried out are curriculum analysis and student needs analysis. Through further examination, the *Introduction to Biotechnology* course was chosen because it has the potential to integrate bioinformatics. In addition, the two fields have a close relationship, especially in research and research data processing. Thus, it is expected that this implementation can help students in achieving the learning outcomes. Based on the analysis of the Semester Learning Plan, there is an opportunity to apply bioinformatics to the topic of health and medical biotechnology in the 9th and 10th meetings.

The learning system for health and medical biotechnology still uses conventional methods and tends to be passive because the learning process only focuses on PPT slide materials, journals, and videos. Therefore, interactive learning media is needed to support students' understanding of the application of biotechnology. Therefore, the integration of bioinformatics can be the right solution to introduce learning about genetic data analysis, vaccine design, and drug discovery from natural products using *in silico* research. To support this implementation, innovative and applicable learning media is needed.

In the needs analysis, questionnaires were distributed to 66 biology education students who had taken or were currently taking the Health and Medical Biotechnology course. The results showed that most of them experienced difficulties in understanding the topic of health and medical biotechnology, including the learning media used. All respondents expressed interest in the development of innovative bioinformatics based learning media, and respondents also showed a high interest in studying bioinformatics material. There were two learning media options to be developed, with the highest number of votes being for digital magazines (e-magazines). In addition, several criteria were provided by respondents for the learning media to be developed, such as ease of access, attractive visuals, supporting videos, and *in silico* research projects equipped with tutorials. So that they could help students in understanding the material.

Design Stage

In the design stage, a storyboard of the media to be developed was created. In this stage, the layout, font, and color scheme of the digital magazine were also determined. Additionally, the content to be included in the digital magazine was arranged, covering the introduction to bioinformatics, the integration of bioinformatics with biotechnology, the utilization of *Moringa oleifera* as medicine, *in silico* research, a bioinformatics research project in health and medical biotechnology using an *in*

silico approach, crossword puzzle exercises, and research tutorials in the form of text and videos.

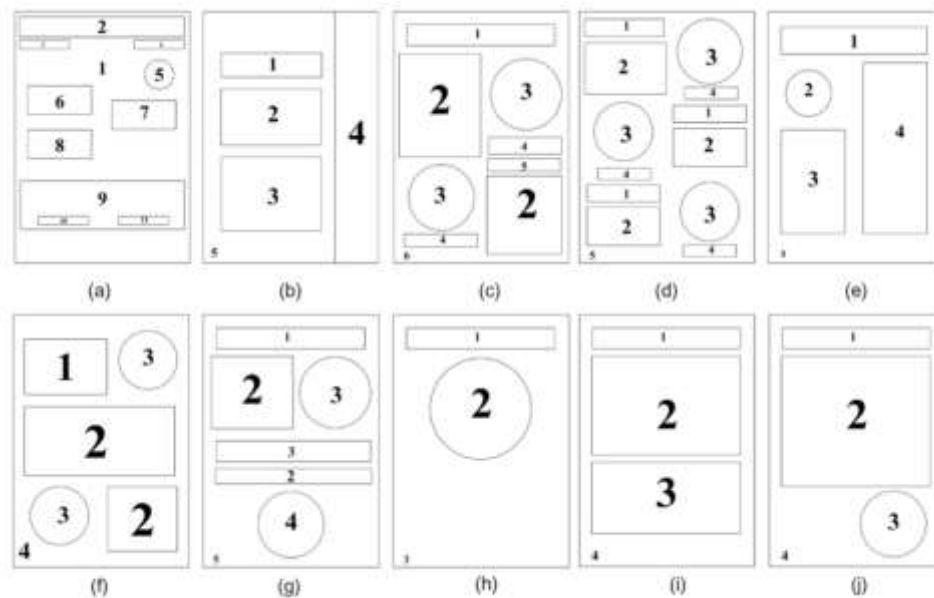


Figure 1. Storyboard of the E-Magazine (a) Front Cover, (b) Qur'anic Verse Page, (c) Chapter 1 Material, (d) Chapter 2 Material, (e) Chapter 3 Material, (f) Chapter 4 Material, (g) Chapter 5 Material, (h) Tutorial Video, (i) Crossword Puzzle, and (j) Compiler Profile

Development Stage

In this development stage, there were two main stages, namely the development of the product according to the storyboard and the validation of the developed product. The product was created using the Canva editing application, which was then uploaded to a digital platform called Hyzine. The developed product consists of 88 pages. The following is the result of product development based on the design framework:



Figure 2. E-Magazine Development (a) Front Cover, (b) Qur'anic Verse, (c) Example of Bioinformatics Definition Material, (d) Example of Integration of Bioinformatics & Biotechnology Material, (e) Example of *In Silico* Research Material, (f) Example of *Moringa oleifera* Content Material, (g) Example of Research Project Material, (h) Example of Tutorial Video, (i) Crossword Puzzle Questions, and (j) Author Profile.

Then, the developed product underwent a feasibility assessment/validation by relevant experts. The product assessment was carried out by material experts (one biotechnology lecturer), media experts (one biology education lecturer), and respondents for readability testing (twenty seven biology education students). The assessment by subject matter experts and media experts aimed to determine the feasibility of the developed product. So that the product met the feasible/valid category and could be used in field testing. The following are the results of the e-magazine assessment by the validators:

Table 5. The Result of Validation from Material Expert

Aspect/Indicator	Average	Percentage (%)	Criteria
Content Feasibility	4.6	92%	Very Feasible
Language Feasiblitty	4.6	84%	Very Feasible
Presentation	4.6	93.3%	Very Feasible
Usefulness	5	100%	Very Feasible
Average	4.6	91.25%	Very Feasible

Table 6. The Result of Validation from Media Expert

Aspect/Indicator	Average	Percentage (%)	Criteria
E-Magazine Size	4.5	90%	Very Feasible
Cover	4.4	88%	Very Feasible
Content Design	4.14	82.8%	Very Feasible
Average	4.34	85.7%	Very Feasible

The first validation was conducted by the subject matter expert, consisting of four assessment components with sixteen assessment items. Based on the assessment, the average score obtained was 4.6 (91.25%) with the description of *very feasible/valid*. This indicates that the e-magazine has met the feasibility criteria in terms of content. However, several suggestions and criticisms were provided by the validator, so the e-magazine required minor revisions before entering the implementation stage. The second validation was carried out by the media expert with three assessment components consisting of fourteen assessment items. Based on the assessment, the average score obtained was 4.34 (85.7%) with the description of *very feasible/valid*. This indicates that the e-magazine has met the feasibility criteria in terms of media. Similar to the content validation, there were several revision notes from the media validator. Therefore, before being tested, the e-magazine had to undergo minor revisions first.

Based on the assessment scores obtained in terms of content and media, it shows the *very feasible/valid* category. The validity criteria of learning media are also mentioned by Arikunto (2013), stating that valid learning media is media that has a validity score according to the established assessment criteria, thereby ensuring

alignment between the two. Referring to the assessment criteria, media with a percentage range of 81%-100% can be categorized as *very valid*, making it highly feasible for use (Riduwan, 2007). Even if there are no revisions or only minor revisions, if the media meets the validity criteria based on the validator's assessment, then the developed media can be categorized as valid (Kintoko, 2017). This is line with the findings of D. W. Sari & Muhammad Iqbal Filayani (2022), who obtained a score of 75% from material and media expert validators, failing in to the '*valid*' category although it still required revisions.

Then is the practicality test. In the practicality test, a readability test was conducted on twenty seven respondents. There were three assessment aspects with seventeen assessment items. The average score obtained from the assessments is presented in the following table:

Table 7. The Result of Validation from Student Readability (Practicality)

Aspect/Indicator	Average	Percentage (%)	Criteria
Design, Language, Visual	4	91.2%	Very Practical
Presentation of Material	4	88.25%	Very Practical
Usefulness	4.25	90.92%	Very Practical
Average	4.16	89.8%	Very Practical

Based on the table, the total average score obtained was 4.16 (89.8%), indicating that the media falls into the *very practical* category. These research results are also supported by the research of Diantari et al., (2018), which states that learning media that meets the practicality criteria is media that obtains a percentage of $\geq 70\%$. In addition, Hastini & Tanjung (2022) also state that the practicality of learning media includes several aspects, such as ease of understanding the material and the suitability of media use for students. If students provide positive feedback on the learning media, then the developed media is considered suitable and easy to use.

Implement Stage

At the implementation stage, the e-magazine was tested in the learning process. The trial was conducted on students of the 6B Biology Education class, consisting of twenty seven students. The first stage was carried out by giving a *pre-test*, then the students were treated by using the e-magazine as a learning reference. In the final stage, students were given a *post-test*. The purpose of this test was to determine whether there was an increase in scores before and after the treatment, as well as to measure students' understanding of the material presented (Aisyah Siregar et al., 2023). This way, it could be identified whether the e-magazine was effective or not.

Table 8. The Average Results of The Pre-test and Post-test

Test	Average	Lowest Score	Highest Score
Pre-test	47.4	30	70

Post-test	78.8	60	95
-----------	------	----	----

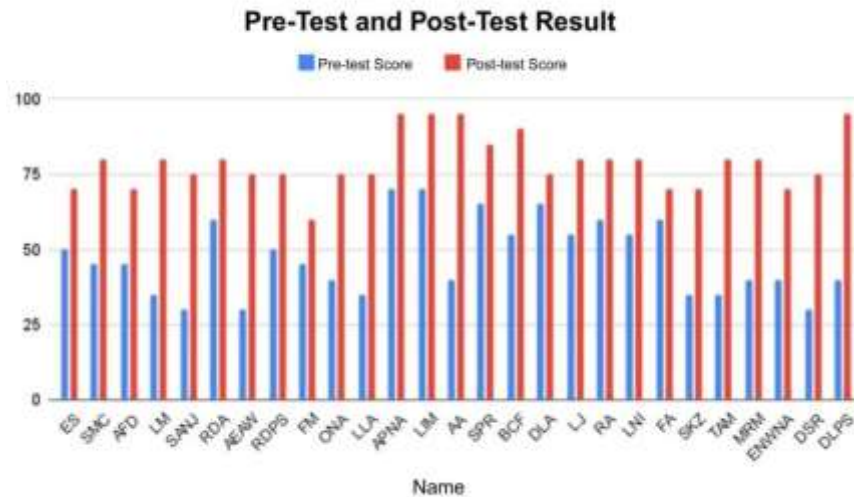


Figure 3. Diagram of pre-test and post-test result

Based on the diagram above, it is known that there was a difference between the *pre-test* and *post-test* results. All participants showed good performance, indicating an increase in scores before and after using the e-magazine in the learning of health and medical biotechnology. The difference in scores can also be seen from the average *pre-test* score of 47.4 and *post-test* score of 78.8. To further confirm the effectiveness of the developed learning media, the pre-test and post-test data were analyzed statistically using SPSS 23.

The first step was to conduct a normality test to determine whether the data were normally distributed or not, as this affects the choice of further tests. The following table presents the results of the normality test.

Table 9. Results of The Normality Test
Kolmogorov-Smirnov^a Shapiro-Wilk

	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	.053	27	.053	.931	27	.075
Post-test	.001	27	.001	.903	27	.015

^aLilliefors Significance Correction

The normality test used the Shapiro-Wilk method, with the *pre-test* score having a significance value of 0.075 and the *post-test* score 0.05. These results showed that the *post-test* data were not normally distributed because the *post-test* significance value was smaller than 0.05. The non normal distribution of data can be influenced by several factors, one of which is the limited research sample size. In this study, the sample consisted of twenty seven students. This is in line with the study by

Zulkipli et al., (2024), who stated that using a sample of ≤ 30 can cause limitations in research, thus meeting the criteria for non-normal data.

An alternative when dealing with non-normal data distribution is to use a non-parametric test, namely the Wilcoxon test. The Wilcoxon test was used to replace the paired sample t-test because of the relatively small sample size (Zulkipli et al., 2024). The following table presents the results of the Wilcoxon test.

Table 10. Results of The Wilcoxon Test	
<i>Post-test-Pre-test</i>	
Z	-4.554 ^b
Asymp.Sig.(2-tailed)	.000

The Wilcoxon test used two hypotheses as a comparison are H_0 (there is no difference in test scores before and after treatment) and H_1 (there is a difference in test scores before and after treatment). Based on the statistical analysis, the significance result showed an Asymp.Sig (2-tailed) value of 0.000. This result indicates that the value was smaller than 0.05, meaning that H_0 was rejected. Thus, the Wilcoxon test revealed a significant difference in students' test scores before and after using the e-magazine.

The students' *pre-test* and *post-test* scores were also analyzed using the N-Gain score. According to Sukarelawan et al., (2024), the N-Gain score is used to determine the level of difference between the *pre-test* and *post-test* scores, providing insight into students' improvement in understanding the material. The following are the results of the N-Gain score and N-Gain percentage tests.

Table 11. The Average Results of The N-Gain Test		
Test	Score	Criteria
N-Gain Score	0.59	Medium improvement
N-Gain Percentage	59.17%	Fairly effective

The N-Gain analysis of data from twenty seven students showed an average score of 0.59, indicating a medium level of improvement in understanding based on the pre-test and post-test results (Sukarelawan et al., 2024). Meanwhile, the N-Gain percentage calculation yielded a value of 59.71%. According to Sukarelawan et al., (2024), product effectiveness values within the range of 56–75% are categorized as fairly effective. Therefore, it can be concluded that the bioinformatics e-magazine is fairly effective as a learning medium. However, the effectiveness of a product can also be viewed from the effectiveness of the learning process itself. According to Buccheri (2011) in (Diwanata et al., 2021), interest, motivation, and learning facilities

can influence learning effectiveness. Thus, effective learning media can also support the overall effectiveness of the learning process.

Evaluation Stage

The evaluation stage was carried out at every stage of the research model, starting from analysis to implementation. According to Branch (2009), evaluation is conducted to assess the quality of the product in the learning process, both before and after implementation. Based on the evaluation results of the *Analysis* stage, it was found that bioinformatics material has potential to be applied in the field of health and medical biotechnology. This was supported by the analysis of the syllabus, which showed the relevance between bioinformatics and biotechnology. Moreover, from the analysis of students' needs, positive responses were obtained toward the development of bioinformatics based learning media, providing a strong foundation for developing media according to student needs.

The evaluation in the *Design* stage focused on planning the e-magazine learning media by creating a storyboard. This stage also determined the planning of e-magazine components such as cover, content, layout, colors, visuals, and other elements based on student needs. Evaluation in the *Development* stage focused on developing the product according to the storyboard created previously. The resulting product was then tested for its validity and practicality by material experts, media experts, and readability test respondents. Evaluation in the *Implementation* stage included evaluating the product trial in the field. This evaluation aimed to observe student responses and product effectiveness. In this stage, treatment was given before (pre-test) and after (post-test) using the e-magazine. This confirmed that the e-magazine was effective for use in learning.

CONCLUSION AND RECOMMENDATION

This R&D study using the ADDIE development model successfully produced a bioinformatics e-magazine as a learning medium that meets the learning needs of students in biotechnology courses. Based on the validation results, the e-magazine received scores of 91.25% from material experts and 85.7% from media experts, indicating that the product is highly valid. The practicality test showed an average score of 89.8%, categorized as very practical. The N-Gain analysis obtained an average score of 0.59, indicating a medium level of improvement in students' understanding, while the N-Gain percentage reached 59.71% classified as fairly effective. These findings demonstrate that the bioinformatics e-magazine is valid, practical, and effective in enhancing students' understanding of bioinformatics applications in biotechnology learning. Therefore, the bioinformatics e-magazine can be used as supplementary learning material, particularly for topics related to health and medical biotechnology. Future researchers are recommended to apply this e-magazine to a broader group of students, integrate it with more interactive learning platforms, and evaluate its long-term impact on students' learning outcomes.

REFERENCES

- Aisyah Siregar, N., Royani Harahap, N., & Sari Harahap, H. (2023). Hubungan Antara Pretest dan Posttest dengan Hasil Belajar Siswa Kelas VII B Di MTS Alwashliyah Pantai Cirebon. *Edunomika*, 07(01), 2–3.
- Amin, M. (2016). Perkembangan biologi dan tantangan pembelajarannya. *Seminar Nasional Pendidikan Dan Saintek*, 2016, 1–11.
- Amiruddin. (2021). *Jejak-jejak praktik baik sang pengajar*. Tangerang Selatan: Pascal Book PT. Mediatama Digital.
- Arikunto, S. (2013). *Prosedur penelitian: Suatu pendekatan praktik* (Cet. 15). Jakarta: Rineka Cipta.
- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.
- Diantari, L. P. E., Damayanthi, L. P. E., Sugihartini, N. S., & Wirawan, I. M. A. (2018). Pengembangan E-Modul Berbasis Mastery Learning Untuk Mata Pelajaran KKPI Kelas XI. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, 7(1), 33. <https://doi.org/10.23887/janapati.v7i1.12166>
- Diwanata, B., Rohman, F., & Munzil. (2021). PENGEMBANGAN MOBILE APPS KEANEKARAGAMAN BURUNG BERBASIS PJBL DAN EFEKTIVITASNYA PADA KEMAMPUAN LITERASI BURUNG MAHASISWA. *Jurnal Pendidikan Biologi*, 12(3), 158–163.
- Fanani, M. Z. (2020). Pengembangan Kurikulum Berbasis Kerangka Kualifikasi Nasional Indonesia (KKNI) Program Studi S1 Manajemen Pendidikan Islam Fakultas Tarbiyah IAIN Kediri Untuk Meningkatkan Mutu dan Daya Saing. *Journal of Islamic Education Management (JoIEM)*, Vol. 1 No., 1–28.
- Hastini, F., & Tanjung, I. F. (2022). Pengembangan Majalah Biologi (Biozine) Terintegrasi Nilai-Nilai Islam Pada Materi Bioteknologi. *Jurnal Pembelajaran*, 8(2), 317–329.
- Husein IM, M. S., & Rusimamto, P. W. (2019). Pengembangan Trainer Smart Traffic Light Berbasis Mikrokontroler Arduino Pada Mata Pelajaran Sistem Kontrol Terprogram Di Smk Negeri 1 Cerme. *Jurnal Pendidikan Teknik Elektro*, 9(1), 105–111. <https://ejournal.unesa.ac.id/index.php/jurnal-pendidikan-teknik-elektro/article/view/30819>
- Kintoko, K. (2017). Problem-Based Interactive Media on Circle'S Tangent By Using Adobe Flash Cs6. *Daya Matematis: Jurnal Inovasi Pendidikan Matematika*, 5(3), 399. <https://doi.org/10.26858/jds.v5i3.4847>
- Lesk, A. M. (2019). *Introduction to bioinformatics* (5th ed.). Oxford University Press.
- Perdani, H. N., & Azka, R. (2019). Teknologi Dan Pembelajaran Matematika Generasi Milenial. *Prosiding Sendika*, 5(1), 508–514.
- Putri, R. R., Muhaimin, & Syahri, W. (2017). PENGEMBANGAN e-MAGAZINE PADA MATERI LARUTAN ASAM DAN BASA UNTUK SISWA KELAS XI MIPA DI SMAN 1 KOTA JAMBI. *FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN UNIVERSITAS JAMBI* UNIVERSITAS JAMBI, 634.
- Rahadian, D. (2017). Teknologi informasi dan komunikasi (tik) dan kompetensi teknologi pembelajaran untuk pengajaran yang berkualitas. *Jurnal Teknologi Pendidikan Dan Pembelajaran*, 2(1), 234–254.
- Riduwan. (2007). *Skala pengukuran variabel-variabel penelitian*. Bandung: Alfabeta.
- Rohmah, A., Saputra, H. J., & Listyarini, I. (2020). PENGEMBANGAN E-MAGAZINE BERBASIS ANDROID DALAM PEMBELAJARAN KELAS V SEKOLAH DASAR.

- Elementary School*, 7(02), 290–296.
- Sari, A. P. P., Amin, M., & Lukiati, B. (2017). Buku Ajar Bioteknologi Berbasis Bioinformatika Dengan Model Addie. *Jurnal Pendidikan*, 2(6), 768–772.
- Sari, D. W., & Muhammad Iqbal Filayani. (2022). Bioeduca: Journal of Biology Education. *Bioeduca: Journal of Biology Education*, 4(2), 1–11.
- Srikandi, N., Putra, I. A., Ayu, N., & Pertiwi, S. (2019). DIFFRACTION: Journal for Physics Education and Applied Physics Majalah Elektronik Materi Rambatn Kalor untuk Meningkatkan Minat Belajar Peserta Didik. *Journal for Physycs Education and Applied Physics*, 2(1), 1–8.
- Sugiyono. Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung Alfabeta, 2006
- Sukarelawan, M. I., Indratno, T. K., & Ayu, S. M. (2024). N-Gain vs Stacking. *Surya Cahya*, 53.
- Syita, A. R., Shofiyah, I., Putri, Y. E., & Afnani, M. R. (2025). Pengembangan E-Modul Bioinformatika Berbasis Program Based Learning (PBL) Tentang Prediksi Interaksi Senyawa Aktif Daun Pepaya Sebagai Kandidat Obat Kanker Paru-Paru. *Otus Education: Jurnal Biologi Dan Pendidikan Biologi*, 3(1), 1–12. <https://doi.org/10.62588/otusedu.2025.v3i1.0243>
- Zulkipli, Zulfachmi, & Rahmad, A. (2024). Alasan Peneliti Menggunakan Analisis Statistik Wilcoxon (Non Parametrik). *Prosiding Seminar Nasional Ilmu Sosial Dan Teknologi (SNISTEK)*, 6, 119–125.

