Journal of Natural Science and Integration
P-ISSN: 2620-4967|E-ISSN: 2620-5092
Vol. 8, No. 2, October 2025, pp 273-284

Available online at:
http://ejournal.uin-suska.ac.id/index.php/JNSI
DOI: 10.24014/jnsi.v8i2.33047

Development of Interactive Multimedia Based on PJBL Using Lumi on Cell Material as a Science Learning Resource

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ABSTRACT
This study aims to describe the development process and feasibility of Project Based Learning (PJBL) based interactive multimedia developed using Lumi on the topic of cells. The research employed a research and development (R&D) approach, adopting the ADDIE instructional design model, which consists of five stages: analysis, design, development, implementation, and evaluation. The feasibility of the developed multimedia was evaluated by experts in terms of validity and practicality. The results indicated that the PJBL based interactive multimedia developed using Lumi was deemed highly feasible, with an average Aiken's validity index of 0.85 (very high). The practicality assessment also demonstrated very positive results, with average scores of 93.93 (very practical) from teachers and 91.10 (very practical) from students. The validity evaluation covered four aspects—design, pedagogy, content, and technique—yielding average scores of 0.87, 0.80, 0.85, and 0.86, respectively. These findings suggest that the PJBL based interactive multimedia developed using Lumi is both valid and practical, making it suitable for enhancing the science learning process in junior high schools, particularly in teaching cell concepts..

Keywords: *cell, development, interactive multimedia, lumi, PJBL.*

INTRODUCTION

Learning in the 21st century demands innovation that integrates digital technology to enhance the quality of science education. Despite this necessity, classroom observations reveal that many teachers continue to rely on conventional teaching methods and printed materials. Such practices often lead to passive learning environments where students exhibit low motivation and limited engagement. Therefore, it is essential to develop interactive, technology based learning media that can foster curiosity and facilitate a deeper understanding of abstract scientific concepts, such as cell structures. Integrating Project Based Learning (PJBL) with interactive multimedia developed through Lumi provides a promising approach to address these challenges, aligning with the competencies required for 21st century learning.

Technology integration in education has been shown to increase the effectiveness of project based learning by enhancing interactivity, supporting communication, and enabling the exploration of real world, problem based contexts (Basilotta Gómez Pablos, Martín del Pozo, & García Valcárcel Muñoz Repiso, 2017). Moreover, digital learning media play a vital role in making abstract scientific concepts more concrete and comprehensible (Astuti et al., 2023). Previous studies have demonstrated that interactive multimedia allows teachers to present complex and abstract materials more effectively, providing representations that are closer to real life phenomena (Wahyuni et al., 2023). The availability of various multimedia authoring tools, such as Lumi, has also made it possible to create engaging, dynamic, and user friendly learning resources (Safira et al., 2024).

However, observations and interviews with junior high school science teachers indicate that most learning resources remain limited to printed modules and traditional media. This limitation is primarily due to insufficient teacher competence in designing and developing digital learning media, such as presentations, videos, animations, or interactive multimedia. Consequently, students often experience boredom and struggle to grasp abstract concepts in science. The lack of pedagogical innovation among educators may negatively affect students' learning outcomes, which reflect their achievements in acquiring knowledge and skills through learning activities (Pasaribu et al., 2020). This condition highlights the importance of developing digital based learning media that can support teachers in facilitating meaningful and engaging science learning experiences.

The quality of educators and the curriculum are two key factors influencing the advancement of education. In the modern era, educational development is inseparable from rapid technological progress, particularly in the integration of digital technology into learning media. The effectiveness of the learning process largely depends on the use of appropriate media that can support the delivery of learning materials (Triana, Widowati, & Achyani, 2021). In general, learning media refer to tools that facilitate teaching and learning activities, ranging from traditional media such as textbooks to the use of digital devices in classrooms (Suryani & Dhiki, 2020). One type of digital media that can be accessed via computers or smartphones is interactive multimedia, which offers dynamic and engaging learning experiences.

Multimedia, derived from the words multi (many) and media (means of communication), represents the integration of various information forms—such as text, images, audio, video, and animation—into a digital platform for interactive or linear presentation (Manurung, 2021; Swara, 2021). Interactive multimedia allows users to engage directly with the learning content, enhancing comprehension and retention. In this research, interactive multimedia is developed using Lumi, an authoring tool designed to facilitate the creation of technology based learning materials (Hamdani et al., 2022).

Lumi Education offers several advantages that make it a highly effective and efficient platform for digital learning. One of its key features is the ability to create interactive learning content—such as quizzes, simulations, and videos—that increase student engagement. Moreover, Lumi is an open source and free platform, making it accessible to educational institutions without incurring substantial costs (Oksaviona et al., 2023). Its user friendly interface allows teachers to develop and manage materials easily without requiring advanced technical expertise. Lumi also provides a variety of templates that can be adapted to different learning objectives and integrates seamlessly with popular learning management systems (LMS) such as Moodle and Blackboard, ensuring accessibility across multiple devices. Additionally, Lumi supports real time feedback, enabling teachers to provide immediate assessment and guidance to students. The platform also facilitates adaptive and self paced learning, allowing materials to be tailored to students' needs and learning speeds. Supported by an active global community that continuously contributes to its feature development, Lumi presents an innovative solution to enhance both classroom and online learning experiences.

Given the challenges identified in current science education, particularly the limited use of engaging learning media, it is crucial to provide digital resources that can stimulate students' interest and motivation. Interactive multimedia based on Project Based Learning (PJBL) using Lumi is proposed as a potential solution to this problem. This combination encourages students to actively construct knowledge through projects while engaging with multimedia elements such as text, animations, images, videos, and audio. Consequently, the use of PJBL based interactive multimedia can help students better understand complex science concepts, such as cell structures, by connecting abstract knowledge with visual and experiential learning.

The novelty of this study lies in integrating the Project Based Learning (PJBL) model with Lumi software to develop interactive multimedia specifically designed for teaching cell material at the junior high school level. While previous studies have explored interactive learning media using other software tools, the application of Lumi within the PJBL framework for this particular topic remains underexplored. This research, therefore, contributes to the field of science education by introducing an innovative and practical approach to developing interactive learning media aligned with the demands of 21st century learning.

METHODOLOGY

The type of research used is research and development. The model used is the ADDIE type. Instructional design consists of 5 stages, namely analyze, design, development, implementation, and evaluation (Fitriyah, Wiyokusumo, and Leksono 2021). The research and development procedure for interactive multimedia of PJBL based cell material using Lumi is shown in Figure 1.

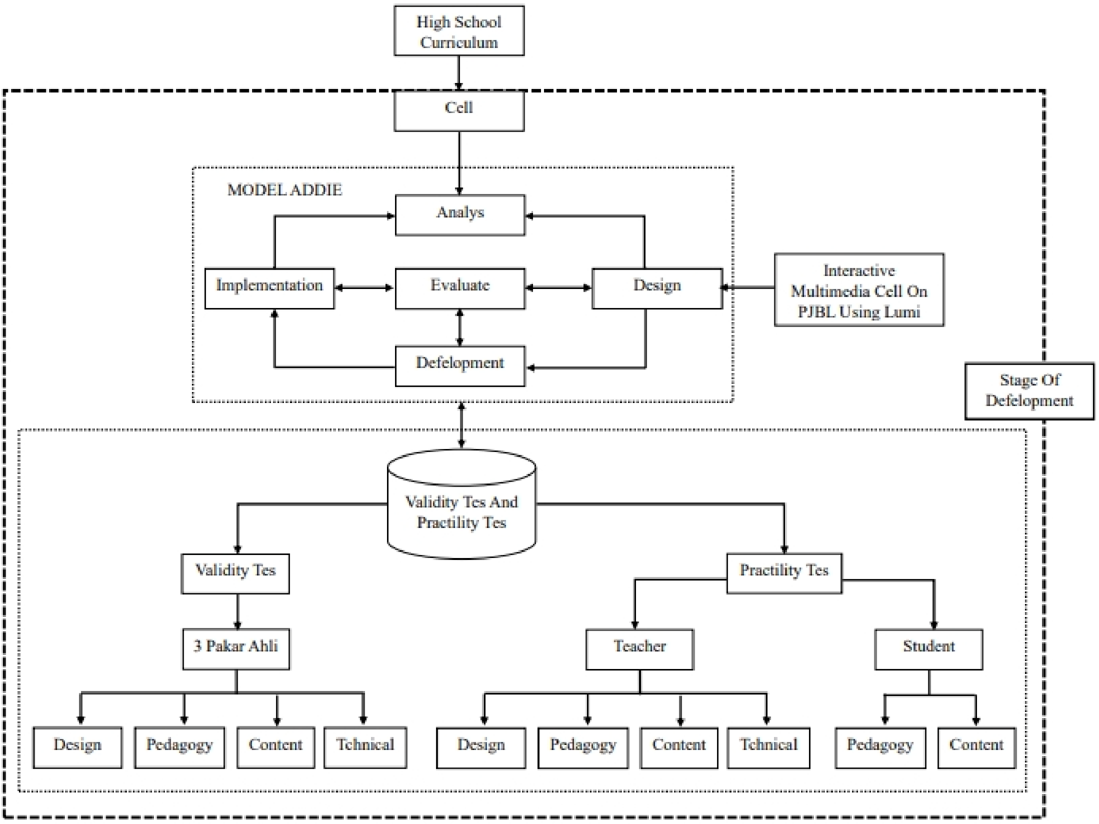

Figure 1. Research Procedure

This study employed a Research and Development (R&D) approach aimed at producing and validating Project Based Learning (PJBL) based interactive multimedia using Lumi on the topic of cell structure for junior high school students. The research followed the ADDIE instructional design model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Fitriyah, Wiyokusumo, & Leksono, 2021). Each stage is described in detail below.

Analysis Stage

The analysis stage comprised two main components: content needs analysis and software needs analysis. The goal of this stage was to identify the learning needs of teachers and students as well as the learning methods and models commonly applied in science instruction. Data were collected through questionnaires distributed via Google Forms and supported by a literature review to strengthen the rationale for developing interactive multimedia for cell material. The content analysis focused on identifying essential competencies, learning objectives, and the appropriate depth of material aligned with the curriculum (Aprido et al., 2020). Various learning sources—such as textbooks, learning modules, scientific articles, and educational videos—were examined to ensure the relevance and accuracy of the cell material for junior high school students.

Design Stage

At the design stage, researchers developed a blueprint for the PJBL based interactive multimedia using Lumi and prepared the necessary development instruments. The design process included the creation of historyboards and storyboards (Auliyak et al., 2022). The historyboard illustrated the overall structure, including menus and navigation flow, while the storyboard provided detailed descriptions of each scene, ensuring that the content corresponded to the syntax of the PJBL model (Setiawan, 2020). In addition, researchers designed an instrument for multimedia validation, consisting of assessment sheets to evaluate the validity of the developed interactive multimedia in terms of design, pedagogy, content, and technical quality.

Development Stage

The development stage involved constructing the interactive multimedia product based on the historyboard and storyboard prepared earlier. The multimedia was created using Lumi software, integrating various content types such as branching scenarios, presentation slides, image hotspots, and embedded videos. These components were designed to support project based learning activities and to enhance student engagement and conceptual understanding. At this stage, a validity and response questionnaire was also developed to measure expert and user evaluations of the product's feasibility. The final output of this phase was an interactive multimedia prototype on cell material aligned with the required competencies (Hariyati & Rachmadyanti, 2022).

Implementation Stage

After the multimedia was developed, it was subjected to a validation process involving media experts, material experts, and practitioners (science teachers). Each expert evaluated the product using predetermined assessment instruments. Following validation, a limited field trial was conducted to assess the practicality of the multimedia in a classroom context (Fadhila et al., 2022). During implementation, researchers ensured that all interactive features, buttons, and navigation elements functioned properly and aligned with the syntax of the PJBL model. Data from teachers and students were collected after the multimedia was declared feasible by the validators (Kristianawati, Degeng, & Sugito, 2020).

Evaluation Stage

The evaluation stage aimed to determine whether the developed interactive multimedia met the initial design expectations and effectively supported the learning process. This phase involved continuous reflection and improvement based on feedback obtained during validation and implementation. Evaluations focused on identifying weaknesses and refining the multimedia content, design, and functionality to achieve optimal quality. After completing the five ADDIE stages, a validity test was conducted on the PJBL based interactive multimedia using Lumi software. Three validators—comprising one material expert, one media expert, and one practitioner assessed the product using a validation sheet adapted from Nasir and Fakhruddin (2023). The instrument covered four main aspects: design, pedagogy, content, and technical quality. Each aspect was rated using a Likert scale, and the results were analyzed using qualitative and quantitative criteria, including the Aiken's V validity index. The validation items used in the assessment are presented in Table 1.

Table 1: Interactive Multimedia Validation Indicators

No	Aspect	Question
1	Design	1 – 9
2	Pedagogy	10 – 19
3	Content	20 – 28
4	Technical	29 – 36

The qualitative data obtained were then converted into quantitative data and presented on a Likert scale from 1 to 5. The scale conversion from qualitative to quantitative is explained in Table 2.

Table 2. Change Qualitative Scale to Quantitative Scale

Criteria	Score
Strongly Agree	5
Agree	4
Disagree	3
Disagree	2
Strongly Disagree	1

Source : (Sugiyono, 2019)

Each assessment indicator on the validation sheet is declared valid if it has a value ≥ 3. If there are indicators that have a value < 3, then improvements or revisions need to be made to each product according to the suggestions or input on the validation sheet. the indicator in question (Isnaini, Listiadi, and Subroto 2022).

Determine the validity value calculated using the following Aiken V formula:

$$V = \frac{\sum s}{n\,(c-1)}$$ (An Nabil et al. 2022)

V = Validity Score
s = Score the score given by the assessor minus the lowest score in the category
c = Highest Rating Score
n = Number of Validators

The data obtained using the Aiken V formula were then interpreted descriptively based on Table 3.

Table 3. Interpretation of Aiken's V Coefficient

Average Score Interval	Criteria
0.80 < ≤ 1.00	Very High
0.60 < ≤ 0.80	High
0.40 < ≤ 0.60	Fair
0.20 < ≤ 0.40	Low
0.00 < ≤ 0.20	Very Low

Source : (Azwar, 2012)

The practicality test was carried out by science teachers using an assessment sheet consisting of pedagogical design, content, and technical aspects, as well as responses from students of SMP Negeri 23 Pekanbaru using an assessment sheet consisting of pedagogical and content aspects. The data from the results of the interactive multimedia practicality test based on PJBL using Lumi were analyzed by looking at the qualitative assessment criteria for each aspect containing several indicators. The qualitative data that had been obtained were converted into quantitative data and presented on a Likert scale, namely 1-5 (Yulianti, 2023) The practicality value is obtained by using the following formula:

$$Practicality = \frac{\text{Total score}}{\text{Maximum score}} \times 100$$

The data obtained were then interpreted descriptively based on Table 4.

Table 4. Practicality Assessment Criteria

Practicality Score (P)	Criteria
$P \leq 20$	Not Practical
$20 < P \leq 40$	Less Practical
$40 < P \leq 60$	Quite Practical
$60 < P \leq 80$	Practical
$80 < P \leq 100$	Very Practical

RESULT AND DISCUSSION

The results of the analysis stage indicate that junior high school students often experience difficulties in understanding cell material. The findings from the needs analysis reveal that this topic is perceived as challenging due to the abundance of abstract concepts and microscopic structures that are difficult for students to visualize. This challenge is further exacerbated by the limited use of innovative learning resources and methods. In practice, most teachers rely heavily on government issued textbooks and student worksheets (Lembar Kerja Peserta Didik or LKPD), which tend to emphasize textual explanations rather than visual or interactive representations. As a result, the learning process becomes monotonous and less engaging. The continued dominance of conventional teaching methods, such as lecture based instruction, also contributes to students' passivity and lack of motivation during learning activities.

These conditions have a direct impact on students' academic performance. Several students' daily assessment results fall below the school's Minimum Mastery Criteria (Kriteria Ketuntasan Minimal, KKM). The analysis therefore highlights the urgent need for the development and implementation of PJBL based interactive multimedia using Lumi as a learning innovation that can make abstract concepts more concrete, stimulate student engagement, and improve learning outcomes in science education. At the design stage, the researchers produced a structured plan for developing PJBL based interactive multimedia using Lumi. The design was represented in the form of historyboards and storyboards (Oksaviona et al., 2023). The historyboard outlined the overall flow and navigation structure of the multimedia, including the arrangement of menus and pages. Meanwhile, the storyboard detailed each scene's content, visuals, and interactions in alignment with the syntax of the PJBL model. This ensured that the multimedia supported the key learning phases such as problem identification, project planning, implementation, and reflection.

Based on the storyboard, an interactive learning scenario was created using Lumi's Branching Question feature. This feature allowed learners to interact with content through guided questions, responses, and feedback loops. Each branching scenario contained a combination of presentation courses, text, images, image hotspots, interactive videos, and standard videos, designed to encourage exploration and inquiry based learning. The branching scenario model enabled students to navigate multiple learning pathways depending on their responses, thereby increasing engagement and providing opportunities for individualized learning experiences. An example of the branching scenario layout developed in Lumi is presented in Figure 1, illustrating how learners are guided through interactive questions and feedback mechanisms that simulate real time decision making processes.

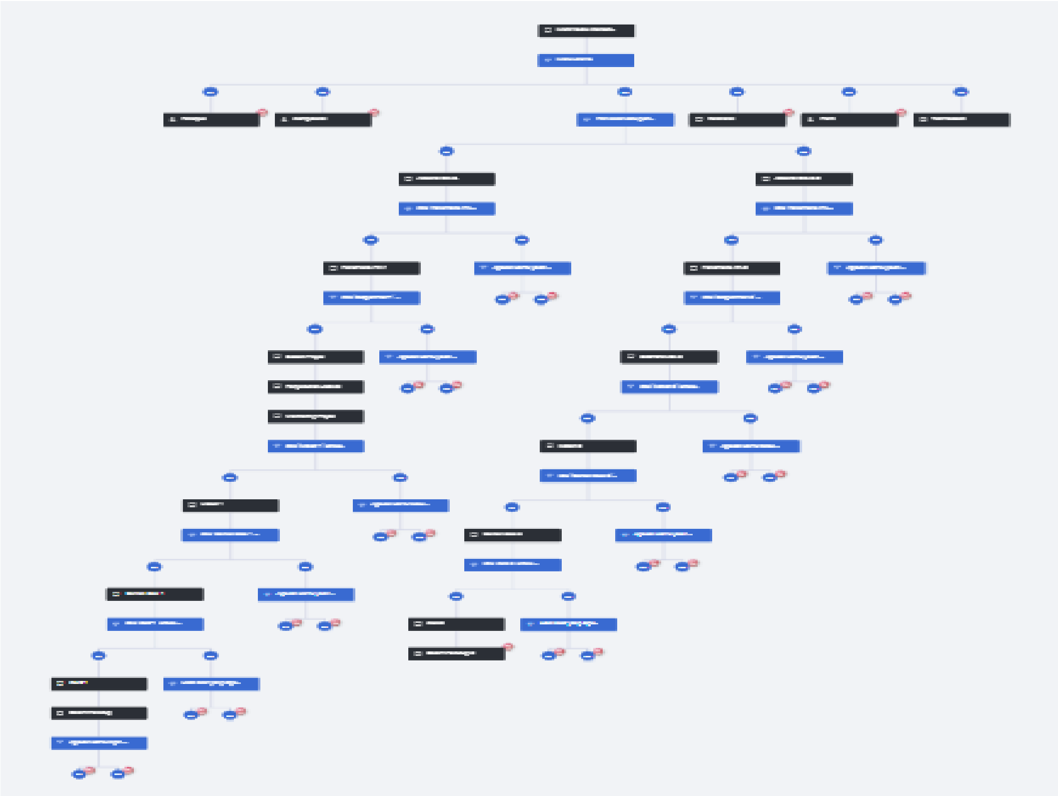

Figure 2. Scenario using Branching Scenario

During the development stage, researchers compiled and integrated a variety of multimedia resources to construct the interactive learning environment. The materials included text, images, hyperlinks, and videos, all designed to support the Project Based Learning (PJBL) framework. The text components consisted of several key elements, namely introductions, learning instructions, competency statements, learning content, project activities, reference lists, and researcher profiles. These textual elements were designed to guide students systematically throughout the learning process. The visual components, primarily developed using the Canva application, served to enhance the aesthetic appeal and improve students' visual understanding of abstract scientific concepts such as cell structures. Meanwhile, the hyperlinks embedded in the multimedia connected learners to various external resources including Google Drive links to student worksheets (LKPD), collections of learning activities, and YouTube videos that provided complementary explanations of the learning material. Additionally, a Google Form link was integrated for recording student attendance and tracking engagement during learning activities.

The results of this stage formed the foundation for developing PJBL based interactive multimedia using Lumi. The creation process involved several main activities: (1) preparing the interface layout, (2) developing interactive learning scenarios, and (3) embedding various media elements into the designed scenario. Each step was carefully executed to ensure that the multimedia product aligned with pedagogical goals and maintained coherence with the PJBL syntax. The final prototype of the developed interactive multimedia product, including interface displays, branching pathways, and embedded media, is illustrated in Figures 3 to 12.

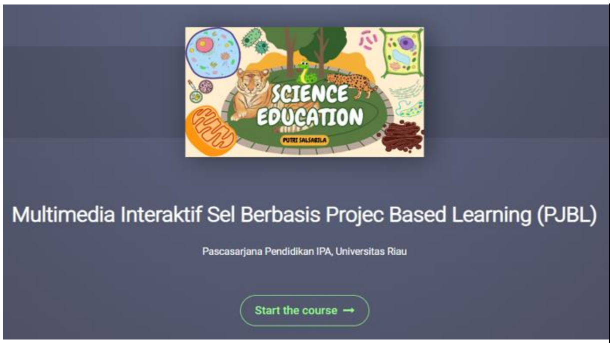

Figure 3. Start the Course initial view

Figure 4. Welcome Display

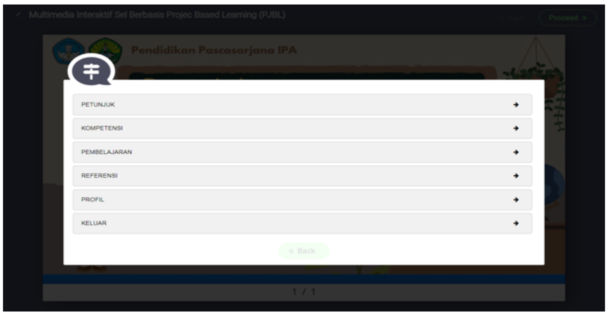

Figure 5. Main Menu Display

Figure 6. Display of the Instructions for Use

Figure 7. Learning Competency Display

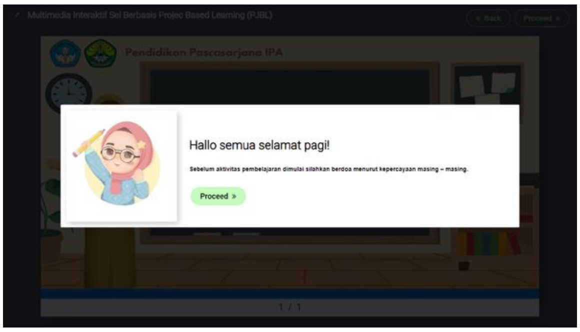

Figure 8. Feedback Display

Figure 9. Learning Display

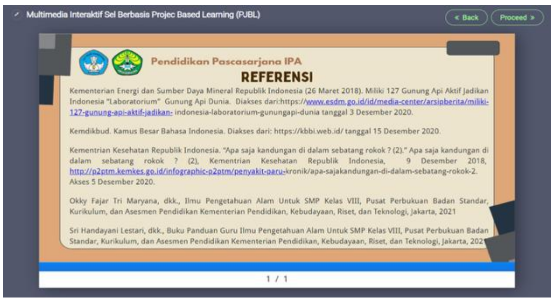

Figure 10. Reference View

Figure 11. Profile of learning media developers

Figure 12. Restart the Course Closing Screen

The interactive multimedia that has been created is then tested for validity based on the assessment sheet that has been prepared by the researcher. The results of this validity test are explained as follows.

Validity Test Results

Validity testing was carried out by providing validity assessment sheets to 3 validators (Walad et al., 2019). The validator conducted an interactive multimedia assessment based on PJBL using Lumi based on the aspects available on the validity assessment sheet. The results of the validity test from each validator are shown in Table 5.

Table 5. Results of Interactive Multimedia Validity Test

Aspect	V	Criteria
Design	0.87	Very High
Pedagogy	0.80	Very High
Content	0.85	Very High
Technical	0.86	Very High
Average	**0.85**	**Very High**

Based on Table 5, the results of the interactive multimedia validity test conducted by three expert validators yielded an average Aiken's V index of 0.85, which falls under the very high validity category. Since the obtained score meets the "very high" criterion and no further revisions were suggested by the validators, the developed interactive multimedia is declared valid and suitable for implementation in the science learning process. Among the evaluated components, the design aspect achieved the highest Aiken's V index of 0.87. This finding aligns with Swandi et al. (2021), who emphasize that the design aspect plays a crucial role in determining the quality and effectiveness of an educational product. A well structured design ensures that the presented content reflects scientific accuracy encompassing facts, concepts, principles, theories, and scientific processes in accordance with the core competencies and learning indicators targeted in the curriculum.

Furthermore, the relevance and currency of the material are essential considerations in multimedia development, as updated and contextually appropriate content facilitates students' comprehension and supports the achievement of learning objectives. These results collectively indicate that the interactive multimedia based on Project Based Learning (PJBL) developed using Lumi meets the validity standards for use in science education, particularly for topics involving abstract concepts such as cell structure.

Practicality Test Results

The practicality test was conducted by providing a practicality assessment sheet to users (teachers and students). The results of the practicality test by teachers and students are shown in Tables 6 and 7.

Table 6. Results of Interactive Multimedia Practicality Test by Teachers

Aspect	P	Criteria
Design	93.62	Very Practical
Pedagogy	91.85	Very Practical
Content	94.82	Very Practical
Technical	95.43	Very Practical
Average	**93.93**	**Very Practical**

Based on table 6, the results of the interactive multimedia practicality test by teachers showed that the design criteria obtained a practicality score of 93.62 with a very practical category, pedagogy obtained a practicality score of 91.85 with a very practical category, content obtained a practicality score of 94.82 with a very practical category, and technique obtained a practicality score of 95.43

with a very practical category. The average overall practicality value from teachers got a score of 93.93 with a very practical category.

Table 7. Results of Interactive Multimedia Practicality Test by Students

Aspect	P	Criteria
Pedagogy	91.35	Very Practical
Content	90.85	Very Practical
Average	**91.10**	**Very Practical**

As presented in Table 7, the results of the practicality test conducted with students demonstrate that the pedagogical aspect achieved a score of 91.35, while the content aspect obtained a score of 90.85, both categorized as “very practical.” The overall average practicality score from students was 91.10, indicating that the developed PJBL based interactive multimedia using Lumi is highly practical and well received by learners. Both teachers and students consistently rated the multimedia as very practical, suggesting that the developed learning media is easy to use, understandable, and effective in supporting the learning process. This finding aligns with Zaputra et al. (2021), who reported that well designed learning media are not only user friendly for teachers and students but also suitable for scientific learning characteristics and capable of improving time efficiency in learning activities.

Furthermore, the combined findings from validity and practicality tests indicate that the PJBL based interactive multimedia using Lumi is both highly valid and practical for classroom implementation. These results are consistent with the statement by Swandi et al. (2021), emphasizing that design quality and interactivity play crucial roles in developing effective educational multimedia. Similarly, Zaputra et al. (2021) highlight that project based learning media enhance student engagement, foster collaboration, and improve learning efficiency. Therefore, the high practicality scores obtained from both teachers and students confirm that the developed multimedia product can be effectively integrated into science learning to support 21st century competencies and promote active, meaningful learning experiences.

CONCLUSION

This study successfully developed Project Based Learning (PJBL) based interactive multimedia using Lumi through the ADDIE instructional design model, which consists of five systematic stages: analysis, design, development, implementation, and evaluation. At the analysis stage, the findings revealed a strong need for the development of interactive multimedia in junior high school science learning, particularly for cell material, which is often perceived as abstract and challenging for students. The design stage resulted in the creation of detailed historyboards and storyboards that served as blueprints for multimedia development. The development stage produced a functional interactive multimedia product integrating text, images, videos, and branching scenarios through the Lumi platform. During the implementation and evaluation stages, the product was tested, validated, and refined based on expert and user feedback to ensure quality and usability.

The validation results showed that the PJBL based interactive multimedia using Lumi achieved an average Aiken validity index of 0.85, categorized as very high, indicating that the product is pedagogically and technically sound. Furthermore, the practicality test results demonstrated that the multimedia was very practical, with an average practicality score of 93.93 from teachers and 91.10 from students. These findings confirm that the developed multimedia is both feasible and effective for use as an interactive learning medium in junior high school science classes. Overall, the integration of PJBL and Lumi technology provides an innovative approach to enhance students’ conceptual understanding, engagement, and motivation in learning science, particularly on complex and abstract topics such as cell structure and function.

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