JPF | Volume 13 | Number 2 | 2025 | 103 - 118

p - ISSN: 2302-8939
e - ISSN: 2527-4015

Jurnal Pendidikan Fisika

https://journal.unismuh.ac.id/index.php/jpf

DOI: 10.26618/jpf.v13i2.17419

Development of a Problem-Based Learning E-Books to Enhance Students' Creative Thinking Skills in Senior High School

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Received: January 13, 2025; Accepted: March 25, 2025; Published: April 26, 2025

Abstract *–The development of students' creative thinking in physics remains a challenge due to the dominance of conventional instructional methods that lack interactive and contextual engagement. This study addresses the urgent need for innovative digital learning resources by developing an interactive physics e-book based on the Problem-Based Learning (PBL) model, focusing on optical device topics. The objective is to enhance students' creative thinking skills through student-centered learning integrated with digital platforms. Using the ADDIE development framework (Analysis, Design, Development, Implementation, Evaluation), the e-book was designed and validated for its design, content, construct, and creative thinking assessment tools. Validation results showed high Aiken's V scores across all components, indicating strong validity. Effectiveness was tested through a quasi-experimental approach involving 35 senior high school students, using pretest and posttest instruments. The N-Gain scores for both modeling (0.702) and implementation classes (0.707) demonstrated significant improvements in students' creative thinking, categorized as high. The novelty of this study lies in the integration of Heyzine and Liveworksheet platforms with PhET virtual labs, providing an interactive, accessible, and collaborative learning environment. The findings suggest that the developed PBL-based e-book effectively facilitates contextual learning and fosters creative problem-solving skills. In conclusion, this e-book serves as a validated and impactful instructional tool that contributes meaningfully to physics education by promoting higher-order thinking through innovative digital pedagogy.*

Keywords: *creative thinking skill; optical devices; physics e-book; problem-based learning*

I. INTRODUCTION

Education in the 21st century represents a transitional phase in which schools shift from a teacher-centered to a student-centered learning approach. This transformation necessitates that students possess the ability to think critically and learn independently as active participants in the learning process (Mardhiyah et al., 2021). Creative thinking plays a pivotal role in education as it enables learners to generate novel and original solutions that deviate from conventional methods

of problem-solving. Additionally, education has become a fundamental need in Indonesian society. Amidst the growing complexity of contemporary challenges, education serves not only as a pillar for personal development but also as a long-term investment for enhancing individual quality (Rawung et al., 2021). Consequently, learners must be equipped with higher-order thinking skills, particularly critical and creative thinking (Haris et al., 2024). In Indonesia, education is granted significant emphasis by the state, as emphasized in the preamble of the 1945 Constitution, which declares “Educating the life of the nation” as one of the country’s primary goals (Wahab et al., 2021).

Physics, as an essential subject in science education, presents a unique challenge due to its abstract nature. Effective understanding of physics concepts often requires direct application and experiential learning (Nurlina, 2020). However, students frequently struggle with mastering these abstract concepts due to various challenges. These include difficulties in problem-solving, conceptual comprehension, formula application in real-world contexts, graphical and visual analysis, and synthesizing conclusions from the material studied (Azizah et al., 2015). Furthermore, Daun et al. (2019) identified that students' challenges in learning physics stem from their difficulty in calculations, concept mastery, and understanding of physics formulas. These difficulties can arise from internal factors such as motivation and cognitive ability, as well as external factors including teacher effectiveness, familial support, and the surrounding learning environment.

The type and model of instruction significantly influence the effectiveness of the learning process. A mismatch between instructional models and learning content often results in suboptimal learning outcomes (Musdiani, 2019). PBL is an instructional model that encourages students to actively engage with real-world problems. The collaborative exploration and investigation involved in PBL not only enhance content understanding but also foster deeper and more meaningful learning experiences (Yulisriyanti, 2024). The PBL model aligns with the core principles of constructivist learning, providing authentic and context-rich learning environments (Purwandari et al., 2022). PBL has the potential to develop creative thinking by prompting students to evaluate prior knowledge, integrate new information, and collaboratively construct solutions (Wibowo, 2015). This approach fosters both problem-solving and creative thinking by creating a student-centered learning atmosphere where learners can express their ideas, supported by an encouraging environment that promotes active participation (Günter et al., 2017).

One of the effective learning resources that can support this process is the use of e-books (Nurlaela et al., 2021). E-books were selected in this study due to their accessibility learners can access them anytime, anywhere, and on various devices. This flexibility supports self-paced learning and promotes the repetition of material. Moreover, e-books enable quick access to

diverse information sources, enhancing literacy and facilitating the development of creative thinking skills (Haslinda et al., 2022). In addition to functioning as supplementary teaching materials, e-books are frequently used by educators as primary learning resources (Raihan et al., 2018). E-books, which integrate multimedia elements such as text, images, audio, and video, can be accessed via computers or mobile devices (Awaludin et al., 2020). These digital formats serve as modern counterparts to traditional print books (Anwar & Wibawa, 2019; Sukardi et al., 2015). Although e-books have certain limitations such as requiring internet access and potentially causing eye strain or distraction from social media their advantages are substantial (Makdis, 2020).

Observations conducted at State Senior High School 3 Yogyakarta reveal that learning remains conventional, primarily relying on lectures, which are ineffective for developing the competencies required in physics education. This approach tends to render students passive and disengaged. Furthermore, students demonstrate difficulty in understanding physics concepts, especially regarding the application of formulas a problem also identified in several other schools, as reported by Daun et al. (2019). This study confirmed that learners face persistent challenges in comprehending physics formulas and concepts. Additionally, students' critical and creative thinking skills in physics are still considered low, and interactive e-books are generally unavailable.

To address these issues, this study aims to develop teaching materials in the form of physics e-books based on the PBL model, utilizing the Heyzine and Liveworksheet applications. The developed e-book will cover topics related to optical instruments and incorporate practical activities via the PhET Simulation virtual laboratory platform. The learning activities within the e-book will be structured according to the syntax of the PBL model.

II. METHODS

This research employs a development research approach, commonly referred to as the Research and Development (R&D) model. It is a methodological framework utilized to produce specific products and assess their effectiveness (Evans et al., 2023). Specifically, this research model is systematically implemented to develop innovative teaching materials in the form of PBL e-books. Research and development is a procedural step aimed at creating new products or improving existing ones. This study adopts the ADDIE model of research and development, originally developed by (Dick et al., 1990). According to Sezer, the ADDIE model is a structured approach that emphasizes the analysis of interactions among components, with adjustments made

according to defined phases. The ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Widyastuti & Susiana, 2019).

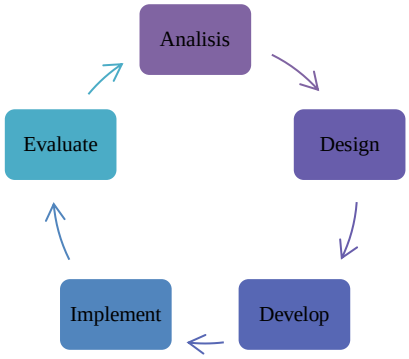

Figure 1. ADDIE model research flow

Data collection in this study was conducted through the administration of validation instrument sheet questionnaires to six expert validators in order to obtain valid research instruments. Furthermore, to collect data on students' creative thinking abilities, pretest and posttest assessments were administered to students at State Senior High School 3 Yogyakarta. The research subjects comprised 35 students from this institution. The instruments used in this study include: (1) a physics e-book media design validation sheet for assessing the overall layout and structure of the e-book; (2) a content and construct validation sheet for verifying the conformity of the material with the intended research objectives; and (3) a validation sheet for the creative thinking ability test instrument to evaluate student competencies. The instrument validation was conducted using Aiken's V analysis, assessed by a panel of expert lecturers. Aiken's V analysis is employed to determine whether individual items within the instrument are valid (Wulandari & Oktaviani, 2021).

According to Amini (2023), each item's validity score is calculated using Aiken's V formula. This index measures the level of agreement among raters concerning how well an item assesses predefined indicators. The resulting V index provides a quantitative assessment of content validity for each item, and items are classified according to their validity levels based on these scores. Product validation, in the form of e-books and test instruments, is further analyzed using feasibility assessments obtained from peer reviews. The validation results are presented in the form of quantitative data and evaluated using a Likert scale. This scale was selected due to its simpler construction compared to the Guttman or Thurstone scales, and its relatively high reliability (Anastasi & Urbina, 2016). The study employed four response categories: "strongly agree" (4), "agree" (3), "disagree" (2), and "strongly disagree" (1). The use of four alternatives was chosen to avoid the tendency of respondents to select a neutral midpoint. The test instruments

were analyzed using Aiken's V-index (Aiken, 1985). The V index for each item, based on ratings from six validators, is calculated using the following formula:

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (1)$$

Description

V : Content validation coefficient
s : $r - l_0$
r : The number given by the validator
l_0 : Lowest validity score
c : Highest validity score
n : Number of validators

Aiken's V scores are then compared against predetermined validity classifications. The results are interpreted based on the categories shown in Table 1 (Istiyono, 2020):

Table 1. Interpretation of Aiken's V result

Average score	Category classification
$V \geq 0.8$	Valid
$0.4 < V < 0.8$	Medium
$V \leq 0.4$	Less Valid

III. RESULTS AND DISCUSSION

A. Research and Instrument

The teaching materials developed in this study are in the form of a physics e-book focusing on the topic of optical equipment. These materials are structured using the PBL model and are enhanced by digital platforms such as Heyzine and Liveworksheet. Research conducted by Firtsanianta & Khofifah (2022) confirmed the effectiveness of Heyzine and Liveworksheet in developing instructional materials and enhancing student learning outcomes. Additionally, Fauzy et al., (2024) concluded that the use of these platforms significantly increased learner engagement an essential component in the development of students' creative thinking skills. The e-book includes learner-centered e-worksheets designed to guide students through practical experiments, such as investigating image formation using convex lenses. These worksheets are aligned with the PBL model's activity framework to ensure consistency with pedagogical principles. The test instruments developed in this study are specifically intended to assess creative thinking skills, which encompass the ability to generate broad, diverse, authentic ideas supported by detailed

explanations (Ridwan & Nasrulloh, 2022). The following is the framework of the e-book developed in this study:

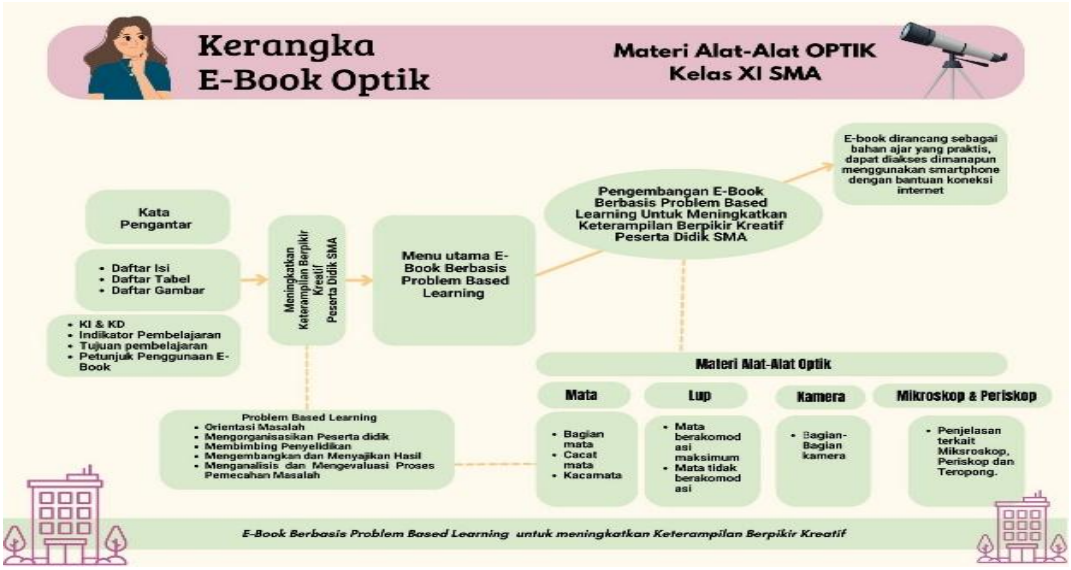

Figure 2. E-book framework

To ensure its academic validity and technical reliability, the e-book underwent a comprehensive validation process involving two main aspects: (1) media and design, and (2) content and construction. This dual validation process was implemented to ascertain the quality, relevance, and educational effectiveness of the developed material (Andani et al., 2022).

1. Media and Design Validity of Physics E-Book

a. Cover Section

Table 2: Media and cover design validation

No.	Aspects that Rated	Assessment						Average
		V1	V2	V3	V4	V5	V6	
1	Cover Section	4	3	3	4	4	4	0.92
2		3	4	4	4	3	3	0.88
3		4	4	3	3	3	4	0.88
4		4	3	4	4	3	4	0.92
5		4	4	3	4	4	4	0.96
6		3	4	3	4	4	3	0.88
7		4	4	4	3	4	3	0.92
8		4	3	3	4	4	4	0.92
9		3	4	3	4	4	4	0.92
Total final		33	33	30	34	33	33	8.17
Average score		0.92	0.92	0.83	0.94	0.92	0.92	0.91

The media and design validation results for the e-book cover are presented in Table 2. Analysis of feedback from six validators showed that the cover section received consistently high ratings across all assessment items, with a final average score of 0.91. This indicates that the

visual and design elements of the cover meet the expected standards for instructional materials. Such results suggest that the developed e-book is both aesthetically pleasing and suitable for academic use. The high validation score reflects alignment with instructional design standards and user expectations.

b. Contents

Table 3. Validation of media and design content section

No.	Aspects that Rated	Assessment						Average
		V1	V2	V3	V4	V5	V6	
1	Contents	4	3	3	4	4	4	0.92
2		3	3	4	4	4	3	0.88
3		4	4	3	4	3	4	0.92
4		4	3	4	3	4	4	0.92
5		4	4	3	3	4	4	0.92
6		3	4	4	4	4	3	0.92
7		4	4	3	3	4	4	0.92
8		4	3	3	4	4	4	0.92
9		4	3	3	4	4	4	0.92
10		3	4	4	4	4	4	0.96
Total final		37	35	34	37	39	38	9.17
Average score		0.93	0.88	0.85	0.93	0.98	0.95	0.92

Validation results for the media and design of the e-book content are detailed in Table 3. The average rating across validators was 0.92, indicating strong feasibility and relevance. These findings suggest that the e-book content was carefully constructed, with attention paid to clarity, layout, and pedagogical effectiveness. The high ratings support the conclusion that the materials are well-suited for use in instructional environments and are likely to enhance the learning experiences of students.

2. Material and Construct Validation of Physics E-Books

a. Material Section

Table 4. Material and construct validation of the content appropriateness section

No.	Aspects that Rated	Assessment						Average
		V1	V2	V3	V4	V5	V6	
1	Material Section	4	4	4	4	3	3	0.92
2		3	4	3	4	4	4	0.92
3		4	4	3	3	4	4	0.92
4		4	3	4	4	4	3	0.92
5		4	3	4	3	4	4	0.92
6		3	4	3	4	3	4	0.88
7		3	3	4	3	4	4	0.88
8		4	4	3	3	4	4	0.92
9		4	3	3	4	4	3	0.88

10a	3	4	3	3	4	4	0.88
10b	4	3	4	3	4	3	0.88
11a	3	4	3	4	3	4	0.88
11b	4	3	4	4	4	3	0.92
12a	3	4	4	3	4	4	0.92
13a	4	3	4	4	3	4	0.92
13b	4	4	3	4	3	4	0.92
Total final	47	45	46	46	48	48	14.42
Average score	0.73	0.70	0.72	0.72	0.75	0.75	0.90

The content validity and appropriateness of the material were assessed and summarized in Table 4. The results demonstrate that the learning materials scored highly, with an overall average validation score of 0.90. This reflects the validators' consensus on the relevance, accuracy, and instructional quality of the content. These results confirm that the materials are aligned with the intended learning objectives and can effectively support the development of students' conceptual understanding.

b. Construction Section

Table 5. Material and construct validation of the construction section

No.	Aspects that Rated	Assessment						Average
		V1	V2	V3	V4	V5	V6	
1	Material Section	4	3	4	3	4	4	0.92
2		4	3	4	4	4	3	0.92
3		3	4	3	4	4	4	0.92
4		4	3	4	3	4	4	0.92
5		3	4	3	4	4	4	0.92
6		4	4	4	3	4	3	0.92
7		3	4	3	4	4	4	0.92
Total final		25	25	25	25	28	26	6.42
Average score		0.89	0.89	0.89	0.89	1.00	0.93	0.92

The results of the content structure validation, displayed in Table 5, reveal a high level of consistency across all validators. The final average validation score for construction quality was 0.92, indicating that the structural design of the materials is logical, well-organized, and pedagogically sound. These characteristics contribute to the material’s effectiveness in facilitating meaningful learning and student engagement. The findings affirm that the e-book is well-developed not only in terms of its content but also in its instructional design and usability.

3. Validation of Students' Creative Thinking Ability Test Instrument

Table 6. Validation of creative thinking ability test instrument

No.	Aspects that Rated	Assessment						Average
		V1	V2	V3	V4	V5	V6	
1	Material Section	4	3	3	4	4	4	0.92
2		3	3	4	4	4	3	0.88
3		4	4	3	4	3	4	0.92
4		4	3	4	3	4	4	0.92
Total final		15	13	14	15	15	15	3.63
Average score		0.94	0.81	0.88	0.94	0.94	0.94	0.91

The validation of the creative thinking ability test instrument is shown in Table 6. The results reveal that the average assessment provided by the validators falls within the "high" category. This indicates that the test instrument is considered to possess high content validity, clarity, and relevance to the intended learning outcomes. Additionally, the overall average validation score of 0.91 for both the media and cover design suggests strong feasibility, visual appeal, and educational appropriateness. These results confirm that the instrument and its supporting materials are suitable for effectively measuring students' creative thinking skills. After confirming the validity of the instrument, an analysis was conducted to evaluate the effectiveness of the developed physics e-book in improving students' creative thinking skills at State Senior High School 3 Yogyakarta. Data analysis was performed using the N-Gain test, which is designed to measure the extent of improvement in students' creative and critical thinking skills. The N-Gain test helps mitigate errors when interpreting changes in data scores.

B. Learning Outcome Data

1. Modeling Class XI MIPA 6

a. Analysis of Students' Creative Thinking Ability in terms of Test Results

Table 7. Analysis of creative thinking ability

No.	Absentee Number	*Pretest* Score	*Posttest* Score	N-Gain Score
1	001	43.75	87.50	0.778
2	002	56.25	93.75	0.857
3	003	50.00	81.25	0.625
4	004	37.50	75.00	0.600
5	005	37.50	87.50	0.800
6	006	56.25	81.25	0.571
7	007	43.75	93.75	0.889
8	008	43.75	93.75	0.889
9	009	37.50	87.50	0.800
10	010	43.75	81.25	0.667

11	011	50.00	75.00	0.500
12	012	43.75	75.00	0.556
13	013	56.25	81.25	0.571
14	014	62.50	87.50	0.667
15	015	50.00	81.25	0.625
16	016	62.50	100.00	1.000
17	017	43.75	81.25	0.667
18	018	37.50	68.75	0.500
19	019	56.25	81.25	0.571
20	020	50.00	87.50	0.750
21	021	37.50	68.75	0.500
22	022	43.75	75.00	0.556
23	023	37.50	81.25	0.700
24	024	50.00	93.75	0.875
25	025	62.50	75.00	0.333
26	026	43.75	81.25	0.667
27	027	37.50	75.00	0.600
28	028	50.00	100.00	1.000
29	029	31.25	87.50	0.818
30	030	56.25	75.00	0.429
31	031	43.75	93.75	0.889
32	032	37.50	87.50	0.800
33	033	50.00	81.25	0.625
34	034	56.25	100.00	1.000
35	035	43.75	93.75	0.889
36	036	31.25	81.25	0727
Average		46.52	84.20	0.702 (High)

Table 7 presents the analysis of students' creative thinking ability, measured using pretest and posttest scores for 36 students. The average pretest score was 46.53, and the average posttest score increased to 84.20. The resulting N-Gain score of 0.702 indicates a moderate to high level of improvement in students' creative thinking abilities. This suggests that the instructional methods employed in the modeling class were effective in enhancing these skills. The positive change observed further highlights the potential of the applied teaching strategies to foster creativity in students, and these methods are likely to yield even greater improvements with continued use.

2. Implementation Class

a. Analysis of Students' Creative Thinking Ability in terms of test results

Table 8. Analysis of creative thinking ability

No.	Absentee Number	*Pretest* Score	*Posttest* Score	N-Gain Score
1	001	75.00	93.75	0.750
2	002	43.75	87.50	0.778
3	003	62.50	87.50	0.667
4	004	68.75	93.75	0.800
5	005	37.50	75.00	0.600
6	006	50.00	93.75	0.875
7	007	43.75	81.25	0.667
8	008	56.25	81.25	0.571
9	009	68.75	87.50	0.600
10	010	62.50	93.75	0.833
11	011	68.75	100.00	1.000
12	012	43.75	75.00	0.556
13	013	68.75	81.25	0.400
14	014	62.50	87.50	0.667
15	015	50.00	81.25	0.625
16	016	68.75	93.75	0.800
17	017	68.75	81.25	0.400
18	018	43.75	75.00	0.556
19	019	68.75	93.75	0.800
20	020	62.50	87.50	0.667
21	021	43.75	81.25	0.667
22	022	75.00	81.25	0.250
23	023	50.00	87.50	0.750
24	024	56.25	75.00	0.429
25	025	50.00	81.25	0.625
26	026	43.75	93.75	0.889
27	027	37.50	75.00	0.600
28	028	68.75	93.75	0.800
29	029	68.75	93.75	0.800
30	030	75.00	100.00	1.000
31	031	87.50	100.00	1.000
32	032	43.75	87.50	0.778
33	033	68.75	100.00	1.000
34	034	50.00	93.75	0.875
35	035	37.50	75.00	0.600
36	036	43.75	87.50	0.778
Average		57.63	87.15	0.707 (High)

In the implementation class, as presented in Table 8, the average pretest score was 57.64, while the posttest score averaged 87.15, leading to an N-Gain score of 0.707. This result marks a significant increase when compared to the modeling class, indicating a stronger effect of the instructional methods applied in the implementation class. The improvement is noteworthy, as creativity is a fundamental component of higher-order thinking skills, which play an essential role in both the learning process and the ability to address complex real-life challenges (Gunawan et al., 2024).

The research and observations at State Senior High School 3 Yogyakarta spanned three weeks, with the initial activity being an observation of the school and classroom environment on Friday, March 22, 2024, from 07:30 to 10:30 WIB. This observation provided insights into the school's condition, the learning activities of students, and the students' existing skills. The first step in the learning activities involved administering a pretest to assess the initial understanding of students regarding the subject matter (Melani et al., 2021). The pretest results provided valuable information to educators, enabling them to adjust their teaching strategies to optimize student comprehension. The pretest was designed to measure both creative and critical thinking abilities. Subsequently, the instructional material related to optical devices was introduced, followed by experiments and worksheets aligned with the PBL model. After the learning sessions, a posttest was administered to evaluate the extent of students' mastery over the material taught and assess any improvements in their creative and critical thinking abilities (Siregar et al., 2023).

Two classes participated in the study: the modeling class and the implementation class. The modeling class was conducted by students using the developed learning media, teaching materials, and test instruments, while the implementation class was conducted by physics subject teachers using the same resources. The modeling class was held for two sessions, on Tuesday, May 7, 2024, from 08:30 to 11:00 WIB and Monday, May 13, 2024, from 10:50 to 12:20 WIB. The implementation class was also held for two sessions, on Tuesday, May 7, 2024, from 13:00 to 14:30 WIB, and Tuesday, May 14, 2024, from 13:00 to 14:30 WIB.

The developed teaching materials, consisting of physics e-books covering optical devices and structured around the PBL model and supported by Heyzine and Liveworksheet, underwent feasibility tests before use. The media validation for the cover section of the e-book achieved a score of 0.91, placing it in the valid category. The content section received a score of 0.92, also in the valid category. The content validity ensures that the prepared material meets the intended educational objectives (Putri et al., 2020). The material validation for both the content section and the construction section also showed strong results, with scores of 0.90 and 0.92, respectively.

The test instruments developed to measure creative thinking skills were similarly validated, achieving a score of 0.91. These instruments were then administered to students to evaluate their

initial and post-learning abilities. The results showed that the N-Gain score for the modeling class was 0.702, categorized as high, while the N-Gain score for the implementation class was 0.707, also indicating significant improvement in creative thinking skills These findings suggest that the use of the PBL model integrated with the developed physics e-book and supported by digital tools like Heyzine and Liveworksheet contributed to enhancing students' creative thinking abilities. This improvement, indicated by the increase in N-Gain scores, underscores the importance of equipping students with skills to address complex challenges in both academic and real-world contexts (Prabayanti et al., 2024). This is consistent with the research of (Pakpahan et al., 2023) which stated that an N-Gain value of 0.7 or higher is considered a significant and effective measure of improvement. The study's results further emphasize the importance of selecting the right instructional model to enhance learning outcomes (Setyawan & Mulyaningsih, 2013). Therefore, the contribution of this study lies in demonstrating the practical application of a digital PBL-based physics e-book to promote creative thinking in high school students. It offers a pedagogical innovation aligned with 21st-century learning demands, providing a replicable model for integrating technology with constructivist learning in physics education.

IV. CONCLUSION AND SUGGESTION

This study successfully developed a physics e-book based on the PBL model, specifically designed to improve students' creative thinking skills in the context of optical devices. The e-book, enhanced by digital platforms such as Heyzine, Liveworksheet, and PhET simulations, was validated in terms of design, content, structure, and assessment tools-receiving high validation scores across all aspects. The implementation of the e-book in both modeling and teacher-led classes demonstrated its effectiveness, as shown by significant increases in students' creative thinking abilities, with average N-Gain scores of 0.702 and 0.707 respectively. These findings confirm that the PBL-based e-book is a valid, feasible, and impactful learning resource that promotes active, student-centered engagement in physics education.

Despite its promising results, this study was limited to a specific topic of optical devices, a single school setting, and a relatively small sample size. Future research should explore broader physics topics, involve diverse educational contexts, and utilize larger samples to strengthen the generalizability of findings. In addition, comparative studies involving other instructional models, such as inquiry-based learning, project-based learning, or discovery learning are recommended to further examine their effects on various aspects of student learning, including motivation, attitudes, and higher-order thinking skills.

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to all those who have participated in this research process. Especially to the principal, physics teachers, and students at State Senior High School 3 Yogyakarta. In addition, the author would also like to thank the Faculty of Mathematics and Natural Sciences, Yogyakarta State University for supporting this research.

REFERENCES

Aiken, L. R. (1985). Three coefficients for analyzing the reliability, and validity of ratings. *Educational and Psychological Measurement, 45*(1), 131-142. https://doi.org/10.1177/0013164485451012

Amini. (2023). Analisis validasi dan reliabilitas instrumen kemampuan berfikir kritis siswa sekolah dasar. *Jurnal Edukatika*, *1*(1), 1–10.

Anastasi, A. & Urbina, S. (2016). *Tes psikologi. Terjemahan Robertus Hariono S. Iman* (7th ed.). PT Indeks.

Andani, T., Zulfa M, I., Yuliani, H., Azizah, N., & Jennah, R. (2022). Analisis validasi media pembelajaran e-book berbasis flip pdf professional pada materi gelombang bunyi di SMA. *Jurnal Kumparan Fisika*, *4*(3), 213–220. https://doi.org/10.33369/jkf.4.3.213-220

Anwar, Z., & Wibawa, B. (2019). Development of learning resources based on e-books in sasak alus language for elementary schools in Lombok. *International Journal of Innovation, Creativity and Change. 6*(8), 36-45.

Awaludin., Wibawa, B., & Winarsih, M. (2020). The development of hypermedia based e-book for integral calculus subject. *International Journal of Online and Biomedical Engineering*, *16*(4), 109–127. https://doi.org/10.3991/ijoe.v16i04.13393

Azizah, R., Yuliati, L. & Latifah, E. (2015). Kesulitan pemecahan masalah fisika pada siswa SMA. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *5*(2), 44–50. https://doi.org/10.26740/jpfa.v5n2.p44-50

Daun, N. S., Helmi., & Haris, A. (2019). Diagnosis kesulitan belajar fisika peserta didik di SMA Negeri 1 Bontomarannu. *Prosiding Seminar Nasional Fisika PPs UNM*, *2*, 37–40. https://ojs.unm.ac.id/semnasfisika/article/view/12881

Dick, W., Carey, L., & Carey, J. O. (1990). *The Systematic Design of Instruction* (3rd ed.). Harper Collins Publishers.

Evans, S. W., Owens, J. S., Bradshaw, C. P. & Weist, M. D. (2023). *Handbook of School Mental Health: Innovations in Science and Practice*. Springer International Publishing.

Fauzy, F., Jesmin, M., Sahruddin, A., Nasir., & Makarim, M. A. (2024). Implentasi media interaktif berbasis heyzine flibook terhadap motivasi belajar siswa SMP negeri 12 Barru. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *9*(4), 342–350. https://doi.org/https://doi.org/10.23969/jp.v9i04.19720

Firtsanianta, H. & Khofifah, I. (2022). Efektivitas e-lkpd berbantuan liveworksheet untuk meningkatkan hasil belajar peserta didik. *Proceedings Conference of Elemntary Studies*, *1*(1), 140–149. https://journal.um-surabaya.ac.id/Pro/article/view/14918

Günter, T., Akkuzu, N., & Alpat, S. (2017). Understanding "green chemistry" and "sustainability": An example of problem-based learning (PBL). *Research in Science & Technological Education*, *35*(4), 500–520. https://doi.org/10.1080/02635143.2017.1353964

Gunawan, K. D. H., Liliasari, L., Kaniawati, I. & Riandi, R. (2024). Status of prospective science teachers' critical and creative thinking skills in energy and its integration topics. *Jurnal Pendidikan Fisika*, *12*(3), 152–162. https://doi.org/10.26618/jpf.v12i3.11521

Haris, A., Martawijaya, M. A., Dahlan, A., Yulianti, E. & Nua, M. T. P. (2024). Analysis of critical thinking skills of high school students. *Jurnal Pendidikan Fisika*, *12*(1), 23–32. https://doi.org/10.26618/jpf.v12i1.12677

Haslinda, F., Maghfiroh, N., & Fadillah, S. R. (2022). Buku digital sebagai media pengembangan literasi. *Prosiding Seminar Nasional Ilmu Ilmu Sosial (SNIIS)*, *1*, 576–584.

Istiyono, E. (2020). *Pengembangan instrumen penilaian dan analisis hasil belajar fisika dengan teori tes klasik dan modern*. UNY Press.

Makdis, N. (2020). Penggunaan e-book pada era digital. *Al Maktabah: Jurnal Komunikasi Dan Informasi Perpustakaan*, *19*(1), 77–84. https://doi.org/10.15408/almaktabah.v19i1.21058

Mardhiyah, R. H., Aldriani, S. N. F, Chitta, F., & Zulfikar, M. R. (2021). Pentingnya keterampilan belajar di abad 21 sebagai tuntutan dalam pengembangan sumber daya manusia. *Lectura : Jurnal Pendidikan*, *12*(1), 29–40. https://doi.org/10.31849/lectura.v12i1.5813

Melani, L., Handoko, A. L., & Wijoyo, H. (2021). Efektivitas pretest dan postest terhadap prestasi belajar siswa dalam mata pelajaran Agama Buddha (Studi kasus SMK PGRI 1 Tangerang). *Jurnal of Social Sciene and Digital Marketing*, *1*(1), 16-24. https://doi.org/https://doi.org/10.47927/jssdm.v1i1.53

Musdiani. (2019). Analisis medel pembelajaran terhadap cara mengajar guru untuk meningkatkan minat belajar siswa pada materi penggolongan hewan di kelas V SD Negeri Pante Cermin. *Jurnal Tunas Bangsa*, *6*(1), 60-68.

Nurlaela, E., Sumantri, M., & Sarkadi. (2021). Development of mind mapping-based e-book in steam for skills skills of grade vi elementary school students. *International Journal of Multicultural and Multireligious Understanding*, *8*(6), 390–399. https://doi.org/10.18415/ijmmu.v8i6.2787

Nurlina. (2020). Application of guided inquiry learning model towards science process skills. *Jurnal Pendidikan Fisika*, *8*(1), 64–77. https://doi.org/10.26618/jpf.v8i1.3201

Pakpahan, S. H., Sani, R. A., & Derlina, D. (2023). Pengembangan e-book IPA berorientasi asesmen kompetensi minimum (AKM) untuk meningkatkan literasi siswa SMP. *Jurnal Pendidikan Fisika* , *12*(2), 158–164. https://doi.org/10.24114/jpf.v12i2.50214

Prabayanti, E., Usman, U., Khaeruddin, K., & Setiawan, T. (2024). Analysis of students' critical thinking abilities in physics learning: A case study at SMAN 5 Sidrap. *Jurnal Pendidikan Fisika*, *12*(3), 141–151. https://doi.org/10.26618/jpf.v12i3.15317

Purwandari, I, D., Rahayu, S., & Dasna, I. W. (2022). Inquiry Learning Model in Chemistry Education: A systematic literature review. *JPMIPA: Jurnal Pendidikan MIPA*, *23*(2),681-691. http://dx.doi.org/10.23960/jpmipa/v23i2.pp681-691

Putri, Z. R., Sari, R., Jumadi., & Ariswan, A. (2020). Pengembangan dan validasi instrumen tes untuk mengukur keterampilan menyelesaikan masalah peserta didik SMA pada pelajaran fisika. *Jurnal Penelitian Pembelajaran Fisika*, *11*(1), 17–25. https://doi.org/10.26877/jp2f.v11i1.3993

Raihan, S., Haryono., & Ahmadi, F. (2018). Development of scientific learning e-book using 3D pageflip professional program. *Innovative Journal of Curriculum and Educational Technology*, *7*(1), 7–14. https://doi.org/10.15294/ijcet.v7i1.24793

Rawung, W. H., Katuuk, D. A., Rotty, V. N. J., & Lengkong, J. S. J. (2021). Kurikulum dan tantangannya pada abad ke 21. *Jurnal Bahana Manajemen Pendidikan*, *10*(1), 29–34. https://doi.org/10.24036/jbmp.v10i1.112127

Ridwan, T., & Nasrulloh, I. (2022). Analisis kemampuan berpikir kreatif dan kritis siswa sekolah dasar. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, *8*(2), 466–471. https://doi.org/10.29210/020221520

Setyawan, A., & Mulyaningsih, S. (2013). Penerapan model pembelajaran konsep untuk meningkatkan hasil belajar siswa pada pokok bahasan usaha dan energi di kelas VIII SMP Negeri 4 Surabaya. *Jurnal Inovasi Pendidikan Fisika*, *2*(3), 184–186.

Siregar, N. A., Harahap, N. R., & Harahap, H. S. (2023). Hubungan antara pretest dan postest dengan hasil belajar siswa kelas VII B Di Mts Alwashliyah Pantai Cermin. *Jurnal Edunomika*, *7*(1), 1–13. https://doi.org/10.29040/jie.v7i1.8307

Sukardi, I., Wigati, I., & Masripah, I. (2015). Pengaruh metode pembelajaran discovery learning terhadap hasil belajar siswa pada mata pelajaran biologi kelas VII di MTs Patra Mandiri Plaju Palembang. *Biolomi: Jurnal Pendidikan*, *1*(1), 22–29. https://doi.org/10.19109/bioilmi.v1i1.1127

Wahab, A., Kosilah., Sanwil, T., Rusnawati., Handayani. G, Hawa, S., Sa'oda.h, Syamsiah, N., Hadi, F. R., & Syarifuddin. (2021). *Teori dan aplikasi ilmu pendidikan* (Nanda Saputra, Ed.). Yayasan Penerbit Muhammad Zanini.

Wibowo, H. (2015). *Pengantar teori-teori belajar dan model-model pembelajaran* (Ibnu Whandi, Ed.). Puri Cipta Media.

Widyastuti, E., & Susiana. (2019). Using the ADDIE model to develop learning material for actuarial mathematics. *Journal of Physics: Conference Series*, *1188*, 1-8. https://doi.org/10.1088/1742-6596/1188/1/012052

Wulandari, I., & Oktaviani, N. M. (2021). Validitas bahan ajar kurikulum pembelajaran untuk Pendidikan guru sekolah dasar. *Jurnal Cakrawala Pendas*, *7*(1), 90–97. https://doi.org/http://dx.doi.org/10.31949/jcp.v7i1.2456

Yulisriyanti. (2024). Penerapan model Problem Based Learning (PBL) untuk meningkatkan kemampuan berpikir kritis peserta didik. *Sentri: Jurnal Riset Ilmiah*, *2*(2), 942–953. https://doi.org/10.55681/sentri.v3i2.2295