



Development of Quantum Physics E-Modules on Wave Function Material Assisted by Flip PDF Professional

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Abstract:

This study aims to determine the results of the development of quantum physics e-modules on wave function material, to determine the feasibility of e-module development, and to determine student perceptions of wave function e-modules using flip pdf professional. The method used in this research is research and development method. The development model used is the ADDIE model which consists of five stages including analysis, design, development, implementation, and evaluation. However, this research is limited to the development stage. The instrument used is a validation questionnaire for material experts, media experts, and student perceptions. The types of data are qualitative and quantitative data. The research results were obtained through expert validation and student perceptions. In the final results of material expert validation, the average score reached 4.94 with a very good category. Furthermore, the final results of media expert validation obtained an average score of 4.82 with a very good category. Then an operational field trial was conducted with the average score reaching 4.22 with a very good category. The main advantage of the developed e-module is the presence of videos on how to read formulas, additional learning videos, quizzes, and sample questions that make it easier to understand the material. Based on the research results obtained, it can be concluded that the quantum physics e-module on wave function material using professional flip pdf developed is in a very good category to be used and disseminated as a complementary learning resource for students.

Keywords: E-Module, Quantum Physics, Wave Function, Flip PDF Professional.

Introduction

The rapid development of science and technology makes the world seem limitless, so this condition has an impact on various aspects of life (Romlah, 2019). One of them is in the aspect of education. In essence, education is a conscious effort that is planned to create an attractive learning and learning atmosphere (Pristiwanti et al., 2022). An interesting learning atmosphere will have a positive impact on achieving optimal learning achievement and is assisted by a wide selection of learning models and media (Azzahrah Putri et al., 2021). The selection of learning models and learning media greatly influences the achievement of learning objectives and the development of individual competencies (Magdalena et al., 2021). One of the media in the teaching and learning process is teaching materials.

Teaching materials are a set of learning tools or tools that contain learning materials, methods, boundaries and ways to evaluate which are systematically designed and attractive in order to achieve the expected goals, namely achieving competencies or subcompetencies with all their complexity (Jasmadi, 2021). Lecturers have an important role in choosing teaching materials to match the material to be mastered by students and at the same time can provide guidelines for learning it (Nurafni et al., 2020). Innovation in the use of various teaching materials is very important to broaden students' horizons. The habit of using various teaching materials will facilitate the desired quality improvement (Nuryasana & Desiningrum, 2020). One of the teaching materials that can facilitate student learning is e-modules.

E-modules are electronic teaching materials designed to be studied independently and

presented systematically (Muzijah et al., 2020). E-modules are information displays in book format and are presented electronically and can be read using a computer or other electronic book reader (Wijayanti et al., 2016). E-modules also contain an image, animation, video, audio and other feedback for students.

The development of e-modules in this study used flip pdf professional. Flip pdf professional is an interactive media that can easily add various types of animative media into the flipbook. Just by dragging, dropping or clicking, you can insert youtube videos, hyperlinks, animated text, images, audio and flash into the flipbook (Khairinal et al., 2021). Flip pdf professional software that can convert pdf files to page turning digital publications so that they can be flipped like a book when opened (Azizah et al., 2023). Flipbook-based e-modules can be applied to various courses including quantum physics courses.

Quantum physics is a branch of physics that studies subatomic particle behavior, energy, and interactions at very small scales (Jones, 2024). Because of its nature, which is very different from the macroscopic world experienced in everyday life, many students face difficulties in understanding it. Some facts explain that concepts in quantum physics are often very abstract and involve aspects such as superposition, particle waves and particle separation. These concepts are not always easy to imagine or intuitive in relation to everyday reality. Understanding quantum physics requires a change in thinking, as the behavior of subatomic particles often contradicts intuitions about the physical world. This requires non-intuitive thinking and flexibility in adapting new concepts.

Based on the results of distributing a needs questionnaire to 2021 physics education students who have contracted quantum physics courses, more than 85% of students answered that it was very difficult to understand quantum physics wave function material. Student difficulties are dominated by the problem of teaching materials. Because the teaching materials used by lecturers in quantum physics lectures use English which is difficult for students to understand, and the teaching materials used today do not fully meet the needs of the material being taught, and do not have examples of learning simulations like those in previous books. In addition, students also need additional teaching materials to support the learning process. Students need an Indonesian textbook that is complete with formula

explanations, illustrations, learning simulations, and additional practice questions.

From the results of the needs analysis, it can be concluded that problem solving lies in the development of effective and attractive teaching materials. To overcome the above problems, the author offers an e-module solution designed using the professional flip pdf application. This e-module can be accessed anywhere and anytime through the online platform provided. Especially in the current era, every student is certain to have a cellphone. So that flexibility in learning allows access without time or place restrictions to learning materials. With this e-module, it will help students to increase their motivation and activity while learning. This e-module also uses an attractive and varied appearance so that it adds to the attractiveness for students. From the explanation above, the researcher is interested in conducting research with the title "Development of Quantum Physics E-Modules on Wave Function Material Assisted by Flip Pdf Professional."

Method

The method used in this research is the research and development method. Research and development is a research method used to produce certain products, and test the effectiveness of the products (Saifudin et al., 2020). In this study the authors used the ADDIE development model. The ADDIE model is a model that uses an effective, efficient, interactive system approach, namely the results of each stage determine the next stage of research (Ninawati et al., 2021). The purpose of this research is to produce a product in the form of quantum physics e-modules on wave function material. The ADDIE model consists of five stages, namely analysis, design, development, implementation, and evaluation (Liana et al., 2019). However, this research is limited to only three stages as follows:

Analysis Stage

The analysis stage is the initial stage in e-module development research using flip pdf professional. Analysis is carried out to determine learning needs and identify problems. The analysis stage aims to identify problems that occur to students during the learning process (Kurnia et al., 2019). To determine this need, a literature study was conducted on articles, journals, theories, and previous research results related to

the use of various platforms that were used as references in the development of quantum physics e-modules. Then the researchers made initial observations using a questionnaire consisting of 10 questions and distributed through whatshapp groups. The results of the analysis showed that the main difficulty of students lies in understanding the material in quantum physics lectures. In addition, students need learning media that is varied, interesting, innovative, and a detailed explanation of the material. So it is concluded that the results of the answers from each student will determine the researcher to carry out the next stage.

Design Stage

The design stage is the stage of planning the design of activities that will be carried out in the development of e-module products using professional flip pdf. At this stage the researcher begins to design the e-module to be developed. Activities at this design stage are carried out in 6 stages as follows: 1.) Determining the development team: At this stage the development team plays a role in developing, validating, monitoring the development and providing product assessments. 2.) Determining the resources needed: at this stage it is very important to determine the resources needed so that the prototyping of the product can be done properly. 3.) Developing a development schedule: The development team must develop a plan that includes a schedule for completing the product to be developed so that the completion runs smoothly. 4.) Making storyboards: Determining the format of making media on e-modules. 5.) Product specifications: Determining the specifications of the e-module related to the technical and content required. 6.) Product prototype: Creating an initial sketch of the product design.

Development Stage

The development stage is the stage to produce a development product. The development stage aims to produce learning tools that are effective when used. The first step that must be taken at this development stage is to test the clarity and content in the e-module on experts. The validation process is carried out by a validation team who are experts in their fields. The evaluation received is in the form of expert

suggestions and comments which are used as guidelines in revising the developed e-modules.

Data collection in this development research was carried out using validation sheets and student perception questionnaires. The validation sheet serves to test the feasibility of the product, while the student perception questionnaire is used to find out their responses to the developed double-slit diffraction guide. Data analysis from the validation sheet and student perception questionnaire was carried out by grouping data based on intervals into five categories: very good, good, quite good, not good, and very bad. The first step to divide the data into five categories is to determine the maximum and minimum scores, which are calculated by multiplying the number of respondents by the number of question items and the Likert scale value. The Likert scale value for the maximum score is 5 and for the minimum score is 1. After determining the maximum and minimum scores, the next step is to determine the interval distance. The equation used to determine the interval distance is:

$$I = \frac{\text{MaximumScore} - \text{MinimumScore}}{\text{NumberOfCategories}}$$

With (i) is the interval class distance. After the interval distance is determined, the data can be divided based on the score range of the interval distance obtained.

The data analysis techniques used are qualitative data analysis and quantitative data analysis. Qualitative data was obtained from questionnaires. The analysis technique used for questionnaires and documentation is miles huberman, which includes data reduction, data collection, data presentation, and conclusion (Kurnada & Iskandar, 2021). The quantitative data analyzed came from questionnaire scores that included the assessment of media experts, material experts, and student perceptions.

Result and Discussion

The results of the development in this study are teaching materials in the form of quantum physics e-modules on wave function material with statistical interpretation, probability, and normalization sub-materials. This e-module was developed using the help of the professional flip pdf application using the ADDIE development model which consists of five stages, namely analysis, design, development, implementation,

and evaluation. However, the stages carried out in this study only reached three stages.

In the analysis stage, researchers first conducted a literature study to determine the availability of teaching materials in quantum physics courses during the learning process. The next stage, researchers analyzed the needs of students in understanding the basic problems in the development of e-modules. By analyzing the results, it can be known the characteristics of students in learning wave function material whether the e-module developed meets their characteristics and needs. This step was taken by distributing a needs questionnaire to Jambi University Physics Education students class of 2021. From the data collected, 34 respondents were obtained. Data collection was carried out via digital google from links and shared with whatsapp groups. The information obtained from the questionnaire was analyzed according to the needs, characteristics of students, objectives and material studied. Based on the results of the initial study, wave function material is one of the materials that is difficult for students to understand, because the derivative formulas in the book used are not described in detail. In addition, the references used when studying quantum physics are mostly in English. Based on these problems, researchers provide solutions in the form of quantum physics e-modules that present Indonesian-language material with a more attractive appearance so that it can be used as an additional learning resource in quantum physics courses.

At this design stage, researchers began designing the e-modules to be developed. The first step to be taken is the structure of the material in accordance with the course learning outcomes and sub-course learning outcomes. At this stage, a storyboard is made using flowchat as a guide to product development. With this design stage, it is expected that the implementation of product development activities will be more structured.

The development stage aims as a follow-up to the previously designed design to be used as the final product. Before the final product is accepted, the developed product must be validated first so that the product can be field tested. The validation process is carried out by a validation team who are experts in their fields. The evaluation received is in the form of expert suggestions and comments which are used as guidelines in revising the quantum physics e-module on wave function material using professional flip pdf. There are two stages of validation that will be carried out,

namely material expert validation and media expert validation. In the material expert validation, suggestions for improvement were obtained from the material expert validator, namely making detailed question instructions and correcting grammatical errors in accordance with scientific principles in the e-module. After the improvements were made, the final result of the average score of the material expert validation obtained was 4.94, which was included in the very good category. Furthermore, in the media expert validation, improvement suggestions were obtained from the media expert validator, namely improving the font size and font selection on the e-module. After making improvements, the final result of the average score of media expert validation obtained was 4.82, which was included in the very good category. Based on the results of material expert validation and media expert validation obtained, it shows that the e-module developed is suitable for field testing.

The next stage is to find out student perceptions of the e-modules developed as follows:



Figure 1. Questionnaire graph regarding the level of ease of e-module in classroom learning

The results of the questionnaire distributed to respondents for the first aspect regarding the level of ease of e-module guidance in classroom learning showed that 50% of respondents answered well on a scale of 4; 32.1% of respondents answered very well with a scale of 5; and 17.9% of respondents answered quite well on a scale of 3. Thus, according to students, the ease of using the guide in learning most students chose a scale of 4 with good information. This confirms that the use of teaching materials can well assist students in using e-modules.



Figure 2. Graph of questionnaire regarding students' perceptions of interest in using e-module

In the second aspect of the question, namely student interest in using e-modules, the data showed that 48.2% of respondents answered very well on a scale of 5; 42.9% of respondents answered well with a scale of 4; and as many as 8.9% of respondents answered quite well with a scale of 3. Thus, most students' interest in e-modules chose a scale of 5 with very good information. This confirms that the use of teaching materials can already attract students' attention well in using e-module.



Figure 3. Graph of questionnaire on perception of being challenged to do a quiz in the e-module

For questions on the third aspect, namely being challenged to do quizzes in e-modules, data obtained by 57.1% of respondents answered well on a scale of 4; as many as 25% of respondents answered very well on a scale of 5; and as many as 17.9% of respondents answered quite well on a scale of 3. Thus, students feel challenged by the quiz in the e-module because most students choose scale 4 with a good description. This confirms that the use of teaching materials in the good category can make students feel challenged by the quiz on the e-module.

From the three aspects of the questions asked to students, it can be seen that the most dominant category in all three is on a scale of 4, which means that the e-module is good to use. The graph of the average value of respondents shows that the highest value in the very good category is 48.2%, then the category with a good description reaches 57.1% of respondents, while the category is quite good reaches 17.9% of respondents.

Based on the results of material expert validation, media expert validation, and student perceptions, it shows that the e-module of quantum physics wave function material using flip pdf professional is very good to be used as an

additional learning resource in quantum physics courses.

Conclusion

This research produces a product in the form of quantum physics e-modules on wave function material developed using the professional flip pdf application. The developed e-module contains wave function material, videos of how to read formulas, learning videos, sample questions, quizzes, and competency tests. The final results of the material feasibility test by material experts with an average obtained reached 4.94 in the very good category. Furthermore, the final results of the media feasibility test by media experts with an average obtained reached 4.82 in the very good category. For the final results of student perceptions, the average obtained was 4.22 in the very good category. Based on the final results of material expert validation, media expert validation, and student perceptions of quantum physics e-modules on wave function material obtained are in the very good category. So that the e-module developed can be an additional teaching material in quantum physics lectures, especially on wave function material.

Suggestion

Quantum physics e-modules on wave function material can be utilized more widely by students who contract quantum physics courses. For further researchers can develop a variety of electronic teaching materials that are more interesting and innovative again. In addition, collaboration between lecturers and students in using this e-module can improve understanding of quantum physics concepts and encourage the emergence of new ideas in teaching and learning. The implementation of the latest and interactive technology in this e-module is also expected to enrich the learning experience and make quantum physics material easier to understand.

References

- Azizah, N., Fitri, D. Y., & Lovia, L. (2023). Pengembangan E-Modul Berbasis Realistic Mathematics Education (RME) Berbantuan Flip Pdf Professional pada Materi Barisan dan. *Jurnal Pendidikan Tambusai*, 7, 11087–11096.
- Azzahrah Putri, R., Magdalena, I., Fauziah, A., & Nur Azizah, F. (2021). Pengaruh Gaya

- Belajar terhadap Pembelajaran Siswa Sekolah Dasar. *Cerdika: Jurnal Ilmiah Indonesia*, 1(2), 157–163. <https://doi.org/10.59141/cerdika.v1i2.26>
- Jasmadi, C. S. W. (2021). *Pand Meny Bahan Ajar Basis Kompetensi+cd*. Elex Media Komputindo. <https://books.google.co.id/books?id=Gv3ZYRgsPkAC>
- Jones, A. Z. (2024). *Quantum Physics For Dummies*. Wiley. <https://books.google.co.id/books?id=dfX8EAAAQBAJ>
- Khairinal, Suratno, & Aftiani, R. Y. (2021). Pengembangan Media Pembelajaran E-Book Berbasis Flip Pdf Professional Untuk Meningkatkan Kemandirian Belajar Dan Minat Belajar Siswa Pada Mata Pelajaran Ekonomi Siswa Kelas X Iis 1 Sma Negeri 2 Kota Sungai Penuh. *Jurnal Manajemen Pendidikan Dan Ilmu Sosial*, 2(1), 458–470. <https://doi.org/10.38035/jmpis.v2i1.583>
- Kurnada, N., & Iskandar, R. (2021). Analisis Tingkat Kecanduan Bermain Game Online terhadap Siswa Sekolah Dasar. *Jurnal Basicedu*, 5(6), 5660–5670. <https://doi.org/10.31004/basicedu.v5i6.1738>
- Kurnia, T. D., Lati, C., Fauziah, H., & Trihanton, A. (2019). Model ADDIE Untuk Pengembangan Bahan Ajar Berbasis Kemampuan Pemecahan Masalah Berbantuan 3D. *Seminar Nasional Pendidikan Matematika*, 1(1), 522.
- Liana, Y. R., Ellianawati, & Hardyanto, W. (2019). Pengembangan E-Modul Interaktif Berbasis Android Menggunakan Sigil Software pada Materi Listrik Dinamis. *Seminar Nasional Pascasarjana Universitas Negeri Semarang*, 926–932.
- Magdalena, I., Fatakhatu Shodikoh, A., Pebrianti, A. R., Jannah, A. W., Susilawati, I., & Tangerang, U. M. (2021). Pentingnya Media Pembelajaran Untuk Meningkatkan Minat Belajar Siswa Sdn Meruya Selatan 06 Pagi. *EDISI: Jurnal Edukasi Dan Sains*, 3(2), 312–325. <https://ejournal.stitpn.ac.id/index.php/edisi>
- Muzijah, R., Wati, M., & Mahtari, S. (2020). Pengembangan E-modul Menggunakan Aplikasi Exe-Learning untuk Melatih Literasi Sains. *Jurnal Ilmiah Pendidikan Fisika*, 4(2), 89. <https://doi.org/10.20527/jipf.v4i2.2056>
- Ninawati, M., Burhendi, F. C. A., & Wulandari. (2021). Pengembangan E-Modul Berbasis Software iSpring Suite 9. *Jurnal Educatio FKIP UNMA*, 7(1), 47–54. <https://doi.org/10.31949/educatio.v7i1.830>
- Nurafni, A., Pujiastuti, H., & Mutaqin, A. (2020). Pengembangan Bahan Ajar Trigonometri Berbasis Literasi Matematika. *Jurnal Borneo Saintek*, 2(1), 37–45. https://doi.org/10.35334/borneo_saintek.v2i1.633
- Nuryasana, E., & Desiningrum, N. (2020). Pengembangan Bahan Ajar Strategi Belajar Mengajar Untuk Meningkatkan Motivasi Belajar Mahasiswa. *Jurnal Inovasi Penelitian*, vol 1 NO.5 (Pengembangan Bahan Ajar Strategi Belajar Mengajar Untuk Meningkatkan Motivasi Belajar Mahasiswa).
- Pristiwanti, D., Badariah, B., Hidayat, S., & Dewi, R. S. (2022). Pengertian Pendidikan. *Jurnal Pendidikan Dan Konseling (JPDK)*, 4(6), 1707–1715.
- Romlah, S. (2019). Peningkatan Kualitas Sumber Daya Manusia Akademik. *Jurnal Studi Islam: Pancawahana*, 14(2), 1–16. <http://ejournal.kopertais4.or.id/tapalkuda/index.php/pwahana/article/view/3601>
- Saifudin, M., Susilaningih, S., & Wedi, A. (2020). Pengembangan Multimedia Interaktif Materi Sumber Energi untuk Memudahkan Belajar Siswa SD. *JKTP: Jurnal Kajian Teknologi Pendidikan*, 3(1), 68–77. <https://doi.org/10.17977/um038v3i12019p068>
- Wijayanti, N. P. A., Damayanthi, L. P. E., Sunarya, I. M. G., & Putrama, I. M. (2016). Pengembangan E-Modul Berbasis Project Based Learning Pada Mata Pelajaran Simulasi Digital Untuk Siswa Kelas X Studi Kasus Di Smk Negeri 2 Singaraja. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 13(2), 184–197. <https://doi.org/10.23887/jptk.v13i2.8526>