



Development of artificial intelligence-based physics learning modules on static fluid material to facilitate student learning outcomes

Alzahrantia Annida *, Yuvita Oktarisa, Yudi Guntara

Universitas Sultan Ageng Tirtayasa, Serang City, Banten, Indonesia, 42163

*Corresponding Author Email: alzahrantiaa@gmail.com | Received date: 28/04/2025; Accepted date: 28/05/2025

Abstract

This study aims to develop a physics learning module based on Artificial Intelligence (AI) on static fluid material to facilitate the learning outcomes of grade XI SMA/MA students. The background of this study is the low learning outcomes of students caused by lack of interest in learning, limited learning media, and the abstract nature of static fluid material that is difficult to understand without the help of interactive and adaptive media. This study uses the Research and Development (R&D) method with a 4D development model modified into three stages, namely define, design, and develop. The product developed is an AI-based learning module with chatbot integration as a virtual tutor, equipped with comics, activity sheets, practice questions, and evaluations that enable independent learning. The validation results from material and media experts show that this module is very feasible to use with a material feasibility value of 4.08 and media of 4.15. Limited trials were conducted on 34 grade XI SMAN 1 Kragilan students with an average response result of 4.46, which indicates a very feasible category. It can be concluded that the developed Artificial Intelligence-based physics learning module is stated to be feasible and effective as an alternative teaching material in physics learning in high school, especially in static fluid material.

Keyword: module development; artificial intelligence; static fluids; learning outcomes; physics

Abstrak. Penelitian ini bertujuan untuk mengembangkan modul pembelajaran fisika berbasis Artificial Intelligence (AI) pada materi fluida statis untuk memfasilitasi hasil belajar peserta didik kelas XI SMA/MA. Latar belakang dari penelitian ini adalah rendahnya hasil belajar peserta didik yang disebabkan oleh kurangnya minat belajar, keterbatasan media pembelajaran, serta sifat abstrak dari materi fluida statis yang sulit dipahami tanpa bantuan media yang interaktif dan adaptif. Penelitian ini menggunakan metode Research and Development (R&D) dengan model pengembangan 4D yang dimodifikasi menjadi tiga tahap, yaitu define, design, dan develop. Produk yang dikembangkan berupa modul pembelajaran berbasis AI dengan integrasi chatbot sebagai tutor virtual, dilengkapi dengan komik, lembar kegiatan, latihan soal, serta evaluasi yang memungkinkan pembelajaran mandiri. Hasil validasi dari ahli materi dan media menunjukkan bahwa modul ini sangat layak digunakan dengan nilai kelayakan materi sebesar 4,08 dan media sebesar 4,15. Uji coba terbatas dilakukan pada 34 peserta didik kelas XI SMAN 1 Kragilan dengan hasil rata-rata respons sebesar 4,46, yang menunjukkan kategori sangat layak. Dapat disimpulkan bahwa modul pembelajaran fisika berbasis Artificial Intelligence yang dikembangkan dinyatakan layak dan efektif sebagai alternatif bahan ajar dalam pembelajaran fisika di SMA, khususnya pada materi fluida statis.

INTRODUCTION

Education in Indonesia continues to experience transformation, one of which is through the implementation of the Independent Curriculum which aims to develop the character, competence, and interests and talents of students. However, the implementation of this curriculum still faces challenges, especially in science subjects such as physics, which are characterized by low student learning outcomes. One of the causes is the lack of interest in learning due to changes in learning approaches that are not yet fully understood by students (Febriani A, 2022).

The problem is exacerbated by the limited teaching materials available in schools. The conventional textbooks that are predominantly used tend to be less flexible and do not support independent learning optimally (Asma, 2022). This has a direct impact on the understanding of abstract concepts in physics, such as static fluid material which has a high level of complexity and often gives rise to misconceptions (Himmah, 2021). The main misconceptions found include misunderstandings about hydrostatic pressure which is considered to be influenced by the shape of the vessel, as well as the Archimedes force which is considered to be influenced by the mass of the object, whereas it should be influenced by the volume of the submerged object and the density of the fluid. The percentage of misconceptions is quite high, for example 41.94% in the concept of hydrostatic pressure and 38.71% in the relationship between the volume of the submerged object and the buoyancy force (Sholahuddin et al., 2019).

Static fluid as part of physics material contains many abstract mathematical concepts. In theory, misconceptions in physics material such as static fluid inhibit the correct understanding of the concept, thus reducing student learning outcomes. Learning should be able to connect students daily experiences with the physics concepts being studied (Oktarisa, 2016). Therefore, innovative learning media are needed that can bridge the gap between theoretical concepts and real applications in everyday life. One potential solution is the development of Artificial Intelligence (AI)-based learning modules.

Artificial Intelligence has great potential in education, especially in providing adaptive and personalized learning. AI such as chatbots or virtual tutors enable interactive and flexible interactions with students, and provide automated feedback that is tailored to individual abilities (Gontina & Asyhar, 2023). In theory, learning modules help improve learning outcomes by presenting material systematically and independently, so that students can learn at their own pace and learning style. Modules also increase student motivation and engagement through interactive support media and exercises.

However, the use of AI in learning must still pay attention to the validity of the information. Therefore, the support of physics textbooks as the main reference is still needed so that the learning process remains focused and accurate (Bransford et al., 2000). In this context, AI-based physics learning modules equipped with textbooks are a promising alternative teaching material.

The results of observations conducted at SMAN 1 Kragilan show that physics learning is still dominated by lecture methods and is not supported by innovative learning media. In addition, students do not yet have appropriate textbooks and interactive media are not yet available to help them understand the material independently. This condition is a challenge for teachers in delivering material effectively and interestingly.

RESEARCH METHODS

This research is development research (Research and Development/R&D) with the development model used in this study is the 4D model (Define, Design, Develop, Disseminate) which is modified into three stages, namely define, design, and develop. With a descriptive quantitative approach, this research does not reach the dissemination stage because it is limited to the development stage and limited product trials. The dissemination stage was not carried out because the research was still limited to the development stage and limited product trials. Scientifically, dissemination of research results is usually carried out after the product or findings are valid, effective, and ready to be disseminated to the wider public so that they can be utilized optimally. The research subjects consisted of material experts, media experts, and 34 students of class XI MIPA SMAN 1 Kragilan. The development stages were carried out through three main stages, includes define, design, and develop.

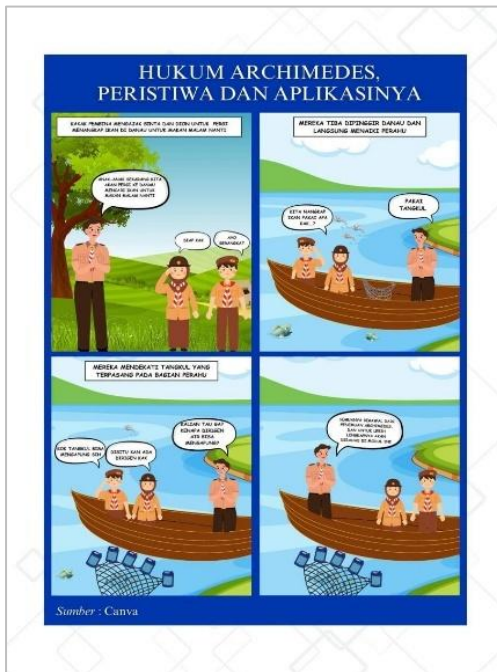


Figure 1 Educational comics

Define: This stage includes curriculum analysis, analysis of student needs, and initial analysis related to static fluid material and student characteristics. Design: Designing the structure and contents of the module, namely, module cover, foreword, table of contents, introduction, comics (Figure 1), flashbacks, learning activities, evaluation and bibliography. Develop: Includes initial product development, expert validation, product revision, and limited testing with students.

The instruments used in this study were validation sheets for material and media experts, as well as student response questionnaires for the module. The instruments were arranged based on a grid that refers to aspects of the feasibility of learning materials and media, as well as user responses, with the aim of obtaining accurate validation data for module development. Validation data were analyzed quantitatively descriptively using the calculation of the percentage of feasibility from each validator. Student response data were also analyzed using percentages to determine the assessment categories (very good, good, sufficient, lacking). The module feasibility criteria were determined based on the percentage range with reference to established standards.

Table 1 Scoring Rules

Score	Scale
5	Very Good
4	Good
3	Enough
2	Not Enough
1	Very Less

(Source: Sugiyono, 2010)

Table 2 Interpretation of Eligibility

Scale	Score
4.21 - 5.00	Very Worthy
3.41 - 4.20	Worthy
2.61 - 3.40	Quite Decent
1.81 - 2.60	Not Worth It
1.00 - 1.80	Not feasible

(Source: McNeill & Pimentel, 2010)

RESULTS AND DISCUSSION

The developed module was validated by two experts, namely material experts and media experts. The validation results showed that the module was declared very feasible to be used in learning. The suitability of the material obtained an average percentage of 4.08 with the category "suitable", covering aspects of suitability of content, suitability of presentation and suitability of language (see Figure 2). The media suitability obtained an average percentage of 4.15 with the category of "suitable", covering aspects of size, module cover, module content design and language rules (see Figure 3). The assessment categories for both are in the "adequate" range, indicating that this module meets the eligibility standards for use in the learning process.

Limited trials were conducted on 34 grade XI students of SMAN 1 Kragilan. Students were asked to study the module independently and provide responses through questionnaires (see Figure 4). The results of the response analysis show the average score of student responses to the module was 4.46, which is

included in the category of "very appropriate". The aspects assessed include clarity of the material, visual appeal, ease of understanding the content, and the benefits of the AI feature (interactive chatbot). The module is considered interesting and makes it easier for students to understand the concept of static fluids independently, especially with the help of a chatbot as a virtual tutor that provides direct feedback.

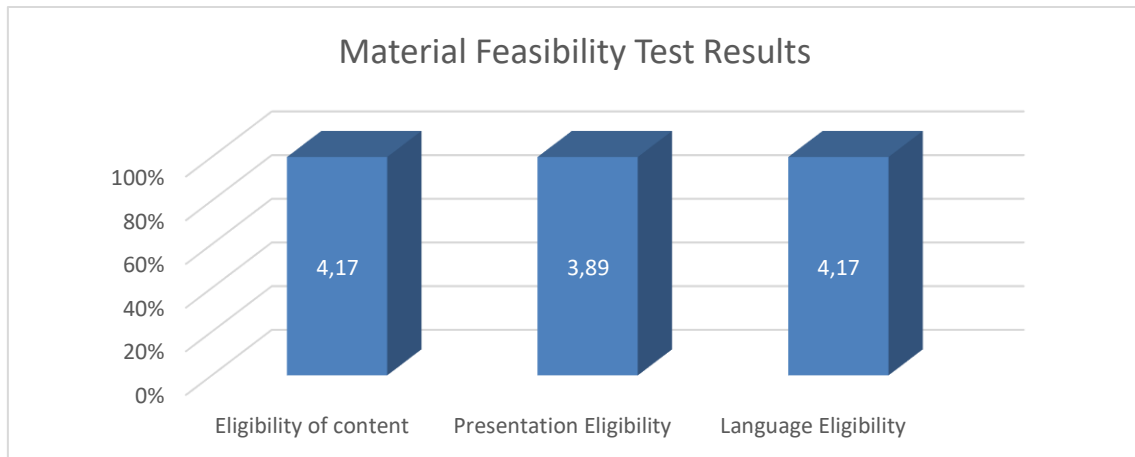


Figure 2 Material feasibility graph

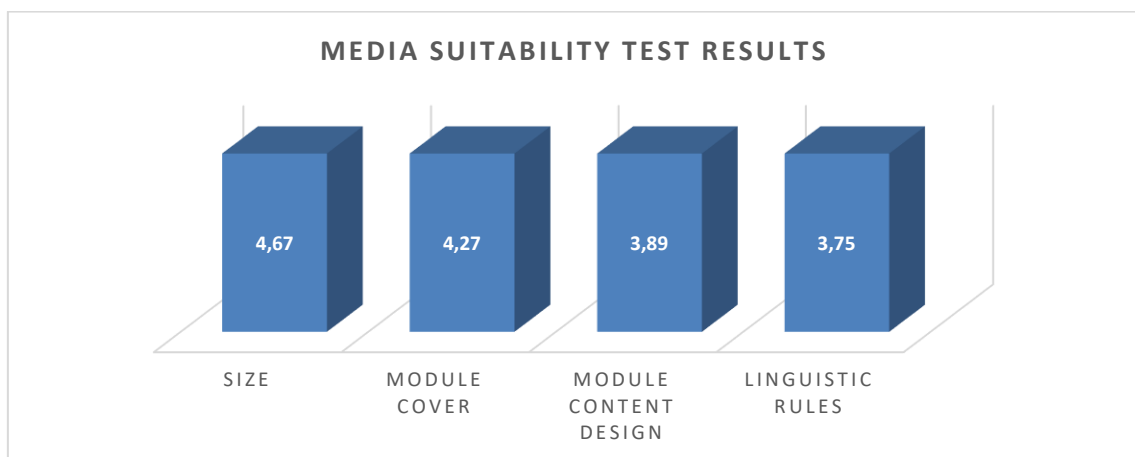


Figure 3 Media feasibility graph

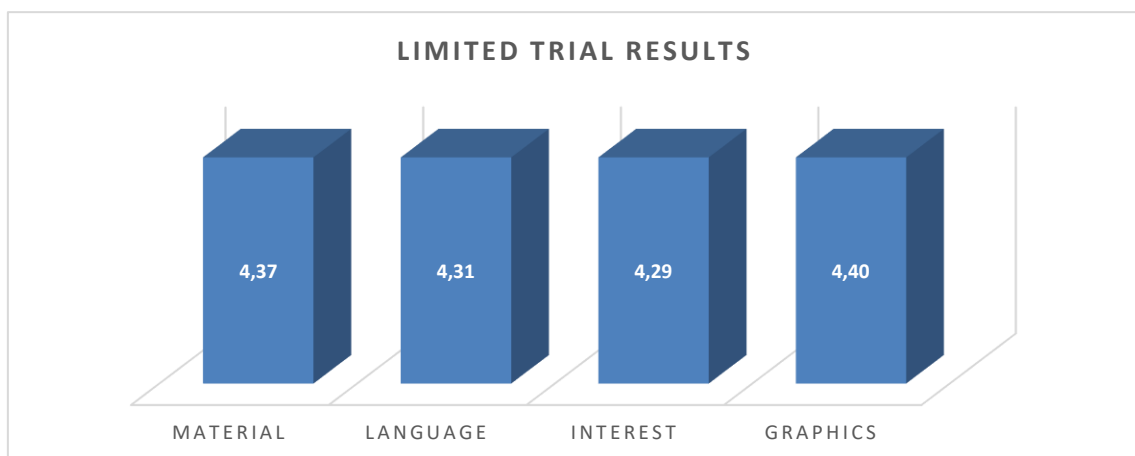


Figure 4 Limited trial results graph

The results of the study indicate that the development of a physics learning module based on Artificial Intelligence (AI) on static fluid material has proven effective in facilitating the improvement of student learning outcomes. This module was developed based on a modified 4D model (Define, Design, Develop, Disseminate). Based on the graph above, the results of expert validation of the feasibility of the material, in the aspect of content feasibility obtained an average of 4.17 with a standard deviation value of 0.79, in the aspect of presentation feasibility obtained an average of 3.89 with a standard deviation value of 0.60, in the aspect of language feasibility obtained an average of 4.17 with a standard deviation value of 0.75. The total average value of all aspects is 4.08 with the criteria obtained "Feasible" to be used as a learning medium. Meanwhile, the media feasibility, in terms of size, obtained an average of 4.67 with a standard deviation of 0.52, in terms of module cover, obtained an average of 4.27 with a standard deviation of 0.80, in terms of module content design, obtained an average of 3.89 with a standard deviation of 1.36 and in terms of language rules, obtained an average of 3.75 with a standard deviation of 0.75. The total average value of all aspects is 4.15 with the criteria obtained "Feasible" to be used as learning media.

In addition, based on the graph of student responses to the AI-based physics learning module from several aspects, namely in the material aspect, the percentage of assessment was 4.49 with a standard deviation of 0.02, in the language aspect, the percentage of assessment was 4.43 with a standard deviation of 0.01, in the interest aspect, the percentage of assessment was 4.42 with a standard deviation of 0.01, and the graphic aspect was 4.50 with a standard deviation of 0.01. Based on the average value of the 4 aspects, it can be concluded that the results of the limited student trial as a whole obtained an average assessment value of 4.46 with the category "Very Eligible" to be used as a learning medium.

The use of AI technology in developing teaching materials is one of the relevant learning strategies in the digital era. The use of AI, especially in the form of chatbots or virtual assistants, allows for the delivery of materials and feedback personally and instantly, according to the level of student ability (Supriadi et al., 2022). This is in line with the findings Maufidhoh & Maghfirah (2023) which states that the integration of AI in learning can increase student motivation and engagement through an interactive and adaptive approach.

Static fluid material is an abstract topic because it involves concepts such as hydrostatic pressure, Pascal's law, and Archimedes' law which are difficult to observe directly in everyday life (Himmah, 2021). Therefore, presenting material through contextual and visual modules is very necessary to avoid misconceptions. Study Saputra et al. (2019) shows that misconceptions about static fluids occur in more than 50% of students, especially in understanding the principles of pressure and buoyancy.

The module developed in this study not only presents material descriptions and practice questions, but is also equipped with problem-solving-based activity sheets, summaries, final evaluations, and AI-based interactive features. This module is designed so that students can learn independently, in accordance with the characteristics of the module that prioritizes self-instruction, stand-alone, user-friendly, and adaptive to technological developments (Septora, 2017).

The students' responses to the module showed that the material aspect obtained an assessment percentage of 4.49 with a standard deviation value of 0.02, the language aspect obtained an assessment percentage of 4.43 with a standard deviation value of 0.01, the interest aspect obtained an assessment percentage of 4.42 with a standard deviation value of 0.01, and the graphic aspect obtained an assessment percentage of 4.50 with a standard deviation value of 0.01. Based on the average value of the 4 aspects, it can be concluded that the results of the limited student trial as a whole obtained an average assessment value of 4.46 with the category of "very feasible" to be used as a learning medium.

Thus, this study proves that the development of AI-based physics learning modules is a relevant innovation for use in Independent Curriculum learning that encourages independent learning and is oriented towards student competency. This finding supports previous research by (Yassir & Saharuna, 2024), which states that AI can improve learning outcomes and creativity through a more personal and flexible approach.

CONCLUSION

Based on the results of the research and development that has been carried out, it can be concluded that the physics learning module based on Artificial Intelligence (AI) on static fluid material for grade XI SMA/MA students is declared very feasible and effective to be used as an alternative teaching material. This is

evidenced by the results of the validation of material experts of 4.08 and media experts of 4.15, both of which are in the "feasible" category. In addition, the results of limited trials showed that the module received a very positive response from students with an average score of 4.46. The use of AI technology, especially interactive chatbots, has been proven to help students understand abstract concepts more easily and interestingly. This module provides an adaptive self-learning experience, and encourages active participation of students in the learning process.

REFERENCES

- Asma, F. N. (2022). *Pengembangan modul pembelajaran fisika berbasis project based learning (PjBL) pada materi fluida statis untuk peserta didik kelas XI tingkat SMA/MA*. UNIVERSITAS ISLAM NEGERI AR-RANIRY.
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind, Experience, and School*. National Academy Press.
- Febriani A, A. Y. dan S. M. (2022). Analisis Perubahan Kurikulum 2013 Terhadap Hasil Belajar Peserta Didik Kelas X Di MAN 1 Solok. *JUPEIS: Jurnal Pendidikan Dan Ilmu Sosial*, 1(4).
- Gontina, W., & Asyhar, R. (2023). Dampak artificial intelligence terhadap pembelajaran IPA/fisika di sekolah. *Silampari Jurnal Pendidikan Ilmu Fisika*, 5(2), 238–250. <https://doi.org/10.31540/sjpif.v5i2.2609>
- Himmah, F. , S. S. (2021). Pengembangan modul pembelajaran fisika SMA pokok bahasan fluida statis berbasis potensi lokal pada Waduk Lecari Banyuwangi. *ORBITA Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, 7(2), 343–350.
- Maufidhoh, I., & Maghfirah, I. (2023). Implementasi Pembelajaran Berbasis Artificial Intelligence Melalui Media Puzzle Maker Pada Siswa Sekolah Dasar. *ABUYA: Jurnal Pendidikan Dasar*, 1(1), 30–43.
- McNeill, K. L., & Pimentel, D. S. (2010). Scientific discourse in three urban classrooms: the role of the teacher in engaging high school students in argumentation. *Science Education*, 94(2), 203–229.
- Oktarisa, Y. (2016). Penerapan model pembelajaran berbasis pengalaman berbantuan multimedia untuk meningkatkan penguasaan konsep dan kompetensi sains siswa. *Gravity*, 2(1).
- Saputra, N., Desnita, Murtiani, & Satria Dewi, W. (2019). Analisis sajian buku teks pelajaran fisika sma kelas xi semester 2 terkait komponen contextual teaching and learning (CTL). *Pillar of Physics Education*, 12(3), 505–512.
- Septora, R. (2017). Pengembangan modul dengan menggunakan pendekatan saintifik pada kelas x sekolah menengah atas. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM METRO*, 2(1).
- Sholahuddin, S., Rusnayati, H., & Suyana, I. (2019). *Profil miskonsepsi siswa berdasarkan hasil tes diagnostik four tier test pada materi fluida statis*. 4(2), 194–199.
- Sugiyono. (2010). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, kualitatif, dan R&D*. Alfabeta.
- Supriadi, S. R. R. P., Sulistiyani, & Chusni, M. M. (2022). Inovasi pembelajaran berbasis teknologi Artificial Intelligence dalam Pendidikan di era industry 4.0 dan society 5.0. *JPSP: Jurnal Penelitian Sains Dan Pendidikan*, 2(2), 192–198. <https://e-journal.iain-palangkaraya.ac.id/index.php/mipa/>
- Yassir, M., & Saharuna. (2024). Pengaruh Artificial Intelligence (AI) Terhadap Hasil Belajar Mahasiswa yang Dimediasi oleh Motivasi Belajar dan Kreativitas. *Jambura Journal of Educational Management*, 5(1), 45–54. <https://ejournal-fip-ung.ac.id/ojs/index.php/jjem/index>