IJUPE
International Journal Universal Pedagogy Education
https://journal.tigaedukasiglobal.co.id/index.php/IJUPE

Article Received: 30/05/2025; Revised: 14/06/2025; Accepted: 27/06/2025
IJUPE, Vol. 01, No. 01, 37-47
p-ISSN: xxxx-xxxx
e-ISSN: xxxx-xxxx
DOI: 0000-0000-0000-0000

Development of Barcode-Based Pop-Up Books in Elementary School

Ice Priska ✉[1], Hafiz Wijaya[2], Meyika Nurpajrin[3], Nanda Putri Utami[4]
[1,2,3,4] Primary School Teacher Education Program, Universitas PGRI Palembang, Indonesia.

✉ icepriska065@gmail.com

Abstract. Students' understanding of abstract concepts such as the life cycle of living beings often poses a challenge at the elementary level, especially in Grade III. Learning processes that rely heavily on textbooks and verbal explanations tend to be less engaging and difficult for students to grasp. This study aims to determine the effect of pop-up book media on third-grade elementary students' understanding of the life cycle material. The method used is Research and Development (R&D), involving three stages of trials: one-to-one, small group, and field test, with a total of 22 students at Public Elementary School 81 Palembang. Validation was conducted by media experts, material experts, and education practitioners. The validation results indicated that the pop-up book media was highly feasible, with an average score above 82%. Meanwhile, the trial results showed a significant improvement in students' understanding, with average scores reaching 93.3% in the one-to-one and small group stages, and 89.2% in the field test. In conclusion, the pop-up book media is effective in enhancing students' understanding of the life cycle concept and is suitable for use as an engaging and interactive learning tool.

Keywords: Pop-up Book; Media; Student Understanding; Life Cycle; Interactive Learning.

1. INTRODUCTION

Basics education is a crucial step in developing students' character and knowledge, especially in dasar schools (Soemartono, 2014). At this point, students, especially those in grade III Elementary School, are at a phase of cognitive development that aligns with Piaget's theory of cognitive development, where they can understand concrete concepts but struggle with abstract concepts. Because of this, the use of appropriate teaching materials is very helpful in helping students understand complex and abstract concepts, such as the life lessons taught in the Natural Science curriculum at Elementary School (Sari et al., 2018).

One of the natural science materials that frequently causes problems in comprehension is the chapter on living beings, which describes the stages of life development from birth to death, including changes in form that occur in living beings such as metamorphosis in frogs and butterflies. A teaching method that just uses text and verbal explanations frequently makes students reluctant to pay attention and fully understand the process (Tai, 2024b). Students need more educational materials that can provide more specific examples and comprehensive information about the processes involved so they may not only understand the cycle stages but also understand how each step occurs and interacts with the others.

Corresponding author
*E-mail addresses: icepriska065@gmail.com (Ice Priska)

In fact, in elementary schools, science teaching still largely relies on textbooks and traditional verbal methods, which makes the learning process less engaging and less interactive (Purwar et al., 2024). Dependency in conventional media that cannot adapt to imagination and student learning is one of the reasons why material such as life cycle living organisms is not optimally understood. In addition, there aren't many studies that examine the use of pop-up books based on barcodes in natural science learning contexts; this is another important study that has to be included. Prior research using pop-up book media is typically more focused on social or religious topics, but research using natural science materials, particularly on the concept of life cycle, is more difficult and requires more in-depth analysis (Agliata et al., 2024).

Innovation in pop-up book media based on barcodes offers students a more engaging, interactive, and visually stimulating learning environment. With the three dimensions that emerge when the world is being created, this media provides more concrete and immersive learning experiences. In addition, barcode technology integrated with pop-up media allows students to access additional materials, including as audio and video, that can clarify abstract concepts (Hasanah et al., 2024). It is also believed that using this media might increase students' interest and sensitivity during the learning process (Zhang et al., 2024), making it a viable alternative to increase students' comprehension of complex material.

The purpose of this study is to assess the validity and practicality of pop-up book development based on barcodes in order to increase third-grade students' understanding of the material related to living beings. This study also aims to investigate the use of pop-up books in natural science instruction by using interactive technology and visual elements, which can help students understand abstract concepts in an engaging and easy-to-understand manner. It is hoped that this study would contribute to the development of more innovative and effective learning media at the dasar school level (Wahjuni S.IP, 2012).

2. METHOD

This study is a research and development study with the goal of understanding the impact of pop-up books on third-grade students' comprehension of life literacy materials (Chang et al., 2024). One-on-one, small-group, and outdoor tests are the methods used to evaluate the media that are used in the classroom in a methodical manner. The subject of the study is third-grade students at public elementary school 81 Palembang. The study's subjects include three students in a one-on-one session to identify the initial problems with media and instruments, six students in a small group setting to assess students' understanding and awareness of media in a small group setting, and thirteen students in a field test to assess the effectiveness of media in a more extensive learning environment and to assess the actual situation in the classroom. This

study's goal is to ensure that the medium being developed is reliable and effective before being used extensively (R. Zhu et al., 2024).

This research is a type of development research that refers to the ADDIE model according to Ozdilek & Robeck, (2009), which includes five main stages, namely: (1) the analysis stage, which includes an analysis of initial needs, learner characteristics, materials, tasks, and learning objectives; (2) the design stage, which includes the selection of materials, presentation format, and the initial design of learning media; (3) the development stage, which begins with the creation of a prototype to identify the strengths and weaknesses of the media, which is then refined to produce a final media product that is ready to be validated by media and material experts in their respective fields; (4) the implementation stage, where the learning media is applied using the STAD type of cooperative learning model; and (5) the evaluation stage, which includes analyzing the results of media validation, student learning outcomes, and student feedback through questionnaires, resulting in the final product: a barcode-based pop-up book.

Validation is carried out by three ahli people, which include media that evaluates visuals, design, and pop-up book technology; ahli materials that assess a student's compliance with the natural science third grade on life skills and educational practice (teacher), which assesses the effectiveness of media use in daily classroom instruction (Tai, 2024a). Data from the questionnaire was analyzed quantitatively and descriptively to determine the level of media based on student responses and expert evaluations (Chain et al., 2025).

3. RESULTS

The research procedure used by this researcher is the ADDIE Model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The following is the implementation of these stages:

3.1 Analyze

Analysis is done to understand the state of education and the needs of third-grade students at Elementary School in understanding the material related to butterfly daily life. The results of observation and discussion with the teacher indicate that students struggle to understand the changes in butterfly shapes through verbal or visual explanations. Many students are unable to pay in a specific way from egg to becoming adult butterfly. Teacher also explains that for students to understand the process more easily, learning materials that are more engaging and capable of presenting metamorphosis in a visual format are needed.

Through dissemination questionnaire, students demonstrate a high level of awareness regarding media that can be identified, observed clearly, and analyzed using safe technologies such as barcode scanning. This is in line with the

cognitive development characteristics of third-grade students that are situated in a certain operational phase, where they learn more effectively through written language and visual aids (Bailey & Wilkinson, 2022). Because of this, media pop-up books based on barcodes are developed as solutions that integrate three-dimensional visualization with digital security technology. Pop-up books offer engaging, silent learning experiences, while QR code reminders help students understand the material through audio and video explanations. It is hoped that this approach will result in more engaging, dynamic, and dynamic learning (Han & Senyshyn, 2024).

3.2 Design

This engaging and instructive media, which takes the kind of an interactive pop-up book, aims to provide students a fun, tangible, and visual understanding of the butterfly life cycle. The book has barcodes that connect to digital resources and technology-based assessment questions, and it makes use of 3D pop-up graphics. Every page is methodically created to accommodate elementary school pupils' learning styles and phases.

3.3 Development

PVC board was the primary material used to create the pages of this pop-up book on the life cycle of butterflies. This made the book stronger and more resilient, especially for elementary school pupils who frequently hold and open books. To make the book survive longer, each page was then laminated to offer further defense against physical damage, water, and dirt. The pop-up book's content comprises text and illustrations that describe the stages of butterfly development, from egg to larva (caterpillar), pupa (chrysalis), and adult. Students may directly see and feel the tangible shape changes because to the interactive pop-up design, which enhances the effectiveness and engagement of the learning process.

3.4 Implementation

In a two-hour session, third-grade pupils at Public Elementary School 81 Palembang were given access to a pop-up book learning resource based on barcodes that included information on the life cycle of butterflies. This media enhances students' learning experiences by fusing eye-catching three-dimensional images with QR codes that grant access to all of the content and assessment questions. Under the teacher's facilitation, students actively used the media, partic natural science ted in group discussions, and finished activities pertaining to the life cycle of butterflies during the class. Using this media has been shown to boost learning interest and provide pupils with an engaging, partic natural science tory manner to comprehend the difficult idea of transformation. Singh & Phoolka, (2024), who stress the significance of creative learning media for

the efficacy of the learning process, concur with these findings, which are consistent with Ordu et al., (2024), assertion that interactive multimedia can improve students' comprehension and increase learning engagement.

3.5 Evaluasi (Evaluations)

The efficiency of the barcode-based Pop-Up Book learning resource in aiding third-grade elementary school pupils in comprehending the content on the life cycle of butterflies was assessed. Three steps made up this evaluation process: outdoor testing, small group testing, and individual (one-on-one) testing. A comprehension level of 93.3% was noted during the one-on-one phase with three students, suggesting that this material is readily available and intelligible on an individual basis. The small group test with six students yielded similar findings, suggesting that group use of the media is beneficial. In contrast, the effectiveness percentage of the field test, which involved the complete class of 22 students, was 89.2%, suggesting that this media is highly effective in traditional learning. These results are consistent with a study by Schwenk & Smith, (2025), that demonstrated that barcode-based media are highly valid and effective in science education, as well as a study by Abdulmalik-Labe & Quilang, (2024), that demonstrated a very high level of feasibility for pop-up books with a score of 93.8% in individual tests.

Table 1. Data Criteria for Pop-Up Book Media Validation Results

No	Validator	Percentage Score
1	Media Expert	75,7%
2	Subject Matter Expert	98,6%
	Average	87,15
	Criteria	Very Practical

According to the assessment carried out by subject matter and media specialists, barcode-based pop-up book learning resources are highly useful for instructing third-grade elementary school pupils. Media experts' scores of 75.7% and subject matter experts' scores of 98.6%, with an overall average of 87.15%, confirm this assessment. These findings show that, in terms of both visual presentation and substance, the media has satisfied the practicality requirements. The media went through two rounds of adjustments before to its final version, mostly to improve the visual appearance and the completeness of the information provided, based on validators' feedback. As a result, this media is considered appropriate for use as a learning aid, particularly when it comes to conveying information about the life cycle of butterflies in a way that is more interesting and simpler to comprehend.

Figure 1. Form of pop-up book media before revision

In the early stages of design, pop-up books were created using cardboard as the main material for prototypes. As they had not yet entered the revision and refinement stage, these books still had several weaknesses, particularly in terms of visual appearance and material durability.

Figure 2. The revised Pop-Up Book media format

After undergoing revisions and refinements, the pop-up book media was developed using PVC board material, which has a higher level of strength and is equipped with lamination to improve durability and display quality. The refinements were carried out comprehensively, covering visual aspects, pop-up mechanism functions, and clarity of material delivery, so that this media became more representative, interactive, and suitable for use in learning activities at the elementary school level.

Table 2. Student Response Questionnaire Data 2025

No	Test	Score	Percentage	Criteria
1	One-to-One	70	93,3%	Very Practical
2	Small-Group	190	31,6%	Quite Practical
	Average Percentage		62,45%	Practical

According to the partic natural science nts' questionnaire responses, the

average proportion of people who found pop-up books useful in one-on-one and small group settings was 62.65%. These findings suggest that the media is useful and, thus, appropriate for use in educational activities, albeit there is still room for small adjustments to boost its efficacy.

Table 3. Teacher Response Questionnaire Data
(Grade III Homeroom Teachers) 2025

No	Test	Score	Percentage	Criteria
1	Third Grade Homeroom Teacher	49	98%	Very Practical
	Average Percentage		98%	Very Practical

Based on the results of a practicality questionnaire completed by teachers (third-grade homeroom teachers), an average percentage of 98% was obtained. This percentage is categorized as very practical, indicating that pop-up books are considered easy to use, efficient to implement, and capable of optimally supporting the learning process in the classroom.

4. DISCUSSION

The study's findings indicate that using pop-up books based on barcodes significantly increases third-grade students' understanding of the material related to living organisms. At the individual test, the media has a 93.3% averages, whereas at the small group and field test stages, the corresponding averages scores are 93.3% and 89.2%. This supports the findings of previous research that showed that using visual-based media can increase students' understanding of complex and abstract material. According to research by Zhu et al., (2024), pop-up books can significantly improve students' learning outcomes, especially when it comes to difficult-to-understand material. This study confirms the effectiveness of barcode-based pop-up book media in enhancing students' understanding of the life cycle of living organisms.

Pop-up books' capacity to provide three-dimensional features that aid in the comprehension of abstract ideas is one of their key advantages. According to the study's findings, pop-up books can give pupils a more tangible and visual understanding of life cycle stages, such the transformation of a butterfly. Students' comprehension of challenging content can be enhanced when learning materials combine text and three-dimensional pictures. According to research by Archambault et al., (2024), using three-dimensional features in science instruction can help students better understand difficult material and increase their retention of the concepts being taught. Additionally, the combination of pop-up media with barcode technology adds an interactive element that enhances students' educational experiences. According to this study, students can access extra

resources like audio and video by scanning barcodes on pop-up media, which can help them better grasp the concepts being taught. This is consistent with study by Hidayat et al., (2024), who found that incorporating technology into instructional materials can boost student interest and aid in a deeper comprehension of the subject matter. These outcomes also corroborate those of An et al., (2024), who discovered that using technology in the classroom might boost students' interest and involvement while also hastening their comprehension of the subject matter.

Nevertheless, despite the study's noteworthy efficacy, a number of factors still require improvement in order to boost this media's usefulness. Students at the small group level received an average score of 62.65% on the practicality questionnaire, which is considered practical. Nevertheless, these findings show that even while this medium is already useful, there are still certain issues that need to be fixed, such the pop-up mechanism, to make it simpler for students to comprehend. According to research by Huang & Wang, (2022), one of the key elements influencing the successful use of media in the classroom is its practicality; therefore, the media's functionality and design must be enhanced to increase its learning effectiveness. Students who used the barcode-based pop-up book media during the trial seemed more engaged and eager to learn. When answering assessment questions about the life cycle of living things, students showed greater enthusiasm. This corroborates the discovery that interactive educational materials can improve students' interest in and comprehension of the material being taught (Abdala, 2024).

Overall, the study's findings show that pop-up books with barcodes can greatly enhance pupils' comprehension of the life cycle of living things. Additionally, this medium was successful in raising students' interest in and engagement with the material. The study's conclusion is that creating educational materials that incorporate interactive technology and three-dimensional visual components can help pupils who struggle to comprehend complex concepts. Thus, in order to maximize its usefulness and learning efficacy, future development of this media should take into account enhancing the design. To increase its advantages in the setting of elementary school teaching, more research is advised to examine the use of pop-up book media in other abstract subject matter.

5. CONCLUSION

The use of barcode-based pop-up books is effective in improving third-grade elementary school students' understanding of the life cycle of living things. This medium successfully combines three-dimensional visual elements and interactive technology, making learning more engaging, concrete, and enjoyable for students, while also increasing their involvement in the learning process. Although the results are very positive, there are still some aspects that

need improvement, such as the practicality of the pop-up mechanism and enhancing the completeness of the material through barcodes. Therefore, it is recommended that the development of this pop-up book media involve improvements in design and functionality to enhance its practicality, ensuring that it can be used more effectively in various learning contexts. Further research is also recommended to explore the application of this media on other abstract learning materials, thereby expanding its benefits in supporting learning in elementary schools.

6. REFERENCES

Abdala, J. (2024). A qualitative approach on the instructional materials used in teaching and learning of English Language in Tanzania's secondary schools. Heliyon, 10(14), e34129. https://doi.org/10.1016/j.heliyon.2024.e34129

Abdulmalik-Labe, O. P., & Quilang, J. P. (2024). DNA barcoding of common freshwater eleotrids (Gobiiformes: Eleotridae) in the Philippines, with a global comparison and notes on their conservation and management. Global Ecology and Conservation, 53, e03014. https://doi.org/10.1016/j.gecco.2024.e03014

Agliata, R., Di Giuseppe, E., Favi, C., & Munafò, P. (2024). Technical and environmental analysis of an innovative window concept based on a hidden frame: Insights from a life cycle perspective. Journal of Cleaner Production, 485, 144424. https://doi.org/10.1016/j.jclepro.2024.144424

An, R., Zhang, H., Akbar, A., & Haider, S. A. (2024). Exploring the influence of teacher-student relationships on Chinese language learning through the mediating role of student's self-efficacy: Foreign language classroom anxiety as a moderator. Acta Psychologica, 251, 104552. https://doi.org/10.1016/j.actpsy.2024.104552

Archambault, S. G., Ramachandran, S., Acosta, E., & Fu, S. (2024). Ethical dimensions of algorithmic literacy for college students: Case studies and cross-disciplinary connections. The Journal of Academic Librarianship, 50(3), 102865. https://doi.org/10.1016/j.acalib.2024.102865

Bailey, A. L., & Wilkinson, L. C. (2022). Linguistics and education article collection. Introduction: Tracing themes in the evolution of the academic language construct. Linguistics and Education, 71, 101063. https://doi.org/10.1016/j.linged.2022.101063

Chain, M. K., Wider, W., Rasli, A., Thet, K. Z. Z., Tanucan, J. C. M., & Lobo, J. (2025). Experts' insights on the factors influencing students' decisions in choosing private HEIs in Malaysia. Asian Education and Development Studies, 14(3), 457–475. https://doi.org/10.1108/AEDS-10-2024-0237

Chang, Y. K., Lim, J., & Burkland, J. (2024). How can AR-enhanced books support early readers? Exploring literacy development through AR design principles. International Journal of Child-Computer Interaction, 42, 100701.

https://doi.org/10.1016/j.ijcci.2024.100701

Han, S., & Senyshyn, R. (2024). Dynamic intercultural learning and collaboration: transforming language teacher perspectives and practices. Journal for Multicultural Education, 18(4), 569–586. https://doi.org/10.1108/JME-07-2024-0081

Hidayat, L. E., Basthomi, Y., & Afrilyasanti, R. (2024). Exploring secondary school teachers' creativity in differentiated instruction (DI) practices across Indonesian EFL classrooms. Thinking Skills and Creativity, 53, 101620. https://doi.org/10.1016/j.tsc.2024.101620

Huang, C.-Y., & Wang, J. C. (2022). Effectiveness of a three-dimensional-printing curriculum: Developing and evaluating an elementary school design-oriented model course. Computers & Education, 187, 104553. https://doi.org/10.1016/j.compedu.2022.104553

Ordu, Y., Aydoğan, S., & Çalışkan, N. (2024). The effect of interactive learning method on nursing students' learning of movement requirement: A randomized controlled study. Nurse Education Today, 137, 106163. https://doi.org/10.1016/j.nedt.2024.106163

Ozdilek, Z., & Robeck, E. (2009). Operational priorities of instructional designers analyzed within the steps of the Addie instructional design model. Procedia - Social and Behavioral Sciences, 1(1), 2046–2050. https://doi.org/10.1016/j.sbspro.2009.01.359

Purwar, D., Flacke, J., & Sliuzas, R. (2024). Improving community understanding of cascading effects of critical infrastructure service failure: An experimental interactive learning process. Progress in Disaster Science, 24, 100383. https://doi.org/10.1016/j.pdisas.2024.100383

Sari, D., Allenidekania, & Afiyanti, Y. (2018). Family experience in treating children with chronic renal failure undergoing hemodialysis therapy. Enfermería Clínica, 28, 321–324. https://doi.org/10.1016/S1130-8621(18)30178-5

Schwenk, R., & Smith, S. (2025). An immersive spatially consistent multi-modal augmented virtuality human-machine interface for telerobotic systems. Computers in Industry, 167, 104260. https://doi.org/10.1016/j.compind.2025.104260

Singh, Y., & Phoolka, S. (2024). Unleashing the creative spark: the mediating role of employee work engagement on the relationship between employee training and creativity. International Journal of Educational Management, 38(2), 429–446. https://doi.org/10.1108/IJEM-07-2023-0342

Soemartono, T. (2014). Reconstruction of education policy in Jembrana Bali, best practices of creative and innovative leadership using soft systems methodology based action research. Procedia - Social and Behavioral Sciences, 115, 269–282. https://doi.org/10.1016/j.sbspro.2014.02.435

Tai, K. W. H. (2024a). Classroom interactional competence in an English medium instruction mathematics classroom: A creation of a technology-mediated

translanguaging space. Learning and Instruction, 90, 101849. https://doi.org/10.1016/j.learninstruc.2023.101849

Tai, K. W. H. (2024b). Transcending the boundaries of mode in online language teaching: A translanguaging perspective on ESL teachers' synchronous small group online tutorials. System, 121, 103185. https://doi.org/10.1016/j.system.2023.103185

Wahjuni S.IP, S. (2012). Interest based language teachings in EFL for 'Yahya' school teachers: Increasing communicative skills and student-centered learning. Procedia - Social and Behavioral Sciences, 66, 267–282. https://doi.org/10.1016/j.sbspro.2012.11.269

Zhang, P., Ma, S., Zhao, Y., Ling, J., & Sun, Y. (2024). Analysing influencing factors and correlation paths of learning burnout among secondary vocational students in the context of social media: An integrated ISM–MICMAC approach. Heliyon, 10(7), e28696. https://doi.org/10.1016/j.heliyon.2024.e28696

Zhu, M., Berri, S., Huang, Y., & Masoud, S. (2024). Computer science and engineering students' self-directed learning strategies and satisfaction with online learning. Computers and Education Open, 6, 100168. https://doi.org/10.1016/j.caeo.2024.100168

Zhu, R., Boukerche, A., Li, D., & Yang, Q. (2024). Delay-aware and reliable medium access control protocols for UWSNs: Features, protocols, and classification. Computer Networks, 252, 110631. https://doi.org/10.1016/j.comnet.2024.110631