

Project-Based Science-Physics E-Book to Train Student Creativity

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Abstract: This study aims to develop a project-based Science-Physics E-Book to enhance student creativity in the Madrasah Ibtidaiyah Teacher Education (PGMI) program at the State Islamic University (UIN) of Mataram. The need for innovative learning resources to improve understanding of science and physics concepts, as well as foster 21st-century skills, particularly creativity, in prospective primary school teachers, forms the basis of this research. The method used is Research and Development (R&D) with the ADDIE model. In the analysis stage, learning needs and student characteristics were assessed through interviews, questionnaires, and document analysis. The design phase included developing an E-Book framework with interactive elements. The content was enriched with multimedia and integrated into a project-based learning approach. Limited and extensive trials were conducted with PGMI UIN Mataram students. Formative and summative evaluations assessed the effectiveness of the e-book in fostering student creativity ($p < 0.05$). Results indicated that the e-book successfully enhanced creativity, as reflected in higher creativity scores and positive feedback from students and lecturers. The novelty of this research lies in the creation of an interactive, project-based E-Book, a first for PGMI UIN Mataram, contributing to the advancement of digital learning resources for primary school teacher education.

Keywords: Creativity; E-Book; Project based learning; Science-Physics

Introduction

Science especially in physics studies, shapes students' understanding of the natural world and its phenomena (Arizona, Gunawan, et al., 2023; Stadermann & Goedhart, 2021; Zollman, 2021). In the context of the Madrasah Ibtidaiyah Teacher Education (PGMI) Study Programme the State Islamic University (UIN) Mata Mataram, the importance of effective and innovative science teaching in physics content is even more crucial considering that these students will become teachers at the primary level who are responsible for instilling the foundations of science understanding in the younger generation (Abdilah & Wulandari, 2024;

Hansson et al., 2023; Setyani et al., 2024; Sucilestari et al., 2023).

Several significant challenges have been identified in the learning process of physics content science at the tertiary level that require attention and innovative solutions (Arizona et al., 2024; Asyari et al., 2024; Fatimah, 2024; Fikriana et al., 2023; Sukma et al., 2019). One of the main problems is the lack of innovative learning resources (Kerimbayev et al., 2023; Pratama & Rohaeti, 2024; S. Wahyuni et al., 2022). Conventional teaching materials that are often used tend to be less exciting and fail to encourage students to develop creative and critical thinking, which is very important in understanding complex physics concepts.

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Closely related to this problem is the lack of practical experience in learning. An overly theoretical approach, without providing opportunities for students to apply their knowledge in real-life situations, often decreases interest and understanding of abstract physics concepts. Meanwhile, the rapid development of technology in the digital era has created an urgency to transform learning methods and media (Anwar, 2024; Klasén et al., 2024; Wang et al., 2020). The demand for more interactive and accessible learning resources is increasing, in line with the changing learning styles of the digital generation, yet many higher education institutions still struggle to adapt to this trend. Furthermore, modern education requires teachers with in-depth knowledge of physics, creativity, and the ability to innovate in their teaching (Chou et al., 2023; Desmet & Sternberg, 2024; Rahimi et al., 2024).

Prospective teachers must be equipped with the skills and mindsets to design and implement inspiring and impactful physics learning (Basaglia et al., 2024; Finegan et al., 2021; Latif et al., 2024; Machalek et al., 2022). Finally, the demands of 21st-century skills are crucial factors that need to be considered in designing physics curricula and learning methods (Arizona, Rohkmat, et al., 2023; Herlinawati et al., 2024; Kain et al., 2024). Prospective teacher students need to be equipped with knowledge of the substance of physics and the ability to think critically, collaborate, communicate effectively, and think creatively, which are essential skills in this era of information and globalisation.

Facing these challenges, developing project-based science E-Books emerges as a promising solution (Alemneh & Gebrie, 2024; Arizona, et al., 2024; Takeuchi et al., 2024; Tang, 2021). This E-Book is designed with project-based learning (PBL) approach, which has several advantages: Project-Based Learning (PBL) significantly increases student engagement by encouraging active participation in the learning process through real projects. It fosters creativity by presenting challenging projects that push students to think outside the box and develop innovative solutions. Additionally, PBL helps students connect theory with practice, as projects in the E-Book format allow them to see the relevance of science concepts in everyday life. The use of technology further enhances the learning experience, with the E-Book integrating various media such as videos, animations, and interactive simulations. This not only enriches the learning process but also prepares future teachers in the PGMI program, equipping them with both science content knowledge and innovative teaching methods that they can apply in their future classrooms.

The development of this project-based Science E-Book aligns with UIN Mataram's vision of producing excellent and competitive graduates. In addition, this

initiative also supports the government's efforts to improve the quality of education, especially in the fields of science and technology.

Considering the urgency and potential benefits, developing a Project-Based Science E-Book to Foster Student Creativity in the PGMI UIN Mataram study program is a strategic step in preparing prospective teachers who are creative, innovative, and ready to face educational challenges in the digital era as part of the Indonesian government's Astacita program.

Method

This project-based science E-Book development research for PGMI UIN Mataram students uses the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model (Branch, 2009).

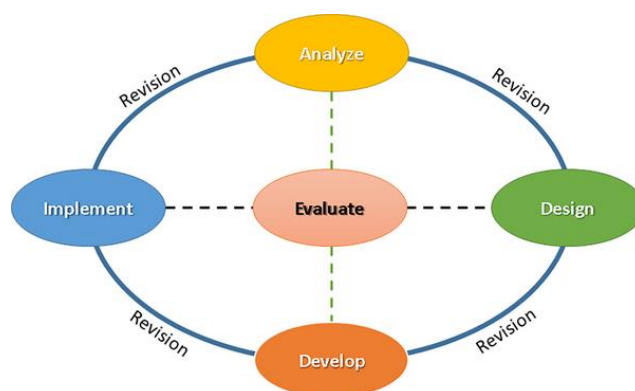


Figure 1. Stages of the ADDIE development model (Branch, 2009)

In the analyze phase, the learning needs, student characteristics, and available resources were identified through interviews with faculty members, a questionnaire completed by 45 students, and document analysis of the curriculum. This stage focused on identifying gaps in current learning resources, students' learning preferences, and the technological infrastructure available for integrating the E-Book.

The design phase involved structuring the E-Book framework according to the curriculum's core science concepts. Interactive elements, such as quizzes, videos, and clickable diagrams, were created to foster student engagement. Evaluation instruments, including creativity test grids and sample questionnaire questions, were developed to assess the impact of the E-Book on student creativity and engagement.

In the develop phase, the E-Book content was organized and formatted to align with the curriculum. Multimedia components, including animations, videos, and interactive simulations, were integrated into the digital platform. Expert validation was conducted by a panel of three specialists, who reviewed the content and

design based on five key aspects: 1) content and material, 2) presentation and design, 3) project-based learning, 4) creativity enhancement, and 5) digital literacy improvement.

The implement phase consisted of two trials. The practicality test involved 48 students, who provided feedback on the usability and effectiveness of the E-Book. For the effectiveness test, 39 students participated in the experimental group, using the project-based science E-Book, while another 39 students in the control group were taught using conventional methods. Both groups were monitored over a 6-week period to assess the E-Book's impact on student creativity and learning outcomes.

In the evaluate phase, data were collected through observations, interviews, and questionnaires. The interview questions focused on student engagement, perceptions of the E-Book's effectiveness in enhancing creativity, and its integration into the learning process. The questionnaires measured student satisfaction, ease of use, and creativity improvement. A Torrance Test of Creative Thinking was used to assess students' creative thinking abilities. Formative evaluations were conducted during the development and implementation stages, while summative evaluations assessed the overall impact of the E-Book on creativity.

Result and Discussion

Developing a project-based science E-Book for PGMI UIN Mataram students has produced a valid, practical and effective learning resource. The Physics E-Book combines interactive technology with a project-based learning approach. This E-Book is designed with

a combination of several supporting applications or software, namely Microsoft Word 2021, Canva, Adobe Acrobat DC, Filp Pdf Corporate Edition, and APK-Builder. The developed E-Book has several optional formats in the form of PDF, flash, HTML, and APK with 192 pages of content, covering nine main chapters that present the core topics of Science-Physics following the curriculum at PGMI Study Programme FTK UIN Mataram. The advantage of this E-Book lies in its interactive features, including explanation videos, concept animations, interactive quizzes, and virtual simulations, which enrich students' learning experience. Each chapter is complemented by a scientific project, allowing students to apply their knowledge in an authentic context.

Validation by three experts on the aspects of learning materials and media shows the quality of the E-Book is very feasible to use, with an average score of 3.69 out of 4 (92.33%), as presented in Table 1. This indicates that the developed E-Book is accurate in content, attractive, and easy to use. The implementation of the E-Book through a limited trial on 48 PGMI students showed promising results. Students' response to the existence of an E-Book is very positive, as shown in the table 1.

Table 1 presents the results of the expert validation test for an e-book, broken down into four main categories: Content and Materials, Presentation and Design, Project-Based Learning, and Creativity Enhancement. The table shows individual expert ratings (A, B, C), the sum of scores (Σ), and the mean scores for each aspect. The overall average score is 3.69 (92.33%), indicating that the e-book is highly rated by experts, with the recommendation that it is very good to use.

Table 1. Tabulation of Expert Validation Test Results

No.	Aspects assessed	A	B	C	Σ	Scores Mean
A. Content and Materials						
1	The material in the e-book is in accordance with the learning objectives	4	4	4	12	4
2	E-book content is accurate and up-to-date	3	3	3	9	3
3	Materi disajikan secara sistematis dan logis	4	3	4	11	3.67
4	The projects presented are relevant to the science material	4	4	4	12	4
5	Content encourages the development of student creativity	4	3	3	10	3.33
B. Presentation and Design						
6	The e-book design is attractive and suitable for students	4	4	4	12	4
7	Easy-to-follow content layout and organisation	4	4	4	12	4
8	Effective use of multimedia (images, videos, animations)	3	3	3	9	3
9	Navigation within the e-book is easy and intuitive	3	3	3	9	3
10	The text in the e-book is easy to read and understand	4	4	4	12	4
C. Project Based Learning						
11	The projects presented encourage active learning	4	4	4	12	4
12	Project instructions are clear and easy to follow	4	4	4	12	4
13	Projects facilitate the development of problem-solving skills	3	3	3	9	3
14	Projects encourage collaboration between students	4	4	4	12	4
15	Project evaluation aligns with learning objectives	4	4	4	12	4
D. Creativity Enhancement						

No.	Aspects assessed					Scores
		A	B	C	Σ	Mean
16	E-books encourage students' creative thinking	4	3	4	11	3.67
17	Activities in the e-book stimulate new ideas	4	4	4	12	4
18	E-books provide space for exploration and experimentation	4	4	4	12	4
19	Projects encourage the use of creative approaches	4	4	4	12	4
20	E-books facilitate creative product development	3	3	3	9	3
Average						3.69 (92.33%)
Categories						Very Good to Use

The content and materials section received strong ratings, particularly for the alignment with learning objectives and the relevance of the projects. The presentation and design aspects also performed well, with high scores for the design, content layout, and readability. Multimedia use, however, received a slightly lower rating. In the project-based learning category, all aspects related to student engagement, clarity of instructions, and alignment with learning objectives scored the highest, further emphasizing the effectiveness of the e-book for active learning. The creativity enhancement section also received positive feedback, with the e-book promoting creative thinking, idea generation, and exploration. In conclusion, the e-book was validated as a highly effective tool for learning,

fostering creativity and student engagement, with a very good overall rating.

Table 2 provides a summary of student feedback on the e-book's effectiveness. The overall response was highly positive, with an average score of 3.51 (87.78%). Students found the material easy to understand, the design motivating, and the multimedia helpful in enhancing their understanding. The projects were viewed as both interesting and challenging, promoting collaboration and creativity. Additionally, the e-book encouraged students to think creatively, generate new ideas, and experiment with scientific concepts. In conclusion, the e-book was considered a very practical tool for learning and engagement.

Table 2. Recap of Student Response to E-Book Implementation

Aspects	Average Response
The material in the e-book is easy to understand	3.48 (86.98%)
The e-book presents relevant and up-to-date information	3.54 (88.54%)
The design of the e-book is exciting and motivating to learn	3.64 (91.14%)
Navigation in the e-book is easy to use	3.46 (86.45%)
Multimedia (images, videos, animations) helps understanding the material	3.58 (89.58%)
The projects in the e-book are interesting and challenging	3.46 (86.46%)
Project instructions are clear and easy to follow	3.52 (88.02%)
Projects help me understand science concepts better	3.52 (88.02%)
I feel motivated to complete projects in e-books	3.48 (86.98%)
The projects encourage me to cooperate with friends	3.52 (88.02%)
The e-book encourages me to think creatively	3.56 (89.06%)
The activities in the e-book help me generate new ideas	3.48 (86.98%)
I feel more confident in expressing creative ideas	3.48 (86.98%)
The projects in the e-book allow me to experiment	3.46 (86.46%)
E-books help me develop creative solutions to science problems	3.48 (86.98%)
Total	3.51 (87.78%)
Description	Very Practical

Table 3 presents a comparison of student creativity data between two groups: one using e-books and the other not using e-books. The table includes the number of participants (N), the mean creativity scores, the standard deviation, and the standard error of the mean for both groups. For the group using e-books, the mean creativity score is 79.33, with a standard deviation of 10.80 and a standard error of 1.73. In contrast, the group without using e-books has a mean creativity score of 67.23, with a standard deviation of 4.32 and a standard error of 0.69. The data suggests that students who used

e-books showed higher creativity scores on average compared to those who did not use e-books, indicating the potential impact of e-book usage on enhancing student creativity.

A broad trial involving 78 students from all classes in Semester II at the PGMI Study Program. Based on the description of the data obtained from the implementation results of students who use Science E-Books with students who do not, there are differences in the average creativity of students.

Table 3. Description of Student Creativity Data

Group	N	Mean	Std. Deviation	Std. Error Mean
Group Using E-Books	39	79.3282	10.80358	1.72996
Group Without Using E-Books	39	67.2272	4.32375	.69235

Overall, the table above shows that the E-Book group had a higher creativity post-test score (mean=79.3282) than the group without using the E-Book (mean=67.2272). However, the group using the E-Book also had greater score variation (higher standard deviation). The more minor standard error of the mean

in the group without using E-Books indicates a more precise estimation of that group's population mean than the group using E-Books. Based on the t-test results on student creativity, the effect of using the Science E-Book is shown in the t-test results (Table 4).

Table 4. T-test Results of the Effect of Science E-Books on Student Creativity

	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	53.777	.000	6.494	76	.000
Equal variances not assumed			6.494	49.869	.000

The Independent Samples t-test results showed a statistically significant difference between the average post-test creativity of the group using the E-Book and the group without using the E-Book. The group using the E-Book had a higher average post-test creativity compared to the group without using the E-Book, with an average difference of 12.10103. This difference is significant at the 95% confidence level.

The effectiveness of the E-Book in enhancing creativity can be explained through the project-based learning approach applied (Adawiyah et al., 2019; Day et al., 2025). The projects integrated with the E-Book provide opportunities for students to apply science concepts in real situations, develop problem-solving skills, collaborate with peers, and express their creative ideas (Day et al., 2025; Fatimah, 2024; Fikriana et al., 2023; Fikriyani & Supriyanto, 2024; Guzdial & Nelson-Fromm, 2025). Significant improvements in flexibility of thinking and elaboration of ideas indicate that this approach encourages students to look at problems from multiple perspectives and develop more complex solutions.

The role of technology in this E-Book cannot be ignored either (Fikriyani & Supriyanto, 2024; Nurohman & Fikri, 2025; Sahjat et al., 2025; Sukma et al., 2019). Interactive features such as virtual simulations and concept animations help students visualise abstract natural phenomena, while interactive quizzes provide immediate feedback that supports self-learning. The significant effect of the E-Book shows that the integration of technology in science learning not only increases motivation but also the effectiveness of knowledge transfer (Day et al., 2025; Guzdial & Nelson-Fromm, 2025; Moonkum et al., 2024).

The results of this study have important implications for primary school teacher education, particularly in the context of science learning. This research emphasises integrating a project-based

approach into the PGMI curriculum. The results indicate the need to improve the digital literacy of prospective primary school teachers. This research reveals the great potential of using interactive E-Books as a tool to enhance the quality of learning at the tertiary level (Boateng et al., 2024; Day et al., 2025; Moonkum et al., 2024; Yu, 2024).

Nonetheless, the implementation of this E-Book also faces some challenges. It requires initial training for students and lecturers on using the interactive e-book. In addition, there are variations in technology readiness among students, and the time needed to complete complex projects must also be considered in lesson planning (Asyari et al., 2024; Buroidah et al., 2024; Ram et al., 2025).

Overall, developing this project-based science E-Book proved effective in fostering the creativity of PGMI UIN Mataram students. Integrating technology, relevant content, and a project-based learning approach has created a learning environment that supports the development of 21st-century skills, particularly creativity. The results of this study provide a solid basis for further development and broader implementation of interactive E-Books in the context of primary school teacher education while keeping in mind the challenges and need for adaptation in their implementation.

Conclusion

This research successfully developed and tested the validity, practicality, and effectiveness of project-based science-physics e-books in enhancing student creativity in the PGMI UIN Mataram program. The implementation of this e-book in the learning process demonstrated that a project-based approach integrated into a digital format significantly improved the creative thinking skills of students, particularly in the context of Physics learning. Statistical analysis revealed that the

difference in mean creativity scores between the experimental and control groups was statistically significant ($p < 0.05$). This result underscores the effectiveness of project-based e-books in fostering creativity among PGMI students. The study contributes to the development of effective digital learning methods in the 21st century, promoting critical skills such as creativity in the field of Science-Physics. Based on the findings, it is recommended that project-based Science-Physics e-books be integrated into higher education curricula, with an emphasis on fostering student creativity and critical thinking. Specific aspects such as interactive elements, multimedia integration, and project-based assignments should be highlighted in curriculum development and teacher training. Furthermore, higher education institutions should prioritize professional development for lecturers to ensure the effective implementation of these e-books in the classroom. Longitudinal studies are needed to assess the long-term impact of project-based e-books on student academic performance and future career prospects. It is also crucial to regularly evaluate and update the e-book content to maintain its relevance in line with the latest developments in Physics. Lastly, policymakers in higher education should adopt specific policies to support the integration of project-based e-books, particularly in teacher candidate education programs such as PGMI, as part of broader efforts to improve the quality of education and prepare students for the demands of the digital era.

Author Contributions

KA and RS served as the main designers of the study, including the initial conceptualisation and overall design of the study. BMAN was responsible for the implementation of the field research and data collection process. KA, RS and LAD conducted statistical analyses and interpretation of results. The first author prepared the initial draft of the manuscript, which was revised and critically edited by RS. All authors reviewed and approved the final version of the manuscript for submission to the journal.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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