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Development of Interactive Physics Learning Media Integrated with Problem-Based Learning to Enhance Students' Learning Interest

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ABSTRACT

This study aimed to develop interactive learning media based on the *Problem-Based Learning* model to enhance students' interest in learning physics among Grade XII physics students at SMAN 2 Majene. The developed media was expected to meet the criteria of validity, practicality, and effectiveness. This study employed a Research and Development (R&D) approach using the Borg and Gall development model. Data were collected using media and content expert validation sheets to assess the validity of the developed media, as well as student and teacher response questionnaires to evaluate its practicality. The effectiveness of the media was assessed using a student learning interest questionnaire. The results showed that the developed learning media met the validity criterion, with an average score of 86.87%. The media was also considered practical, with average response scores of 90.62% from teachers and 85.14% from students. In terms of effectiveness, the improvement in students' interest in learning physics resulted in an N-gain score of 0.50, which falls within the moderate category and indicates a sufficient level of effectiveness, with an effectiveness percentage of 50%. Based on these findings, the developed interactive learning media met the established feasibility criteria of validity, practicality, and effectiveness.

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1. INTRODUCTION

Education is a conscious and planned effort to develop individuals and promote changes in behavior, knowledge, and skills within the family, society, and nation. In education, the curriculum serves as a key component and a guideline for the learning process (Suryaman, 2020). Therefore, teachers need to be able to interpret the curriculum appropriately, manage the learning process effectively, and be supported by high-quality learning resources.

Learning resources that are aligned with advances in science, technology, and the arts can support the effective implementation of the learning process (Yanto, 2019). One of these resources is learning media, which can help teachers deliver instructional content and facilitate students' understanding. Interactive media can also make learning more engaging and help increase students' interest in learning (Shalikhah et al., 2017). This is consistent with the *Merdeka Curriculum*, which emphasizes the development of students' talents and interests (Putri et al., 2022, Sampe & Aslan, 2025).

Observations of Grade XI physics classes at SMA Negeri 2 Majene indicated that students' interest in learning physics remained low. This was reflected in their limited participation in classroom activities, lack of engagement with learning materials, irregular attendance, and the decision of some students to leave the physics specialization because they considered physics difficult to understand. The observations also showed that teachers had not yet fully utilized available learning resources. The student worksheets and instructional videos used in class did not provide sufficient activities to actively engage students. In addition, mathematical calculations remained dominant, making it difficult for students to relate physics concepts to everyday life and develop a deeper understanding of the subject matter.

These issues highlight the need for greater variation in instructional approaches through the use of appropriate learning media and learning models. The use of learning media can support more effective and efficient learning (Mansur & Rafiuddin, 2020). One medium that can be utilized is *PowerPoint*, as it is practical, can be used in classes of different sizes, allows teachers to observe students' responses, offers various presentation formats, and can be used repeatedly (Kamil, 2018). This medium can be integrated with the *Problem-Based Learning* (PBL) model.

PBL encourages students to learn through practical problems encountered in everyday life (Direktur Pembinaan SMA, 2017, Karan & Brown, 2022, Chang et al., 2022). Through contextual problems, students are encouraged to actively construct knowledge and develop problem-solving skills (Sholikhakh et al., 2019). Therefore, the development of interactive learning media based on PBL is expected to enhance students' interest in learning physics. Based on this rationale, this study is entitled "Developing Problem-Based Interactive Media to Enhance Students' Interest in Physics Learning."

2. METHODS

This study employed a *Research and Development* (R&D) approach using the Borg and Gall development model (Sugiyono, 2019). The development process was limited to nine stages: identifying potentials and problems, data collection, product design, design validation, design revision, product testing, product revision, field testing, and final product revision.

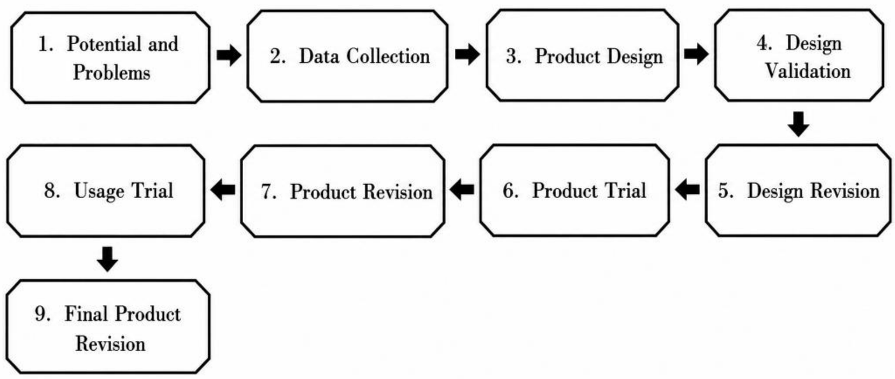

Figure 1. The Nine Stages of the Research and Development Process.

The study was conducted at SMA Negeri 2 Majene during the first semester of the 2023/2024 academic year. The participants included three validators (two university experts and one physics teacher), nine Grade XII Physics students involved in the limited product trial, and 27 students and two physics teachers involved in the field testing. The product developed was *Problem-Based Learning* (PBL)-based interactive learning media using *PowerPoint*.

The development process began with identifying potentials and problems through observations and interviews, followed by a literature review and field survey. The product was designed based on students' needs, the *Merdeka Curriculum*, and the syntax of PBL. It was subsequently validated by three experts and revised according to their feedback. A limited trial involving nine students was then conducted, followed by product revision.

The revised product was tested on 27 students and evaluated by two physics teachers. The effectiveness of the media was examined using a *One-Group Pretest–Posttest Design* (Hamzah, 2019), consisting of a pretest, treatment using the developed media, and a posttest. The final product was revised based on the results of the field testing.

The research instruments included expert validation sheets, student and teacher response questionnaires, and a student learning interest questionnaire (Sugiyono, 2019). All instruments employed a five-point Likert scale. The validation sheets were used to assess the validity of the developed media, the response questionnaires were used to evaluate its practicality, and the learning interest questionnaire was used to examine its effectiveness.

Table 1. Research Instruments Used in the Study

No.	Feasibility Criterion	Data	Data Source	Research Instrument
1.	Validity	Expert Validation	Media Expert	Media Expert Validation Questionnaire
2.	Practicality	Responses	Students and Teachers	Student and Teacher Response Questionnaire
3.	Effectiveness	Learning Interest	Students	Student Learning Interest Questionnaire

Data analysis in this development study included assessments of the validity, practicality, and effectiveness of the learning media. The validity of the media, as evaluated by the expert validation team from the Faculty of Teacher Training and Education, Universitas Sulawesi Barat, and its practicality, as assessed through teacher and student response questionnaires, were calculated using the following percentage formula (Sugiyono, 2019):

$$\text{Percentage} = \frac{\text{Total score obtained}}{\text{Maximum possible score}}\ x\ 100\% \tag{1}$$

The aspects assessed included programming, visual presentation, and content quality. The percentage scores were interpreted according to the criteria presented in Table 2.

Table 2. Validity Criteria for the Learning Media

Category	Percentage
Highly Valid	81% - 100%
Valid	61% - 80%
Moderately Valid	41% - 60%
Invalid	21% - 40%
Highly Invalid	0% - 20%

(Sugiyono, 2019)

The effectiveness of the learning media was assessed based on the improvement in students' learning interest, including enjoyment, interest, attention, and engagement. The improvement was calculated using the normalized gain (N-gain) formula proposed by Meltzer, as cited in Saputra et al. (2017):

$$N - Gain = \frac{S_{final} - S_{initial}}{S_{max} - S_{initial}} \tag{2}$$

where: S_{final} = final learning interest score, S_{awal} = initial learning interest score, and S_{maks} = maximum possible score.

The N-gain scores were categorized as high ($g > 0.70$), moderate ($0.30 < g \leq 0.70$), and low ($g \leq 0.30$). Furthermore, the effectiveness percentages were interpreted according to the following criteria: highly effective (81–100%), effective (61–80%), moderately effective (41–60%), less effective (21–40%), and ineffective (0–20%) (Sugiyono, 2019).

3. RESULTS

3.1. Potential and Problem Identification

The development of *Problem-Based Learning* (PBL)-based interactive learning media for the Electricity and Magnetism topic for Grade XII students at SMA Negeri 2 Majene followed the Borg and Gall development model. Observations showed that the school had adequate facilities, including LCD projectors and a stable internet connection. However, physics instruction remained relatively monotonous, with a strong emphasis on mathematical calculations and limited connections to real-life contexts. In addition, interactive learning media had not been optimally utilized. On the other hand, students showed a preference for visually presented materials using *PowerPoint* combined with real-life problem-based approaches. Therefore, PBL-based interactive *PowerPoint* media were developed to address these needs.

3.2. Data Collection and Product Design

Data were collected through a literature review and field survey. Based on the results, the product was designed by integrating the *Problem-Based Learning* (PBL) syntax into a hyperlink-based interactive medium. The media included a cover page and user guide containing the topic title, navigation features, and descriptions of the instructional icons. The main menu presented the curriculum components, including the Learning Outcomes and Learning Objectives related to physics understanding and process skills. The PBL syntax was integrated into the material and assignment sections. The material section incorporated the first stage of PBL, namely problem orientation, through contextual animated videos, while the assignment section integrated Stages 2 to 5, including organizing students for learning, guiding investigation, presenting the results of their work, and analyzing and evaluating the problem-solving process. The media was also equipped with an evaluation section containing eight interactive quiz questions and a developer profile.

3.3. Expert Validation and Design Revision

The product and research instruments were validated by three validators, consisting of two lecturers from the Physics Education Department, Faculty of Teacher Training and Education, Universitas Sulawesi Barat, and one physics teacher. The validation results are summarized in Table 3.

Table 3. Expert Validation Resutls for the Learning Media and Research Instruments

No.	Aspect	Average (%)	Category
1	Programming	86,67	Highly Valid
2	Visual Presentation	86,67	Highly Valid
3	Content	87,27	Highly Valid
	Average	86,87	Highly Valid

The validators suggested several improvements, including reducing the number of animations, adding an animation illustrating magma movement related to the formation of the Earth's magnetic field, removing unnecessary image backgrounds, and adjusting the font size. The design was revised according to the validators' recommendations before proceeding to the field testing stage.

3.4. Product and Field Testing: Practicality and Effectiveness

The limited product trial was conducted with nine students and resulted in an average practicality score of 83.59%, which falls within the highly practical category. Subsequently, a larger-scale field trial was conducted involving 27 students and two physics teachers. The practicality questionnaires yielded average scores of 90.62% from the teachers and 85.14% from the students, both categorized as highly practical. Based on feedback from the teachers, a final revision was made by reducing the amount of text on several slides to improve readability. The effectiveness of the developed media was evaluated based on improvements in students' learning interest by comparing their pretest and posttest scores using the normalized gain (N-gain).

Table 4. Results of the Improvement in Students' Learning Interest

No.	Indicator	*Pretest*	*Posttest*	S_a-S_i	100-S_i	N-gain	Category
1	Enjoyment	59.88	87.78	27.90	40.12	0.7	High
2	Interest	55.98	77.78	21.80	44.02	0.5	Moderate
3	Attention	57.31	74.81	17.50	42.69	0.4	Moderate
4	Engagement	49.26	69.26	20.00	50.74	0.4	Moderate
	Average	55.61	77.41	21.80	44.39	0.5	Moderate

Based on the N-gain scores obtained from the students' pretest and posttest results, the improvement in learning interest is illustrated in the Figure 2.

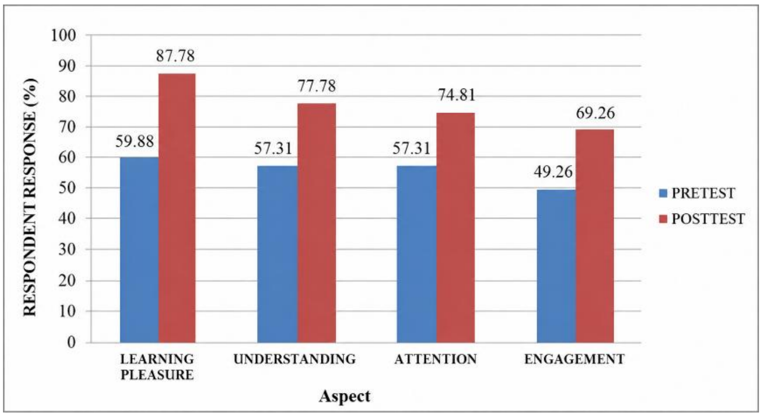

Figure 2. Comparison of the Average Pretest and Posttest Scores of Students' Learning Interest.

An average N-gain score of 0.50 indicated a moderate improvement in students' learning interest, corresponding to an effectiveness level of 50.00%, which falls within the moderately effective category.

3.5. Discussion of Media Feasibility

A summary of the feasibility analysis of the developed media is presented in Table 5.

Table 5. Summary of the Feasibility of the PBL-Based Learning Media

Evaluation Aspect	Percentage	Category
Validity	86.87	Highly Valid
Practicality (Student – Limited Trial)	83.59	Highly Valid
Practicality (Teachers – Field Trial)	90.62	Highly Valid
Practicality (Students – Field Trial)	85.14	Highly Valid
Effectiveness (N-Gain of Learning Interest	50.00	Moderately Effective

Overall, the *Problem-Based Learning* (PBL)-based interactive learning media met the criteria of validity, practicality, and effectiveness. Therefore, the developed media is considered feasible for use in senior high school physics learning.

4. DISCUSSION

The findings demonstrate that the *Problem-Based Learning* (PBL)-based interactive learning media developed using *Microsoft PowerPoint* met the established criteria of validity, practicality, and effectiveness. Overall, the results suggest that the integration of multimedia elements with PBL activities can provide an alternative approach to physics instruction, particularly for learning environments in which instruction has previously been dominated by mathematical calculations and relatively passive learning activities. The developed media incorporated text, images, animations, videos, simulations, games, practice activities, and hyperlink-based navigation. These features were designed not merely to improve the visual appearance of the learning materials but also to support students in accessing information, exploring concepts, responding to problems, and participating in learning activities.

The expert validation results showed an overall validity score of 86.87%, placing the developed media in the highly valid category. The programming and visual presentation aspects each obtained a score of 86.67%, while the content aspect obtained the highest score of 87.27%. These findings indicate that the media was considered appropriate in terms of its technical functionality, visual design, and alignment with the intended learning content. However, the validation process also resulted in several recommendations, including reducing the number of animations, improving the visualization of the Earth's magnetic field, removing unnecessary image backgrounds, and adjusting font sizes. These findings demonstrate the importance of expert validation not only for determining whether a product is acceptable but also for identifying design elements that require improvement before classroom implementation.

The need to revise several multimedia components is consistent with the Cognitive Theory of Multimedia Learning, which emphasizes that multimedia elements should support meaningful cognitive processing rather than merely increase the visual complexity of instructional materials. According to this theory, students learn through limited visual and auditory processing channels and must actively select, organize, and integrate relevant information during learning. Consequently, unnecessary visual elements or overly complex presentations may distract learners and increase extraneous cognitive processing rather than support understanding (Mayer, 2024). The revisions made in this study, particularly the reduction of excessive animations and the adjustment of visual and textual elements, therefore strengthened the alignment between the developed media and evidence-based principles of multimedia design (Mayer, 2017; Mayer, 2024).

The relatively high validity of the content component also suggests that the integration of PBL activities into the media was considered appropriate for the targeted physics topic. The learning materials were organized around contextual problems, beginning with problem orientation and continuing through investigation, presentation, and evaluation activities. This structure allowed the media to function not only as a presentation tool but also as a guide for students' learning activities. Interactive multimedia environments are most effective when learners are provided with meaningful activities, opportunities for reflection, feedback, and an appropriate degree of control over their learning process (Moreno & Mayer, 2007).

The practicality results further support the feasibility of the developed media. During the limited trial, the media obtained a practicality score of 83.59%, which was categorized as highly practical. In the field trial, the practicality score increased to 85.14% based on student responses, while teachers provided an even higher score of 90.62%. These results indicate that both students and teachers perceived the media as relatively easy and convenient to use in the learning process.

The higher practicality score provided by teachers may be related to the ability of the media to organize different instructional components within a single learning resource. The hyperlink-based navigation enabled teachers and students to move between learning objectives, materials, contextual problems, assignments, simulations, and evaluation activities. Such organization may reduce the need to switch between multiple learning resources during instruction. From a practical perspective, interactive multimedia can provide teachers with greater flexibility in presenting learning materials while allowing students to access different types of information and activities in a more structured manner.

The students' positive responses are also important because the media was developed to address the initial problem of limited student engagement in physics learning. Multimedia learning environments can support meaningful learning when students actively interact with instructional materials rather than simply receive information passively (Moreno & Mayer, 2007). The combination of visual elements, interactive navigation, contextual videos, simulations, and learning activities may therefore have contributed to students' positive perceptions of the media.

Nevertheless, the final revision based on teacher feedback revealed that the practicality of instructional media is closely related to the clarity and readability of its design. The reduction of text density on several slides was necessary to improve the usability of the media. This finding supports the principle that multimedia materials should be designed to direct learners' attention toward essential information and avoid unnecessary cognitive demands (Mayer, 2017; Mayer, 2024). Therefore, the high practicality scores should not be interpreted as evidence that the original product was already optimal; instead, they reflect the importance of an iterative development process involving testing, feedback, and revision.

The effectiveness analysis showed an average N-gain score of 0.50, indicating a moderate improvement in students' learning interest. The effectiveness percentage was 50.00%, which was categorized as moderately effective. At the indicator level, enjoyment showed the highest improvement, with an N-gain of 0.70, while interest, attention, and engagement showed moderate improvements, with N-gain scores ranging from 0.40 to 0.50.

The relatively high improvement in enjoyment suggests that the developed media successfully created a more enjoyable learning experience for students. This finding is particularly relevant to the initial classroom observations, which indicated that physics learning was often perceived as difficult and was dominated by mathematical calculations. The inclusion of animations, videos, simulations, games, and contextual problems may have provided students with alternative ways of engaging with physics concepts. According to the Cognitive Theory of Multimedia Learning, the appropriate combination of words and graphics can support students in processing and organizing information more meaningfully than verbal information alone (Mayer, 2017; Mayer, 2024).

The findings also suggest that the integration of PBL may have contributed to the improvement in students' learning interest. PBL encourages students to engage with meaningful problems and actively participate in identifying information, investigating possible solutions, and evaluating their understanding. Previous research has reported positive effects of PBL on students' attitudes and interest toward physics learning. For example, Nardin and Tawil (2016) found that students taught using a problem-based learning approach demonstrated higher interest in physics than students taught using discovery learning. More recent research has also reported improvements in students' interest in physics when PBL was supported by interactive learning technologies and simulations (Kanyesigye et al., 2022; Harahap et al., 2024).

However, the moderate overall N-gain indicates that the developed media did not produce an equally strong improvement across all dimensions of learning interest. Attention and engagement, for example, showed lower improvements than enjoyment. One possible explanation is that making learning enjoyable does not automatically ensure sustained attention or active participation throughout the learning process. Students may respond positively to animations, videos, and interactive features but still require additional instructional support to engage deeply with challenging physics concepts. This interpretation is consistent with research showing that students' motivation and interest do not always translate directly into active cognitive engagement, as engagement can also be influenced by social, situational, and instructional factors (Suhudi et al., 2026).

Another possible explanation is the complexity of the Electricity and Magnetism topic. Physics learning requires students not only to interact with multimedia materials but also to understand abstract concepts and relate different representations, including verbal explanations, visualizations, and mathematical relationships. When students have limited prior knowledge, interactive multimedia alone may not be sufficient to support conceptual understanding. Instead, teacher guidance, collaborative discussion, and appropriately structured scaffolding may be necessary to help students process complex information and connect it with the contextual problems presented in the media (Moreno & Mayer, 2007; Mayer, 2024).

Implications for Physics Learning

The findings have several practical implications for physics instruction. First, *Microsoft PowerPoint* can be developed beyond its conventional function as a presentation tool. Through the integration of hyperlinks, multimedia elements, simulations, quizzes, and structured learning activities, it can function as an interactive learning environment. This approach may be particularly relevant for schools with limited access to specialized educational software but with access to computers, projectors, and standard office applications.

Second, the results highlight the importance of combining instructional technology with an appropriate pedagogical model. The positive responses and improvement in learning interest cannot be attributed solely to the use of multimedia. The PBL structure provided a pedagogical framework that connected multimedia resources with student activities, contextual problems, investigation, and reflection (Syarkin, 2026). Thus, the educational value of technology depends not only on the availability of interactive features but also on how those features are integrated into meaningful learning activities (Moreno & Mayer, 2007; Mayer, 2024).

Third, the improvement in students' learning interest has potential implications for broader physics learning outcomes. Recent evidence indicates that students' learning activities and interest in physics are associated with physics achievement, suggesting that efforts to improve students' engagement and interest may contribute to more positive learning outcomes. However, because the present study focused primarily on learning interest rather than cognitive achievement, this potential relationship should be examined directly in future studies.

Limitations and Future Research

Several limitations should be considered when interpreting the findings. First, the effectiveness test involved a relatively small sample of 27 students and employed a *One-Group Pretest–Posttest Design*. Without a comparison group, the observed improvement in learning interest cannot be attributed exclusively to the developed media. Other factors, such as teacher support, classroom interaction, or students' familiarity with the learning activities, may also have contributed to the results.

Second, the effectiveness evaluation focused on students' self-reported learning interest. Although learning interest is an important affective outcome, self-report data may not fully represent students' actual behavioral or cognitive engagement during learning. Future studies could therefore combine questionnaires with classroom observations, learning analytics, interviews, or measures of student participation to provide a more comprehensive understanding of how students interact with the media.

Third, the study was conducted in a single school and focused on a specific physics topic. The findings may therefore not be directly generalizable to other schools, student populations, or physics topics. Future research should involve larger and more diverse samples and examine the implementation of the media across different learning contexts.

Future studies should also investigate the effectiveness of the developed media using more rigorous experimental or quasi-experimental designs involving comparison groups. In addition to learning interest, future research could examine conceptual understanding, problem-solving skills, learning achievement, motivation, and long-term retention. Further development should also focus on optimizing the multimedia design by reducing unnecessary visual elements, improving the integration of simulations and contextual problems, and providing adaptive guidance or feedback for students who experience difficulties with complex concepts. Such improvements may strengthen not only students' enjoyment of learning but also their attention, engagement, and deeper understanding of physics concepts.

5. CONCLUSION

Based on the results of the data analysis, it can be concluded that the *Problem-Based Learning* (PBL)-based interactive learning media developed in this study has the potential to enhance students' interest in learning physics. In addition, the developed media met the established feasibility criteria of validity, practicality, and effectiveness. The validity results indicated that the media was categorized as highly valid. Its practicality was demonstrated through both the limited and field trials, which showed that the media was categorized as highly practical. Furthermore, the field trial results revealed an improvement in students' learning interest after using the developed media. Therefore, the developed interactive learning media can be considered feasible for use in physics learning.

For future research, the development of PBL-based interactive learning media could utilize a more recent version of *Microsoft PowerPoint* or other appropriate technologies to further optimize its features and functionality. For students, the media is expected to support greater interest and enthusiasm in learning. For teachers, it can serve as an instructional resource as well as a reference for developing similar media for other physics topics. At the school level, the developed media may serve as a reference for promoting more interactive and engaging learning through the integration of images, animations, videos, applications, and other interactive features.

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REFERENCES

Chang, T. S., Wang, H. C., Haynes, A. M., Song, M. M., Lai, S. Y., & Hsieh, S. H. (2022). Enhancing student creativity through an interdisciplinary, project-oriented problem-based learning undergraduate curriculum. *Thinking Skills and Creativity*, *46*, 101173. https://doi.org/10.1016/j.tsc.2022.101173

Direktur Pembinaan SMA. (2017). Model-model Pembelajaran. Jakarta: Kementrian Pendidikan dan Kebudayaan.

Hamzah, A. (2019). Metode Penelitian dan Pengembangan (Research & Development). Malang: Literasi Nusantara.

Kamil, P. M. (2018). Perbedaan Hasil Belajar peserta didik pada Materi Sistem Pencernaan pada Manusia dengan Menggunakan Media powerpoint dan Media Torso. *Bioedusiana*, 3 (2), 64, 68. https://doi.org/10.34289/277901

Karan, E., & Brown, L. (2022). Enhancing Student's Problem-Solving Skills through Project-Based Learning. *Journal of Problem Based Learning in Higher Education*, *10*(1), 74-87. https://doi.org/10.16920/jeet/2022/v35i0/167898

Kanyesigye, S. T., Uwamahoro, J., & Kemeza, I. (2022). Effect of problem-based learning on students' attitude towards learning physics: a cohort study. *F1000Research*, *11*, 1240. https://doi.org/10.12688/f1000research.125085.1

Mansur, H., & Rafiudin. (2020). Pengembangan Media Pembelajaran Infografis untuk Meningkatkan Minat Belajar Mahapeserta didik. *Jurnal Komunikasi Pendidikan*, 4(1), 37-48. www.journal.univetbantara.ac.id/index.php/komdik

Mayer, R. E. (2017) *Using multimedia for e-learning*. *Journal of Computer Assisted Learning*, 33: 403–423. doi: 10.1111/jcal.12197

Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, *36*(1), 8. https://doi.org/10.1007/s10648-023-09842-1

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends. *Educational psychology review*, *19*(3), 309-326. https://doi.org/10.1007/s10648-007-9047-2

Putri, C. A. D., Rindayati, E., & Damariswara, R. (2022). Kesulitan Calon Pendidik dalam Mengembangkan Perangkat Pembelajaran pada Kurikulum Merdeka. *PTK: Jurnal Tindakan Kelas,* 3(1), 18-27. https://doi.org/10.53624/ptk.v3i1.104

Sampe, P. D., & Aslan, A. (2025). Optimising student interest and talent development through intracurricular learning options and thematic projects in the Merdeka curriculum. *Indonesian Journal\ of Education (INJOE)*, *4*(3), 423-433. https://www.felifa.net/index.php/INJOE/article/view/293

Saputra, H., Al Auwal, T. M. R., & Mustika, D. (2017). Pembelajaran Inkuiri Berbasis Virtual Laboratory Untuk Meningkatkan Kemampuan Literasi Sains Mahapeserta didik Calon Guru Pendidikan Fisika Universitas Samudra. *Jurnal IPA & Pembelajaran IPA*, *1*(2), 143–148. https://doi.org/10.24815/jipi.v1i2.9688

Shalikhah, N. D., Primadewi, A., & Iman, M. S. (2017). Media Pembelajaran Interaktif Lectore Inspire Sebagai Inovasi Pembelajaran. *Warta LPM,* 20 (1),9-16 https://journals.ums.ac.id/index.php/warta/article/view/2842/2718

Sholikhakh, R. A., Pujiarto, H., & Suwandono. (2019). Keefektifan Model Pembelajaran Problem Based Learning Terhadap Minat dan Prestasi Belajar Matematika. *Juournal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, 3(1), 33-39. https://doi.org/10.31331/medivesveteran.v3i1.561

Sugiyono. (2019). *Motode dan Penelitian (R&D)* (S. Y. Suryandari (ed.); 4th ed.). Penerbit Alfabeta.

Suryaman, M. (2020). Orientasi Pengembangan Kurikulum Merdeka Belajar. *Prosiding Seminar Daring Nasional: Pengembangan Kurikulum Merdeka Belajar,* 13-28. https://ejournal.unib.ac.id/index.php/semiba/issue/view/956/

Syarkin, M. (2026). Development of Interactive Multimedia Integrating Problem-Based Learning. *ISEJ: Indonesian Science Education Journal*, *7*(1), 61-76. https://doi.org/10.62159/isej.v7i1.2312

Yanto, D. T. P. (2019). Praktikalitas Media Pembelajaran Interaktif Pada Proses Pembelajaran Rangkaian Listrik. *Jurnal Inovasi Vokasional dan Teknologi*, 19(1), 75-82. https://doi.org/10.24036/invotek.v19vi1.409