Increasing Learning Results with Interactive Digital Materials PjBL Assisted by Heyzine Flipbook Maker

Muhaimin*, Leny, and Almubarak
Physics Education Study Program, Faculty of Teacher Training and Education
Universitas Lambung Mangkurat, Banjarmasin, Indonesia
*muhaimin915@gmail.com

Abstract

The internet has not been optimally utilized to support student learning, especially chemistry. Therefore, a research study was conducted to develop interactive digital teaching materials as an interactive e-module supported by the Heyzine application on colloids. This study aimed to develop teaching materials that possess (a) validity, (b) practicality, and (c) effectiveness. The research employed a Research and Development (R&D) approach with a 4D development model (Define, Design, Develop, & Disseminate). The developed e-module was tested on grade XI MIPA 2 students at SMA Negeri 10 Banjarmasin during the 2022/2023 academic year. The testing was conducted individually, in small groups, and a limited manner. Data was collected using questionnaires for validation, readability, response, and test assessment. Descriptive analysis was used to analyze the data. The results showed that the developed e-module met the validity, practicality, and effectiveness criteria. The validity test results indicated a high level of validity, with an average score of 95.64%. The e-module was also found to be practical based on the readability test, student and teacher response questionnaires, and the observation of teacher's abilities and implementation of learning. The practicality test scores indicated good to excellent quality. Furthermore, the limited testing demonstrated the effectiveness of the e-module in achieving learning objectives, as indicated by a high average n-gain score of 0.74. Overall, the developed e-module was able to enhance students' knowledge and learning outcomes in the field of colloids.

Keywords: colloids; interactive digital materials; internet, heyzine; project-based learning

INTRODUCTION

The use of internet-based media can potentially attract students' attention and enhance their learning outcomes in the studied material (Simatupang & Sormin, 2020). However, in reality, using the Internet to support the learning process is still suboptimal, and it has not completely succeeded in improving students' learning achievements, especially in chemistry. This finding aligns with observations made in 2020 in class XI MIPA at SMA Negeri 5 Bengkulu, where approximately 98.7% of students preferred internet access on their laptops or smartphones for games and social media rather than accessing educational content. This preference resulted in lower student learning achievements (Khumairah et al., 2020). Proper internet use, such as accessing learning materials through e-modules or other

media, can increase students' active participation in the learning process, potentially improving their learning achievements (Murni, 2022).

Observations at SMAN 10 Banjarmasin indicate that the utilization of the internet for accessing learning materials has not been optimal, suggesting a lack of opportunities for teachers and students. Therefore, teachers need guidance to help students utilize Internet resources more effectively. Research by Nenohai et al. (2022) showed that teachers generally use learning media such as PowerPoint and rarely incorporate other media like Macromedia Flash, Kvisoft Flipbook Maker, Heyzine, etc. Consequently, students often play a passive role, limiting active interaction. Despite this, the current generation of students is very familiar with touch screens and capable of embracing information systems in various learning contexts (Merdekawati et al., 2022).

Efforts are required to maximize the Internet's role as an extensive learning resource. Teachers can guide learners to access relevant online learning resources, fostering a deep understanding of the material. This approach enables learners to actively engage in learning, promoting in-depth knowledge and skill optimization. Learners should not only be passive users of learning media but also be involved in selecting and utilizing learning media to enhance their ownership of the learning process (Nurgiansyah, 2022).

Chemistry is a subject studied in high school, and colloids represent an essential topic in this field due to their direct relevance to daily life. A thorough understanding of colloidal system materials is crucial for students. However, students often resort to memorization instead of grasping the fundamental concepts behind colloidal materials. Consequently, acquiring the basic skills outlined in the learning curriculum becomes challenging. Additionally, students tend to show less enthusiasm and feel bored when learning about colloids (Eli & Sari, 2018).

This lack of excitement can impede effective learning. Therefore, an interactive method is needed to engage students and encourage thorough interaction with the subject matter to better understand colloidal system ideas. Colloid material was chosen for its perceived dullness and rote nature, leading to low student interest and poor learning outcomes. This phenomenon can be attributed to suboptimal learning quality and less supportive teaching materials, hindering smooth learning (Sirait & Simatupang, 2023).

Interactive digital teaching materials have the potential to help students understand crucial ideas for everyday life, such as those related to colloidal material. These materials can serve as supporting tools for students' independent learning and during classroom sessions. According to a research study by Gunawan et al. (2017) & Husein et al. (2017), interactive multimedia enhances students' understanding of learning concepts. This finding aligns with another study (Khamidah et al., 2019), which concluded that interactive digital teaching materials improve learner achievement, surpassing those who did not use such resources.

Interactive digital teaching materials, often referred to as e-modules, boast several advantages: (1) The ability to capture attention due to multimedia elements; (2) Active learner participation in interactive processes; (3) Environmentally friendly, reducing paper usage; and (4) Compatibility with various platforms, making them accessible through different internet-connected devices (Ilham et al., 2020).

Heyzine Flipbook Maker, an innovative application, can transform PDF files into interactive digital books, catalogs, magazines, and brochures with an appealing appearance. The app is accessible online, offering a free version and a paid subscription (Palumpun et al., 2022). The main advantage of Heyzine lies in its ability to embed various multimedia elements, including videos, images, animations, audio, and links. This significantly increases interactivity and enhances learners' overall experience. The media produced by the

Heyzine application is in flipbook form with an HTML format that can be accessed on various devices such as Android, iPhone, tablet, and PC (Saraswati, & Salsabila, 2021).

Teachers need to select effective learning models, such as project-based learning, to enhance students' competencies. This method has been proven to improve students' knowledge through individual or group creative activities. Project-based learning places students at the center of the learning process, allowing them to develop creativity and teamwork. By focusing on learners, this approach can significantly improve learning achievement (Nurhadiyati et al., 2021).

Students' knowledge-learning outcomes have been shown to increase after project-based learning treatment. This finding was demonstrated in a study with different class groups, where the application of the project-based learning (PjBL) model was more effective in improving knowledge learning outcomes compared to the expository learning model, as indicated by the increase in the N-Gain value (Santi et al., 2019). Additionally, Rumahlatu & Sangur's (2019) research stated that applying project-based learning strategies significantly improved students' metacognitive skills, concept understanding, and retention compared to conventional learning.

The PjBL model offers opportunities for students to learn actively through project implementation, problem-solving, and connecting to real-world contexts (Anggraini & Wulandari, 2021). Students become more active and creative in the learning process, and the PjBL model improves critical thinking skills and problem-solving abilities (Sumardiana, et al., 2019). Wena (2014) stated that the PjBL model has advantages such as increased motivation, enhanced problem-solving ability, better collaboration, and the development of critical thinking skills and creativity.

In light of the above, there is a need for innovation in learning through interactive digital teaching materials and project-based learning models. The innovation in this study involves using interactive digital teaching materials with the assistance of Heyzine flipbook maker to make learning more interactive. This is achieved by including moving animation effects and the addition of videos, photos, and direct links in the design. These teaching materials can be accessed through a web browser and contain visual, audio, and video content that enriches the learning experience (Erawati et al., 2022). Applying interactive digital teaching materials assisted by Heyzine is accompanied by a project-based learning model to consistently improve students' knowledge learning outcomes and enhance their classroom engagement.

This research aims to develop teaching materials that integrate interactive digital teaching materials and project-based learning approaches. This integration aims to increase students' interest and enthusiasm in learning. This research aims to evaluate the validity, practicality, and effectiveness of the developed teaching materials, with the ultimate goal of creating a learning resource that can positively impact improving student learning outcomes in the longer term. In addition, this research also seeks to build students' active involvement in the classroom environment, creating a more dynamic and interactive learning atmosphere.

METHOD

The research and development (R&D) technique proposed by Sugiyono in 2017 was applied in this study. Due to time constraints, the development model used in this study was the 4D model (Define, Design, Develop, and Disseminate), which was adjusted to a 3D model (Define, Design, and Develop). Figure 1 shows the flow of the 3D model used.

Figure 1 Model 3D

The participants in this study were 11th-grade students from SMA Negeri 10 Banjarmasin. This sample was chosen based on the availability of learning facilities required to develop interactive digital teaching materials. The research subjects comprised five expert validators with the competence to evaluate the validity of the interactive digital teaching materials developed, 11 students who participated in the media readability test, and one class XI MIPA 2, which served as the research group to evaluate practicality and effectiveness through knowledge tests. This research aims to create interactive digital teaching materials on colloidal material using the Heyzine flipbook maker tool. The purpose of creating this teaching material is to enhance student knowledge and learning outcomes by focusing on validity, practicality, and effectiveness.

The methods used in the data collection process include questionnaires in various forms, such as validation questionnaires, readability questionnaires, response questionnaires, and test assessments. A descriptive analysis approach was employed to analyze the data. Measurements were made based on scores from five professional validators who evaluated each aspect, including content, presentation, language, and media. The scores were then converted into percentages using a certain formula to determine the qualification conditions based on the percentage achieved. The e-module feasibility assessment sheet by professional validators and the survey answers from students and teachers were used as data collection tools in this study. The information collected from these various sources was used to determine the validity, readability, and response to the interactive digital learning materials produced.

Data analysis of the feasibility evaluation of interactive digital teaching materials assisted by the Heyzine flipbook maker application is considered valid if it receives a minimum score of 70%. The calculation is done by converting the score given by the expert validator into a percentage. The percentage results of the validity test can be compared with the criteria provided in Table 1.

Table 1 Criteria for the feasibility of digital teaching materials

Percentage	Validity description	Information
85 - 100	Very valid	Without revision
$70 \leq 85$	Valid	Without revision
$50 \leq 70$	Less valid	Minor revisions
$01 \leq 50$	Invalid	Major revisions

(Akbar, 2013)

From the results of the questionnaire, which focuses on the readability test by students, responses from students, and also responses from teachers, an analysis is carried out to assess the practicality of the teaching materials that have been designed. To assess learners' responses to the teaching materials under consideration, the criteria are outlined in Table 2.

Table 2 Criteria for learner responses

Average score	Description
> 3.25 – 4.0	Very good
> 2.5 – 3.25	Good
> 1.75 – 2.5	Not good
1.0– 1.75	Not very good

Adapted from Widoyoko (2018)

This study analyzed the effectiveness of teaching materials in the form of interactive e-modules using the Heyzine flipbook maker application. The effectiveness assessment was conducted with the help of a knowledge test instrument consisting of multiple-choice questions with justification. The data in this study include the results of knowledge tests that

have been conducted on students. This information was used to assess the level of achievement of the learners' learning objectives. The analysis process begins by assigning scores to the answers given by the learners based on the questions in the knowledge test. The scoring process follows the guidelines listed in Table 3.

Table 3 Learner answer scoring guidelines

Assessment Criteria	Score
Wrong reason & wrong answer	0
Correct reason & wrong answer	1
Incorrect reason & correct answer	2
Correct reasoning & correct answer	3

Adapted from Widoyoko (2018)

Data analysis was carried out to determine the percentage of student learning outcomes involving the initial score and final score based on predetermined criteria, described as follows:

$$\text{Percentage of learning outcomes (\%)} = \frac{\text{Total score obtained}}{\text{maximum number of scores}} \times 100\% \ \dots \ (1)$$

After calculating the results of the knowledge test and the percentage of students' learning outcomes, the researchers categorized the students' knowledge learning outcomes based on Table 4.

Table 4 Criteria for assessing students' knowledge learning outcomes

Criteria	Percentage
Very High	80-100
High	60-79
Medium	40-59
Low	20-39
Very Low	0-19

(Arikunto, 2015)

RESULT AND DISCUSSION
Define
The first stage, defining, aimed to identify learning challenges experienced by students during face-to-face learning. This stage took place at SMA Negeri 10 Banjarmasin to obtain the basis for preparing tests and designing lessons in the research process. The initial analysis indicated a significant problem: students struggled to concentrate during the learning process. This could be attributed to boredom or the use of uninteresting learning resources. A more in-depth analysis revealed that students were more engaged in group and practical activities, while they showed less participation when working individually. Learners appeared more active and excited when collaborating with their classmates.

The task analysis was conducted to enable learners to 1) differentiate between solutions, colloids, and suspensions; 2) categorize colloidal systems based on the dispersed phase and dispersing phase; 3) assess the use of colloids in daily life based on their properties; and 4) create culinary skills or other objects that are colloids or involve colloidal principles. Professors assigned various formats, such as individual assignments, group assignments, projects, and practicums.

Furthermore, the main concepts of the material, designed and arranged sequentially, were adjusted to the Core Competencies and Basic Competencies (KD) to obtain effective teaching materials (Herianingtyas, 2022). The Basic Competencies used were KD 3.14, which involves classifying various types of colloidal systems, explaining the properties of colloids and their application in everyday life, and KD 4.14, which pertains to making food

or other products that are colloidal or involve colloidal principles. The last analysis involved learning objectives in the form of GPA on colloidal material, which included 1) distinguishing between solutions, colloids, and suspensions; 2) categorizing colloidal systems based on the dispersed phase and the dispersing phase; 3) investigating the characteristics of colloids found in everyday life; 4) investigating the use of colloids in daily life; 5) designing the manufacture of colloidal food or other products; and 6) producing colloidal food or other products.

Design

The next step is the design stage, where initial planning for creating required learning materials takes place. One of the crucial components in this stage is creating the initial design of the learning materials. Additionally, selecting supporting software to create interactive digital teaching materials on colloidal material, namely Canva and Heyzine Flipbook Maker, is necessary. Canva is used for graphic designs. After completion, the document is converted to PDF format and uploaded to the Heyzine Flipbook platform (Erawati et al., 2022).

Teaching materials were compiled, paying attention to aspects such as size, content layout, color, and illustrations by the predetermined design. This ensures that the concepts, messages, and materials presented in these teaching materials become clearer and more effective (Mufida et al., 2022). The following format is used in the learning materials created: 1) Frontpage (cover); 2) Home page, which includes e-module identity, instructions for using the e-module, preface, table of contents, list of videos, concept map, core competencies, basic competencies, and learning objectives; 3) Content page, which includes systematically arranged learning materials about colloids, project assignment sheets for making food based on colloidal principles with the Project-Based Learning (PjBL) learning model, crossword puzzles, summaries, formative tests, and learning objectives. Figure 2 shows the front cover page of this e-module.

Figure 2 Front cover page of the e-module

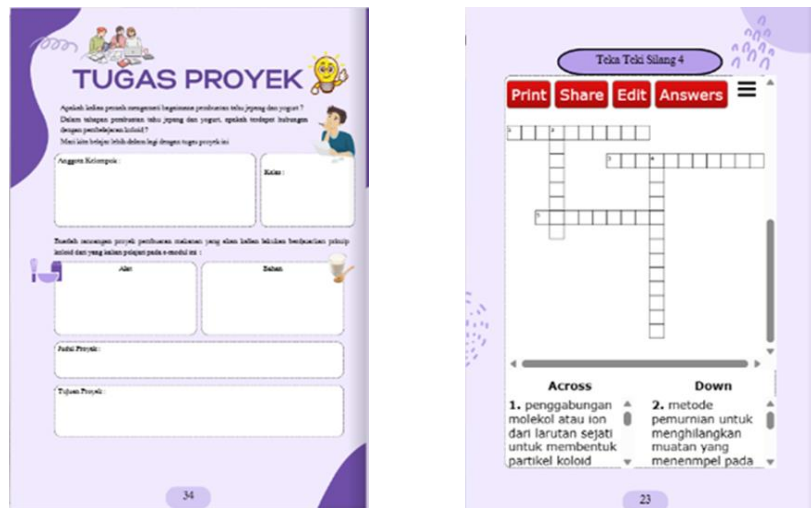The content of this e-module can be found on several pages, as shown in Figure 3.

Figure 3 shows some of the content pages of the e-module

Develop

The third stage is the development stage of this procedure. At this stage, three lecturers of Chemistry Education FKIP ULM Banjarmasin, one lecturer of Educational Technology FKIP ULM Banjarmasin, and one chemistry teacher from SMA Negeri 10 Banjarmasin checked the validity of the product. The validity test was carried out by distributing validation sheets to the validators. This validation sheet consisted of four main aspects, namely content, presentation, language, and media. Figure 4 illustrates the results of the validator's assessment of the feasibility of the material in the e-module.
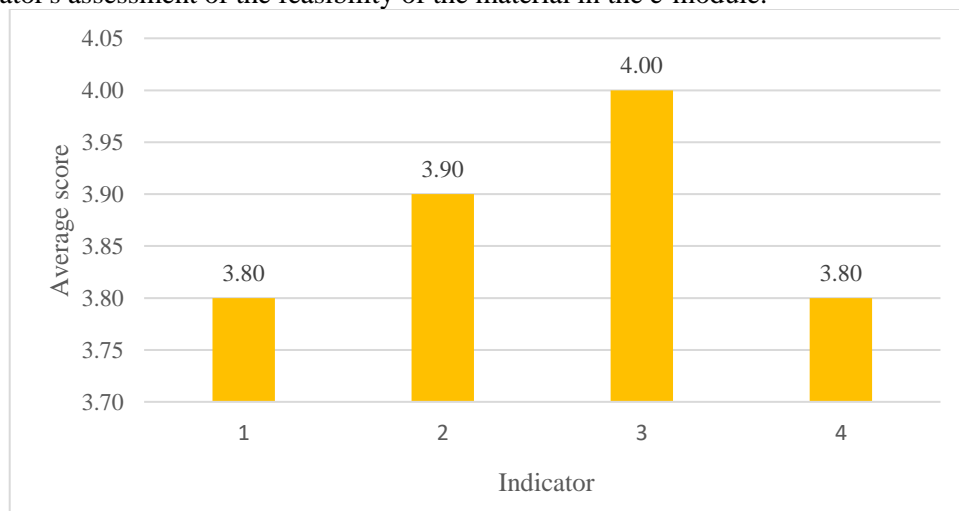

Figure 4 Shows a diagram of the results of the validator's assessment of an interactive digital e-module with the help of Heyzine Flipbook Maker on content feasibility

Indicator Description:
1. Suitability of material with content
2. The accuracy of the material
3. Supporting learning material
4. Up-to-date material

A high average score was achieved for each evaluation item based on the validators' assessment results for the content feasibility aspect. This shows that the feasibility of the

content of an interactive digital e-module assisted by Heyzine flipbook maker has been thoroughly evaluated. Thus, no revision is needed in this section because it meets the eligibility criteria. With a very valid category, the percentage of content feasibility obtained for an e-module that utilizes the Heyzine flipbook maker reaches 95.34%.

This research is in accordance with the findings of the research (Ningsih, Ruhiat, and Saefullah, 2020) which found the percentage of feasibility of e-module material of 77.8% in the valid category. Furthermore, further research by (Rahmatsyah and Dwiningsih, 2021) supported these findings, with the percentage of content feasibility achieved at 90%, with a very valid category in the content criteria.

Furthermore, the results of the presentation feasibility assessment are shown in Figure 5
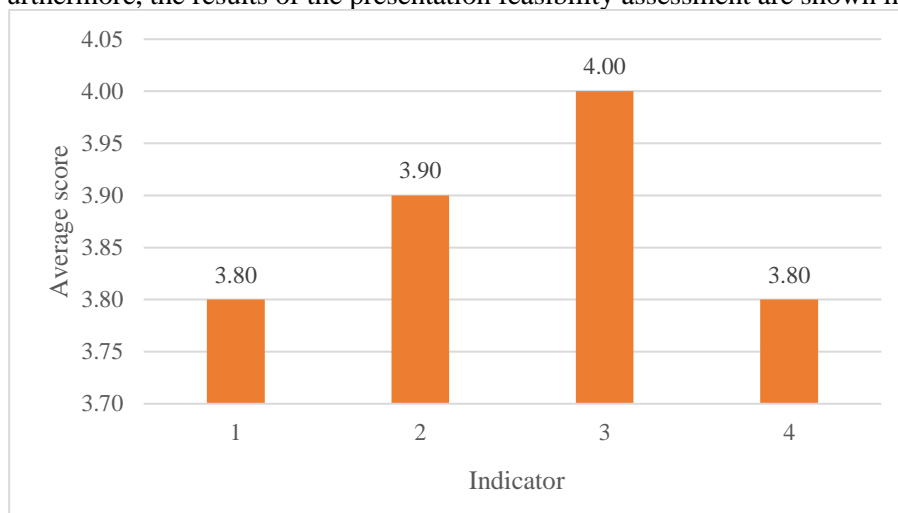

Figure 5 The results of the validator's assessment of the interactive digital e-module assisted by the heyzine flipbook maker on the presentation feasibility aspect

Indicator description:
1. Presentation technique
2. Supporting presentation
3. Presentation of learning
4. Completeness of presentation

In Figure 5, Indicators 1, 2, 3, and 4 have scores of 3.7, 3.87, 4, and 3.87, respectively, with a very valid category. Based on the feedback from the validators, revisions were made which included adding a list of videos to the e-module content to ensure completeness and perfection. In addition, suggestions also included replacing the preface with a foreword with a minimum of 2 pages. This revision aims to improve the quality and empowerment of information presented in e-modules, including increasing the attractiveness of teaching materials by utilizing various illustrations, such as images, videos, and animations in learning materials (Rama et al. 2022). Figure 5, listed below, compares the appearance of the e-module before and after the revision. This comparison illustrates the changes and improvements applied to improve the e-module. Through the comparison, it can be seen how modifications have been made to enrich the e-module so that it is more comprehensive, informative, and relevant to the needs of learners.

Before Revision No Video
List

After Revision

Before Revision
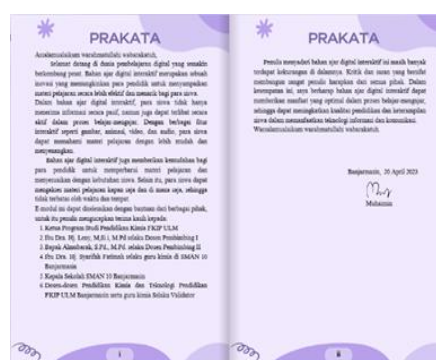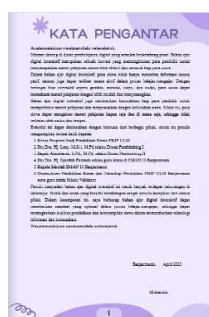The foreword is still written on
1 page

After Revision

Figure 6 Compares the appearance before and after the revision of indicator 2 in the aspect of presentation feasibility

The feasibility of the presentation in an interactive digital e-module, assisted by Heyzine Flipbook maker, obtained a percentage value of 96.25%, which was a very valid category based on the validator's assessment. This conclusion is in line with a research study by Ningsih et al. (2020) in the e-module they developed, which received a score of 91% in the presentation aspect with a very feasible category. Similar findings were found in research conducted by (Rahmatsyah & Dwiningsih, 2021), where the proportion of presentations received was 93%, indicating a very valid category in these criteria.

The results of the validator's assessment of the e-module in the aspect of language feasibility can be seen in Figure 7.
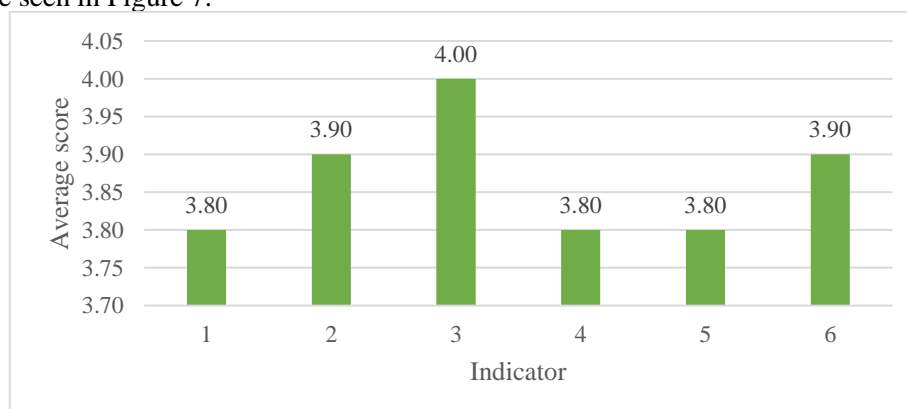

Figure 7 The results of the validator's assessment of the interactive digital e-module assisted by the heyzine flipbook maker on the aspect of language feasibility

Indicator description:
1. Straightforward
2. Communicative
3. Dialogical and interactive
4. Appropriateness to the level of learner development
5. Orderliness and cohesiveness of the train of thought
6. Use of terms, symbols, or icons

Based on the validator's assessment results for the language feasibility aspect, the percentage value of language feasibility for the e-module assisted by Heyzine Flipbook Maker is 95.38%, with a very valid category so that it can be categorized as communicative. Good media is media with the characteristics of using a common language, being simple, easy to understand, and presenting information that can assist users (Astutik et al., 2021). In addition, research (Rahmatsyah & Dwiningsih, 2021) is also in line with these findings, where the study obtained a percentage of 100% with a very valid category in linguistic criteria.

Furthermore, the results of the validator's assessment of the e-module on the media feasibility aspect are presented in the diagram in Figure 8.
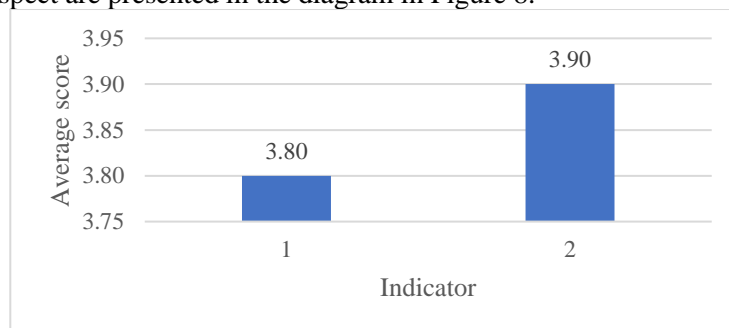

Figure 8 The results of the validator's assessment of the interactive digital e-module assisted by the heyzine flipbook maker on media feasibility

The first and second indicators scored 3.8 and 3.9 in the assessment. These scores indicate that the e-module has reached a very good level of completeness and cohesiveness in the flow of thought. However, the validator suggested revisions by adding captions to the video numbers in the e-module. This revision aims to improve and increase the clarity of information conveyed to students.

Changes in the appearance of the e-module before and after revision can be seen in Figure 9.

Before revision No caption Video number

After revision

Figure 9 Display of e-module after adding video number captions

The percentage value of the feasibility of interactive digital e-module media assisted by the heyzine flipbook maker is 95.62%, with a very valid category based on the validator's assessment of the media feasibility elements. According to Husnulwati et al. (2019), the assessment of the media feasibility element reached 77% in the feasible category.

Overall, the validity results of the e-module showed that the validators gave a high percentage of validation of the content, presentation, language, and media feasibility elements, reaching 95.34%, 96.25%, 95.38%, and 95.62%, respectively. As a result, an average percentage of 95.65% was obtained. The percentage is included in the very valid category, indicating that the interactive digital e-module assisted by the Heyzine flipbook application and using Project Based Learning (PjBL) learning is suitable for use without needing revision.

These results are in line with the findings of Ketut et al. (2022), who found that the results of making an e-module using Heyzine showed that the average value of the three validators reached 85%, so it was in the very valid category. Thus, the resulting e-module is suitable for teachers and students to use in learning.

After the development stage, based on input from experts, the e-module was evaluated in terms of its practicality through the use of readability questionnaires in individual and small group trials and the evaluation of responses from students and teachers. Table 5 shows the results of the e-module readability score on the individual trial.

Table 5 Results of e-module readability questionnaire for individual trial

No.	Learner Name	Average score	Assessment criteria
1.	Learner A	3.43	Very good
2.	Learner B	3.14	Good
3.	Learner C	3.14	Good
	Average	**3.24**	**Good**

Referring to the information listed in Table 5, it was found that the responses from students in individual trials reached an average score of 3.24, equivalent to a percentage of 81%. This shows that the response is included in the good category, so no further revisions are needed.

The findings of the e-module readability score for the small group trial are shown in Table 6.

Table 6 Results of e-module readability questionnaire small group test

No.	Learner Name	Average score	Description
1	Learner A	3.50	Very good
2	Learner B	3.00	Good
3	Learner C	3.63	Very good
4	Learner D	3.00	Good
5	Learner E	3.00	Good
6	Learner F	3.50	Very good
7	Learner G	3.00	Good
8	Learner H	3.25	Good
9	Learner I	3.75	Very good
	Average	**3.29**	**Very good**

Based on Table 6, the e-module practicality evaluation method at the small group trial stage resulted in an average score of 3.29, comparable to a percentage of 82% and classified

as very good. These results are in accordance with the research findings of Ketut et al. (2022), who found that 96% of student answers met the criteria of very practical.
Table 7 contains findings from students' answers regarding the use of e-module in the limited trial.

Table 7 Results of limited trial learner responses

Average score	Criteria	Frequency
> 3.25 – 4.00	Very good	20
> 2.25 – 3.25	Good	12
> 1.75 – 2.5	Not good	0
1.0 – 1.75	Not very good	0
Total		**32**
Average		**3.39**

Based on the information in Table 7, the results of student answers show a positive reaction, as seen from the total average score of 3.39 or 84.7%, which falls into the excellent category. Based on the learning criteria, this indicates that the interactive digital e-module assisted by Heyzine flipbook maker has reached the appropriate practical level. Furthermore, this interactive e-module has indeed proven to be practical, which is reflected in the results of learners' responses. Each criterion scored above 81%, indicating a very positive response level (Rahmatsyah & Dwiningsih, 2021).

Teacher response in the use of e-module is measured through the use of teacher response questionnaires to assess the practical level of e-module during the learning process. Based on the information in Table 7, the results of students' answers show a positive reaction, as seen from the total average score of 3.39 or 84.7%, which falls into the excellent category. The instructor's competence in applying the e-module was evaluated based on the aspects displayed in the classroom activities, and the observer's average score was 3.95, placing it in the excellent category. Furthermore, the instructor's implementation of classroom learning was evaluated based on the elements seen in the classroom management skills during the teaching process. In this instance, the observer's average score was 3.88, which also falls within the good range.

The effectiveness of the development of teaching materials in the form of interactive digital e-module using Heyzine flipbook maker can be measured by students' ability to complete the knowledge learning outcomes test that has been provided. The analysis procedure was carried out on the results of the knowledge test done by students using the N-gain calculation in a limited trial of one class. Table 8 presents data on students' knowledge learning outcomes determined by the mean pretest and post-test scores in the limited trial class.

Table 8 Average pretest and post-test knowledge learning outcomes of learners in the limited trial

No.	Value	Limited Trial Class	
		Pre-test	**Post-Test**
1	Lowest	6.67	70.00
2	Highest	46.67	96.67
Average		**20.83**	**79.69**

Referring to Table 8, the pre-test scores ranged from 6.67 to 46.67, with an average score of 20.83. Meanwhile, the post-test results had the lowest and highest score ranges of 70 to 96.67, with an average score of 79.69. Based on this information, the average post-test score exceeds the pre-test. The comparison of the average pre-test and post-test scores shows that students' knowledge-learning outcomes increased after using the e-module. Table 9 shows

the criteria for students' knowledge-learning outcomes based on the pre-test and post-test results.

Table 9 Criteria for knowledge learning outcomes

No.	Criteria	Percentage	*Pretest*	*Post-Test*
1.	Very High	80 – 100	0	17
2.	High	60 – 79	0	15
3.	Medium	40 – 59	3	0
4.	Low	20 – 39	17	0
5.	Very Low	0 - 19	12	0
	Total		**32**	**32**

Based on the data collected, it can be concluded that students' knowledge-learning outcomes improved after engaging in learning by using the designed e-module. This conclusion is consistent with another study by Erawati, Purwati, and Saraswat (2022), who found that the math logic e-module using heyzine was very successful. The learning outcomes of the study showed that all students completed the exam with scores above the Minimum Completeness Criteria.

Learning effectiveness can be assessed from the increase in student motivation and learning outcomes in limited trial learning. Learning through e-module is successful, according to the results of the percentage of learning motivation, which is in the high category, and the N-gain of learning outcomes, which is also in the high category (Rahmila et al., 2022).

N-gain data is obtained by processing data from pre-test and post-test results. The purpose of using N-gain is to assess the increase in student learning outcomes from pre-test to post-test after using learning materials in the form of an interactive digital e-module made using Heyzine flipbook creator during the learning process. Table 10 shows the N-gain statistics of students in the limited trial.

Table 10 N-gain results of student learning outcomes test

No.	N-gain interval	Category	Frequency
1.	$(g) < 0.3$	Low	0
2.	$0.3 \leq (g) \leq 0.7$	Medium	15
3.	$(g) > 0.7$	High	17

Based on the findings of the N-gain value in the limited trial, a value of 0.74 was obtained, which falls within the high range. This indicates that using teaching materials in the form of interactive digital e-module made with Heyzine flipbook maker on colloidal material contributes significantly to improving student learning outcomes, as demonstrated by the increase in post-test scores surpassing pre-test scores.

Statistically, there was a considerable improvement in students' knowledge learning outcomes after participating in learning using an interactive digital e-module assisted by Heyzine Flipbook Maker. All students met or exceeded the minimum completion criteria score of 70. This finding aligns with Ketut et al.'s (2022) research, where all students met the MCC with a score of 76, highlighting the effectiveness of electronic modules in enhancing student learning outcomes. Additionally, the increase in the N-gain value indicates a boost in effectiveness, supporting Rahmatsyah & Dwiningsih's (2021) analysis that the interactive E-module was effective based on the gain score increase. Moreover, the findings underscore the significant contribution of the adopted learning paradigm, namely Project Based Learning (PjBL).

Research on developing an interactive digital e-module with the PjBL model on colloidal material revealed several weaknesses. Firstly, there is a dependence on a stable internet

connection to access the e-module, posing an obstacle if learners or teachers lack consistent internet access. Secondly, the e-module lacks clear working instructions in the worksheets, causing confusion for learners and requiring teacher assistance. Thirdly, access to learners' complete crossword answers is limited and incurs costs. Consequently, evaluating learners' answers to the crossword puzzles cannot be done effectively, diminishing the feedback aspect of the learning process.

CONCLUSION

The conclusion that can be drawn based on the results of the research and analysis that has been done is that the interactive digital E-module assisted by Heyzine flipbook maker, which is applied to learning colloidal material, has a very high level of validity. Media validation shows a significant percentage, namely 95.3% for content aspects, 96.25% for content feasibility aspects, 95.38% for language feasibility aspects, and 95.62% for media feasibility aspects. This E-module also achieved strong validity through readability tests at both individual and small group levels, with average scores of 3.24 and 3.29, both categorized as good. The application of an interactive digital e-module assisted by Heyzine flipbook maker also showed a high practicality. This is indicated by the results of the readability questionnaire given to students and instructors after the limited trial, where the average score reached 3.39, indicating a very good category in terms of module practicality. In addition, this electronic module also meets the effectiveness criteria, as indicated by an increase in student learning outcomes on colloidal material. The increase in students' concept knowledge is reflected in the N-gain value, which reached 0.74, which placed students in the high group in the limited trial class.

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