

Application of *BioTranspezia* Multimedia to the Learning Outcomes Students of SMA Muhammadiyah 1 Surakarta

Auranur Priyanka Rahim¹, Ima Aryani^{2*}

^{1,2}Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta, Jawa Tengah, Indonesia 57162

*Corresponding author: ia122@ums.ac.id

APA Citation: Rahim, A. P., & Aryani, I. (2025). Application of *BioTranspezia* Multimedia to the Learning Outcomes Students of SMA Muhammadiyah 1 Surakarta. *Quagga: Journal of Education and Biology*, 17(2), 105-113. DOI: 10.25134/quagga.v17i2.384.

Received: 17-02-2025

Accepted: 14-04-2025

Published: 04-07-2025

Abstract: *BioTranspezia* is a multimedia that is useful for improving student's understanding so that it has an impact on their learning results. This study was carried out because learning media that is still often found is less interesting so that learning tends to be boring. *BioTranspezia* multimedia focuses on Biology materials, including circulation, respiration, digestion, and excretion systems. This study aims to see the impact of the application of *BioTranspezia* multimedia on the learning outcomes of high school students in learning Biology of Transport and Human Body Substance Exchange. The method in this study is quantitative using a type of Pre-experimental research with a One Group Pretest-Posttest Design. All classes XI became the population in this study with a sample of class XI-3 totaling 36 students. The instruments used are in the form of question sheets (Pretest-Posttest) and affective observation sheets. Statistical data analysis uses normality tests, homogeneity tests, also hypothesis tests. The results showed that there was a significant difference in cognitive learning outcomes in the average Pretest as well as Posttest scores, namely the Pretest of 65 and the Posttest of 80,69. Likewise, in the achievement of the affective aspect, there was an increase in each indicator in the second meeting consisting of a discipline indicator of 74,30%, a cooperation indicator of 73,61%, a responsibility indicator of 76,38%, and an activeness indicator of 70,13% with the four indicators included in the good category. Thus in this research, it can be concluded that the implementation of *BioTranspezia* multimedia has an effect on student learning outcomes at SMA Muhammadiyah 1 Surakarta in learning Biology.

Keywords: *BioTranspezia*, Multimedia, Cognitive, Affective

1. INTRODUCTION

Transformation in the world of education is closely related to the advancement of information as well as communication technology which has undergone significant development. Technology in education has evolved to change the learning paradigm significantly. Technological advances in education have revolutionized learning and teaching styles. Technology encourages students to create good interactions with teachers through teaching tools and discussion forums, as well as create a more dynamic learning atmosphere. Ika Sri Wahyuni et al. (2024) explained that creating

a creative, innovative, and interesting learning atmosphere can be realized by utilizing developing technology.

Technology, especially in the field of education, is very helpful in developing material through more innovative learning. Technology in the context of learning has a crucial role to support teaching materials because according to Nisa Pangsuma et al. (2024), teaching materials are means and media to support learning activities. Teachers in teaching have the freedom to modify teaching materials into a learning medium. Learning media is used as a means or tool that

helps teachers to deliver lessons that contain a collection of materials. However, there are still often learning media that are not interesting, which allows students to feel bored in understanding the material, which makes learning outcomes less than optimal (Faizahain, 2024). Worth the statement Sepindah & Hermawan (2023), using makeshift learning media such as textbooks in the current era is considered less effective so that students find it hard to understand the material. Therefore, presenting the material into a more interesting innovation is needed to avoid this, namely with the existence of multimedia-based learning media.

Multimedia is a digital-based learning media that combines audio, text, images, videos, and animations which are used in providing information (Nurcahyanto et al., 2023). Multimedia is one of the alternative learning media in building a more interesting and interactive learning atmosphere with the presentation of easy-to-understand material so that student's understanding can improve. In the era of digitalization, multimedia has an effect on the quality of learning with interactive and comprehensive learning experience so that students gain a deep understanding (Taswadi et al., 2025). Learning media in the form of applications is one example of multimedia that follows current technological developments. This is because the learning application in the program is directly into the smartphone system so that it makes learning easier. One of the multimedia/learning applications that can support the teaching and learning process is *BioTranspezia*.

BioTranspezia is a multimedia in the form of a smartphone-based learning application in which there are various features such as learning videos, materials in the form of text, student comprehension quizzes, and images and explanations that have been designed according to learning objectives. *BioTranspezia* is designed offline or online which can be accessed anywhere and anytime and can be used on smartphone and laptop devices. *BioTranspezia* multimedia has been validated by media experts and it can be said that *BioTranspezia* is feasible to be applied in learning to encourage the improvement of learning comprehension so that it has an effect on learning results, especially in Biology subjects.

Biology is one of the materials whose theoretical concepts are difficult to digest directly by the senses without the help of media. Such as the material on the transportation and exchange of substances of the human body in class XI of high school which studies the physiological functions of the four organ systems of the human body, namely the circulatory, respiratory, digestive, as well as the excretory systems (Solihat, 2022). Difficulties in studying the material generally students tend to be confused and difficult to understand how the process of the four processes of the body's organ system occurs which is only explained in the form of text without a more complex explanation. The material is difficult to understand because of the many names of organs that must be memorized, causing students to have difficulty memorizing, the difficulty of imagining the image from the illustration so that there needs to be a clear and specific picture, and the difficulty of understanding how the process of the organ system occurs which is only explained in the form of text so that it requires video assistance to clarify students' understanding because according to Suhardi (2024), Through videos, it can help students deepen their understanding of abstract concepts and make it easier to explore situations that are difficult to reach directly.

The topic is very difficult to understand if it is only understood in the form of a book without any real process because, according to [Agustina & Wibowo \(2022\)](#), biology has abstract concepts and materials. Supported by [Dinda Wardhani & Tika Mayang Sari \(2024\)](#) which states that using textbooks in studying human digestive system material is very difficult to understand because the material is very specific, as a result of which it has an effect on the achievement of learning results. In dealing with related problems, the application of interesting learning media is needed in biology learning, especially in the material of transportation and exchange of substances of the human body.

Based on the observation results, there are still many biology learning that depend on printed books, especially at SMA Muhammadiyah 1 Surakarta. Interesting media is indispensable in learning Biology, especially on concepts that are difficult to understand. In dealing with this, it is important to have interactive learning media, one of which is in the form of multimedia because

transportation materials and the exchange of human body substances are inseparable from the help of the media. With the help of multimedia, it can foster an understanding of biological concepts that previously could not be understood theoretically because according to [Aryani et al. \(2023\)](#) the more students who take advantage of the dual learning, the more ideas, ideas, and knowledge they have. It can be said that utilizing multimedia will have an impact on learning outcomes.

In this research, the application of *BioTranspezia* multimedia as a Biology learning medium needs to be carried out, especially on the material of transportation and exchange of human body substances to see the impact on learning outcomes, one of which is students at SMA Muhammadiyah 1 Surakarta. So that the background that has been mentioned multimedia is very necessary as a means of learning Biology to realize satisfactory learning outcomes. Therefore, this research aims to see how the impact of the application of *BioTranspezia* multimedia on the learning outcomes of high school students in grade XI in learning Biology of Transportation and Human Body Substance Exchange. It is hoped that *BioTranspezia* multimedia will have a great influence on Biology learning outcomes.

2. RESEARCH METHOD

This study uses a quantitative research method with the type of *Pre-experimental* research and *One Group Pretest-Posttest Design* research design. The design of this study was used to see the influence of the application of *BioTranspezia* multimedia on the learning outcomes of grade XI students in the subject of Biology of Transportation and Human Body Substance Exchange. The research was conducted at SMA Muhammadiyah 1 Surakarta for the 2024/2025 academic year. All XI classes became the population in the study carried out. The sample used was class XI-3 which amounted to 36 students based on random sampling techniques.

Table 1. Research Design

Pretest	Treatment	Posttest
O ₁	X	O ₂

Source: (Sugiyono, 2022)

Information:

O₁ = *Pretest* (before treatment)

O₂ = *Posttest* (after treatment)

X = Treatment by applying *BioTranspezia* multimedia

The techniques to collect data in this study are tests in the form of questions (*Pretest* and *Posttest*) and observation. The instruments used are question sheets (*Pretest* and *Posttest*) as well as observation sheets of learning activities. *Pretest* and *Posttest* sheets are used to assess student's cognitive learning results in the form of questions that have been prepared according to learning outcomes at school and have been validated by instrument experts. Observation sheets are used in assessing student's affective learning outcomes in the learning process using *BioTranspezia*.

The cognitive data analysis technique uses prerequisite tests in the statistical *SPSS version 25*, namely the normality test (*Shapiro wilk*), the homogeneity test (*Levene's*), and the hypothesis test (*Paired sample t-test*). The normality test is used to test whether the distribution of data is normal. The homogeneity test is used in identifying homogeneous or not homogeneous data variants. The data produced is not normally distributed, so the hypothesis test utilizes the *Wilcoxon Test*. The withdrawal of results can be seen in the hypothesis test data to identify whether there is an effect of the difference in the average test score of a treatment.

The collection of observation data was analyzed based on observation indicators and then converted into a scale value of 100 to determine the student's affective score with the following formula.

$$NA = \frac{\sum R}{N} \times 100\%$$

Information:

NA = Percentage of value acquisition

$\sum R$ = Number of scores obtained

N = Maximum number of scores

100 = Fixed numbers

The learning results of the affective aspects of students are then categorized in the form of percentages that refer to the *likert scale* in Table 2 below.

Table 2. Categories of *Likert Scale* Affective Learning Outcomes

(%)	Category
81 – 100	Excellent
66 – 80	Good
51 - 65	Not Good
< 50	Bad

Source: (Sugiyono, 2022)

3. RESULTS AND DISCUSSION

The data of this study consists of cognitive and affective learning results of students based on the application of *BioTranspezia* multimedia. Student learning outcomes are assessed based on cognitive and affective aspects. Referring to Table 3, data on cognitive learning outcomes from *Pretest* and *Posttest* scores are obtained in the table below.

Table 3. Statistical Data on Student Cognitive Learning Outcomes

No	Statistics Data	Learning Outcomes	
		<i>Pretest</i>	<i>Posttest</i>
1	Number of samples	36	36
2	Minimum	50	70
3	Maximum	75	95
4	Average	65	80,69
5	Standard Deviation	5,98	6,78
6	Varians	35,71	45,93

It is known in Table 3 the lowest *Pretest* score was obtained at 50 and the highest score of 75, while the results of the *Posttest* gained the lowest score of 70 and the highest score of 95. It was found that there was a distinction in learning outcomes in *Pretest* and *Posttest* scores seen from the average score obtained, where the *Pretest* score was 65 which had a standard deviation of 5.98 and the *Posttest* score was 80,69 which had a standard deviation of 6,78. Descriptively, conclusions can be drawn if there is a distinction in learning outcomes from the *Pretest* and *Posttest* due to the application of *BioTranspezia* in

learning so that students are able to understand the material more deeply.

The average difference between before and after the application of *BioTranspezia* can be known through hypothesis testing. From the cognitive learning outcome data that has been obtained, analysis prerequisite tests are carried out, including normality tests, homogeneity tests, as well as hypothesis tests. Below are the results of the normality test using the *Shapiro Wilk* test where to identify the distribution of data whether it is normal or not presented in Table 4.

Table 4. Normality Test Results

Indicator	<i>Shapiro Wilk</i> Test		
	Statistics	Df	Sig.
<i>Pretest</i>	,932	36	,028
<i>Posttest</i>	,935	36	,035

The statistical results of the normality test in Table 4 indicate that the findings of the *Pretest* data were obtained sig. 0,028 where the value of sig. < 0,05, while the *Posttest* data findings were obtained by sig. 0,035 where the value of sig. < 0.05. The findings of the two normality tests in the *Pretest* and *Posttest* values had a significance value (sig) below 0,05 so that the two data were not normally distributed.

The normality test that has been carried out is then continued with the homogeneity test using *Levene's* test to identify whether the two data are homogeneous or not. Below are the results of the *Pretest* and *Posttest* homogeneity tests in Table 5.

Table 5. Homogeneity Test Results

Value	<i>Levene's</i> Test		
	Df 1	Df 2	Sig.
<i>Based on Mean</i>	1	70	,236

The statistical results of the homogeneity test in Table 5 show that the results of the significance value based on mean are 0,236 where the value of sig. > 0,05. This indicates that the data has a homogeneous variation. Because the data obtained from the normality test results is not distributed normally, therefore a non-parametric test is carried out. Non-parametric tests are carried out if there are inconsistent assumptions, one of the non-parametric analyses to test the difference

in paired data is the *Wilcoxon* test ([Arista Rizki & Watulingas, 2023](#)).

The hypothesis test was carried out after a homogeneity test using a non-parametric test (*Wilcoxon Test*) due to abnormal data distribution. The following is the data from the hypothesis test in Table 6.

Table 6. Hypothesis Test Results

Indicator	<i>Wilcoxon Test</i>
	Asymp. Sig. (2-tailed)
<i>Pretest - Posttest</i>	.000

The results of the hypothesis test in Table 6 show the Asymp value. Sig. 0,000 where the result is sig. < 0,05. From the hypothesis data obtained, it is stated that if H_0 is rejected and H_a is accepted, which means that a significant average difference is found in the *Pretest* and *Posttest* scores. This can be interpreted if *BioTranspezia* multimedia has a significant impact on student learning results.

Learning outcomes in the affective aspect are assessed based on 4 indicators (Discipline, Cooperation, Responsibility, and Activeness). Attitudes observed to assess affective learning outcomes during learning are discipline, cooperation, responsibility, and also active (Hanifah & Purbosari, 2022). Based on observation data, the results of student's affective achievement can be percentaged in Figure 1.

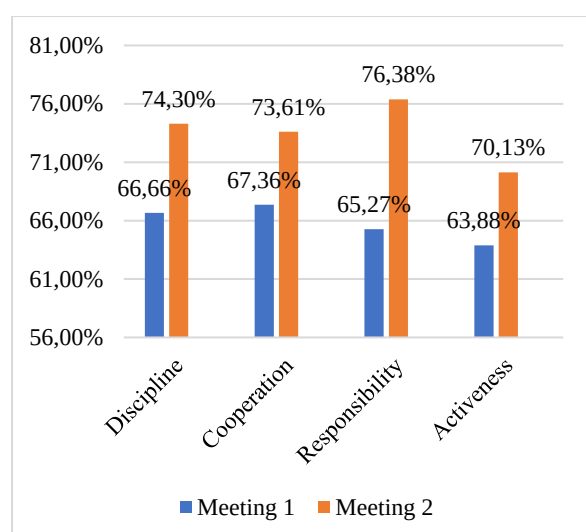


Figure 1. Comparison of Students' Affective Learning Outcomes

According to Figure 1, the percentage of student's affective learning outcomes in both meetings has a difference in percentage. Meeting 2 of the four indicators had a higher percentage than meeting 1 which was lower. The application of *BioTranspezia* multimedia in learning can affect the affective learning results of students in meeting 2 with the highest indicator percentage of 76,38% and the lowest indicator percentage of 70,13%, compared to meeting 1 with the highest indicator percentage of 67,36% and the lowest indicator percentage of 63,88%. The results of the student's affective percentage on each indicator are then categorized which refers to Table 7.

Table 7. Affective Learning Outcomes of Each Indicator

Indicator	Meeting 1		Meeting 2	
	(%)	Category	(%)	Category
Discipline	66,66	Good	74,30	Good
Cooperation	67,36	Good	73,61	Good
Responsibility	65,27	Not Good	76,38	Good
Activeness	63,88	Not Good	70,13	Good

Based on Table 7, it shows concluded that learning through applying multimedia is able to encourage the improvement of students' affective learning outcomes by building student's attitudes/characters to be better and also active when participating in learning. This can be seen from the first phase, namely meeting 1 and also the second phase, namely meeting 2, where it is proven that meeting 2 has a larger percentage than meeting 1. With a good category at the time of learning by applying *BioTranspezia* multimedia, it shows that students have an interest in investigating what *BioTranspezia* multimedia looks like. Supported by Eljonahdi et al. (2024) which gives a statement that student's interest in something is a form of desire. With a high interest in everything presented in learning, learning activities are more valuable so that learning outcomes increase.

Cognitive and affective student learning outcomes can be improved through the implementation of *BioTranspezia* multimedia. The existence of multimedia such as *BioTranspezia* can make students better understand the material and learning activities

more interesting so that the learning stages are not boring. *BioTranspezia* multimedia also brings students to learn to understand the content of more complex material so as to create a deeper interest in learning. [Ayurachmawati et al. \(2022\)](#), also argue that learning becomes more conducive, learning interest and concentration increase due to the function of multimedia as a learning medium that provides learning stimulation. According to Saddam Husein et al. (2024), learning stimuli from external factors include teachers presenting material with media. In this study, the medium displayed is *BioTranspezia*.

The application of *BioTranspezia* multimedia as a learning medium is able to influence cognitive learning outcomes. In according to the study results of Wulandari et al. (2022), that multimedia has a substantial effect on learning results and encourages an increased in concept mastery and thinking ability. Supported by the statement of Fikriyah Safira & Nahdi (2024), that student's understanding and learning achievement increased assisted by the existence of more effective multimedia in helping students realize better cognitive outcomes. Student's understanding of the material increased with *BioTranspezia* which contained material in the form of videos to help students analyze and describe material that was difficult to understand. Supported by the statement of Haka et al. (2020), Multimedia that combines video elements can help abstract biology learning. This is the basis that multimedia plays a very important role in helping learning activities to facilitate students in learning, therefore student's knowledge of the material increases

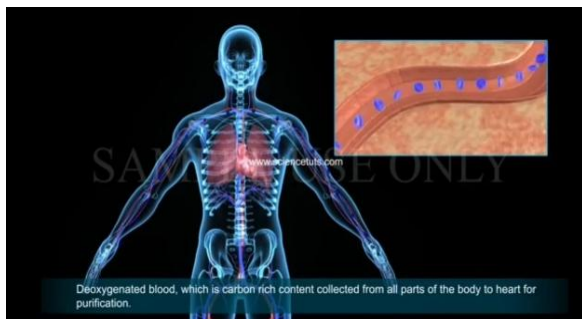


Figure 2. *BioTranspezia* multimedia video materials

Student's understanding is also strengthened by learning evaluations in the form of quizzes or games to influence cognitive outcomes. The form of student learning evaluation is able to be in the form of more interesting and effective multimedia-based learning media because according to the statement of Musdalifa et al. (2021), Multimedia is used in learning as a form of learning aid. Aligned with research by Rigawati (2024), The application of game-based learning media indicates that it can transfer materials and knowledge in strengthening student understanding so that students can actively participate in learning activities.



Figure 3. *BioTranspezia* multimedia learning evaluation

The use of *BioTranspezia* multimedia in transportation materials and the exchange of human body substances helps students in solving problems so that students are more understanding in creating new knowledge. The emergence of new knowledge is obtained from the spirit of learning in exploring the material which is also facilitated by multimedia in the form of (text, images, videos, quizzes, animations) (Mutiara et al., 2024). Supported by the statement Pahmi & Albina (2023), the existence of media in learning can provide a big priority so as to inspire students in learning to improve learning outcomes.

BioTranspezia is proven to influence student attitudes as an affective learning outcome on each indicator assessed. The student discipline indicator has a percentage of 74.30% with a good category. This category shows that students have discipline when learning using *BioTranspezia* multimedia. The provision of video material to *BioTranspezia* at the beginning of learning makes students maintain a disciplined attitude where

students are given the chance to understand the material through videos. Student indiscipline in the learning process can have an impact on student's knowledge of the material being studied. A disciplined attitude will bring students to participate in learning to understand the material so that the achievement of learning outcomes has a positive impact (Rofiuddin, 2024).

The student cooperation indicator has a percentage of 73.61% with a good category. This is because the indicators of cooperation are seen from the learning process of students in groups. *BioTranspezia* facilitates students in groups to work together in solving evaluation questions in a series of learning. The evaluation of learning in *BioTranspezia* multimedia can give rise to a good attitude of cooperation between students and mutual help between others. Good cooperation then has a positive effect on learning results. In line with the statement by Utari & Sanoto (2023), student learning outcomes can be influenced by cooperation between students in seeking new knowledge and sharing with each other. Supported by the statement of Syahfitri & Endang Sulaiman (2023), that good cooperation in the group will create ideas in developing their reasoning skills.

The student responsibility indicator has a percentage of 76.38% with a good category. In this category, the responsibility indicator is seen when using *BioTranspezia* in group learning. Students are in groups to understand the material contained in *BioTranspezia*. The various topics contained in *BioTranspezia* are divided among all group members so that each member has a great responsibility to create a superior team. Because a superior team comes from a sense of responsibility between members and each member has a risk of responsibility. Supported by the statement of Nugroho & Mawardi (2021), the attitude of responsibility is a challenge to oneself by taking all risks. So the magnitude of the sense of responsibility in learning activities will be at risk to learning outcomes.

The student activity indicator has a percentage of 70.13% with a good category. Indicators of activity are generated when students try to understand the *BioTranspezia* videos that are shown during the learning process. In the video, it triggered student's questions in finding out more complex related to the material being

studied, causing interaction between students and teachers. In line with [Anyan & Setyawan \(2022\)](#), the existence of videos allows students to respond or respond to the information obtained and can trigger questions as reciprocity between students and teachers.

BioTranspezia is able to realize the attitude of students who are active in seeking knowledge and also as a new learning facility in learning complex materials such as the transportation and exchange of substances of the human body. According to ([Arum et al., 2025](#)) the existence of interactive multimedia that combines media elements makes learning more enjoyable and can increase the spirit of learning so that it affects their learning achievement. Therefore, the evidence of this study shows that *BioTranspezia* multimedia is able to significantly affect the learning outcomes of student's cognitive and affective aspects and facilitate learning to be more effective and interactive.

4. CONCLUSION

From the outcomes of the study obtained, it is inferred that *BioTranspezia* multimedia can affect student learning outcomes in cognitive and affective aspects. The achievement of cognitive learning outcomes was seen in the average *Pretest* score of 65 and *Posttest* score of 80,69 with an average increase of 15,69. It is also seen in the outcomes of the hypothesis test that the Sig. value is $0,000 < 0,05$, meaning that there is a substantial average difference between the *Pretest* and *Posttest* scores. The achievement of affective learning outcomes was seen from each indicator which increased in the second meeting with the results of the discipline indicator 74,30%, the cooperation indicator 73,61%, the responsibility indicator 76,38%, and the activeness indicator 70,13%, of which the four indicators were included in the good category. It is hoped that from the results of this research, *BioTranspezia* multimedia can be used continuously in a series of biology learning processes on different but still interrelated materials to support students' learning facilities.

5. REFERENCES

Agustina, L., & Wibowo, S. (2022). Pemanfaatan Whatsapp sebagai Media Komunikasi dan Media Pembelajaran Daring Ditinjau dari

- Hasil Belajar dan Proses Pembelajaran Biologi. In *Prosiding SNPBS (Seminar Nasional Pendidikan Biologi Dan Saintek)*, 602–607.
- Anyan, A., & Setyawan, A. E. (2022). Keefektifan Video Pembelajaran Interaktif Dalam Meningkatkan Motivasi Belajar Siswa SMK Pada Masa Pandemi Covid-19. *VOX EDUKASI: Jurnal Ilmiah Ilmu Pendidikan*, 13(1), 140–148. <https://doi.org/10.31932/ve.v13i1.1574>
- Arista Rizki, N., & Watulingas, J. R. (2023). Analisis Perbedaan Nilai Setiap Siklus dalam Penelitian Tindakan Kelas Menggunakan Uji Wilcoxon. *Buana Matematika: Jurnal Ilmiah Matematika Dan Pendidikan Matematika*, 13(2), 169–180. <https://doi.org/https://doi.org/10.36456/buanamatematika.v13i2.7258>
- Arum, W. S. A., Khalilah, H. N., Marini, A., Yarmi, G., Safitri, D., & Dewiyani, L. (2025). Managing students' learning interest in civics learning through a genially-based interactive multimedia. *Journal of Education and Learning*, 19(2), 658–664. <https://doi.org/10.11591/edulearn.v19i2.21264>
- Aryani, I., Aziz Pramudita, D., Nauli Sinangkling, N., & Destya Adi Tama, I. (2023). Development of Android-Based Learning Media Applications to Determine Validity and Feasibility for Grade VII Middle School Students on Ecosystem Material. *Jurnal IPA Dan Pembelajaran IPA*, 7(1), 72–85. <https://doi.org/10.24815/jipi.v6i4.28885>
- Ayurachmawati, P., Syaflin, S. L., & Prasrihamni, M. (2022). Pengembangan Multimedia Berbasis Kearifan Lokal Pada Muatan Materi IPA di SD. *Jurnal Cakrawala Pendas*, 8(3), 1–10. <https://doi.org/10.31949/jcp.v8i2.2602>
- Dinda Wardhani, & Tika Mayang Sari. (2024). Development of E-LKPD based on Problem Based Instruction on Human Digestive System Material for Class XI Students of SMA Negeri 5 Metro. *Quagga: Jurnal Pendidikan Dan Biologi*, 16(2), 138–143. <https://doi.org/10.25134/quagga.v16i2.133>
- Elijonnahdi, E., Suhaili, H., Sartini, T., & Nurlatifah, N. (2024). Minat Belajar dengan Hasil Belajar Biologi. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, 7(1), 357–363. <https://doi.org/10.31539/bioedusains.v7i1.10184>
- Faizahain, N. (2024). Development of Articulate Storyline Interactive Learning Media to Support Basic Accounting Learning for Class X. *Jurnal Pendidikan Ilmu Sosial*, 34(2).
- Fikriyah Safira, R., & Nahdi, D. S. (2024). Keragaman Perangkat Lunak Multimedia Interaktif Untuk Meningkatkan Kualitas Pembelajaran IPA Sekolah Dasar. *Jurnal MADINASIKA*, 5(2), 68–77.
- Haka, N. B., Suryaasih, P. A., Anggoro, B. S., & Hamid, A. (2020). Pengembangan Multimedia Interaktif Terintegrasi Nilai Sains Sebagai Solusi Peningkatan Kemampuan Berpikir Kritis Kelas XI Mata Pembelajaran Biologi Di Tingkat SMA/MA. *Quagga: Jurnal Pendidikan Dan Biologi*, 13(1), 1. <https://doi.org/10.25134/quagga.v13i1.3202>
- Hanifah, M., & Purbosari, P. P. (2022). Studi Literatur: Pengaruh Penerapan Model Pembelajaran Guided Inquiry (GI) terhadap Hasil Belajar Kognitif, Afektif, dan Psikomotor Siswa Sekolah Menengah pada Materi Biologi. *BIODIK*, 8(2), 38–46. <https://doi.org/10.22437/bio.v8i2.14791>
- Ika Sri Wahyuni, Arsad Bahri, & Muhiddin Palennari. (2024). The Effect of Discovery Learning Model Assisted by Liveworksheet on Biology Learning Independence of Class XI SMA. *Quagga: Jurnal Pendidikan Dan Biologi*, 16(2), 216–222. <https://doi.org/10.25134/quagga.v16i2.316>
- Musdalifa, N., Syuhendri, S., & Pasaribu, A. (2021). Pengaruh Penggunaan Multimedia Interaktif Berbasis STEM Terhadap Hasil Belajar Siswa. *Jurnal Inovasi Dan Pembelajaran Fisika*, 8(1), 73–84.
- Mutiara, D., Widodo, W., & Roqobih, F. D. (2024). Multimedia Interaktif Untuk Meningkatkan Hasil Belajar Siswa Pada Materi Rotasi dan Revolusi Bumi. *BIOCHEPHY: Journal of Science Education*, 4(1), 321–329. <https://doi.org/10.52562/biochephy.v4i1.1128>

- Nisa Pangsuma, Wahyu Surakusumah, & Yayan Sanjaya. (2024). Comparative Study of Learning Models and Teaching Materials on Student Cognitive Learning Outcomes. *Quagga: Jurnal Pendidikan Dan Biologi*, 16(2), 108–117. <https://doi.org/10.25134/quagga.v16i2.127>
- Nugroho, A. S., & Mawardi, M. (2021). Pengembangan Instrumen Penilaian Sikap Tanggungjawab dalam Pembelajaran Tematik di Sekolah Dasar. *Jurnal Basicedu*, 5(2), 808–817. <https://doi.org/10.31004/basicedu.v5i2.825>
- Nurchayanto, G., Djumadi, D., Hariyatmi, H., Agustina, P., Sidiq, Y., Kusumadani, A. I., Ismiyanto, M., & Ripdianti, A. D. (2023). Pelatihan Pengembangan Multimedia Pembelajaran Interaktif di SMP Mutu Menggunakan Articulate Storyline. *Sasambo: Jurnal Abdimas (Journal of Community Service)*, 5(1), 102–114. <https://doi.org/10.36312/sasambo.v5i1.1052>
- Pahmi, A. S., & Albina, M. (2023). Pengaruh Model Discovery Learning Terhadap Hasil Belajar Pendidikan Agama Islam Siswa. *Munaddhomah: Jurnal Manajemen Pendidikan Islam*, 4(3), 778–786. <https://doi.org/https://doi.org/10.31538/munaddhomah.v4i3.673>
- Rigawati, M. D., W. S., N. S. N., & N. G. (2024). Pengaruh Game Based Learning Berbasis Dimensi Kolaborasi 21CLD Terhadap Kompetensi Kolaborasi Ssiwa SMA. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, 7(2), 381–393. <https://doi.org/https://doi.org/10.31539/bioedusains.v7i2.11750>
- Rofiuddin, A. N., & D. D. (2024). Pengaruh Disiplin Belajar terhadap Hasil Belajar pada Mata Pelajaran Pendidikan Agama Islam Siswa Sekolah Menengah Atas Setingkat. *JOECIE*, 3(1). <https://journal.stai-muafi.ac.id>
- Saddam Husein, A., Jumiarni, D., & Hidayat, S. (2024). Implementasi Pembelajaran Higher Order Thinking Menggunakan PhET Interactive Simulation Pada Mata Kuliah Evolusi Untuk Meningkatkan Hasil Belajar Kognitif Mahasiswa. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 2, 353–359. <https://doi.org/10.33369/diklabio.8.2.353-360>
- Sepindah, S. S., & Hermawan, H. D. (2023). *Development of Innovative Learning Media Educational Game Periodic Chemistry Based on Scramble for Class X SMA Students*. 1991–2008. https://doi.org/10.2991/978-2-38476-086-2_160
- Solihat, R. dkk. (2022). *Buku Panduan Guru Biologi SMA/MA Kelas XI*. Kementerian Pendidikan Kebudayaan, Riset dan Teknologi.
- Sugiyono, S. (2022). *Metode penelitian kuantitatif, kualitatif dan R&D*, (2nd ed.). Bandung: Alfabeta.
- Suhardi, M., Murtikusuma, R. P., & Islamiah, M. A. U. (2024). *Langkah Tepat Meningkatkan Hasil Belajar Siswa Menggunakan Video Pembelajaran*. Lombok Tengah: Penerbit P4I.
- Syahfitri, J., & Endang Sulaiman. (2023). Implementation of Student Worksheets Based on Problem Based Learning to Improve Students' Critical Thinking Skills. *Quagga: Jurnal Pendidikan Dan Biologi*, 15(2), 188–192. <https://doi.org/10.25134/quagga.v15i2.43>
- Taswadi, Kurnia, G. J., & Pawitan, Z. (2025). Analysis of Computational Bibliometric Mapping in Multimedia for Art Learning Media Publications using VOSviewer. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 52(1), 163–179. <https://doi.org/10.37934/araset.52.1.163179>
- Utari, P., & Sanoto, H. (2023). Penerapan Model Pembelajaran Stad untuk Meningkatkan Sikap Kerja Sama dan Hasil Belajar IPA Siswa SD. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, 6(9), 7414–7424. <http://Jiip.stkipyapisdompu.ac.id>
- Wulandari, A., Sulistyowati, R., & Hakim, L. (2022). Pengaruh multimedia interaktif berbasis google sites pada materi usaha dan energi untuk peningkatan hasil belajar siswa. *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika*, 3(2). <https://doi.org/https://doi.org/10.31851/luminous.v3i2.8860>