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Development of an Interactive E-Booklet to Improve Science Process Skills in Ecology and Biodiversity Topics

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ABSTRACT

Students' difficulties in understanding ecology and biodiversity concepts indicate that science learning still emphasizes content mastery and test results rather than process skills. This condition leads to low levels of Science Process Skills (SPS), as shown in a preliminary study at SMP Muhammadiyah 15 Surabaya, where students' SPS average was only 18.99%. To address this issue, this research developed an interactive e-booklet designed to improve students' basic SPS. The study employed the ADDIE development model, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation. The subjects were 28 seventh-grade students (class VII-F). The instruments used included validation questionnaires, readability questionnaires, student response questionnaires, and SPS tests. The results showed that the interactive e-booklet had high feasibility, with an average media validity score of 99% and material validity score of 96%. The readability test achieved an average score of 88.79%, while the student response questionnaire reached 89.48%, both in the very high category. Furthermore, the implementation of the interactive e-booklet improved students' basic SPS, as indicated by an average N-Gain score of 0.59 in the moderate category. These findings suggest that the developed interactive e-booklet is valid, practical, and effective in enhancing students' basic SPS in ecology and biodiversity learning.

INTRODUCTION

Science education is the study of the natural world in a systematic way. Science education learning is not just about mastering concepts but also emphasizes experiential learning through experiments, which help students understand scientific principles (Sifah et al., 2024). However, in reality, students often fail to grasp or apply science education concepts in daily life. Current science education learning focuses only on achieving test scores, with students studying out of obligation rather than interest (Nurrahma & Az-Zahra, 2024). This contrasts with 21st-century demands, where students must develop skills

through hands-on learning. One such essential skill is Science Process Skills (Jalaludin et al., 2024).

Science Process Skills (SPS) involves scientific methods to gain understanding through experiments and experience (Minarni et al, 2024). It trains students to solve real-life problems (Awaliyah et al., 2023), helps them grasp scientific concepts, encourages active particscience educationtion in discussions and experiments (Hiğde & Aktamış, 2022), and fosters responsibility in appreciating scientific processes (Inayah et al., 2020). One topic suited for SPS is ecology and biodiversity, as it relates to students' daily lives and natural phenomena. This material covers ecology, populations, habitats, energy flow, conservation, and ecosystems yet, students still struggle to understand it (Az-Zahro & Fitriyah, 2023).

A pre-study survey at SMP Muhammadiyah 15 Surabaya found that 75% of students had difficulty with ecology and biodiversity. Interviews with science teachers revealed limitations in teaching media (e.g., reliance on printed books, no digital tools). A SPS pre-test showed an average score of 18.99%, indicating low SPS levels. Teachers attributed this to the lack of hands-on experiments or observations in science education lessons. To improve SPS, interactive e-booklets can be used as learning media. Research (Fitriati et al., 2023) shows that interactive e-booklets effectively enhance SPS.

An e-booklet is a digital teaching tool containing concise material, text, images, quizzes, and interactive content. It is practical, flexible, and accessible anywhere (Damayanti et al, 2022) . E-booklets improve learning outcomes and motivation (Nurjanah et al., 2024). Based on this background, the researcher proposes a study titled "Development of an Interactive E-Booklet to Improve Science Process Skills in Ecology and Biodiversity." The e-booklet will include videos, quizzes, images, and activities to boost SPS. Its interactivity facilitates active teacher-student engagement (Fauzizah et al., 2023). This study aims to analyze the e-booklet's validity, readability, student responses, and its impact on KPS for 7th-grade students at SMP Muhammadiyah 15 Surabaya.

METHOD

Research Design

This study adopts the Research and Development (R&D) method using the ADDIE development model. The ADDIE stages consist of Analyze, Design, Development, Implementation, and Evaluation. The final product of this research is an interactive e-booklet aimed at improving basic science process skills (SPS). The analysis stage was carried out through observation, interviews with science teachers, and the distribution of pre-research questionnaires to students. In the design stage, several activities were conducted, including preparing the content to be included in the e-booklet, determining the learning tools, and developing the research and development instruments.

The product development stage was carried out using the Canva application. This stage included designing the booklet layout, adding animations, and integrating content according to the initial design. The product was then refined through expert validation in media and material. The implementation stage involved applying the product after it had been validated and revised accordingly.

Population and Samples

The research was conducted in the even semester of the 2024/2025 academic year. The study was carried out at SMP Muhammadiyah 15 Surabaya. The population of this study was all seventh-grade students at SMP Muhammadiyah 15 Surabaya during the even semester of the 2024/2025 academic year. The sample was class VII-F consisting of 28 students. The sampling technique used was purposive sampling.

Instrument

The instructional instruments used in this research were in the form of learning tools. The tools used included teaching modules and student worksheets. The teaching module was used as the main reference during the learning process. It was developed based on the Merdeka Curriculum for seventh-grade junior high school science, specifically covering the topics of ecology and biodiversity. The module was designed for three days.

In addition, expert validation sheets were required, in the form of a media expert validation questionnaire to ensure the feasibility of the developed product, and a material expert validation questionnaire to assess the suitability of the content presented in the product. The data collection instruments in this research included a readability questionnaire, a student response questionnaire, and a science process skills test.

Procedure

The research procedure followed the ADDIE development model, consisting of the stages Analyze, Design, Development, Implementation, and Evaluation. At the Analyze stage, several types of analysis were conducted. First, a problem analysis was carried out to identify issues occurring during science learning. The identified problems were analyzed to determine appropriate solutions, using methods such as classroom observation, interviews with science teachers, and the distribution of pre-research questionnaires to students. Next, a needs analysis was conducted to determine the needs of teachers and students regarding learning media for the topic of ecology and biodiversity. Data collection was done through interviews with the teacher and questionnaires distributed to students to explore their interest in learning media. Finally, a material analysis was carried out to identify and align the content to be used in the development of the learning media. The selected topic was ecology and biodiversity.

In the Design stage, the researcher designed the learning media product based on the results of the previous analysis. The product developed was an interactive e-booklet on ecology and biodiversity. This stage involved preparing the content to be included in the e-booklet, determining the learning tools, and developing research and development instruments. The Development stage involved the creation of the product using the Canva application. This included designing the layout of the booklet, adding animations, and inserting content according to the previously planned design. The product was then refined through expert validation by media and material experts to ensure the product's quality and feasibility. After the validation stage and once the product was declared feasible, a trial was conducted. The trial included individual testing (with one student from grade VIII) and small group testing (with nine grade VIII students), where the students were given the e-booklet to use.

During the Implementation stage, the validated and revised product was implemented in class VII-F at SMP Muhammadiyah 15 Surabaya, involving 28 students. The purpose was to measure student responses, readability of the media, and improvement in science process skills after using the interactive e-booklet on ecology and biodiversity. The Evaluation stage focused on analyzing the readability of the interactive e-booklet and student responses toward the media. This stage included both formative and summative evaluations. Formative evaluation was conducted through out the development process to monitor the product’s progress, while summative evaluation was carried out at the end to assess whether the interactive e-booklet was appropriate and feasible for use as a learning medium.

Data Analysis Techniques

The data analysis techniques used in this study consisted of several stages. First, instrument validation was carried out by expert validators to ensure the validity of the research instruments. The validity score was calculated by dividing the total score given by

the validator by the maximum possible score, then multiplying by 100%. The results were then interpreted using predetermined assessment criteria. The readability of the e-booklet was analyzed by calculating the percentage of the total score obtained from student responses against the maximum score, then converting it into percentage form and categorizing it based on the readability criteria. Student responses to the product were analyzed using a similar method by calculating the percentage of the total score achieved over the maximum possible score and interpreting the results according to response criteria.

The science process skills (SPS) test results were analyzed by calculating the percentage of the raw score obtained by each student against the maximum possible score. To measure improvement, pretest and posttest scores were compared using a normalized gain (N-gain) formula, which compares the difference between posttest and pretest scores relative to the maximum possible gain, then categorized based on gain score interpretation guidelines.

RESULT AND DISCUSSION

This study developed an interactive e-booklet to enhance students' basic science process skills (SPS) in class VII F of SMP Muhammadiyah 15 Surabaya. Problem analysis from teacher interviews revealed students had never conducted direct observations and that interactive media had not been used in science learning. Pre-research questionnaires showed that students faced difficulties in understanding science content, especially ecology and biodiversity, and lacked hands-on activities. Based on this, ecology and biodiversity were chosen as the focus materials due to their potential to improve SPS through active learning. The design phase involved preparing content, SPS-based activities, illustrations, quizzes, videos, a three-meeting STAD-based teaching module, and corresponding worksheets. Validation instruments for material, media, readability, responses, and SPS tests were also prepared. The development phase involved creating the e-booklet using Canva, with a size of 14.8 cm x 21 cm. The product was validated by content and media experts, and revisions were made based on their feedback.

The validation conducted in this study included material validation, which was carried out by two validators. The average material validity score obtained from both validators was 96%, categorized as very valid. This indicates that the material in the interactive e-booklet to enhance basic science process skills (SPS) is feasible for use with minor revisions. Media validation was also conducted by two validators, with an average media validity score of 99%, categorized as very valid. This shows that the interactive e-booklet effectively trains basic SPS indicators such as observing, classifying, measuring, predicting, communicating, and drawing conclusions through direct learning experiences gained by students (Santiawati et al., 2022).

Readability was assessed to determine the readability level of the interactive e-booklet. In the implementation phase, readability was tested through a large group trial in class VII-F, involving 28 students at SMP Muhammadiyah 15 Surabaya. The readability results were analyzed based on three main aspects. The material and media aspect received an average score of 88.63%, categorized as very good. The next aspect, language presentation, obtained an average percentage score of 88.84%, also categorized as very good. Meanwhile, the format aspect received an average score of 88.90%, categorized as very good. This indicates that the developed interactive e-booklet is easy to read and understand; the visual appearance encourages students to be more engaged in learning, and the layout of text and images is neatly arranged to help students better comprehend the content (Nurjanah et al., 2024). These results show that the interactive e-booklet is suitable for use as a learning medium.

Student responses were collected to assess their reaction to the interactive e-booklet. The responses were analyzed based on three main aspects: content, language presentation,

and format. In the content aspect, the e-booklet received an average score of 88.45%, categorized as very good. This result indicates that the material presented was appropriate to the topic and delivered in an engaging way. Activities in the interactive e-booklet, such as "Let's Observe," "Let's Try," and "Let's Discuss," helped students actively understand the concepts of ecology and biodiversity. This aligns with Santiawati et al., (2022), who found that students' understanding improves when engaging in activities involving real-world contexts. The language presentation aspect received a score of 88.90%, also categorized as very good. For the format aspect, the percentage score was 88.75%, also within the very good category. It can be concluded that the interactive e-booklet received a highly positive response from students, indicating that it is effective for use in learning.

The measurement of science process skills (SPS) was carried out by administering an essay test consisting of 12 questions, with each SPS indicator represented by two questions. The test was conducted before the implementation of the e-booklet (pre-test) and after its implementation (post-test). The developed media included basic SPS indicators such as observing, classifying, measuring, predicting, concluding, and communicating (Sifah et al., 2024). The results of the pre-test and post-test were analyzed using the N-Gain formula.

Table 1
N-Gain Results of Basic Science Process Skills (SPS).

Indicator		Pre-Test	Post-Test	N-Gain
Science Process Skills (SPS)	Observing	20,00%	64,70%	0,56
	Predicting	44,64%	68,57%	0,43
	Classifying	5,71%	67,50%	0,66
	Communicating	2,86%	54,64%	0,53
	Concluding	11,43%	66,07%	0,62
	Measuring	29,29%	80,71%	0,73
Average		18,99%	67,03%	0,59

The observing indicator obtained an N-Gain score of 0.56, with an increase from a pre-test average of 20,00% to 64,70% in the post-test. This improvement was supported by observation activities through images and real practices, aligning with Piaget's theory that direct experiences enhance learning (Magdalena et al., 2023). The predicting indicator scored an N-Gain of 0.43, with the average rising from 44,64% to 68,57%. Problem-solving activities presented in the e-booklet effectively trained students' prediction skills (Hartati et al., 2022). The classifying indicator achieved an N-Gain of 0.66, with scores increasing from 5.71% to 67.50%, showing improved student ability in grouping and distinguishing problems (Agustina et al., 2024). The communicating indicator showed an N-Gain of 0.53, increasing from 2,86% to 54,64%. Initially, students struggled to express data in words, but through presentations and discussions, their communication skills improved (Santiawati et al., 2022). The concluding indicator reached an N-Gain of 0.62, rising from 11.43% to 66.07%. Students were guided to draw conclusions based on observations, discussions, and experiments, which is consistent with Prananda et al., (2022), stating that structured media supports conclusion-making. The measuring indicator had the highest N-Gain at 0.73, improving from 29,29% to 80,71%. Interactive media activities, such as measuring in artificial ecosystems, significantly enhanced students' measuring skills (Fitriati et al., 2023).

CONCLUSION

The interactive e-booklet developed in this study is considered suitable for use in the learning process, with an average media validity score of 99% and material validity score of 98%, both falling into the very valid category. The readability of the e-booklet received an average score of 88.79%, categorized as very high, while student responses reached an average of 89.48%, also in the very high category. Furthermore, students' basic

science process skills showed improvement after the implementation of the learning materials, with an average N-Gain score of 0.59, categorized as moderate.

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