

## Development of Biology E-Flashcard – Based Instructional Resource for Tenth–Grade Topic: *Classification of Living Organism at SMA Negeri 2 Gorontalo–High School*

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### Abstract

**Background:** Several students experience difficulties in mastering biological classification concepts. To address this issue, a digital E-Flashcard was developed as an instructional medium that supports technology-integrated learning, enhances motivation and comprehension, and offers flexible and practical use. This study evaluates the validity, practicality, and impact on learning outcomes of the E-Flashcard designed for Tenth-grade students at SMA Negeri 2 Gorontalo. **Methodology:** This study employed a Research and Development (R&D) method using the ADDIE development model, with a one-group pretest-posttest design involving 20 students from class X4 at SMA Negeri 2 Gorontalo. The instruments used included interview instruments, media and material validation instruments, and pretest and posttest instruments. **Findings:** The evaluation results indicated that the developed E-Flashcard met high feasibility standards, with material validation reaching 95.33% and media validation achieving 91%, both categorized as very feasible. Practicality assessment showed highly positive responses, reflected by a 98.5% score from teachers and 86% from students, both within the very practical category. Furthermore, analysis of learning improvement based on pretest and posttest scores yielded an N-gain value of 0.55, which falls into the moderate improvement level. These findings confirm that the E-Flashcard media satisfies the criteria of validity and practicality and demonstrates a meaningful improvement in student learning outcomes during limited-scale implementation. **Contributions:** This research advances digital biology instruction by introducing and empirically validating an ADDIE-based E-Flashcard model that enhances students' conceptual understanding of biological classification, offering a scalable alternative to conventional printed flashcards in secondary education

**Keywords:** Classification; Development; E-Flashcard; Living Organisms



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## INTRODUCTION

Educators must continuously follow developments in science and information, particularly in biology, especially in the topic of classification of living organisms. Classification is the process of grouping living organisms based on their similarities and differences in characteristics (Pratami et al., 2022). The material on classification of living organisms is included in the *Merdeka* (Emancipated) Curriculum with Learning Objectives (TP) codes 10.2.3 and 10.2.4. Some students struggle to understand biology material, especially the classification of living organisms. These difficulties arise because students need to visualize the material they are studying, including distinguishing the morphological characteristics of each organism and recognizing its species (Insani, 2016).

Learning is an interaction process between teachers and students, either directly through face-to-face activities or indirectly through the utilization of various learning media. This process involves interconnected components such as learning objectives, material, media, classroom management, evaluation, and follow-up of learning outcomes (Mawarti et al., 2023).

Teachers should use learning media as tools to deliver material effectively and facilitate students' understanding. Learning media are instructional aids that function as channels for conveying messages during learning, thereby stimulating students' cognitive, affective, and attentional aspects and increasing learning motivation to achieve optimal learning objectives (Ariyanto et al., 2018). Learning media serve as intermediaries between teachers and students, facilitating effective and efficient understanding of instructional material (Hasan et al., 2021). Through learning media, the teaching and learning process becomes more effective and efficient, fostering positive interaction between teachers and students (Firmadani, 2020). Therefore, teachers must carefully plan classroom instruction and understand the crucial role of learning media.

Based on observations conducted at SMA Negeri 2 Gorontalo and interviews with a Grade X Biology teacher, several issues involving students, teachers, and classroom learning processes were identified. Questionnaire analysis indicated that 76% of students experienced difficulties in learning classification material, particularly in distinguishing morphological characteristics and pronouncing or memorizing scientific names of animals and plants. Additionally, the learning media used by teachers were limited to PowerPoint presentations. Teachers reported difficulties teaching students to distinguish morphological characteristics and to pronounce scientific names, due to complex terminology and broad material coverage, constrained by limited instructional time. Classroom learning issues included limited student participation and students' reluctance to express opinions or answers.

One alternative solution to these problems is the utilization of Flashcard-based learning media. Flashcards are educational tools that use picture cards for learning. Along with technological development, flashcards that were previously small printed cards can now be developed into digital flashcards (Hermansyah et al., 2023).

Flashcards can increase students' learning motivation by mimicking the experience of learning while playing, thereby reducing boredom during instruction (Anggreani & Satrio, 2022). Additionally, flashcards provide simple visual and textual presentations that support right-brain processing and memory (Ardika et al., 2024). Although various studies have shown the effectiveness of digital flashcards in increasing motivation and memory retention, limited development specifically addresses morphological visualization and pronunciation of scientific terms in Grade X classification material. Based on the description above, this study focuses on developing E-Flashcard learning media for the classification of living organisms material at SMA Negeri 2 Gorontalo. This study aims to develop digital learning media that are both feasible and practical for classroom implementation.

## **METHOD**

### **Research Design**

This study employed a Research and Development (R&D) approach to develop a new product or improve an existing one, thereby enhancing its effectiveness in supporting the learning process. The product developed was an E-Flashcard on the classification of living organisms for Grade X students. The development referred to the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) developed by Dick & Carey (1978).

### **Development Procedure**

#### *Analysis Stage*

1. Curriculum Analysis

Curriculum analysis was conducted by collecting data through observation and interviews with the biology teacher, which served as the basis for planning the development of learning media. The purpose was to obtain comprehensive information regarding the material on the classification of living organisms and its learning objectives. This analysis was conducted to confirm that the developed learning media were aligned with students' needs and consistent with the school's curriculum regulations.

2. Student Characteristics Analysis

A student characteristics analysis was conducted by collecting data using a needs assessment instrument to determine students' level of understanding of the classification of living organisms material.

3. Teaching Material Analysis

Teaching material analysis was conducted through observation and interviews with the biology teacher to obtain information regarding instructional materials commonly used in the learning process, particularly on the classification of living organisms topic.

4. School Facilities Analysis

School facilities analysis was conducted through observation and interviews with the biology teacher to identify facilities frequently used in biology instruction, especially for the classification of living organisms material.

### *Design Stage*

At this stage, the researchers designed the product according to the identified needs. The instructional media design focused on the learning objectives: students could identify the grouping of living organisms based on their morphological characteristics and describe the benefits of classification in daily life. To consider students' cognitive load, the material was presented concisely, systematically, and without excessive content. The design stage was conducted after identifying problems at SMA Negeri 2 Gorontalo. Several steps were undertaken in designing the E-Flashcard media, including determining display design elements such as background color, font type, and images, and selecting the content to be presented. Backgrounds, illustrations, and typography were designed attractively to provide an engaging learning experience when students began using the E-Flashcard media.

### *Development Stage*

#### 1) Development of Learning Media and Instruments

The previously designed media were further developed into a complete instructional product to be validated by three validators with minimum academic qualifications of a master's degree (S2) for media and material experts, and at least a bachelor's degree (S1) for practitioner experts (teachers).

#### 2) Expert Validation

This stage involved evaluation based on several aspects. For material experts, the aspects included material coverage, content feasibility, presentation feasibility, and language aspects. For media experts, the aspects included content quality, display quality, and media usability. Comments and suggestions from validators served as the basis for improving the product's design and ensuring its accuracy, effectiveness, and optimal quality.

#### 3) Revision

The revision stage was conducted after the validation process. Assessment scores, comments, and suggestions from validators were used to address weaknesses in the developed media, ensuring it met feasibility standards for field testing.

### **Product Trial**

Before implementation, the E-Flashcard product on the classification of living organisms material was validated by media and material experts and revised (Stage I revision). The revised product was then evaluated for practicality by one biology teacher and 20 Grade X students at SMA Negeri 2 Gorontalo. The learning media trial was conducted on a limited scale by implementing the teaching and learning process using the E-Flashcard media. The research design employed a pre-experimental one-group pretest–posttest design with intervention conducted over two meetings (2 × 45 minutes).

**Instrument**

The data collection instruments in this study included a media expert validation instrument comprising 3 items, each rated on a 4-point Likert scale from *not valid* to *very valid*. The assessment indicators covered alignment of concepts and learning objectives (2), material presentation (2), E-Flashcard presentation (4), E-Flashcard quality (2), and E-Flashcard usability (3). The material expert validation instrument consisted of 4 items, each assessed on a 4-point Likert scale ranging from *not valid* to *very valid*. The indicators included alignment with learning objectives (1), material accuracy (3), display supporting the material (2), presentation techniques (3), presentation support components (2), compliance with language rules (1), and communicativeness (1). The practicality instrument included a teacher response questionnaire with 4 items, measured on a 4-point Likert scale ranging from *not practical* to *very practical*. The assessment indicators included E-Flashcard content (2), E-Flashcard presentation (3), material accuracy (2), proper and correct language use (1), clarity of language (1), and feasibility of the E-Flashcard media (1). The student response instrument also consisted of 4 items, each rated on a 4-point Likert scale from 'not appropriate' to 'very appropriate'. The learning outcome test instrument was administered through pretest and posttest assessments to determine improvement in learning outcomes. Improvement was measured using the normalized gain (N-gain) analysis, categorized into low, moderate, and high levels.

**Data Analysis Technique**

This development research utilized both qualitative and quantitative data obtained from validation results by lecturers serving as media and material experts, as well as from the biology teacher and students during the practicality testing stage. Quantitative data, such as validation scores from media and material expert instruments, were analyzed using an adapted Likert scale and subsequently described qualitatively. The Likert scale assessment method is presented in Table 1.

**Table 1.** *Likert* Scale Validation Categories (Khalbu et al., 2018)

Score	Description
4	Very Feasible (VF)
3	Feasible (F)
2	Less Feasible (LF)
1	Not Feasible (NF)

The percentage calculation of the data analysis was conducted using the following formula, as referenced (Ernawati et al., 2022),

$$P = \frac{\Sigma s}{\Sigma \text{Max}} \times 100 \% \dots\dots\dots (1)$$

- Where,
- P: Validity Percentage (%)
- Σ: Total Score Obtained
- x: Maximum Score

The obtained percentages were subsequently adjusted according to validation percentage criteria categorized into several levels, as shown in Table 2

**Table 2.** Expert Validation Score Categories (Khalbu et al., 2018)

Percentage (%)	Interpretation Criteria
0 - 20	Not Valid
21 - 40	Less Valid
41 - 60	Fairly Valid
61 - 80	Valid
81 - 100	Very Valid

The data obtained from the biology teacher and student response sheets were analyzed to determine the practicality level of the E-Flashcard media for the classification of living organisms material, following a limited trial implementation. The following practicality formula was used to analyze teacher and student response data (Prananda et al., 2020):

$$\text{Practicality (\%)} = \frac{\text{Total score per statement}}{\text{Total respondents}} \times 100\% \dots\dots\dots (2)$$

**Table 3.** Practicality Categories (Destiara, 2020)

Percentage (%)	Category
0 - 20	Not Practical
21 - 40	Less Practical
41 - 60	Fairly Practical
61 - 80	Practical
81 - 100	Very Practical

Teacher and student response data were analyzed using quantitative descriptive analysis by reviewing percentage-based assessment results. To measure the improvement in students' learning outcomes before and after instruction using the E-Flashcard media. The N-gain formula refers to Huda (2021), gain scores were calculated using the following formulas:

$$N - gain = \frac{(\text{postest score} - \text{pretest score})}{\text{maximum score} - \text{pretest score}} \dots\dots\dots (3)$$

Where,  
*N-gain*: normalized gain  
*Postest* score: average final score  
*Pretest* score: average initial score

The normalized gain scores were classified into three levels of improvement, as shown in Table 4. An N-gain score greater than 0.70 indicates that E-Flashcard, as a learning medium, is highly effective in improving learning outcomes. A score between 0.30 and 0.70 indicates moderate effectiveness, while a score below 0.30 indicates low effectiveness in improving learning outcomes.

**Table 4.** N-gain Categories (Yusuf, 2017)

Categories	Average N-gain
Low	$N\text{-gain} \leq 0.30$
Moderate	$0.30 < N\text{-gain} \leq 0.70$
High	$N\text{-gain} \geq 0.70$

## RESULTS AND DISCUSSION

### Analysis Stage

#### *Curriculum Analysis*

Based on interviews with the Grade X Biology teacher at SMA Negeri 2 Gorontalo, students still struggle to distinguish morphological characteristics and to pronounce the scientific names of animals and plants. This difficulty arose because many scientific terms are challenging to pronounce when learned solely through PowerPoint media.

#### *Student Characteristics Analysis*

This analysis was conducted to identify students' cognitive abilities, prior knowledge background, level of understanding, and learning motivation. The activity was carried out by having Grade X students at SMA Negeri 2 Gorontalo complete an initial observation instrument, covering instructional tools, learning resources, learning methods, and learning media.

#### *Teaching Material Analysis*

Based on interviews with the Biology teacher, this analysis aimed to obtain information on the learning resources most frequently used in the instructional process, particularly in the classification of living organisms material. The results indicated that commonly used teaching materials included textbooks, teaching modules, and student worksheets (LKPD).

#### *School Facilities Analysis*

Facilities available at SMA Negeri 2 Gorontalo to support biology instruction, especially in the classification of living organisms material, include LCD projectors. However, several classrooms had malfunctioning LCD projectors, requiring teachers to exchange classrooms to access functional equipment. The results of this analysis were used to determine the type of learning media that would be practical and facilitate students' learning.

### Design Stage

Based on the analysis results, the researchers began designing the E-Flashcard learning media using the Wordwall platform and a microsite. The media were developed for a single instructional unit, namely the classification of living organisms for Grade X. The activities conducted included the following,

### Software Selection

The researchers used Wordwall and microsite software in developing the E-Flashcard learning media. The media can be accessed via computers and smartphones.

### Content Design

The material in the media aligned with biology textbooks and was supplemented with references from online sources. When students accessed the media link, content on taxonomy and morphology of vertebrates and angiosperms was displayed. Images and audio supported this section to help students better understand the material on classification.

### Product Design

At this stage, the steps undertaken were as follows:

#### Initial Display

When students or teachers accessed the E-Flashcard link, an initial display screen appeared (Figure 1).



Figure 1. Initial Display of the E-Flashcard Media



Figure 2. Example of Taxonomy Content Display (Piscis)



Figure 3. Example of Morphology Content Display (Pisces)

### *Content Display*

The display included instructional material covering taxonomy and morphology of vertebrates and angiosperms (Figures 2 and 3).

### *Typography*

The font type used in the E-Flashcard was Comic. The use of this font aimed to clarify instructional content and enhance the media's visual appeal, thereby attracting students' attention.

### *Image and Audio Design*

E The E-Flashcard incorporated images and audio obtained from the Wordwall platform when adding instructional content.

## **Development Stage**

### *Validity Analysis of the E-Flashcard*

Before being tested with students, the developed media were evaluated by media and materials experts. Material expert assessment focused on several aspects (Figure 4). Based on the material expert validation results, it can be observed that: (1) the material coverage aspect obtained a percentage score of 100% with a very valid criterion; (2) the content feasibility aspect obtained a percentage score of 83%, categorized as very valid; (3) the presentation feasibility aspect obtained a percentage score of 81%, also categorized as very valid; and (4) the language aspect obtained a percentage score of 100%, classified as very valid.

The assessment conducted by the media expert focused on several aspects, as illustrated in the following figure 5. Based on the media expert validation results, it can be observed that: (1) the content quality aspect obtained a score of 100%, categorized as very valid; (2) the display quality aspect obtained a score of 86%, categorized as very valid; and (3) the use of the flashcard media obtained a score of

100%, also categorized as very valid. During the evaluation process, both material and media expert validators provided several comments and suggestions regarding the developed E-Flashcard learning media. These inputs were utilized as the basis for revising and improving the learning media.

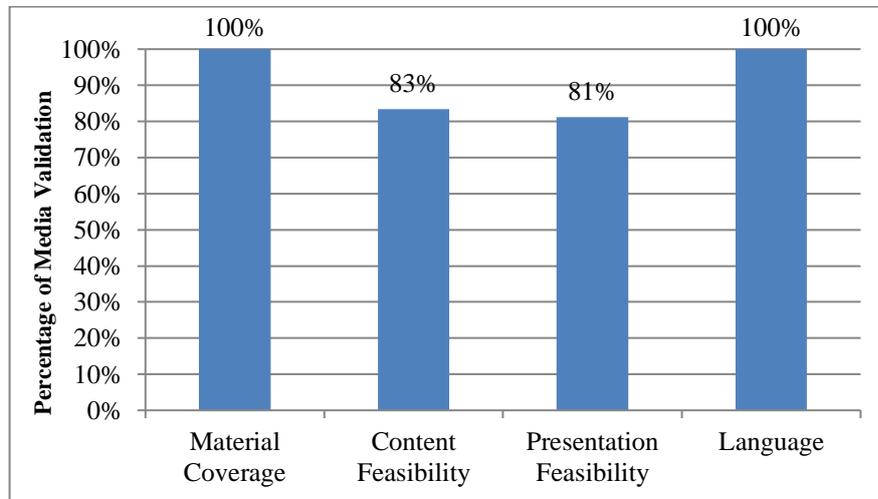


Figure 4. Graphic for the Results of Material Expert Validation Analysis

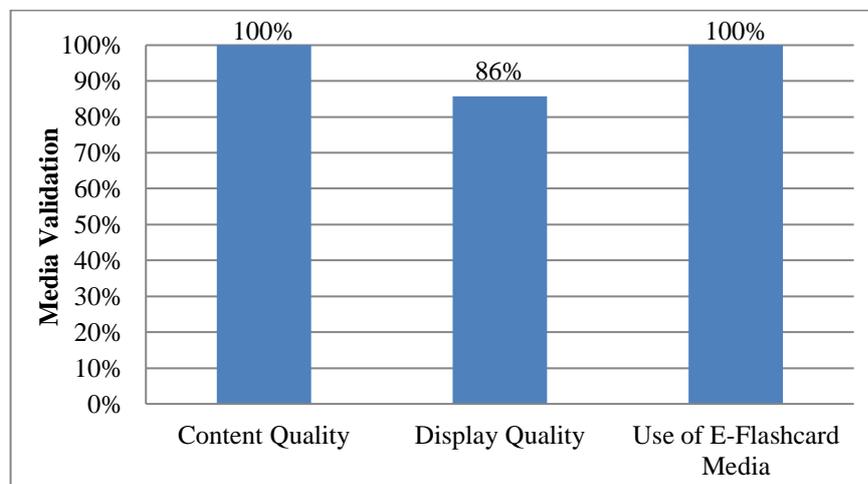


Figure 5. Graphic for the Results of Media Expert Validation Analysis

### *Practicality Analysis*

Based on student response results, the limited trial involving 20 respondents indicated that the developed learning media were well received and perceived as innovative.

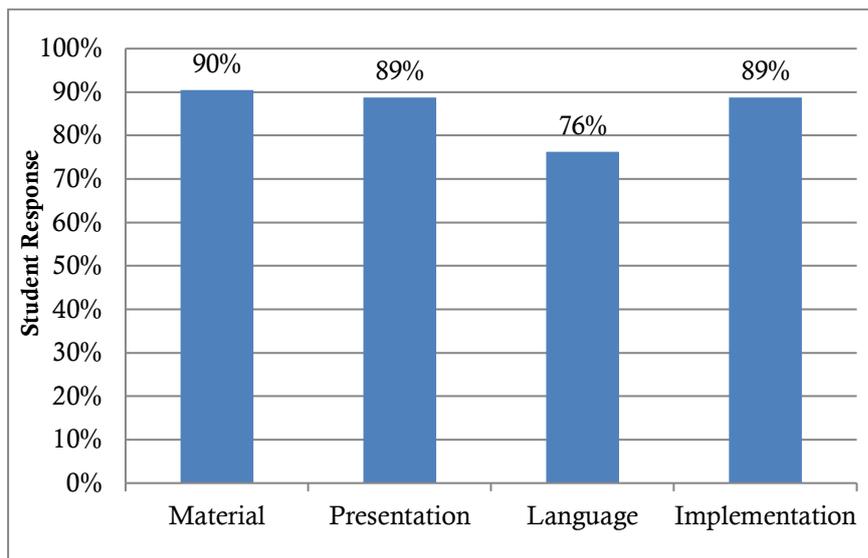


Figure 6. Graphic for the Student Response Analysis

Based on the students' responses after using the E-Flashcard learning media, four aspects were evaluated: material, presentation, language, and implementation. The material aspect received a 90% score, categorized as good. The presentation aspect achieved 89%, categorized as very good. The language aspect obtained 76%, categorized as very good, and the implementation aspect achieved 89%, also categorized as very good. Overall, the students' responses to the E-Flashcard learning media were very good, with an average score of 86%.

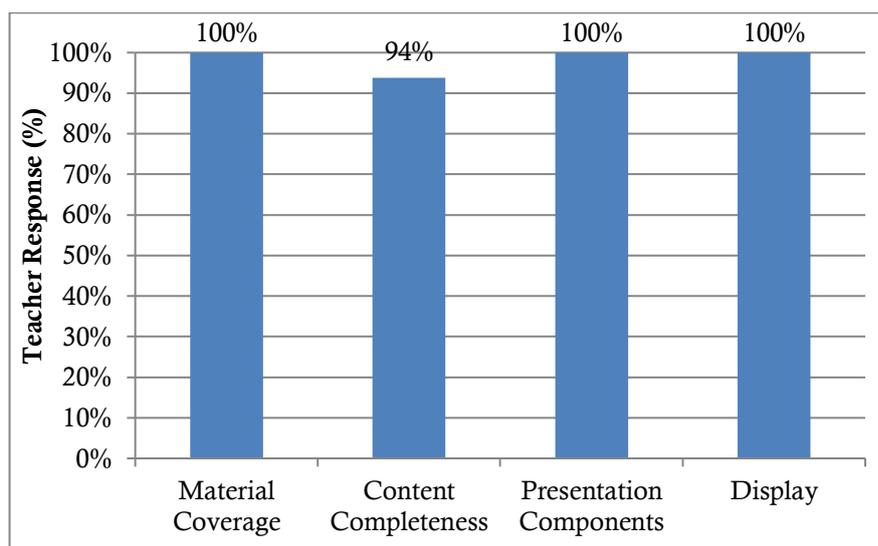


Figure 7. Teacher Response Graphic

### Learning Outcome Analysis

The N-gain analysis from the small-scale trial indicated that all 20 students improved in learning outcomes, with the improvement categorized as moderate. The average N-gain score was 0.55, which falls within the moderate improvement category.

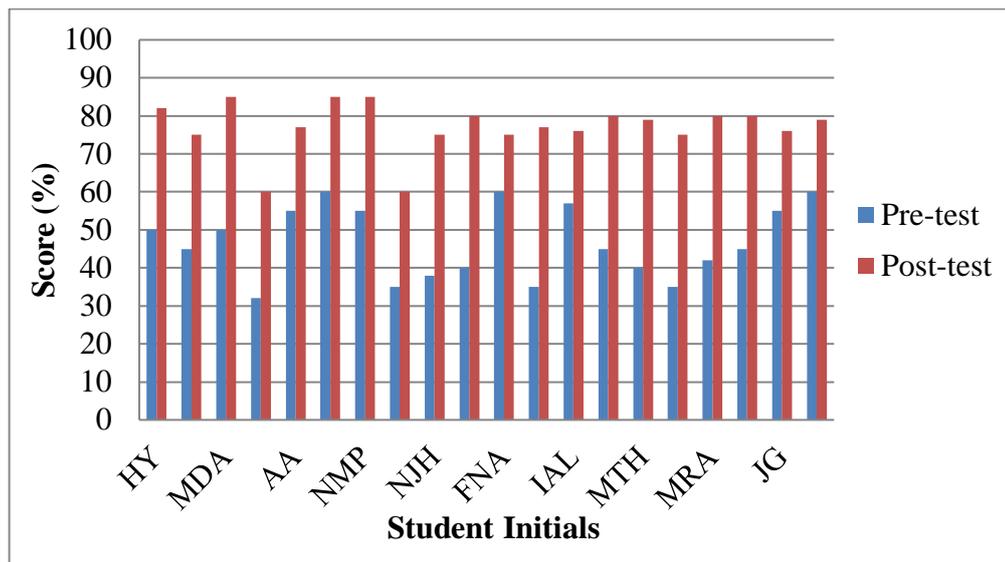


Figure 8. Graphic of Students' Learning Outcomes

## DISCUSSION

### *Analysis Stage*

Curriculum analysis was conducted to obtain information on the *Merdeka* Curriculum implemented at SMA Negeri 2 Gorontalo, which has been in place since 2022. This analysis included evaluation of teaching modules, learning objectives, and delivered materials. The implementation of the *Merdeka* Curriculum provides teachers with flexibility to adjust instruction to students' levels of understanding and does not require mastery of all material. If students have mastered part of the material, teachers may proceed to subsequent topics in accordance with flexible and student-centered learning principles (Kemendikdasmen, 2022).

The analysis of student characteristics was conducted to determine students' level of understanding of the material on the classification of living organisms. The findings indicated that students still experienced difficulties in understanding classification concepts, distinguishing morphological characteristics, and pronouncing scientific names of animals and plants. Therefore, students require technology-based learning media beyond PowerPoint to better support the learning process and facilitate understanding. This finding is consistent with the view that technology-based instructional media can enhance conceptual understanding and help visualize abstract material (Arsyad, 2017).

The analysis of teaching materials aimed to identify the instructional resources used in the learning process. The results indicated that commonly used materials included textbooks, teaching modules, and student worksheets (LKPD). Furthermore, based on the needs analysis, most students expressed interest in using E-Flashcards as supplementary instructional support. Technology-based media such as E-Flashcards can increase learning interest and conceptual understanding by presenting information visually and interactively, thereby helping students recognize and remember instructional material more effectively than traditional media alone (Ilmah et al., 2026).

The school facilities analysis was conducted to identify infrastructure supporting biology instruction, particularly in the classification of living organisms material. The findings showed that LCD projectors and laptops were available; however, some LCD projectors were damaged, which hindered classroom instruction. This condition required the development of practical, easily accessible learning media that could be used on smartphones or laptops without the need for LCD projectors. The E-Flashcard media were considered suitable because they are flexible and can be used independently by students. This finding aligns with research [Mardin et al., \(2025\)](#) which states that technology-based flashcard media are valid and feasible for biology instruction because they effectively support conceptual understanding.

### **Design Stage**

At this stage, the learning media were designed using Wordwall and microsite platforms. The design process began with planning the media display, including (1) the initial interface, (2) content presentation, (3) typography, and (4) image and audio design. After completing the design stage, the process proceeded to media development.

### **Development Stage**

#### ***Validity***

Validity testing aimed to determine whether the developed instrument accurately measured the intended constructs ([Hamid, 2019](#)). The E-Flashcard learning media were validated by material and media experts. The material expert assessment covered material coverage, content feasibility, presentation feasibility, and language aspects, with an average validation score of 91%, indicating very validity. This result aligns with [Wuryanti & Kartowagiran \(2016\)](#) who state that a product is considered valid if it meets the minimum valid category ( $\geq 80\%$ ). The media expert assessment included content quality, display quality, and ease of use of the E-Flashcard media, yielding an average score of 95.33%, categorized as very valid. This finding is consistent with [Khayati & Raharjo \(2020\)](#) who report that validity falls within the very valid category if it is within the 81 – 100% interval.

Based on validation results, several comments and suggestions were provided to improve the E-Flashcard, particularly regarding morphological accuracy, image quality, and color combinations. These inputs served as guidance for revising the developed media ([Khalbu et al., 2018](#)). The validation results indicate that the E-Flashcard media fulfilled the required validity criteria and were deemed feasible for classroom implementation. According to [Dyah et., al \(2024\)](#), media validation is essential to evaluate the developed product's display and ensure its feasibility before classroom use.

#### ***Practicality***

The practicality of the E-Flashcard was evaluated through teacher and student response instruments. Teacher responses were obtained from four assessment indicators comprising 12 statements, while student responses were collected through four indicators comprising 13 statements from 20 students.

Limited trial results showed that teacher responses regarding material coverage, content completeness, presentation components, and display received an average score of 98.5%, indicating that they were very practical. Meanwhile, student responses regarding material, presentation, language, and implementation obtained an average score of 86%, also categorized as very practical. This finding aligns with [Kartini & Putra \(2020\)](#) who state that questionnaire responses are categorized as very good if the percentage falls within the 86 – 100% range.

These findings indicate that the developed E-Flashcard media are highly practical for instructional implementation. This conclusion is supported by [Hestari et al., \(2016\)](#) who state that instructional media are considered practical if they are easy for students to use during the learning process.

### ***Learning Outcomes***

Learning outcomes were measured by administering a pretest at the beginning of the lesson and a posttest at the end of the instructional session. This approach is consistent with [Nurrita \(2018\)](#) that the teaching and learning process, preceded by a pretest and concluded with a posttest, aims to determine the extent of students' cognitive development regarding the material before and after instruction.

According to [Gunawan \(2017\)](#) learning outcomes refer to the assessment results students achieve as a measure of performance during the learning process. The measurement of learning outcomes through pretest and posttest administration serves as an indicator of instructional effectiveness. This statement is supported by [Effendy \(2016\)](#) who explains that the results of both tests can function as benchmarks for student achievement and demonstrate improvements in learning outcomes.

The pretest and posttest were administered to analyze students' achievement in the classification of living organisms material delivered through the E-Flashcard media. The pretest results indicated that none of the students achieved the Minimum Completeness Criteria (KKM) prior to the intervention. The pretest was administered to assess students' initial abilities and their understanding of the material.

Posttest results showed that 18 students achieved the Minimum Completeness Criteria (KKM) score of 75, while two students did not meet the required standard. The lack of mastery observed in these two students was attributed to differences in individual learning abilities, leading to incomplete competency attainment. This finding is consistent with [Armansyah et al., \(2019\)](#) who reported that one common issue in classroom instruction is students' lack of mastery of the material taught. Similarly [Kurniawan & Nita \(2018\)](#) state that difficulties in understanding instructional material lead to lower comprehension levels.

Based on the findings, it can be concluded that students' learning outcomes improved. This improvement is reflected in the average N-gain score of 0.55, categorized as moderate, in biology learning using the E-Flashcard media. The moderate classification may be attributed to the limited scale of the study's implementation. This result is consistent with [Narestuti et al., \(2021\)](#) who reported that E-Flashcard media can enhance students' learning outcomes.

## CONCLUSION

Based on the results of the study conducted on the development of E-Flashcard learning media for the classification of living organisms material for Grade X4 students at SMA Negeri 2 Gorontalo, it can be concluded that the E-Flashcard media demonstrated a very high level of validity. Validation by media experts yielded a score of 95.33%, categorized as very valid, while validation by material experts obtained a score of 91%, also categorized as very valid. The practicality of the E-Flashcard media was likewise high, as indicated by teacher responses (average score of 98.5%; very practical category) and student responses (average score of 86%; very good category). The results of the limited-scale trial showed an improvement in students' learning outcomes, reflected in an average N-gain score of 0.55 (moderate) and an average student achievement score of 77.5%, exceeding the Minimum Completeness Criteria (KKM) of 75. Furthermore, this study contributes to science education and instructional media development by presenting systematically designed digital E-Flashcards that can serve as a reference for teachers and future researchers. Based on these findings, further research is recommended on a broader scale, involving multiple classes or schools, to strengthen the generalizability of the results.

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