



Science E-Book Development Using Project-Based Learning (PjBL) Model Integrated with Pancasila Student Profile

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Abstract: The rapid advancement of technology has led students to prefer digital learning materials over traditional textbooks. However, at SMP Negeri 1 Kota Ternate, science teaching materials remain limited to conventional textbooks, with minimal integration of digital resources. This study aims to develop a science e-book utilizing the Project-Based Learning (PjBL) model integrated with the Pancasila Student Profile to enhance student engagement and understanding. Employing a Research and Development (R&D) approach, the study followed the ADDIE model, comprising analysis, design, development, implementation, and evaluation. The e-book was validated by two lecturers and two science teachers, with assessments focusing on content and language aspects. Results indicated an average validity score of 79%, categorizing the e-book as moderately valid. Field trials showed that students found the e-book easy to use, with practicality scores averaging 3.20 from teachers and 3.00 from students. The integration of PjBL and the Pancasila Student Profile in the e-book facilitated student-centered learning, promoting critical thinking, collaboration, and creativity. These findings suggest that the developed science e-book is a suitable and effective digital learning resource for enhancing science education at the secondary level.

Keywords: Digital learning; Pancasila student profile; Project-based learning; Science e-book; Student engagement

Introduction

Science education has undergone a significant transformation in line with the development of digital technology that allows the use of more interactive and adaptive learning media (Chercules et al., 2023; Yani & Rosana, 2024). One of the innovations that is developing is science-based e-books, which can accommodate the learning needs of the 21st century (Akina et al., 2023; Anharuddin & Fatonah, 2023; Pratiwi et al., 2023). The Project-Based Learning (PjBL) learning model has been shown to increase student engagement and strengthen conceptual understanding through a more in-depth and contextual learning experience (Arfat et al., 2023; Setianingrum & Jumadi, 2024). By integrating the values in the Pancasila Student Profile, this e-book not only aims to improve science literacy, but also to shape

student character based on national values and social cooperation (Rosmiati et al., 2022; Zulfikar et al., 2024).

Previous studies have explored the use of e-books in science learning as well as the application of the PjBL model in improving students' conceptual understanding (Chercules et al., 2023; Kamila et al., 2025). Several studies show that interactive e-books with multimedia features are able to increase the attractiveness and effectiveness of science learning (Febrianti et al., 2022; Mohsen & Alqassab, 2023). However, there are still few studies that specifically develop PjBL-based e-books that are integrated with the Pancasila Student Profile. Although the PjBL model has been widely used in science education, its application in local cultural contexts that reflect Pancasila values has still been rarely discussed in previous research (Ardiansyah et al., 2024a; Sarlita et al., 2024; Setianingrum & Jumadi, 2024).

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This research aims to develop a PjBL-based science e-book that is integrated with the Pancasila Student Profile to improve understanding of science concepts and form student character in accordance with national values (Agnafia & Anfa, 2025; Kamila et al., 2024). In particular, this study will examine the effectiveness of e-books in improving student understanding, critical thinking skills, and character aspects developed through the application of Pancasila Student Profile values (Amelia et al., 2024; Cahyono et al., 2024; Musdalifah et al., 2023). Thus, this research is expected to fill the gap in literature related to the development of learning resources that are not only science-based, but also have a strong character dimension (Blanckesteijn et al., 2021; Kuo & Chang, 2021; Tang et al., 2019).

The importance of this research lies in its contribution to the world of education in presenting a more comprehensive and contextual approach to learning (Samaniego et al., 2024; Villegas-Ch & García-Ortiz, 2023; Wasim et al., 2024). By utilizing digital technology, the e-books developed can provide a more interesting learning experience and suit the needs of today's students. In addition, the integration of Pancasila values in this e-book supports the goal of national education in forming a generation that is not only superior in cognitive aspects but also has a strong character and is oriented towards national values (Ardiansyah et al., 2024b; Khasawneh & Khasawneh, 2023; Ramadhan et al., 2024). The results of this study are expected to be a reference for educators and learning media developers in implementing project-based learning models that are in accordance with Indonesian character and culture.

Method

This study employs a Research and Development (R&D) design following the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2016). The research focuses on developing a Science E-Book integrated with the Project-Based Learning (PjBL) model and the Pancasila Student Profile to enhance students' scientific understanding and character development (Satria et al., 2022; Uktolseja et al., 2022).

Research Design

The study follows the R&D approach as outlined by Borg and Gall, modified to align with the ADDIE model (Sugiyono, 2016). This model was selected due to its structured framework for designing and evaluating educational materials. The research spans a period of six months (February–November 2024) and was conducted at SMP Negeri 1 Kota Ternate. This methodological

approach ensures a systematic and iterative process for product development and evaluation (Limatahu et al., 2023).

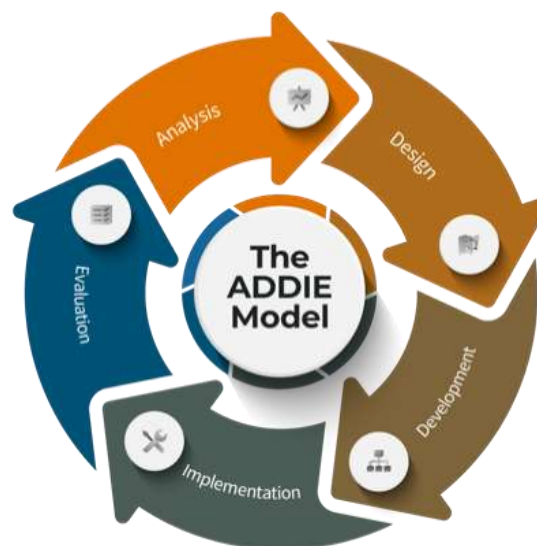


Figure 1. ADDIE models

Participants and Data Sources

The study involved two groups of participants: science teachers and students from SMP Negeri 1 Kota Ternate, who tested the e-book's usability and practicality, and expert validators, comprising two university lecturers and two science teachers, who evaluated the e-book's validity based on content and language aspects. The sampling technique used was purposive sampling, selecting participants who met specific criteria, such as familiarity with digital learning materials and prior exposure to the PjBL model (Purnamasari, 2015).

Research Instruments

The primary research instruments included observation sheets, structured interviews, questionnaires, and validation sheets. The validity and reliability of the instruments were assessed before use. The Likert scale was employed to evaluate the practicality and feasibility of the Science E-Book, while student responses were collected using the Guttman scale. The instruments were designed to measure the effectiveness of the PjBL model and the integration of Pancasila values in learning.

Data Collection Procedures

Analysis Stage: Initial observations were conducted at SMP Negeri 1 Kota Ternate to identify challenges in existing science learning materials. Data were collected through teacher and student interviews to determine needs and expectations. **Design Stage:** The Science E-

Book was structured based on the PjBL model and the six dimensions of the Pancasila Student Profile. The design included interactive learning activities, multimedia content, and assessments aligned with science education objectives. Development Stage: The e-book was developed and underwent content validation by subject matter experts and media specialists. Revisions were made based on their feedback to enhance instructional design and user experience. Implementation Stage: The revised e-book was tested in classroom settings with eighth-grade students, where teachers facilitated its use in learning activities. Student engagement and comprehension were observed and recorded. Evaluation Stage: The effectiveness of the e-book was assessed through student performance analysis and feedback from teachers and students. The evaluation focused on user experience, learning outcomes, and the extent to which the PjBL model and Pancasila values were effectively integrated.

Data Analysis Techniques

Descriptive statistical analysis was used to process validation data. The feasibility of the Science E-Book was determined using percentage-based criteria, where scores of 81–100% indicated high feasibility, 61–80% moderate feasibility, and below 60% required further revisions . The practicality of the e-book was assessed based on student and teacher responses, with an average score above 2.50 categorized as practical. The effectiveness of the e-book was measured through a comparative analysis of students' understanding before and after using the e-book.

This methodological framework ensures the systematic development, validation, and evaluation of the Science E-Book, providing a structured approach to

improving digital science learning resources at the secondary school level.

Result and Discussion

This research is a development study using the ADDIE method, which consists of five main stages: analysis, design, development, implementation, and evaluation.

At the analysis stage, the research team, together with science teachers from SMP Negeri 1 Ternate City, conducted an analysis of the specifications of the science e-book, including concept maps, content, book structure, the application of the project-based learning model (PjBL), and the dimensions of the Pancasila Student Profile to be evaluated. The dimensions of the Pancasila Student Profile include: faith and fear of God Almighty and have noble morals; independent; collaborative; respecting global diversity; critical thinking; and creative. This analysis process aims to ensure that the e-book developed can meet educational criteria in accordance with national values.

In Project-Based Learning (PjBL)-based science learning integrated with the Pancasila Student Profile, students are not only invited to understand scientific concepts theoretically, but also to develop critical thinking skills, creativity, and collaboration through project-based activities. One example of the application of this method can be seen in the Solar System material, where students explore the concept of planetary orbits with a simple experimental approach. The following Figure 2 shows how the Pancasila Student Profile dimension is applied in PjBL learning activities on the topic of the Solar System, showing how students interact with science concepts through observations, discussions, and innovative experimental activities.

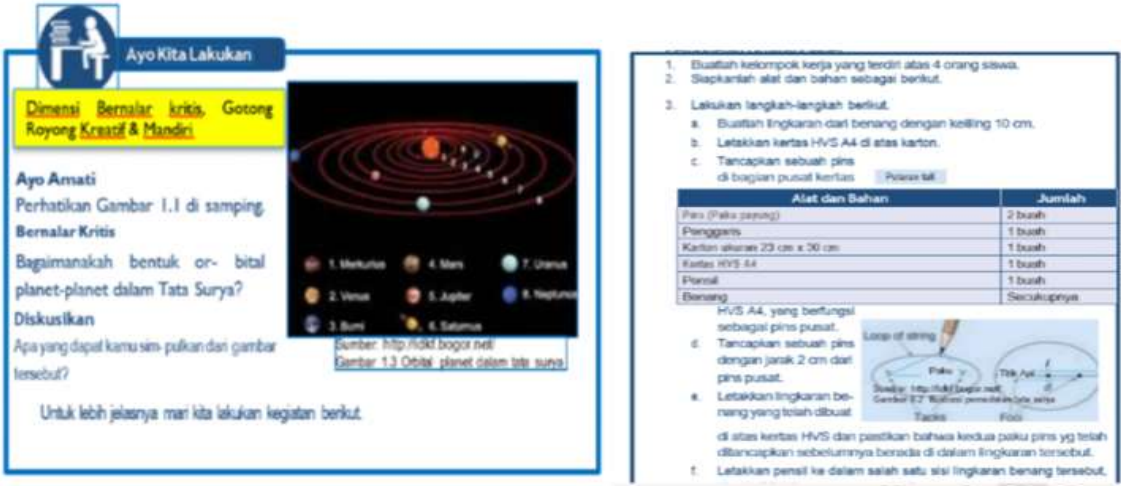


Figure 2. Examples of Pancasila student profile dimensions in the solar system material of the PjBL-based science e-book learning activities

Figure 2 shows the application of the Pancasila Student Profile dimension in Project-Based Learning (PjBL)-based science learning on Solar System materials. In the image, students were invited to observe a model of the orbits of planets in the Solar System and conduct simple experiments using tools such as threads, pins, paper, and rulers. This activity not only helps students understand scientific concepts concretely, but also develops several main dimensions of the Pancasila Student Profile, such as critical reasoning, mutual cooperation, *and* creativity and independence. For example, through a trigger question, students are invited to think critically about the shape of the planet's orbit and draw conclusions based on the results of their observations. In addition, learning is carried out in groups, which reflects the spirit of mutual cooperation and the ability to work together in completing tasks collectively.

This image also illustrates how PjBL-based science e-books provide a more interactive and applicable learning experience. With structured experimental steps, students can explore scientific concepts independently, thereby encouraging independence and creativity in learning. In addition, this activity allows students to experience first-hand the scientific process, from observation, analysis, to drawing data-based conclusions. The integration of Pancasila values in science learning shows that PjBL-based e-books not only function as digital learning resources, but also as a tool to shape character and skills in the 21st century. Therefore, the use of this e-book is an innovative solution in improving the quality of science learning by connecting technology, exploring scientific concepts, and strengthening student character in accordance with the Pancasila Student Profile.

In the design stage, the research team designed an e-book that covers important topics such as motion and force measurements, temperature, heat, as well as the solar system. Each topic is designed using the PjBL model which is integrated with the Pancasila Student Profile dimension. The e-book design includes learning activities that are practical, allowing students to learn through experimentation and collaboration. This project-based learning is designed to build critical thinking and collaboration skills, as well as provide space for students' creativity in completing projects related to scientific topics.

At the development stage, the e-book that has been designed is then assessed by a team of experts, consisting of two lecturers and one science teacher. After the assessment, the team of experts provides constructive feedback to improve the content, design, and structure of the e-book. Several revisions were made to improve the quality of the material, clarify the

learning instructions, and add interactivity to make the e-book more interesting and easy for students to understand.

In science learning, an understanding of the concepts of temperature and heat can not only be obtained through theory, but also through experimental activities that allow students to observe phenomena directly. The Project-Based Learning (PjBL) approach that is integrated with the Pancasila Student Profile dimension provides opportunities for students to develop critical, independent, and analytical thinking skills in understanding the concept of thermal energy. Through the experimental activities arranged in this e-book, students not only learn about heat transfer and temperature changes, but also are trained to work independently and be responsible in carrying out scientific procedures safely. The following Figure 3 shows how the dimensions of the Pancasila Student Profile are implemented in temperature and heat materials through interactive and applicable project-based learning activities.

Figure 3 shows the implementation of the Pancasila Student Profile dimension in science learning on Project-Based Learning (PjBL)-based temperature and heat materials. In this activity, students were given the task of comparing heat energy in various substances, such as cooking oil and water, as well as conducting experiments related to heating water and stones using a spirit burner. This approach reflects several main dimensions of the Pancasila Student Profile, namely Independent and Critical Reasoning, where students not only observe scientific phenomena directly, but are also encouraged to analyze and communicate the results of their observations. With the occupational safety instructions in this experiment, students are also trained to be responsible in carrying out scientific procedures safely and disciplined. In addition, the summary of concepts and exercises provided helps students reflect on their understanding of the concept of temperature and heat independently.

The relevance of this image to the title of the article "Science E-Book Development Using Project-Based Learning (PjBL) Model Integrated with Pancasila Student Profile" lies in how this e-book adopts the PjBL approach to improve concept understanding while developing students' character in accordance with Pancasila values. Project-based learning in this e-book allows students to actively explore scientific concepts through challenging and meaningful experimental activities. In addition, the integration of the Pancasila Student Profile dimension in each activity ensures that in addition to gaining a deep conceptual understanding, students also develop critical thinking skills, problem-solving, and an independent attitude in learning. Thus,

this e-book is not only an effective digital learning resource, but also a pedagogical tool that can help shape students' character in accordance with national values and the needs of the 21st century.

At the implementation stage, the revised e-book is handed over to students to be used in classroom learning activities. During the implementation, the research team with science teachers monitored and documented the

use of e-books in teaching and learning activities. Several challenges arose, such as the students' adaptation to the digital format, but the team immediately made improvements and adjustments. This e-book is expected to facilitate more interactive learning, which not only focuses on understanding science concepts but also on character development through the application of Pancasila values.

Dimensi: Mandiri dan Bernalar Kritis

Membandingkan Energi Panas Benda

Misalkan kamu memiliki minyak goreng dan air. Apakah energi panas yang dikandung minyak goreng dan air sama? Lalu, dengan jumlah yang berbeda apakah energi panas yang dikandung juga sama?

- 1) Siapkan 4 gelas ukur (A, B, C, D)
- 2) Isikan gelas A dengan 200 g minyak goreng, gelas B dengan 100 g minyak goreng, gelas C dengan 200 g air dan gelas D dengan 100 g air.
- 3) Ukur suhu awal gelas A.
- 4) Panaskan air di gelas A dengan pembakar spiritus hingga suhu naik 30°C. (Apabila suhu awalnya 31°C berarti dinaikkan hingga 61°C).
- 5) Ukur waktu yang diperlukan
- 6) Ulangi langkah 1 sampai 5 pada gelas B, C dan D.

Petunjuk Keselamatan Kerja
Hati-hati dengan api, air panas dan minyak panas

Menalar dan Mengomunikasikan
Kenalkan suhu air berasal dari energi panas pembakar spiritus yang menyala. Berdasarkan data pengamatanmu, buatlah keterkaitan antara massa zat dan jenis zat dengan banyaknya energi panas yang dikandung zat tersebut

Dimensi: Mandiri dan Bernalar Kritis

Lakukanlah langkah-langkah berikut ini.

1. Siapkan gelas beker bersi 400 gram es batu.
2. Ukur suhunya
3. Panaskan gelas beker itu dengan pembakar spiritus
4. Aduk dan ukur suhunya setiap 20 detik, sampai 3 menit.
5. Catat hasil pengukurannya pada tabel pengamatan.

Hati-hati dengan api. Saat pemanasan air dengan api. Saat mengangkat gelas beker, gunakan kain lap.

Menalar dan Mengomunikasikan
Berdasarkan data pengamatanmu, bagaimana suhu benda saat terjadi perubahan wujud? Bandingkan dan diskusikan dengan hasil kelompok lain.

RANGKUMAN

1. Kalor merupakan salah satu bentuk energi yang berpindah dari benda yang suhunya lebih tinggi ke benda yang suhunya lebih rendah jika kedua benda saling bersentuhan.
2. Kalor jenis adalah banyaknya kalor yang dibutuhkan untuk menaikkan suhu 1 g zat sebesar 1°C.
3. Zat dapat berubah wujud apabila:
 - perubahan wujud zat yang memerlukan kalor yang mencair, menguap, dan menyublim;
 - perubahan wujud zat yang melepas kalor yang membeku, mengembun, dan mengkristal.
4. Azas Black berbunyi banyaknya kalor yang dilepaskan benda bersuhu lebih tinggi sama dengan banyaknya kalor yang diterima benda yang bersuhu lebih rendah.
 - Kalor dapat berpindah dengan cara konduksi, konveksi, dan radiasi.
 - Konduksi adalah perpindahan kalor melalui suatu zat tanpa disertai perpindahan partikel zat.
 - Konveksi adalah perpindahan kalor melalui suatu zat yang disertai perpindahan partikel zat tersebut.
 - Radiasi adalah perpindahan kalor tanpa melalui zat perantara.

LATIHAN SOAL

1. Tentukan kalor yang diperlukan untuk menaikkan suhu 2 kg air, sehingga suhunya naik 50°C. Kalor jenis air 4200 J/(kg.K).
2. Semangkuk air dan semangkuk alkohol yang ukurannya sama diletakkan di atas meja di dekat pendola pada siang hari yang cerah. Beberapa jam kemudian ternyata volume kedua zat cair itu berkurang. Namun alkohol lebih banyak berkurang dibandingkan dengan air. Manakah penjelasan yang paling tepat terhadap kejadian itu? Pilih yang paling tepat dan jelaskan.
 - a) Semua cairan menguap.
 - b) Alkohol mendapatkan kalor yang lebih banyak daripada air.
 - c) Zat cair tertentu menguap lebih cepat dibandingkan dengan jenis zat cair yang lain.
 - d) Zat cair hanya menguap saat hari cerah.
 - e) Air lebih panas dibandingkan dengan alkohol.
3. Sendok logam, sendok plastik, dan sendok keramik diletakkan pada air panas. Setelah 15 detik, adakah sendok yang terasa paling panas? Coba jelaskan.

Figure 3. Examples of Pancasila student profile dimensions in the temperature and heat material of the PjBL-based science e-book learning activities

At the evaluation stage, the quality of the e-book is assessed based on the results of expert assessments and feedback from teachers and students. This assessment includes content and language aspects, with an average score for the content aspect of 75.5% and the language aspect of 77.5%. Based on this evaluation, the science e-book is included in the quite valid category. These results show that this e-book is worthy of being used as

a learning resource, although there is still room for improvement, especially in terms of content presentation and alignment of learning activities with the dimensions of the Pancasila Student Profile.

To ensure the quality of the science e-books developed, evaluations are carried out by experts covering language and content aspects. This evaluation aims to assess the extent to which e-books meet the

standards of clarity, readability, and suitability with the curriculum and Project-Based Learning (PjBL) approach integrated with the Pancasila Student Profile. The results of the validation by two lecturers and two science teachers provide an overview of the feasibility level of e-books as an innovative digital learning resource. The following Table 1 presents the results of the evaluation of science e-books based on these two aspects.

Table 1. Results of the science e-book evaluation

Aspect	Score (%)	Criteria
Language Aspect	77.5	Moderately valid
Content Aspect	75.5	Moderately valid
Average Score	79.00	Moderately valid

Table 1 presents the results of the evaluation of the validity of Project-Based Learning (PjBL)-based science e-books that are integrated with the Pancasila Student Profile. The results of the evaluation by experts showed that the language aspect obtained a score of 77.5% and the content aspect obtained a score of 75.5%, both of which were included in the moderately valid category. The overall average score is 79.00%, which is also in the moderate validity category. This shows that the e-book developed has met quite good standards in terms of language and content, although there is still room for further improvement. The language aspects assessed include the clarity of instructions, readability, and the appropriateness of the use of scientific terms in the context of science learning. Meanwhile, the content aspect is assessed based on the completeness of the material, suitability with the curriculum, and the effectiveness of the PjBL method in improving understanding of science concepts and the integration of Pancasila values.

The relevance of these results to the research title "Science E-Book Development Using Project-Based Learning (PjBL) Model Integrated with Pancasila Student Profile" lies in how the validity of e-books is tested as an effective and meaningful learning resource. With a fairly good validity score, this e-book can be considered a potential innovation in project-based science learning that not only sharpens students' scientific understanding, but also shapes their character in accordance with the values of the Pancasila Student Profile. However, even though the e-book has been declared quite valid, there is an opportunity to improve its quality even further, for example by improving the clarity of the language to make it more communicative and ensuring that each project in the e-book really encourages students to think critically and work collaboratively. Therefore, the results of this evaluation provide important insights for digital teaching material

developers to continue to improve the quality of e-books in supporting more effective and holistic science learning.

The results of further evaluation revealed that this e-book was easy for students to understand during the field trial. Based on feedback from teachers, the e-book's ease of use and readability score reached 3.20, while students gave a score of 3.00. This score shows that the e-book is quite practical to use in learning. Thus, PjBL-based science e-books integrated with the Pancasila Student Profile can be considered an effective learning tool to improve understanding of science concepts and support the formation of student character in accordance with Pancasila values.

To obtain a clearer picture of the results of the evaluation of the science e-book developed, an analysis was carried out on the validity of the language and content aspects. This evaluation aims to assess the extent to which e-books meet readability standards, clarity of instructions, and the suitability of their content with the Project-Based Learning (PjBL) approach and the integration of Pancasila Student Profiles. The validation results from the experts are presented in the form of a diagram in the following Figure 4, which illustrates the comparison of the language aspect score and the content aspect based on the validator's assessment.

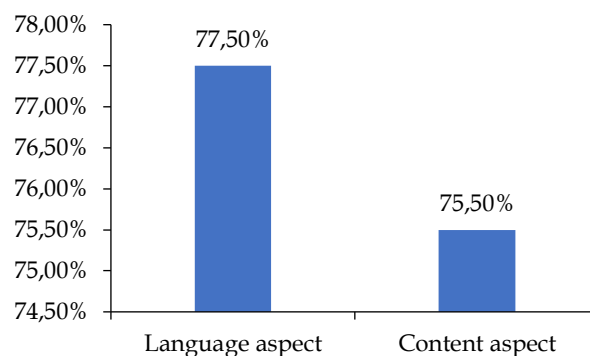


Figure 4. Diagram of science e-book evaluation results

The diagram in Figure 4 presents the results of the validation of a Project-Based Learning (PjBL)-based science e-book that is integrated with the Pancasila Student Profile based on two main aspects, namely the language aspect and the content aspect. The validation results showed that the language aspect obtained a score of 77.5%, while the content aspect received a score of 75.5%. Both scores are in the moderately valid category, which indicates that the e-book developed has met fairly good quality standards, although it still needs some refinement. The higher score of the language aspect compared to the content aspect shows that the preparation of the text in this e-book is clear and communicative enough for users, while the content

aspect can still be improved to be more in line with the learning objectives and integration of the values of the Pancasila Student Profile.

The results of this evaluation are closely related to the title of the research "Science E-Book Development Using Project-Based Learning (PjBL) Model Integrated with Pancasila Student Profile", because it shows the effectiveness of e-books as a digital learning resource designed to improve understanding of science and shape students' character. With a PjBL approach, this e-book aims to provide a more immersive, interactive, and real project-based learning experience. However, a slightly lower score on the content aspect indicates the need for further improvement in terms of material completeness, integration with the curriculum, and the effectiveness of the PjBL strategy in supporting students' critical thinking skills and collaboration. Therefore, even though this e-book is quite feasible to use, there is still an opportunity for further development to be more optimal in improving the quality of digital-based science learning that is in line with Pancasila values.

The evaluation of the results of this e-book also indicates that the e-book developed is very relevant to the demands of 21st century education which prioritizes the development of critical thinking skills, collaboration, and creativity. The integration of the PjBL model with the Pancasila Student Profile provides a new dimension in learning, which not only pays attention to the cognitive aspect but also the moral and social character of students. These findings support previous research that shows that multimedia-based and interactive learning materials can improve the attractiveness and effectiveness of learning.

This research also contributes to the literature on the development of digital learning materials that not only focus on improving science literacy, but also on strengthening character based on national cultural values. The results of this study show that PjBL-based science e-books integrated with the Pancasila Student Profile can create a comprehensive learning experience, combining cognitive learning with character formation in accordance with Indonesia's national education goals.

Conclusion

The findings of this study indicate that the development of a science e-book using the Project-Based Learning (PjBL) model integrated with the Pancasila Student Profile has proven to be a viable and effective digital learning resource. The e-book achieved an average validity score of 79%, categorizing it as moderately valid. Furthermore, the practicality assessments from both teachers and students suggest that the e-book is user-friendly, with respective scores of

3.20 and 3.00. These results highlight the potential of integrating PjBL and the Pancasila Student Profile in digital learning materials to enhance student engagement, critical thinking, and collaboration. This research contributes to the growing body of knowledge on the effectiveness of PjBL in science education by demonstrating how the integration of national character values into digital resources can support both cognitive and character development. Unlike previous studies that primarily focused on content delivery, this study emphasizes the alignment of pedagogical strategies with cultural values, providing a framework for the development of contextually relevant digital learning tools. The theoretical implications of this study reinforce the role of PjBL as a method that not only improves conceptual understanding but also fosters student-centered learning. Practically, the findings suggest that science educators can benefit from adopting e-books that combine interactive project-based tasks with value-based education. The application of this e-book in classroom settings demonstrates its potential to serve as an innovative solution in modernizing science education while maintaining a focus on national identity and moral development. While this study provides a foundation for further digital learning innovations, there are limitations that warrant future research. The current validation process categorized the e-book as moderately valid, indicating room for refinement in content quality and instructional design. Future studies should explore methods to enhance the integration of multimedia elements to further engage students. Additionally, longitudinal studies are needed to assess the long-term impact of PjBL-based e-books on students' academic performance and character development. Expanding the study to different educational levels and school settings could also provide more comprehensive insights into its broader applicability. In conclusion, the development of a science e-book integrating PjBL and the Pancasila Student Profile presents a promising approach to enhancing science education. By incorporating interactive and value-based learning experiences, this e-book not only improves student engagement and understanding but also contributes to character building in line with national educational goals. With continuous improvement and further research, such digital innovations have the potential to transform science education in Indonesia and beyond.

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Author Contribution

S.S. conceptualized the study and led the research process; N.M. contributed to data collection and analysis; I.L. was responsible for the development and technical design of the e-book; A.S. contributed to the implementation and evaluation stages. All authors reviewed and approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interest related to this study.

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