

DEVELOPMENT OF DIGITAL COMIC GENETIC ENGINEERING BASED ON ANDROID WITH INTEGRATED ISLAMIC VALUES

Akhmad Syaferi*, Hening Widowati, Agus Sutanto

Biology Education Study Program, Postgraduate Program,
 Universitas Muhammadiyah Metro

Jl. Gatot Subroto No.100, Yosodadi, Kota Metro, Lampung, Indonesia

*corresponding author: akhmadsyaferi@gmail.com

Abstract: Technological advances encourage learning media innovations, one of which is digital comics. This study aims to develop digital comics with the theme of genetic engineering integrated with Islamic values using the ADDIE model (analyze, design, development, implementation, and evaluation). The results of the needs analysis showed that 90% of students had difficulty understanding the concept of genetic engineering, while 87% were interested in using digital comics as learning media. The developed digital comics were validated by three experts, namely material, media, and Islamic values experts, with the percentage of feasibility of 85%, 98%, and 92%, respectively, all of which were included in the category of “very feasible.” The results of the trial conducted with one teacher obtained an average percentage of 98%, while the trial with 30 students obtained an average percentage of 88%, both in the “very good” category. These findings indicate that digital comics are feasible to use as biology learning media in high school with interactive audio-visual advantages. Further research is recommended to focus on measuring the achievement of learning objective criteria to determine the impact of using this digital comic on improving overall student learning outcomes.

Keywords: android, digital comic, genetic engineering, islamic values, qr code

INTRODUCTION

Rapidly growing technological advances affect various aspects of life, including education. To create superior human resources in the modern era, education must be able to integrate technology in the learning process. This is important so that education policy can answer the challenges of the industrial revolution 4.0, which demands the use of advanced technology in supporting the effectiveness and quality of learning (Nirmala et al., 2023). Educators are required to develop effective and innovative learning media to achieve learning objectives. Learning media acts as a supporting tool in the learning process, ensuring information and communication between teachers and students are well conveyed (Syaferi et al., 2022). Audio-visual learning media, such as images and videos, are more effective in conveying ideas or information than text or oral (Barutu & Harfiani, 2023). In learning complex high school biology, these media help clarify the material and improve student understanding. Digital comics offer advantages by combining attractive images, videos, and text, making it easier for students to access and understand information quickly through smartphones (Utomo, 2021).

The results of interviews with biology teachers of class X phase E at SMAN 1 Sekampung revealed that many students have difficulty in understanding genetic engineering material because of its complex and abstract nature. Genetic engineering itself involves gene manipulation to produce recombinant DNA through gene insertion. This finding is in line with the results of previous research which shows that genetics material is a difficult topic for students to understand because it involves molecular concepts that are not easily observed directly (Darlian, 2024). In addition, Indah & Fadilah, (2024) added that the limitations of media capable of visually

Published by: Program Studi Pendidikan Kimia FKIP Universitas Lambung Mangkurat
 How to Cite: Syaferi, A., Widowati, H. Sutanto, A. (2025). Development Of Digital Comic Genetic Engineering Based On Android With Integrated Islamic Values. *QUANTUM: Jurnal Inovasi Pendidikan Sains*, 16(2), 160-171. <http://dx.doi.org/10.20527/quantum.v16i2.22018>

Article History:

Received : 28-02-2025, *Accepted* : 26-06-2025, *Published* : 08-10-2025

displaying biological processes also exacerbated students' learning difficulties in understanding these concepts. To overcome this difficulty, a more effective learning media is needed. Furthermore, a needs analysis was conducted through a questionnaire given to 30 students through Google Form, showing that 90% of students found it difficult to understand the material and 70% considered the teacher's delivery to be less interesting. In addition, 63% of students assessed that the learning media used were still limited to textbooks and PowerPoint. As many as 87% of students expressed interest in the development of digital comics as an innovative learning media for genetic engineering material.

The use of digital comic learning media is expected to be an alternative solution in learning. Digital comics are media in the form of stories with characters or figures that convey information through digital media. Digital comics offer an adaptive approach as a solution to student learning difficulties with various advantages. This media is easily accessible through Android devices without the need to carry heavy physical books (Aini, 2024). Audio-visual elements, such as colorful images, animations, and interactive features, make the material more interesting and improve comprehension (Bernadhed et al., 2024). In addition, students can study according to their schedule, repeat difficult parts, and access the material outside of school hours (Fidianingsih & Priyana, 2022). Digital comics are also more cost-effective, as they do not require printing and distribution, as well as being environmentally friendly by reducing the use of paper (Putro, 2021). Digital comics are an interactive learning solution that can improve student understanding through audio-visual elements. The integration of Qur'an-based Islamic values not only enriches the material but also shapes the character of students with noble character. This is in line with the Merdeka Curriculum, which encourages contextual learning and strengthening the Pancasila Student Profile, including religious aspects. Islamic content in learning media supports the achievement of academic competence as well as spiritual character development (Suprianingsih et al., 2022). Along with technological developments, many students have used Android smartphones in their daily lives, opening up great opportunities for the use of technology in the education field (Atika et al., 2022). One technology that can support the development of digital comics is the QR code, which has the ability to store and translate information quickly and efficiently (Ardhi & Farell, 2023). With this feature, digital comics can be equipped with videos and practice questions that can be accessed directly by students, so that learning becomes more interesting and effective.

Several previous studies have explored the effectiveness of digital comics in improving students' understanding of science concepts. The use of digital comics in science learning can significantly improve students' learning outcomes and communication skills (Naila et al., 2022). However, these studies have not specifically integrated Islamic values as part of the learning content. In addition, the use of QR codes in learning can increase student engagement by providing quick access to additional learning resources (Ratnasari et al., 2024), but the research is still limited to technical aspects and has not examined its impact on understanding science concepts in more depth.

The research gap filled by this study is the absence of digital comic-based learning media that specifically integrates QR Code technology with Islamic values in science learning, especially on genetic engineering material. Although there have been several studies that develop Islamic nuanced science learning media, most of them are still limited to general materials such as the human digestive system (Rahmayani et al., 2022), the human respiratory system (Umami & Ramadhan, 2022), and biodiversity (Nurhidayah & Hakim, 2024). Previous research shows that the

integration of Qur'anic values can improve students' understanding of science concepts while strengthening religious character. However, there are still few studies that explore how this approach can shape students' concept understanding and character in an Islamic perspective. Islamic perspectives in learning include the integration of moral values such as honesty, responsibility, and hard work, as well as contextualizing science with Qur'anic verses to show the harmony between science and Islamic teachings (Elmontadzery et al., 2024). However, previous studies have limitations, such as not utilizing interactive technologies such as QR codes, focusing on general science materials, and evaluations that are limited to media validity without assessing their impact on concept understanding and character building. Therefore, the purpose of this research is to develop learning media in the form of Android-based digital comics and QR Codes on Genetic Engineering material by integrating Islamic values for Phase E high school students, not only offering innovation in terms of technology and learning media, but also answering the need for student character building based on Islamic teachings, in line with the objectives of the Merdeka Curriculum.

METHOD

This research uses the research and development method with the ADDIE development model (Latip, 2022). This model consists of five main stages. The first stage, analyze, includes performance, needs, and curriculum analysis (Hidayah & Hakim, 2024). Second, the design stage involves plot design, character design, and scenario creation (Zaharah et al., 2023). Third, the development stage involves the process of preparing storyboards, making applications, and product validation (Syafari et al., 2022). Fourth, the implementation stage is carried out with product trials to see the responses of teachers and students to the digital comics developed by Ristanto et al., (2024). Finally, the evaluation stage includes evaluation and revision based on the results of expert validation or trials to ensure the quality of the digital comics developed (Pinatih & Putra, 2021). The flow of research conducted can be seen in Figure 1.

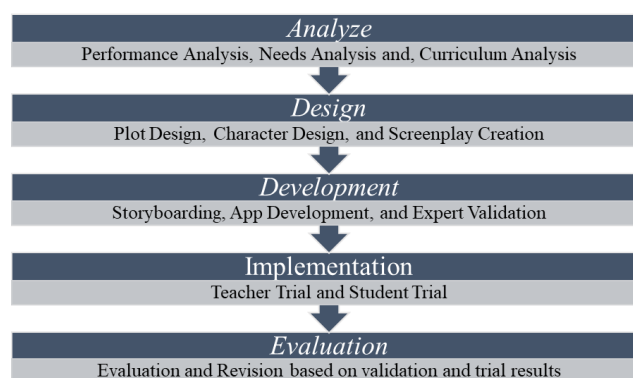


Figure 1. Research flow

The research was conducted in one of the high schools in East Lampung Regency, Lampung Province, at the analysis stage one teacher and 30 students were interviewed and pre-surveyed. Then validation was carried out to three validators namely genetic engineering material experts, media, and Islamic values. Product trials were conducted with one teacher and 30 students of class X phase E SMA. The number of instruments used in the validation process and product trials totaled 20 items. Validation by genetic engineering material experts includes three aspects,

namely aspects of learning, language, and material presentation. Validation by media experts covered four aspects, namely visual aspects, interactivity, learning content, and technical aspects. Meanwhile, validation by Islamic values experts included three aspects, namely the accuracy of the material, the presentation of the material, and the suitability of the benefits of the material with Islamic values.

In the process of validation and product testing, there are two types of data used, namely qualitative and quantitative data. Qualitative data is in the form of suggestions and input from validators, teachers, and students related to the digital comics developed, while quantitative data is in the form of questionnaire assessment results by validators, teachers, and students in the form of numbers. The data obtained can then be calculated using the following formula (Roisatulkusna & Hakim, 2024).

$$P = \frac{\sum x}{n} \times 100\% \quad (1)$$

Description:

P = percentage

$\sum x$ = number of scores obtained

n = maximum score

Based on this formula, the results obtained in the validation and product trials can be seen in the following Table 1.

Table 1. Categories of expert validation and product trials

Rating Scale	Percentage	Criteria Category	
		Expert Validation	Product Trial
5	84% – 100%	Very Feasible	Very good
4	68% – 83,9%	Feasible	Good
3	52% – 67,9%	Feasible Enough	Enough
2	36% – 51,9%	Less Feasible	Less
1	20% – 35,9%	Very Less Feasible	Very Less

Roisatulkusna & Hakim (2024)

RESULTS AND DISCUSSION

Analyze

The analysis stage is carried out to identify problems and find appropriate learning media development solutions through performance, needs, and curriculum analysis (Hidayah & Hakim, 2024). Performance analysis shows that teachers in one of the high schools in East Lampung Regency, Lampung Province only use textbooks, so learning is less innovative, and Android-based digital comics and QR codes have not been used. In addition, the needs analysis showed that genetic engineering material is classified as abstract and difficult to understand without the help of representative visual media. Digital comics are seen as a potential alternative because they present the material narratively and visually, thus bridging the understanding of complex science concepts. In terms of curriculum, schools have implemented the Merdeka Curriculum, which emphasizes project-based learning, differentiation, and character strengthening. Thus, the development of Android and QR Code-based digital comics with Islamic values is not only relevant in content, but also supports the implementation of the Merdeka Curriculum as a whole.

Design

The design stage is carried out by designing the plot, characters, and scenarios (Zaharah et al., 2023). Komik ini bertema materi rekayasa genetika dengan bermuatan nilai-nilai keislaman. This comic is themed on genetic engineering material with Islamic values. Islamic values include moral values, sharia, and faith. Moral values

are instilled through scientific attitudes such as honesty and responsibility in understanding and applying genetic engineering technology. Sharia values are reflected in the emphasis on ethical boundaries in genetic engineering according to Islamic law. Meanwhile, the value of faith is strengthened by understanding that science is part of the search for truth that leads to strengthening faith in Allah as the Creator (Raito & Sukmawati, 2023).

This comic was developed by having three main characters, namely two male characters and one female character. The male characters are named Ahmad and Prof. M and the female character is named Lia. The character characteristics can be seen in Table 2.

Table 2. Character characteristics

Character Name	Character characteristics
Ahmad	Ahmad was a smart and insightful boy. He likes to read and discuss
Lia	She has a best friend named Ahmad. Lia is a caring and curious child.
Prof. M	Professor M is a geneticist who is Ahmad's uncle. He is kind and often provides information.

The storyline focuses on the characters Ahmad and Lia, two students who are mentored by Prof. M in the laboratory through interactive discussions. The story begins at Ahmad's house, then continues to the laboratory where they learn about genetic engineering and Islamic values. Character design includes physical appearance and appropriate personality. Scenarios were developed to facilitate comic development with place settings such as home, school, and laboratory.

Development

The development stage realizes comic design through panel layout, recreating comics, and making applications. Panel layout or storyboard includes a visual planning process consisting of making panels or initial sketches, as well as composing dialog that will be used in digital comics. At this stage, initial illustrations are made to describe the overall storyline, determine the panel layout, and organize the visual composition so that the message conveyed is clearer and more interesting (Syafaeri et al., 2022). The stage of making a panel layout can be seen in Figure 2.

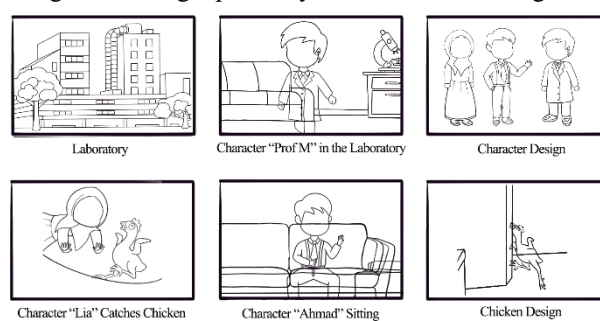


Figure 2. Layout panel creation

At the recreating comic stage, the sketches are converted into digital illustrations using Adobe Illustrator CC 2017 and Procreate, with additional colors, fonts, and QR codes for videos and practice questions. The results of the recreating comic stage produce JPG files. Furthermore, the comic is converted into an Android application using Flip PDF and Website 2 APK software. In the first stage, comics in

JPG format are imported into Flip PDF software for further processing. In this stage, various interactive elements are added, such as a table of contents to facilitate navigation, a logo as the visual identity of the application, as well as practice questions and videos to increase user engagement and enrich the learning experience. Once all elements are well integrated, the results are saved in HTML format.

Furthermore, in the second stage, the folder containing the HTML file is converted into APK format using Website 2 APK software. This process allows the digital comic to be accessed through Android devices, so students can use it more flexibly without relying on an internet connection. Thus, this digital comic application becomes more practical, interactive, and easy to use as a technology-based learning media (Nikmati, 2024). The first and second stages in making the application can be seen in Figures 3 and 4.

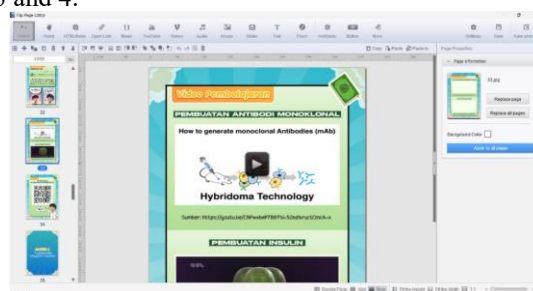


Figure 3. Stage one (adding interactive features)

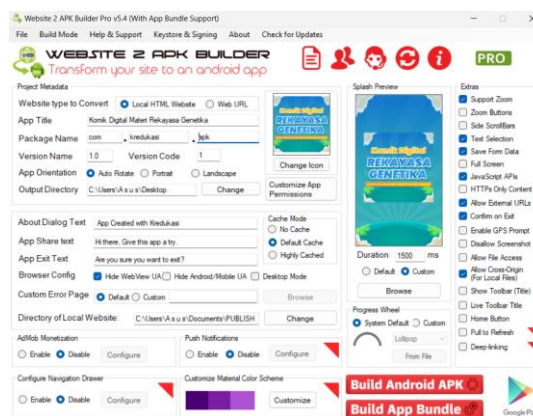


Figure 4. Second stage (conversion to APK format)

Digital comics that have been developed in the form of applications are consulted with three validators, namely material, media, and Islamic values experts, using 20 assessment items. Validation by genetic engineering material experts covered three aspects, namely learning aspects, language, and material presentation. Validation by media experts covered four aspects, namely visual aspects, interactivity, learning content, and technical aspects. Meanwhile, validation by Islamic values experts includes three aspects, namely the accuracy of the material, the presentation of the material, and the suitability of the benefits of the material with Islamic values. The conclusions from the validation results of material, media, and Islamic values experts on the feasibility assessment of the developed digital comic application can be presented in Table 3.

Table 3. Expert validation results

Expert validator	Score obtained	Percentage	Category
Material	85	85%	Very Feasible
Media	98	98%	Very Feasible
Islamic values	92	92%	Very Feasible

Table 3 shows that the validation results show the percentage of feasibility of 85%, 98%, and 92% respectively, all of which are in the category of “very feasible.” Thus, the digital comic application based on genetic engineering material has met the eligibility standards. After being revised according to the validator's suggestions, this application is ready to be further tested on teachers and students in learning, with the test subject being one teacher and using one class X Phase E SMA with a total of 30 students.

The input from the validator includes changing the color of the cover and the instructions for using the comic, which is considered too contrasting; adding information about the negative impact of genetic engineering; and adding relevant Al-Qur'an verses. The revised digital comic application display according to the suggestions can be seen in Figure 5.

**Figure 5. Final view of the Digital Comic Application**

Implementation

The digital comics that have been feasible were then tested on one teacher and 30 students of class X phase E SMA Negeri 1 Sekampung using 20 assessment items covering three main aspects, namely material, media, and Islamic values. The trial stage can be divided into 2 discussions as follows.

Teacher Trial

The digital comic application trial was conducted to one biology teacher at SMA Negeri 1 Sekampung. The instrument used in the trial consisted of 20 items covering three main aspects, namely material, media, and Islamic values. The details of each aspect include 7 items for the material aspect, 8 items for the media aspect, and 5 items for the Islamic values aspect. The results of the teacher trial on the digital comic application developed can be presented in Table 4.

Table 4. Recapitulation of teacher trial results

Aspect	Score obtained	Percentage	Category
Material	34	97%	Very Good
Media	39	97,5%	Very Good
Islamic values	25	100%	Very Good
Total Percentage		294,5	Very Good
Average Percentage		98%	

Based on Table 4, the results of the teacher trial show that the material, media, and Islamic values aspects obtained percentages of 97%, 97.5%, and 100%, respectively, all of which fall into the category of “very good.” Thus, the overall average percentage reached 98% with the same category. Since there were no suggestions for improvement, the product did not need to be tested again.

Student Trial

The digital comic application trial was also carried out on students of class X phase E at SMA Negeri 1 Sekampung, with a total of 30 people. The instrument used in the pilot test consisted of 20 items covering three main aspects, namely material, media, and Islamic values. The details of each aspect include 5 items for the material aspect, 5 items for the media aspect, and 10 items for the Islamic values aspect. The results of the teacher trial on the digital comic application developed can be presented in Table 5.

Table 5. Recapitulation of student trial results

Aspect	Average score obtained	Percentage	Category
Material	22	88%	Very Good
Media	22,5	90%	Very Good
Islamic values	43,4	87%	Very Good
Total Percentage		265	Very Good
Average Percentage		88%	

Based on Table 5, the results of the student trial show that the material, media, and Islamic values aspects obtained percentages of 88%, 90%, and 87%, respectively, all of which fall into the “very good” category. The overall average percentage reached 88% with the same category. These results are in line with research by Pinatih & Putra (2021), who found that character value-based digital comics showed a high level of material and media feasibility in science learning. Similarities were also found in a study by Raneza et al., (2022), who reported that the integration of digital media based on religious values can improve students' conceptual understanding without reducing the depth of Islamic values. However, the main difference in this study lies in the use of QR codes as an innovative feature that allows direct access to additional interactive content such as videos and practice questions, making it more flexible and contextualized than similar media products.

Evaluation

The final stage in the ADDIE model is the evaluation stage. At this stage, revisions are made to the digital comics that have been developed based on input and suggestions from material expert validators, media experts, and Islamic values experts. In addition, assessments from teachers and the results of student response trials at the implementation stage are also used as a basis for revision (Pinatih & Putra, 2021).

The results of this study show that Android and QR Code-based digital comics are learning media that are very feasible to use in the classroom, with a high level of validation from experts as well as positive responses from teachers and students. The effectiveness of this media compared to other media lies in the combination of visual elements, interactivity, and flexibility of access that is not found in conventional printed media or modules. Digital comics are able to present complex material, such as genetic engineering, in the form of interesting narratives and illustrations, making it easier for students to understand abstract concepts. Another advantage is the integration of QR codes that allow students to access videos, interactive simulations, and practice questions, which not only increase engagement but also deepen their understanding of the material (Wahyudi et al., 2025). Theoretically, this effectiveness is supported by the theory of cognitivism, specifically Dual Coding Theory, which states that information will be more easily understood and remembered when presented through verbal and visual channels simultaneously (Handoyo et al., 2025).

When compared to previous studies, these results are consistent with the findings of previous studies showing that digital comics can improve learning outcomes and students' communication skills in the science learning (Naila et al., 2022). Research by Narestuti et al., (2021) also shows that the application of digital comic media significantly improves student learning outcomes. This is in line with the findings of Megantari et al., (2021) who emphasized that digital comics are effective in simplifying complex material through the presentation of contextual storylines, especially in learning biology, which is full of abstract concepts. This research is superior because it does not only rely on visual aspects but also incorporates QR Code-based technology that increases interactivity and flexibility in the learning experience. This integration is in line with the needs of 21st-century learning, which requires adaptation to digital media that is attractive, easily accessible, and able to encourage active student involvement in understanding the material.

The practical implication of this research is that Android and QR Code-based digital comics can be integrated into technology-based learning in the classroom, especially to support the blended learning approach. Teachers can use digital comics as the main teaching media or as supporting materials that students can access before or after learning in class. With the QR Code feature, teachers can insert various additional resources, such as experimental videos, further explanations, or interactive quizzes that allow students to learn more independently. In addition, this digital comic can also be an alternative in formative assessment, where students can access practice questions provided in the QR Code to measure their understanding in real-time. Thus, the use of digital comics encourages learning that is more interactive, flexible, and in accordance with technological developments in the digital era.

CONCLUSION

The Android-based digital comic application and QR code on genetic engineering material with the integration of Islamic values have been successfully developed using the ADDIE model, which includes the stages of analyze, design,

development, implementation, and evaluation. The validation results show that this media is very feasible to use as learning media, both from the aspects of material, media, and content of Islamic values. Field trials also showed excellent responses from teachers and students. For further development, it is recommended that further research focus on measuring the achievement of learning objective criteria to determine the impact of using this digital comic on improving student learning outcomes as a whole.

REFERENCES

- Aini, R. P. (2024). Menelusuri Media Pembelajaran: Solusi Kreatif untuk Pembelajaran IPA di Sekolah Dasar. *Jurnal Madinasika Manajemen Pendidikan dan Keguruan*, 5(2), 48–57. <https://doi.org/10.31949/madinasika.v5i2.7689>
- Ardhi, R., & Farell, G. (2023). Perancangan Website Point of Sales menggunakan Teknologi QR Code (Studi Kasus Gofha Studio Parfum Danguang-Danguang). *Jurnal Pendidikan Tambusai*, 7(1), 2756–2771. <https://doi.org/10.31004/jptam.v7i1.5636>
- Atika, Kosim, Sutrio, & Ayub, S. (2022). Pengembangan Media Pembelajaran Fisika Mobile Learning Berbasis Android pada Materi Fluida Statis. *Jurnal Ilmiah Profesi Pendidikan*, 7(1), 13–17. <https://doi.org/10.29303/jipp.v7i1.381>
- Barutu, A. A., & Harfiani, R. (2023). Pelaksanaan Pembelajaran Wudhu dengan Media Gambar bagi Anak Usia Dini Tadika Al Fikh Orcard Pendamar Indah 2 Selangor. *Journal on Education*, 5(3), 8739–8749. <https://doi.org/10.31004/joe.v5i3.1668>
- Bernadhed, Sulistiyono, M., & Negara, P. A. (2024). Digital Interactive Comic “Virus Fighter.” *Jurnal Sistem Telekomunikasi Elektronika Sistem Kontrol Power Sistem dan Komputer*, 4(1), 91–98. <https://doi.org/10.32503/jtecs.v4i1.4744>
- Darlian, L. (2024). Pengembangan Media Pembelajaran Interaktif Berbasis Adobe Animate Creative Cloud pada Materi Genetik Kelas XII SMA. *AMPIBI: Jurnal Alumni Pendidikan Biologi*, 9(3), 194–203. <https://doi.org/10.36709/ampibi.v9i3.243>
- Elmontadzery, A. Y. F., Basori, A. R., & Mujadid, M. (2024). Internalisasi Nilai-nilai Pendidikan Islam dalam Peningkatan Karakter Religius di MA NU Putra Buntet Pesantren Cirebon. *TSAQAFATUNA: Jurnal Ilmu Pendidikan Islam*, 6(1), 67–81. <https://doi.org/10.54213/tsaqafatuna.v6i1.413>
- Fidianingsih, A., & Priyana, J. (2022). Pengembangan Materi Membaca Berbasis Komik untuk Kegiatan Pengayaan Bahasa Inggris di Sekolah Menengah Pertama. *Jurnal Inovasi Teknologi Pendidikan*, 9(1), 1–14. <https://doi.org/10.21831/jitp.v9i1.39373>
- Handoyo, T., Ashriyah, I., & Kamal, R. (2025). Pengembangan Bahan Ajar Berbasis Multimedia. *Harmoni Pendidikan: Jurnal Ilmu Pendidikan*, 2(1), 230–250. <https://doi.org/10.62383/hardik.v2i1.1064>
- Hidayah, Q. N., & Hakim, N. (2024). Pengembangan LKPD Materi Sel Terintegrasi Nilai Ke Islaman untuk Kelas XI SMAS TMI Roudlatul Qur'an. *Journal of Banua Science Education*, 4(1), 64–76. <https://doi.org/10.20527/jbse.v4i1.248>
- Indah, R. A., & Fadilah, M. (2024). Literature Review: Pengaruh Media Pembelajaran Literasi Visual Terhadap Hasil Belajar Biologi Siswa SMA: (Literature Review: The Influence of Visual Literacy Learning Media on High School Students Biology Learning Outcomes). *BIODIK*, 10(2), 188–

198. <https://doi.org/10.22437/biodik.v10i2.33803>
- Latip, A. (2022). Penerapan Model ADDIE dalam Pengembangan Multimedia Pembelajaran Berbasis Literasi Sains. *DIKSAINS: Jurnal Ilmiah Pendidikan Sains*, 2(2), 102–108. <https://doi.org/10.33369/diksains.2.2.102-108>
- Megantari, K. A., Margunayasa, I. G., & Agustiana, I. G. A. T. (2021). Belajar Sumber Daya Alam melalui Media Komik Digital. *Mimbar PGSD Undiksha*, 9(1), 139–149. <https://doi.org/10.23887/jpgsd.v9i1.34251>
- Naila, N., Winarti, A., & Mahdian, M. (2022). Pengembangan Media Pembelajaran Komik Kimia Bermuatan Literasi Sains untuk Meningkatkan Pemahaman Konsep dan Kemampuan Komunikasi Peserta Didik. *Quantum: Jurnal Inovasi Pendidikan Sains*, 13(1), 1–19. <https://doi.org/10.20527/quantum.v13i1.11817>
- Narestuti, A. S., Sudiarti, D., & Nurjanah, U. (2021). Penerapan Media Pembelajaran Komik Digital untuk Meningkatkan Hasil Belajar Siswa. *Bioedusiana: Jurnal Pendidikan Biologi*, 6(2), 305–317. <https://doi.org/10.37058/bioed.v6i2.3756>
- Nikmati, H. A. S. E. (2024). Pemanfaatan Media Ajar Interaktif Berbasis Digital dalam Meningkatkan Berfikir Kritis Peserta Didik. *Aksiologi: Jurnal Pendidikan dan Ilmu Sosial*, 5(2). <https://doi.org/10.47134/aksiologi.v5i2.270>
- Nirmala, R., Wahyuni, S., & Ridlo, Z. R. (2023). Pengembangan E-LKPD Berbasis Liveworksheet untuk Meningkatkan Creative Thinking Skill Siswa SMP pada Materi Pencemaran Lingkungan. *Quantum: Jurnal Inovasi Pendidikan Sains*, 14(2), 266–278. <https://doi.org/10.20527/quantum.v14i2.16240>
- Nurhidayah, S., & Hakim, N. (2024). E-Modul Keanekaragaman Hayati Terintegrasi Nilai Keislaman untuk Peserta Didik Kelas X SMA. *Journal of Banua Science Education*, 4(2), 18–26. <https://doi.org/10.20527/jbse.v4i2.273>
- Pinatih, S. A. C., & Putra, S. (2021). Pengembangan Media Komik Digital Berbasis Pendekatan Saintifik pada Muatan IPA. *Jurnal Penelitian dan Pengembangan Pendidikan*, 5(1), 115–121. <https://doi.org/10.23887/jppp.v5i1.32279>
- Putro, D. (2021). Perkembangan Tren Membaca Komik pada Era Digital di Indonesia. *Source: Jurnal Ilmu Komunikasi*, 7(2), 115–126. <https://doi.org/10.35308/source.v7i2.3640>
- Rahmayani, S., Mahsul, A., & Sholehah, N. (2022). Pengembangan Modul Sistem Pencernaan Manusia dengan Mengintegrasikan Ayat-ayat Al-Qur'an. *Jurnal Eksakta Pendidikan (JEP)*, 6(1), 69–76. <https://doi.org/10.24036/jep/vol6-iss1/647>
- Raito, & Sukmawati, S. (2023). Implikasi Internalisasi Nilai-nilai Ajaran Islam dalam Pembelajaran PAI terhadap Kesadaran Moral Siswa. *Masagi*, 2(1), 238–246. <https://doi.org/10.37968/masagi.v2i1.498>
- Raneza, F., Widowati, H., & Santoso, H. (2022). Pengembangan Komik Digital dengan Mengintegrasikan Nilai-Nilai Keislaman sebagai Media Pembelajaran pada Materi Pokok Ruang Lingkup Biologi. *Bioedusiana: Jurnal Pendidikan Biologi*, 7(1). <https://doi.org/10.37058/bioed.v7i1.3168>
- Ratnasari, F. E., Sucipto, & Sumiyati. (2024). Pengembangan Media E-Book Berbasis Multimedia Interaktif dengan QR-Code untuk Meningkatkan Minat Belajar dan Kemampuan Berpikir Kritis pada Peserta Didik Tingkat Sekolah Dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(3), 542–546. <https://doi.org/10.23969/jp.v9i3.17809>
- Ristanto, R. H., Heryanti, E., & Madaniyyah, S. (2024). E-Modul Edu-Kehati Berbasis I-SETS: Pengembangan Bahan Ajar Beroientasi pada Literasi Keanekaragaman Hayati. *Jurnal Inovasi Pembelajaran Biologi*, 5(2), 66–83. <https://doi.org/10.26740/jipb.v5n2.p66-83>
- Roisatulkusna, N., & Hakim, N. (2024). Development of An Integrated E-Booklet I-

- SETS (Islamic, Science, Environment, Technology, and Society) Environmental Change Material for Class X SMA/MA Students. *Quantum: Jurnal Inovasi Pendidikan Sains*, 15(1), 39–52. <https://doi.org/10.20527/quantum.v15i1.18372>
- Suprianingsih, N., Yenti, E., & Kurniawati, Y. (2022). Pengembangan Bahan Ajar Komik Terintegrasi Islam pada Materi Hakikat Ilmu Kimia. *Journal of Chemistry Education and Integration*, 1(1), 16–25. <https://doi.org/10.24014/jcei.v1i1.15901>
- Syaferi, A., Hakim, N., Yudiyanto, Y., & Suhendi, S. (2022). Developing COVID-19 Digital Comic by Using Flip PDF Professional as a Learning Media for Tenth Grade of Senior High School. *Assimilation: Indonesian Journal of Biology Education*, 5(1), 1–8. <https://doi.org/10.17509/aijbe.v5i1.43479>
- Umami, R., & Ramadhan, A. (2022). Pengembangan Lembar Kerja Siswa (LKS) Berbasis Integrasi Islam Materi Pokok Sistem Pernapasan pada Manusia Kelas VIII MTs. NW Jauhar Pelita. *ORYZA (Jurnal Pendidikan Biologi)*, 11(1), 43–50. <https://doi.org/10.33627/oz.v11i1.716>
- Utomo, E. P. (2021). Pengembangan Komik Digital Berbasis Problem Based Instruction pada Materi Kelangkaan dan Kebutuhan Manusia. *Soedirman Economics Education Journal*, 3(1), 53–65. <https://doi.org/10.32424/seej.v3i1.4064>
- Wahyudi, E. P., Tuwoso, T., & Prasetya, D. D. (2025). Pengembangan Media E-Learning Koi Park Berbasis Scan QR Android pada Mata Pelajaran Kewirausahaan di SMK Negeri 1 Udanawu. *Briliant: Jurnal Riset dan Konseptual*, 10(1), 50–58. <https://doi.org/10.28926/briliant.v10i1.1743>
- Zaharah, E., Murniviyanti, L., & Pratama, A. (2023). Pengembangan Perangkat Pembelajaran Berbasis E-Komik Kelas V Sekolah Dasar. *Jurnal Perseda: Jurnal Pendidikan Guru Sekolah Dasar*, 6(3), 184–194. <https://doi.org/10.37150/perseda.v6i3.2124>