



Flipbook development based on problem based learning on chemical bonding material

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Abstract

The Merdeka Curriculum requires interactive digital media, but chemistry learning, especially on chemical bonding material, is still dominated by limited and uninteresting media. Previous studies have produced useful teaching materials, but they are generally small in scale, not yet integrated with PBL, or have not maximized the features of digital flipbooks, so there is still a need for more innovative media. This study developed a flipbook medium based on Problem-Based Learning (PBL) to enhance the effectiveness of chemical bonding instruction. The purpose of this research was to determine the needs, feasibility, practicality, and attractiveness of the developed flipbook. This research employed a Research and Development (R&D) design using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The instruments used consisted of interview questionnaires, needs analysis questionnaires, expert validation questionnaires (media and material), as well as practicality and attractiveness questionnaires. The research subjects were chemistry teachers and high school students at public senior high schools in Langsa City. The results of the teacher needs assessment showed a percentage of 71.1%, categorized as “needed.” Media and material expert validations yielded average scores of 0.87 and 0.83, respectively, both classified as “highly feasible.” The media trials with teachers and students resulted in practicality and attractiveness scores of 95% and 83.09%, respectively, categorized as “highly practical” and “highly attractive.” It can be concluded that the PBL-based flipbook developed in this study is practical, useful, and engaging in supporting more effective learning processes. Therefore, this medium can support the implementation of the Merdeka Curriculum through interactive digital learning. Keywords: flipbook; problem-based learning; chemical bonding.

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Abstrak. Kurikulum Merdeka menuntut media digital yang interaktif, tetapi pembelajaran kimia, terutama pada materi ikatan kimia masih didominasi media yang terbatas dan kurang menarik. Penelitian sebelumnya menghasilkan bahan ajar yang bermanfaat, namun umumnya berskala kecil, belum terintegrasi PBL, atau belum memaksimalkan fitur flipbook digital, sehingga masih terdapat kebutuhan akan media yang lebih inovatif. Penelitian ini mengembangkan media flipbook berbasis Problem Based Learning (PBL) untuk meningkatkan efektivitas pembelajaran ikatan kimia. Tujuan dari penelitian ini adalah untuk mengetahui kebutuhan, kelayakan, kepraktisan dan kemenarikan media flipbook yang dikembangkan. Jenis penelitian ini merupakan penelitian pengembangan (R&D) yang menggunakan model ADDIE yang meliputi tahap analisis, perancangan, pengembangan, implementasi, dan evaluasi. Instrumen yang digunakan meliputi angket wawancara, angket analisis kebutuhan, angket validasi ahli (media dan materi) serta angket kepraktisan dan kemenarikan. Subjek penelitian ini adalah guru kimia dan siswa SMA Negeri di Kota Langsa. Hasil penilaian kebutuhan guru menunjukkan persentase 71,1% yang diklasifikasikan sebagai “dibutuhkan”. Validasi oleh ahli media dan ahli materi menghasilkan skor rata-rata 0,87 dan 0,83 yang termasuk dalam kategori “sangat layak”. Uji coba media dengan guru dan siswa menghasilkan kepraktisan sebesar 95% dan kemenarikan sebesar 83,09%, yang keduanya termasuk dalam kategori “sangat praktis” dan “sangat menarik”. Dapat disimpulkan bahwa flipbook berbasis PBL yang dikembangkan dinilai praktis, bermanfaat dan menarik untuk mendukung proses pembelajaran yang lebih efektif. Sehingga media ini dapat mendukung implementasi Kurikulum Merdeka berbasis pembelajaran digital interaktif.

INTRODUCTION

The Merdeka Curriculum emphasizes 21st-century learning, which requires digital literacy and innovation from teachers in developing learning media. According to Kusuma & Fitrihidajati (2024), 21st-century education requires high-quality teachers. To improve the quality of life of the nation, everyone must participate in education, especially teachers and students. In today's digital era, teachers are required not only to master technology but also to be able to create innovative media that optimally supports student learning activities. This challenge is even more apparent in chemistry learning, which is known to have abstract and complex material that requires a creative and interactive approach. Therefore, innovation in learning media is very important so that students can more easily understand chemistry concepts and be motivated in the learning process.

According to Asmi et al. (2018), material management increasingly utilizes technology to create new and innovative learning media. In accordance with Permendikbud No. 12 of 2024, the learning process is designed to improve the quality of education by providing flexibility to teachers in designing interactive learning processes with an emphasis on literacy that is relevant to the times, namely digital literacy.

The interview results show that using a semi-structured interview method to obtain information from three chemistry teachers on February 5, 2025, at a public high school in Langsa City, teachers only used PowerPoint as a learning medium. This shows that there is a lack of innovation in electronic media to support the implementation of the independent curriculum in the learning process. Therefore, interactive and interesting learning media are needed so that students can participate more actively and develop higher learning motivation. Chemical bonding material is often considered difficult by students because they find it difficult to memorize the names of molecular forms. This finding is in line with the research by Sa'diyah & Suryandari (2021), which states that chemical bonding is one of the materials in chemistry that is considered complicated by students because of its abstract nature.

The lecture method, which is often used in teaching and learning activities, makes students less active, resulting in a monotonous, boring, and less than optimal learning atmosphere in achieving the expected competencies (Gulo & Tafonao, 2023). These limitations indicate the need for innovation in creating interactive learning media that can support the learning process with various model approaches. The problem-based learning (PBL) model is an attractive alternative that can support innovative learning (Setyawan & Koeswanti, 2021). According to Oktaviani et al. (2019), PBL is a recommended approach in the implementation of the Merdeka Curriculum because it provides opportunities for students to participate directly in learning experiences. Through solving the problems given, students can increase their motivation and learning achievements in cognitive, psychomotor, and affective aspects. This is due to the application of the PBL model, which involves students in various stages, such as constructing a problem framework, examining the problem, collecting and organizing data, compiling facts, analyzing information, and formulating arguments for problem solving. Furthermore, students solve the problems given, either independently or in groups. However, PBL is also used as an approach or basic concept for media development. In this study, the researcher used PBL as the basis for media development.

Based on previous research conducted by Sa'diyah & Suryandari (2021), it was indicated that this LKPD was valid and suitable for use and received positive responses from teachers and students. However, the research was only tested on a small group, had not yet reached the stage of widespread distribution, and the LKPD used was still in printed form, so it did not take advantage of the advantages of digital media. Furthermore, research by Nenohai et al. (2022) found that this teaching material is very suitable for use, with excellent feasibility and student response. However, the interactive features are still simple and not fully integrated with online learning. Similarly, research conducted by Febriani & Aini (2021) indicates high validity and very high practicality in the learning process. However, the media developed in the form of interactive PowerPoint is still functionally limited and less flexible than more innovative digital media. From these studies, it appears that flipbook-based digital media has the potential to enhance learning independence, but it has not been widely developed using the PBL approach.

One type of learning media that is considered effective in attracting students' interest and creating a comfortable learning atmosphere is flipbooks (Mulyadi et al., 2016). This study used Canva and Heyzine Flipbook as tools to develop interactive flipbooks. Canva was chosen because of its ease in creating attractive graphic designs. Meanwhile, heyzine flipbook was used to convert learning materials into digital

media in the form of a book that can be opened online with page-turning effects, making it more attractive and accessible to students. This study aims to determine the level of need, feasibility, practicality, and attractiveness of the PBL-based flipbook media developed.

RESEARCH METHODS

This research is a development study that applies the ADDIE model. The model consists of five phases: analysis, design, development, implementation, and evaluation. The ADDIE model is appropriate for developing educational products and other learning resources. ADDIE provides a framework for complex situations (Branch, 2009). In addition, with the ADDIE model, the validity of the developed product is guaranteed because each stage must be based on analysis, design, development, implementation, and evaluation, in which each stage is evaluated before proceeding to the next stage (Waruwu, 2024). The ADDIE model implemented covers all stages of the ADDIE model, but the evaluation stage is limited to internal (formative) evaluation. This research does not reach the external (summative) stage, which is a large-scale field trial to measure the effectiveness of the product.

This study involved chemistry teachers and 11th grade students at a public high school in Langsa City as subjects. The data collection methods used were interviews, validation, and questionnaires. The research instruments were validated by two validators, who were selected based on their competence and expertise in learning materials and media, their master's degrees, and their positions as lecturers. Data on teacher needs were analyzed using the Formula 1. The results of the calculations using the above formula are then interpreted using the needs assessment criteria table shown in Table 1. Feasibility data analysis using Aiken's V Formula 2. The results of the calculations were then interpreted using the Aiken's V validity assessment criteria, which can be seen in Table 2. Analysis of product practicality data using the Formula 3. The results of the calculations are then interpreted using the practicality questionnaire analysis with score criteria, as shown in Table 3. Analysis of product attractiveness data using the Formula 4. The results of the calculations are then interpreted using the questionnaire analysis with score criteria, as shown in Table 4.

$$P_s = \frac{S}{N} \times 100\% \dots \dots \dots \text{Formula 1}$$

$$V = \frac{\sum s}{[n(c-1)]} \dots \dots \dots \text{Formula 2}$$

$$\text{Practicality (\%)} = \frac{\text{Total score}}{\text{Maximum score}} \times 100\% \dots \dots \dots \text{Formula 3}$$

$$\text{Attractiveness (\%)} = \frac{\text{Total score}}{\text{Maximum score}} \times 100\% \dots \dots \dots \text{Formula 4}$$

Table 1 Assessment Criteria for Teacher Needs Analysis Questionnaire

No	Percentage (%)	Interpretation
1.	76 – 100	Highly needed
2.	51 – 75	Required
3.	26 – 50	Simply required
4.	≤ 25	Not required

(Source: Winarni et al., 2014)

Table 2 Aiken's V Validity Assessment Criteria

No	Aiken's V	Level of validity
1.	0.80 – 1.00	Very valid
2.	0.60 – 0.80	Valid
3.	0.40 – 0.60	Valid enough
4.	0.20 – 0.40	Not valid
5.	0.00 – 0.20	Not very valid

(Source: Sa'diyah & Suryandari, 2021)

Table 3 Practicality Score Criteria

No	Percentage (%)	Category
1.	0 – 20	Not practical
2.	21 – 40	Less practical
3.	41 – 60	Quite practical
4.	61 – 80	Practical
5.	81 – 100	Very practical

(Source: Destiara, 2019)

Table 4 Attractiveness Score Criteria

No	Percentage (%)	Interpretation
1.	80 – 100	Very Interesting
2.	66 – 79	Interesting
3.	56 – 65	Quite interesting
4.	46 – 55	Less interesting
5.	≤ 45	Not very interesting

(Source: Yanti & Sari, 2021)

RESULTS AND DISCUSSION

Analyze

The first step in this study was the analysis stage, in which the researcher collected data and information in the field related to the research problem. The researcher analyzed teachers' needs through interviews and questionnaires involving three chemistry teachers at Langsa 2 Public High School, Langsa 3 Public High School, and Langsa 5 Public High School as a preliminary step. Based on the results of the interviews and questionnaires, chemical bonding material is often considered difficult by students because they have difficulty memorizing the names of molecular forms.

Referring to Table 5, teachers stated that chemical bonding material was appropriately presented using flipbook media. It can be concluded that flipbooks are necessary in chemistry learning, with a requirement level of 71.1%. This finding indicates that teachers need more interactive and innovative learning media to help students understand abstract concepts such as chemical bonding. This finding is in line with Nazira's (2021) research, which states that Flip PDF Professional-based e-modules on chemical bonding are designed to support student independent learning through attractive and accessible media. This study emphasizes the need for interactive digital media in delivering abstract chemistry material.

Table 5 Results of Teacher Needs Questionnaire Analysis

Aspects	Question item	SMAN 2	SMAN 3	SMAN 5
Independent curriculum	1			
Development of learning media	2,3,4,5			
Problem-based learning model	6,7,8,9,10	60%	66.67%	86.67%
Learning process	11			
Material	12,13,14,15			
Average			71.1%	
Criteria			Required	

(Source: Teacher survey results, 2025)

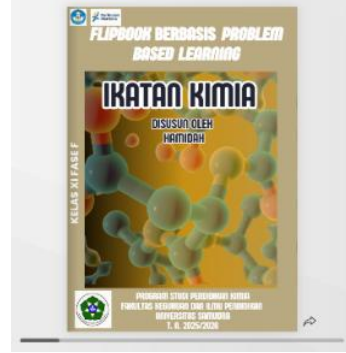
Design

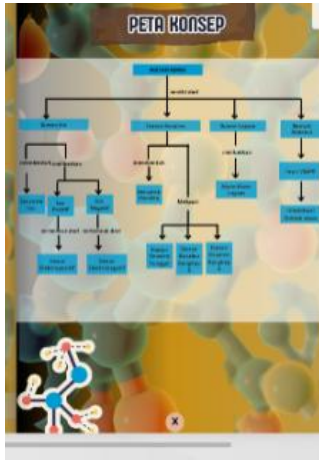
The design stage begins with the creation of an outline. The outline serves as a reference for the layout of the flipbook cover, foreword, list of materials, user guide, concept chart, desired competencies, learning objectives, PBL syntax, and summary of chemical bonding material that will be included in the outline.

The flipbook format developed consists of 75 pages in A4 size (29.7 cm x 21 cm) in accordance with ISO standards. This flipbook was created using Heyzine flipbook software. The interactive features include multimedia elements that combine various types of media such as text, images, videos, sounds, barcodes,

hyperlinks, and Google Drive. In addition, the flipbook also has various interactive control buttons such as arrow buttons to turn pages, a zoom button to switch to full screen mode, and a toolbar button for searching, sharing, and downloading to facilitate user access.

Table 6 Flipbook Learning Media Design

No	Aspects	Objective	Image
1.	Initial display	Attract attention, provide initial visual orientation, and communicate the main topic to prepare the reader.	
2.	Foreword and learning outcomes	Expressing gratitude to readers and learning outcomes focused on what students are expected to be able to do after studying the components.	
3.	Learning objectives	Providing an overview of the competencies that must be achieved so that students can be more focused and independent in understanding the material presented.	
4.	Learning instructions	Ensuring that the learning process is systematic, efficient, and in accordance with the learning model design used.	
5.	Problem-based learning syntax	Helping students develop critical thinking skills and problem-solving abilities through learning experiences.	

No	Aspects	Objective	Image
6.	Concept map	Presenting the relationships between concepts to make them easier for students to understand.	
7.	Questions for evaluation and self-reflection	Providing a formative assessment mechanism, allowing students to reflect on their understanding and reflect on what they have learned after using the flipbook.	
8.	Summary and glossary	Providing quick and accurate definitions of key terms and helping to explain important terms that may be unfamiliar to readers.	
9.	Bibliography and periodic table of elements	Includes references used by the author in compiling the flipbook, including various books and journal articles that serve as the main sources of information.	
10.	Author biography and final appearance	To identify the author as an academic subject who is responsible and qualified for the work produced.	

Development

The feasibility assessment was conducted by two validators, namely media and material experts. The two validators involved in testing the validity of the product were media experts and material experts who were active as lecturers in the Chemistry Education Study Program, Faculty of Teacher Training and Education, Samudra University. Their extensive experience in teaching for more than 5 years, researching, and developing curricula at the university level made them qualified as validators.

Both experts' Aiken's V values were above 0.80, indicating that the media was highly valid. The media expert suggested improvements in color alignment and text positioning, while the material expert recommended strengthening the emphasis on concepts through images and problem-based questions. Based on the results obtained, the flipbook developed was deemed suitable for use in terms of media and material expert feasibility. This is in line with the research conducted by Kusuma & Fitrihidajati (2024) that the average flipbook validity score reached 3.99% with a percentage of 99.65%, which is categorized as very feasible in theory and suitable for use in the learning process. In addition, research by Wahyuni et al. (2023) shows that based on data analysis and validity test discussions, flipbook-based e-modules obtained an average percentage of 90%, so they are considered very valid and practical for use in learning. Furthermore, Ismail & Hasanah (2024) concluded that the production of e-module products in the form of flipbooks distributed in the form of links had a validation score of 4.13 in terms of material and 4.65 in terms of media, which is equivalent to the "highly valid" category. These findings indicate that e-modules in the form of flipbooks are good and suitable for classroom learning.

This study developed a flipbook media that combines Canva as a visual design platform and Heyzine Flipbook as an interactive conversion tool. Canva was chosen for its ease in creating attractive graphic designs, while Heyzine Flipbook was used to convert learning materials into digital media in the form of a book that can be opened online (Heyzine Flipbook link) with page-turning effects and navigation links. This innovation makes the media more interactive, accessible, and appealing to users. The interaction between the two platforms is a novelty in chemistry learning, as it allows for the compilation of material using a problem-based learning (PBL) approach, accompanied by interactive features and visual contexts that support contextual understanding of concepts and increase student motivation to learn.

Table 7 Media Expert Validation Results

No	Aspects	Question item	Aiken's V	Criteria
1	Flipbook presentation techniques	4	0.83	Very valid
2	Supporters of flipbook material presentation	3	0.89	Very valid
3	Presentation of lessons	3	0.89	Very valid
Total items		10		
Average			0.87	Very valid

Table 8 Results of Content Expert Validation

No	Aspects	Question item	Aiken's V	Criteria
1	Flipbook content coverage and accuracy	3	0.83	Very valid
2	Up-to-date	3	0.83	Very valid
3	Developing skills and stimulating curiosity	1	1.00	Very valid
4	Contains contextual insights	1	1.00	Very valid
5	Compatibility with problem-based learning	3	0.83	Very valid
Total items		11		
Average			0.83	Very valid

Implementation

The implementation was carried out by testing the flipbook product for practicality and attractiveness. The trial design used was a one-shot case study involving three chemistry teachers at Langsa City High School. The aspects assessed were graphics, clarity of material, and usefulness in learning. The attractiveness of the media was assessed by 52 students. The aspects assessed included learning motivation, media effectiveness, and language and communication.

Table 9 Results of the Practicality Questionnaire Analysis

No	Aspects	Question item	Percentage (%)	Criteria
1	Graphics	3	97.22	Very practical
2	Materials	3	94.44	Very practical
3	Benefits	5	93.33	Very practical
Total items		11		
Average			95.00	Very practical

Table 10 Results of the Attractiveness Questionnaire Analysis

No	Aspects	Question item	Percentage (%)	Criteria
1	Learning motivation	3	81.73	Very interesting
2	Effectiveness of media	3	84.62	Very interesting
3	Language and communication	2	82.93	Very interesting
Total items		8		
Average			83.09	Very interesting

Based on the results obtained, flipbooks are very practical to use as learning media in the classroom. The questionnaire given to teachers covered three aspects of assessment, namely graphics (97.22%), material (94.44%), and benefits (93.33%), resulting in a percentage of 95% with the criterion of very practical. This shows that teachers are suitable for using this media and that it is useful for delivering chemistry material effectively. The high practicality score indicates that the flipbook's appearance is attractive, the colors used are harmonious, the material in the flipbook is systematically arranged in accordance with the independent curriculum, and the flipbook is easily accessible to teachers and students. The flipbook is also considered flexible because it can be accessed through various digital devices. This finding is in line with the research by Nurhayati & Anwar (2022), which reported an average teacher response of 88.52%. The results of the analysis show that the FlipHTML5-based e-module for chemical bonding material is suitable for use in the classroom. In addition, Nazira's (2021) research shows that the results of trials with teachers were in the "very good" category with a percentage of 93.33%. Therefore, the Flip PDF Professional-based chemistry e-module on the topic of chemical bonding is very suitable for use in the learning process.

The attractiveness of the developed flipbook obtained a percentage of 81.73% in terms of learning motivation, 84.62% in terms of media effectiveness, and 82.93% in terms of language and communication. The average score for the attractiveness of the PBL-based flipbook was 83.09%, which is categorized as very attractive. Therefore, the developed flipbook is very attractive and can be used by students as a self-learning medium. This is in line with the research conducted by Wahyuni et al. (2023) that the developed flipbook meets the criteria of being very practical because students consider the flipbook to be very simple to use and able to support the self-learning process. Furthermore, research conducted by Simanjuntak & Purba (2024) states that the student response was 91.52%, indicating that the product is of high quality and suitable for use as a learning support tool.

Evaluation

The final stage is the evaluation of the quality of the flipbook that has been created. The evaluation serves to measure the achievement of objectives, effectiveness, practicality, and overall appeal of the media. During the development stage, the evaluation was conducted through input from two expert validators. The media expert provided suggestions for improvements in color coordination and text positioning to optimize the visual display, while the subject matter expert recommended strengthening the emphasis on concepts through images and problem-based questions. All of these suggestions for improvement were implemented in the flipbook before it entered the implementation stage, so that the product tested was a revised product. After the implementation stage, the flipbook media achieved the criterion of being highly practical for teachers with a percentage of 95%. Thus, the PBL-based flipbook on chemical bonding material is declared ready and effective to support the learning process of high school students.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that flipbook media using the problem-based learning (PBL) approach is effective for chemical bonding material and meets the criteria of feasibility, practicality, and attractiveness. The results of the teacher's needs analysis show that this media is needed by 71.1%. In terms of feasibility, the validation scores from media experts and subject matter experts were 0.87 and 0.83, respectively, placing both in the highly feasible category. In addition, this media is highly practical, with an average practicality score of 95% across the three aspects assessed, namely graphics, content, and benefits. In terms of attractiveness, the average score was 83.09% from the assessment of 52 respondents, covering the aspects of learning motivation, media effectiveness, and language and communication, which are classified as very attractive. These findings reinforce the effectiveness of PBL as a basis for developing interactive digital media in chemistry learning. Teachers are advised to integrate this flipbook into project-based learning in the Merdeka Curriculum.

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