Pedagonal : Jurnal Ilmiah Pendidikan
Vol. 09, No. 01, April 2024, pp. 1~14
ISSN: 2550-0406, DOI: 10.55215/pedagonal.v9i1.21

Development of Interactive Web-Based Learning Media Using a Differentiated Approach in Information and Communication Technology Elements with a Problem-Based Learning Model

Muhammad Alfan*, Rahmat Faisal, Pratama Aprilianto
Pendidikan Profesi Guru, Universitas Negeri Malang, Malang, Indonesia
Muhammad.alfan.fs@um.ac.id*; rahmat.faisal.2331537@students.um.ac.id;
pratama.aprilianto.2331537@students.um.ac.id
*Corresponding author

Article Info

Article history:

Submission Oct 30, 2024
First Revised Nov 11, 2024
Accepted Nov 30, 2024
Published Apr 30, 2025

Keywords:

ADDIE
differentiated
interactive web
Kurikulum Merdeka
problem-based learning

ABSTRACT

This study aims to develop a web-based interactive learning media with a differentiated approach applied to Information and Communication Technology (ICT) using the Problem-Based Learning (PBL) model for 8th-grade students. The Research and Development (R&D) approach was utilized, with the ADDIE instructional design model guiding the process, which includes Analysis, Design, Development, Implementation, and Evaluation stages. Product validation was conducted with material and media experts, who evaluated its validity through structured questionnaires using a Likert scale (1-5). Additionally, the practicality of the media was assessed through student and teacher responses. Results showed that the material content achieved a very high validity level, with an overall validity score of 91.09%. The media components also scored highly, with a 92.78% validity rating. During implementation at State Junior High School 24 Malang, 90.08% of the teacher and student responses rated the media as very practical. The learning outcomes test indicated that 82.75% of students achieved mastery, surpassing the 75% effectiveness threshold. In conclusion, the web-based learning media is both valid and effective for enhancing ICT learning, meeting the high standards required for educational tools in an interactive, web-based format.

How to cite:

Alfan, M., Faisal, R., & Aprilianto, P. (2025). Development of interactive web-based learning media using a differentiated approach in information and communication technology elements with a problem-based learning model. *Pedagonal : Jurnal Ilmiah Pendidikan*, *9*(1), 1–14. https://doi.org/10.55215/pedagonal.v9i1.21

Introduction

The Fourth Industrial Revolution and the advancement of globalization have increased the need for the education sector to foster critical thinking, creativity, and teamwork, among

other vital abilities. Students have distinct abilities, passions, and learning preferences, necessitating a variety of flexible teaching strategies. These demands are addressed by the *Kurikulum Merdeka* (Freedom Curriculum), which gives teachers the flexibility to create learning procedures that better suit the unique needs of each student (Kurniawaty, 2024; Wijayanti, 2023; Hadi et al., 2024). Furthermore, increasing access and facilitating more dynamic learning experiences depend heavily on the incorporation of educational technology (Sisco & Turnip, 2023; Haleem et al., 2022).

Students can now access course materials from anywhere at any time thanks to digital platforms, making learning more flexible and engaging. Teachers can adapt teaching strategies and instructional materials to meet the requirements of individual students by implementing differentiation in the classroom (Nisa, 2023; Grecu, 2023). Students can actively participate in the learning process in a more effective and engaging learning environment when interactive web-based media are used (Wahyuni, 2022; Kefalis & Drigas, 2019; Oktaviani et al., 2021). Therefore, a responsive curriculum and cutting-edge technology may work together to produce a fair and productive learning environment that supports each student in realizing their greatest potential.

With the presentation of text, music, motion pictures, and video, media offers a substantial alternative to conventional lecture techniques. Interactive media supports a flexible approach to education by improving learning's efficacy and usefulness. Students get a meaningful learning experience when interactive web-based learning materials are combined with important learning procedures (Sukmawati et al., 2023).

Problem-Based Learning has a significant impact on student learning outcomes, particularly in the context of informatics education. This method actively engages students in solving real-world problems, allowing them to develop the necessary analytical skills (Wardani, 2023). Additionally, according to Masruroh & Arif (2021), this learning approach strengthens collaboration skills among students, which are essential in modern learning environments. Students who work together can share ideas and solutions, enriching the learning process. Consequently, students will be better prepared to face real-world challenges, and this method is also effective in enhancing students' mental and emotional engagement (Suherman, 2021; Nurramadhani et al., 2021).

Based on observations made during the PPL PPG internship at a partner school, the learning was conducted face-to-face in the laboratory using PowerPoint presentations and electronic textbooks. The teacher delivered the material through projected PowerPoint slides and provided verbal feedback. However, there was a lack of clear content differentiation, which left students with the freedom to seek their own learning resources. The use of interactive web-based learning media is expected to enhance the learning experience by presenting educational content in an engaging manner and providing immediate feedback.

In light of this, the researcher conducted a study titled "Development of Interactive Web-Based Learning Media Using a Differentiated Approach in Information and Communication Technology Elements with a Problem-Based Learning Model." This study aims to design web-based learning media that offers content differentiation tailored to the diverse learning needs of students, particularly in the subject of ICT at the junior high school level.

This research innovation as novelty manifests through the development of web-based learning media with a content differentiation approach specifically designed to meet various learning needs. The media provides diverse instructional materials, including videos, texts, and images, allowing students the flexibility to choose the type of content that best aligns

with their learning styles, whether visual, auditory, or textual. This approach aims to deepen students' understanding and facilitate the implementation of more personalized and effective learning methods.

The significancy of this research is the development of interactive web-based media with differentiated content enables teachers to deliver lessons in a more engaging manner, catering to the individual needs of students. This is crucial in the context of 21st-century learning, which demands technology-based methods to enhance student motivation and academic outcomes. Furthermore, the findings of this research are expected to serve as a reference for other educational media developers in creating platforms responsive to diverse learning styles, ultimately fostering an inclusive learning environment that supports the success of every student.

Method

The Research and Development (R&D) technique is the research methodology employed in this study. Research and development, according to Okpatrioka (2023), is a research technique used to create a particular product and evaluate its efficacy (Okpatrioka, 2023). The ADDIE instructional design model, which comprises the phases of analysis, design, development, implementation, and evaluation, is used as the development model in this study. Every ADDIE step is completed in order, with iterative assessments conducted at each level, particularly the last one (Cahyadi, 2019).

The viability of the generated product will be examined. If the product satisfies the three primary requirements of validity, effectiveness, and practicality, it is deemed useable (Hidayat & Nizar, 2021). Data is gathered using tools such as media validity and content validation surveys in order to evaluate validity. Likert scales with scores of 1 (very poor), 2 (poor), 3 (adequate), 4 (good), and 5 (very good) are employed in these surveys. The practicality of the generated product is then assessed using the data gathered from these surveys (Maulidta & Sukartiningsih, 2018).

The instruments used to measure the validity of the content refer to aspects adapted from Yusoff (2019). While the instrument for assessing the validity of the media is based on the Learning Object Review Instrument (LORI) developed and adapted from Nabilah et al. (2023). The content and media are considered valid if each aspect achieves a high or very high Achievement Percentage (PC) (Ersan et al., 2019). The criteria for the validity of the content and media can be seen in the following Table 1:

Table 1. Validity Criteria

No	Achievement Percentage	Validity Criteria
1	$86 \leq AP \leq 100$	Very high
2	$69 \leq AP \leq 85$	High
3	$53 \leq AP \leq 68$	Medium
4	$37 \leq AP \leq 52$	Low
5	$20 \leq AP \leq 36$	Very low

Data responses from students and teachers obtained through questionnaires are used to measure the practicality of the developed learning media. The achievement percentage is interpreted qualitatively. The learning media is considered practical if the achievement percentage meets the practical or very practical criteria (Ersan et al., 2019). The criteria for the achievement percentage of practicality can be seen in Table 2 below.

Table 2. Practicality Criteria

No	Achievement Percentage	Practicality Criteria
1	86% - 100%	Very practical
2	69% - 85%	Practical
3	53% - 68%	Fairly Practical
4	37% - 52%	Less practical
5	20% - 36%	Not practical

A Likert scale with five rating levels—1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for highly agree—is used to determine the scoring criteria (Astuti et al., 2015). In order to evaluate the degree of validity and practicality, the Achievement Percentage (AP) is computed using the data gathered from the instructor and student questionnaire replies (Ersan et al., 2019).

The passing requirement is 75 in order to assess the efficacy of the learning outcomes test, which has a maximum score of 100. Accordingly, a student is deemed to have passed if their score is equal to or higher than 75, and to have failed if their score is lower than 75. The percentage of completeness is then determined by counting the number of students who pass, which may be done using the formula (Ersan et al., 2019). Learning materials are deemed successful if at least 75% of students exceed the school's Minimum Passing Criteria (KKM) or attain completion (Margita et al., 2023).

This study employs a research and development (R&D) methodology, utilizing the ADDIE model as its primary framework. The ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation, which are adapted here to develop an interactive web-based learning medium (Rohma et al., 2022). One of the strengths of the ADDIE model is its systematic and measurable structure, making it well-suited for designing web-based learning tools that are both effective and aligned with user needs (Sidabutar & Reflina, 2022).

The study began with school observations to understand the current learning environment and to identify challenges faced in using existing learning media. Based on these observations, a needs analysis followed, in which the researcher analyzed the existing teaching materials and assessed both student and teacher learning needs. Following this analysis, the researcher designed a web-based learning medium with a content differentiation approach, incorporating various formats such as video, text, and images. The design phase was aimed at accommodating diverse student learning styles. After completing the design, the development stage commenced, where the learning medium was created according to the established design. The developed medium was then implemented in the classroom learning process, engaging students in using the new media. In the final ADDIE stage, an evaluation was conducted to assess the effectiveness of the learning medium by gathering feedback from students and teachers, as well as analyzing student learning outcomes. These steps are expected to produce an interactive and effective learning medium that enhances the quality of learning in the field of Information and Communication Technology (Anggraeni et al., 2023). Figure 1 below shows a flowchart of the ADDIE model.

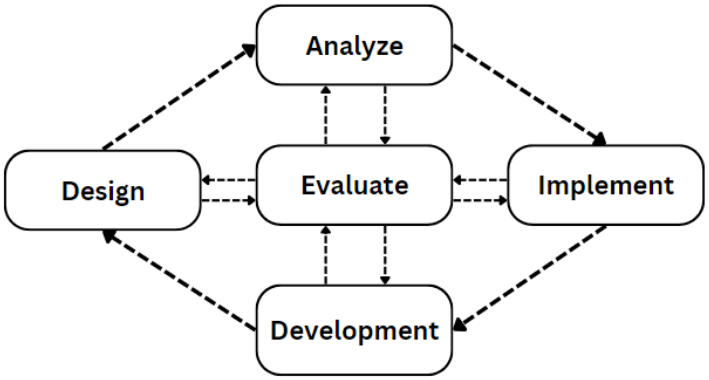

Figure 1. Diagram ADDIE model.

Results and Discussion

The goal of this review and development is to provide differentiated interactive web-based learning materials that apply the Problem-Based Learning (PBL) model to information and communication technology components. In order to create a product that can be utilized online, this medium was developed for the eighth grade. The ADDIE development model's phases are followed in this study.

Results of the Analysis Phase

The data produced by analyzing the resources and instructional techniques is utilized to choose the best software and technology. Based on the findings of this study, the chosen software and technology are customized to satisfy the development requirements, as indicated in Table 3:

Table 3. Technology Analysis Results

No	Requirement	Technology
1	Learning media display	HTML and CSS
2	Responsive display	CSS
3	Displaying text materials, images, and videos	HTML, CSS and Javascript
4	Linking each page	HTML
5	Practice exercises	HTML, CSS and Javascript
6	Student worksheets	Google Workspace
7	Evaluation	JSON and Firebase
8	Graphic and video processing	Corel Draw and Canva
9	Publication of learning media	Netlify

Results of the Design Phase

The sitemap, media interface, and content design of the learning resources in the form of learning modules are all included in the design stage. The purpose of the sitemap is to arrange the pages and show the connections between them in the learning media application that will be developed. Figure 2 below displays the application's sitemap.

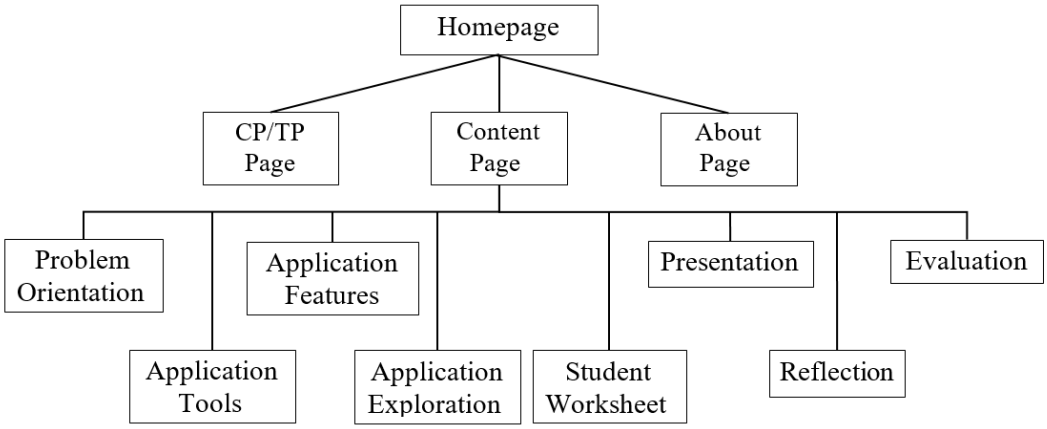

Figure 2. Sitemap Design

Based on the findings of user interface analysis, the researcher created the media interface as an initial design depiction of the user interface program, as shown in Figure 3.

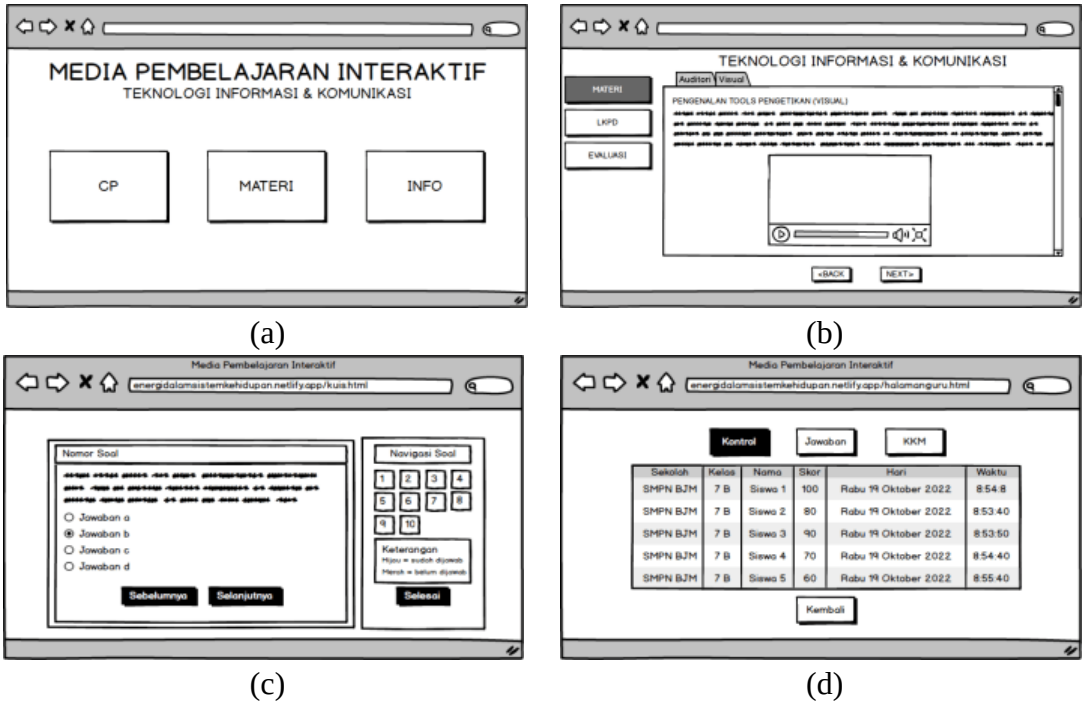

Figure 3. Media interface design
(a) Home page, (b) Content Page, (c) Evaluation Page, (d) Teacher Page

Four subject matter experts in the field of informatics education-two lecturers and two teachers-have validated the design of the instructional content included in the learning medium. Table 4, which displays the validity of the instructional materials, displays the findings of the material validity.

Table 4. The Results of Material Expert Validation

No	Aspect	ES	AS (Validator 1)	AS (Validator 2)	AS (Validator 3)	AS (Validator 4)	AS	Validity
1	Content Feasibility	160	34	37	40	40	94,38	Very high
2	Presentation Feasibility	160	32	39	36	35	88,75	Very high

3	Linguistic Feasibility	100	20	25	23	21	89,00	Very high
4	Differentiated Learning	40	9	9	9	10	92,50	Very high
5	Total Achievement	460	95	110	108	106	91,09	Very high

Table 4's computation of the four material experts' scores reveals a 91.09% overall success level, which is classified as having very high validity. Consequently, it can be said that the instructional resources that are utilized as the learning media's content are legitimate and useful.

Results of the Development Phase

The development stage resulted in a product in the form of web-based interactive learning media. The technology used to develop this product is based on the results of the technology analysis. The developed learning media follows the design created in the design stage. There are three main menus on the homepage: CP/TP, Material, and About. Figure 4 shows the results of the homepage development.

Figure 4. Homepage display

Students can obtain additional content and directions for going to the previous or next topic in the materials section's table of contents. Through the table of contents navigation, students are free to select the content they want to view without any restrictions. Additionally, the content is provided in textual, visual, and audio modes through the use of differentiated learning. Figure 5 displays the outcomes of the learning media's created materials page.

Figure 5. Materials Page Display

The learning flow is created by taking into account the phases included in the Problem-Based Learning (PBL) model when implementing it in the learning materials, specifically:

Problem Orientation

Discussing the learning objectives, learning activities, and providing examples and illustrations of the problems. The display is shown in Figure 6.

Figure 6. Problem Orientation Display

Organizing Groups

The process of arranging students into small groups to facilitate collaboration, communication, and shared learning. The display is shown in Figure 7.

Figure 7. Group Organization Display

Independent and Group Investigation

A learning approach where students explore and research to understand a concept or solve a problem. The display is shown in Figure 8.

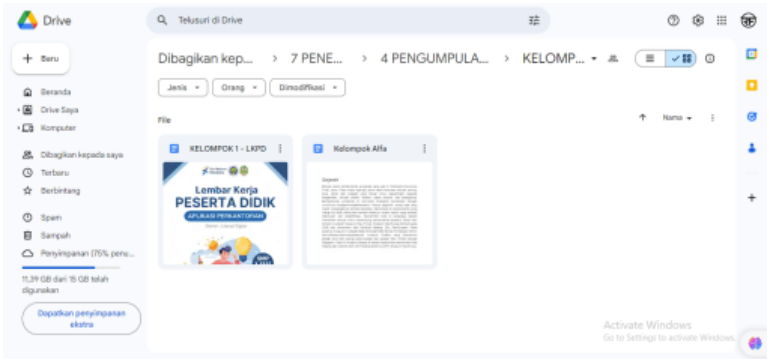

Figure 8. Independent and Group Investigation Display

Developing Solutions

The process in which students design and create ways to address the problems or challenges they encounter. The display is shown in Figure 9.

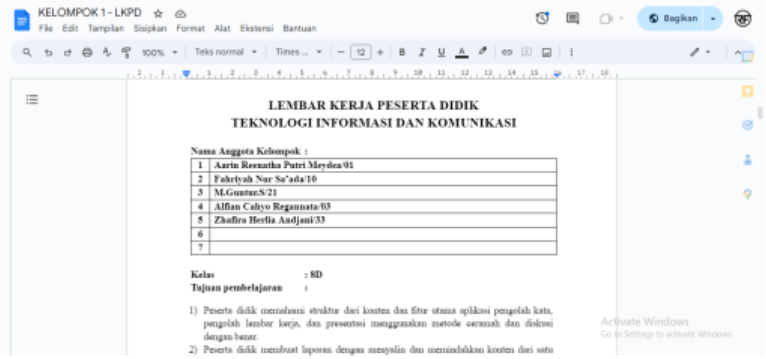

Figure 9. Solution Development Display

Presenting

Students present the results of their work or solutions they have developed to an audience, which can include peers, teachers, or other groups. This media includes a feature to randomize the order of presentation, which can be used by teachers to determine the turn of students. The display is shown in Figure 10.

Figure 10. Presentation Display

Reflecting on Learning Experience:

Students are asked to consider what they have learned, how they learned it, and how that experience has influenced their understanding of the material. The display is shown in Figure 11.

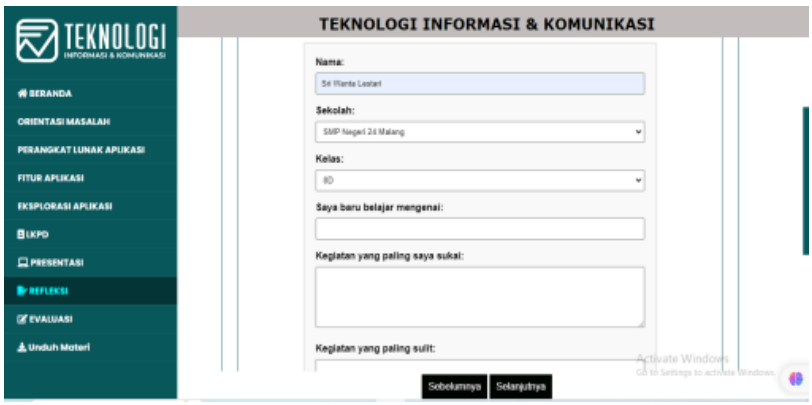

Figure 11. Learning Experience Reflection Display

On the material evaluation page, students can select an answer for each question. Features like randomized questions, question navigation, and answer explanations that show up after each response is selected are also available on the page. This page was created with

the help of Firebase, HTML, CSS, JavaScript, and JSON. Figure 12 displays the evaluation page developed for this learning media.

Figure 12. Evaluation Page Display

The developed learning media was then validated by four media experts, the same individuals who conducted the content validation. Table 5 shows the results of the learning media validity assessment.

Table 5. The Results of Media Expert Validation

No	Aspect	ES	AS (Validator 1)	AS (Validator 2)	AS (Validator 3)	AS (Validator 4)	AP	Validity
1	Feedback and Adaptation	20	5	5	5	4	95,00	Very high
2	Display Design	100	20	25	23	22	90,00	Very high
3	User Interaction	60	14	15	14	15	96,67	Very high
4	Total Achievement	180	39	45	42	41	92,78	Very high

Results of the Implementation Phase

Students in Grade VIII participated in the implementation in person at SMPN 24 Malang. This learning material was used in order to assess its efficacy and collect instructor and student feedback following its use in instructional activities. Table 6 displays the findings of the practicality assessment of the media in the field, which was based on comments from teachers and students.

Table 6. The Results of the Student and Teacher Practicality Responses

No	Aspect	AP	Practicality
1	Ease of Use	89,31	Very high
2	Cognitive Content	88,51	Very high
3	Scope of Knowledge and Information Presentation	90,05	Very high
4	Aesthetics	91,59	Very high
5	Overall Function	89,66	Very high
6	Ease of Learning	91,38	Very high
7	Total Achievement	90,08	Very high

Table 6 shows that the interactive learning materials have a 90.08% practicality rate, which is categorized as very practical. The data was provided by responses from 29 students and one information technology teacher.

A learning outcomes test administered to 29 eighth-grade students at SMP Negeri 24 Malang was used to determine the efficacy findings. The test consisted of twenty multiple-

choice questions. According to the learning outcomes exam findings, 24 students met the minimum competency standard (KKM), while 5 students did not. Consequently, the classical completion percentage for the learning outcomes test was 82.75%. Therefore, since the classical completeness is above 75%, it can be stated that the medium is effective.

Based on the development results, this interactive web-based learning media was designed using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis stage, learning needs were identified to determine the appropriate technology and strategies. The Design stage produced the site map and user interface for the learning media, while the Development stage focused on creating the product according to the established design. The Implementation stage involved field testing through student use, and the Evaluation stage was conducted to assess the product's effectiveness and quality, ensuring the learning media optimally supports the learning process.

The product validation results show excellent ratings from experts. Content expert validation yielded a total score of 91.09%, covering aspects of content feasibility, presentation, language, and differentiated learning, indicating that the teaching materials meet high-quality standards and are suitable for use in education. Meanwhile, media validation received a score of 92.78%, reflecting a very high feasibility level in terms of presentation and technical aspects. Thus, the product is declared valid and ready for implementation.

The implementation results of this interactive web-based learning media indicate that the developed media is not only practical but also effective in improving student learning outcomes. Based on data from Table 6, the media's practicality percentage reached 90.08%, showing that both students and teachers found the media highly helpful in the learning process. Additionally, test results reveal that 82.75% of students successfully met the Minimum Competency Criteria (KKM), indicating that the media effectively enhanced material comprehension in class. These results align with research by Soimah (2018), which shows that the use of technology-based learning media can improve student learning outcomes in the digital era. Further research by Hayya'(2023) supports these findings, noting that interactive media in learning can boost student motivation and participation. This indicates that the use of information and communication technology in learning not only facilitates material comprehension but also creates a more engaging and interactive learning environment for students (Riyanti et al., 2024; Abykanova et al., 2016).

Conclusion

From this study, it can be concluded that the web-based interactive learning media with a differentiated approach in the elements of Information and Communication Technology (ICT) for eighth-grade students has proven to be effective. This approach allows content to be tailored to various learning styles of students, creating a flexible learning experience that meets individual needs and supports the improvement of overall learning quality. The development of the media using the ADDIE model meets very high eligibility criteria, supported by technologies such as HTML, CSS, JavaScript, JSON, Firebase, Canva, and Netlify. Expert validation indicates that this media is very valid and suitable for use, and the assessment of the practicality and effectiveness of the media received very high categories. As a suggestion, there is a need to develop deeper interactive features, such as dynamic project-based assessment elements, and conduct trials with a more diverse range of students to validate the media's flexibility. Collaboration with teachers to enrich content and updates

in accordance with curriculum developments is also essential to ensure that the media remains relevant and supports future learning objectives.

Acknowledgment

We sincerely express our gratitude to the Rector of Malang State University for the guidance and full support for this research, which would not have been possible without the policies and facilities provided by the university. We also thank the Institute for Research and Community Service (LPPM) of Malang State University for their funding assistance and guidance throughout the research process, as well as our highest appreciation to the Director of the Graduate School and the Head of the Teacher Professional Education (PPG) Program at Malang State University for their support and constructive feedback. This research, titled "Development of Interactive Web-Based Learning Media Using a Differentiated Approach in Information and Communication Technology Elements with the Problem-Based Learning Model," would not have been realized without solid collaboration. We hope the results of this research can contribute to the development of education in the field of information technology and be beneficial for all parties involved in the learning process.

References

Abykanova, B., Nugumanova, S., Yelezhanova, S., Kabylkhamit, Z., & Sabirova, Z. (2016). The Use of Interactive Learning Technology in Institutions of Higher Learning. *International journal of environmental and science education*, *11*(18), 12528-12539.

Anggraeni, A., Darmansyah, & Fitria, Y. (2023). Transformasi peningkatan kualitas pembelajaran di sekolah dasar melalui pemanfaatan teknologi informasi dan komunikasi. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *08*, 5463–5477.

Astuti, W. Y., Bachrawi, S., & Basuki, A. T. (2015). Prosedur penelitian: Suatu pendekatan praktek pada "Keterkaitan pengangguran terdidik dengan masalah pendidikan". *Journal of Social Science Studies*, *3*(6), 49-56.

Cahyadi, R. A. H. (2019). Pengembangan bahan ajar berbasis addie model. *Halaqa: Islamic Education Journal*, *3*(1), 35-42.

Ersan, Marli, S., & Uliyanti, E. (2019). Pengaruh model mind mapping terhadap hasil belajar tematik. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *8*(3), 1–8.

Grecu, Y. V. (2023). Differentiated instruction: Curriculum and resources provide a roadmap to help English teachers meet students' needs. *Teaching and Teacher Education*, *125*, 104064.

Hadi, M. S., Izzah, L., Khatun, A., & Gita, G. (2024). An Analysis of Freedom to Learn Curriculum Implementation at Jakarta's English Primary School Teachers. *English Language in Focus (ELIF)*, *6*(2), 179-184.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable operations and computers*, *3*, 275-285.

Hayya', L. A. (2023). Dampak media pembelajaran interaktif dalam pendidikan. *Eksponen*, *13*(2), 66-76.

Hidayat, F., & Nizar, M. (2021). Model ADDIE (analysis, design, development, implementation and evaluation) dalam pembelajaran pendidikan agama islam. *Jurnal Inovasi Pendidikan Agama Islam (JIPAI)*, *1*(1), 28–38.

Kefalis, C., & Drigas, A. (2019). Web Based and Online Applications in STEM Education. *Int. J. Eng. Pedagog.*, *9*(4), 76-85.

Kurniawaty, J. B. (2024). Nasionalisme di era digital: Tantangan dan peluang bagi generasi z indonesia. *Jagaddhita*, *3*(2), 42-50.

Margita, E., Sukmawati, R. A., & Adini, M. H. (2023). Pengembangan media pembelajaran interaktif berbasis web pada materi pengetahuan dasar pemetaan dengan metode tutorial. *Computing and Education Technology Journal*, *3*(1), 55.

Masruroh, L., & Arif, S. (2021). Efektivitas model problem based learning melalui pendekatan science education for sustainability dalam meningkatkan kemampuan kolaborasi. *Jurnal Tadris IPA Indonesia*, *1*(2), 179–188.

Maulidta, H., & Sukartiningsih, W. (2018). *Pengembangan media pembelajaran interaktif berbasis adobe flash untuk pembelajaran menulis teks eksposisi siswa kelas III Sekolah Dasar* (Doctoral dissertation, State University of Surabaya).

Nabilah, N., Chaeruman, U. A., & Ariani, D. (2023). Pengembangan learning object untuk mata pelajaran ekonomi. *Jurnal Pembelajaran Inovatif*, *6*(1), 50–55.

Nisa, A. F. (2023). pembelajaran diferensiasi DiscoTIK (model discovery inquiry berbasis tik) untuk meningkatkan kreativitas siswa. *Prosiding Seminar Nasional Pendidikan Dasar*, 102–111.

Nurramadhani, A., Kumala, F., & Permana, I. (2021, November). STEAM-based project learning: the effect to middle school's student's collaboration competences. In *Journal of Physics: Conference Series* (Vol. 2098, No. 1, p. 012038). IOP Publishing.

Okpatrioka, O. (2023). Research and development (R&D) penelitian yang inovatif dalam pendidikan. *Dharma Acariya Nusantara: Jurnal Pendidikan, Bahasa dan Budaya*, *1*(1), 86-100.

Oktaviani, L., Fernando, Y., Romadhoni, R., & Noviana, N. (2021). Developing a web-based application for school councelling and guidance during COVID-19 Pandemic. *Journal of Community Service and Empowerment*, *2*(3), 110-117.

Riyanti, A., Agus, E., Sugito, E., Murthada, & Lapasau, M. (2024). Penguasaan pendidikan kewarganegaraan di sekolah dasar negeri: pemanfaatan teknologi infiormasi dan komunikasi. *JRPP : Jurnal Review Pendidikan Dan Pengajaran*, *7*(2), 3513–3520.

Rohma, S., Subandowo, M., & Atiqoh. (2022). Pengembangan media pembelajaran berbasis web model addie untuk mata pelajaran desain grafis percetakan. *MUADDIB: Studi Kependidikan Dan Keislaman. Vol. 12 No. 01 Januari-Juni 2022*, *12*(01), 1–23.

Sidabutar, N. A. L., & Reflina, R. (2022). Pengembangan media pembelajaran matematika sma dengan aplikasi animaker pada materi vektor. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(2), 1374–1386.

Sisco, R., & Turnip. (2023). Peningkatan literasi digital di kalangan pelajar: pengenalan dan praktik penggunaan teknologi pendidikan abstrak. *JRPP: Jurnal Review Pendidikan Dan Pengajaran*, *6*(4), 2302–2310.

Soimah, I. (2018). Pengaruh media pembelajaran berbasis komputer terhadap hasil belajar ipa ditinjau dari motivasi belajar siswa. *Natural: Jurnal Ilmiah Pendidikan IPA*, *5*(1), 38.

Suherman, Y. (2021). Pengaruh model pembelajaran problem based learning terhadap hasil belajar mata pelajaran informatika sma negeri 2 sungai ambawang. *PINISI: Journal of Teacher Professional*, *2*(2), 94–100.

Sukmawati, R. A., Sari, D. P., Amin, R. Al, & Suryaningsih, Y. (2023). Media pembelajaran interaktif berbasis web pada materi program linear dengan metode drill and practice. *EDU-MAT: Jurnal Pendidikan Matematika*, *11*(1), 97.

Wahyuni, A. S. (2022). Literature review: Pendekatan berdiferensiasi dalam pembelajaran IPA. *Jurnal Pendidikan Mipa*, *12*(2), 118–126.

Wardani, D. A. W. (2023). Problem based learning: membuka peluang kolaborasi dan pengembangan skill siswa. *Jawa Dwipa : Jurnal Penelitian Dan Penjaminan Mutu*, *4*(1), 104–116

Wijayanti, N. (2023). Freedom of learning (kurikulum merdeka) in the view Ki Hadjar Dewantara and relevance to the character education. *Jurnal Suluh Pendidikan*, *11*(2), 190-198.

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. *Education in medicine journal*, *11*(2), 49-54.