



Development of an Edpuzzle-Based Learning Video on the Human Digestive System to Enhance Conceptual Understanding among Eleventh-Grade High School Students

^{1*}Alya Rahma, ²Rohani

^{1,2}Department of Biology Education, Faculty of Education and Teacher Training, Universitas Islam Negeri Sumatera Utara, Indonesia.

*Corresponding Author e-mail: alya0310223065@uinsu.ac.id

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Abstract: This study aimed to develop an Edpuzzle-based instructional video on the human digestive system and evaluate its validity, practicality, and effectiveness in improving students' conceptual understanding. This research employed a Research and Development (R&D) approach using the 4D development model, consisting of Define, Design, Develop, and Disseminate stages. The participants were 25 eleventh-grade students at SMA Negeri 7 Medan. The research instruments included expert validation sheets, teacher and student response questionnaires, and essay tests in the form of pre-tests and post-tests based on Anderson and Krathwohl's indicators of conceptual understanding, including interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. Data were analyzed through validity, practicality, and effectiveness assessments using percentage analysis and N-Gain calculations. The results showed that the Edpuzzle-based instructional video was categorized as highly valid, with validation scores of 98.75% from media experts, 96.25% from material experts, and 94% from assessment experts. The practicality assessment indicated that the developed media was highly practical, with scores of 97.50% based on teacher responses and 98.33% based on student responses. Furthermore, the effectiveness analysis demonstrated an improvement in students' conceptual understanding, with the average score increasing from 49.52 on the pre-test to 86.04 on the post-test and an N-Gain value of 0.72, categorized as high. Therefore, the Edpuzzle-based instructional video developed in this study is a valid, practical, and effective learning medium that can support students' conceptual understanding of the human digestive system and provide an innovative alternative for Biology learning in accordance with the needs of modern education.

Keywords: Instructional video; Edpuzzle; conceptual understanding; biology; human digestive system

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INTRODUCTION

In the modern educational era, students are expected to develop critical and conceptual thinking skills to adapt to rapid advances in science and technology. Conceptual understanding refers to the ability to comprehend abstract ideas, including processes, definitions, and relationships within a specific knowledge domain (Nurhidayat et al., 2023). This ability is essential because it provides a foundation for constructing deeper knowledge and applying concepts in meaningful contexts (Samaduri, 2022). In biology learning, students' conceptual understanding develops when they are able to establish relationships between biological phenomena and the underlying theories and principles, and subsequently apply these concepts in real-life situations (Nurhidayat et al., 2023). Therefore, improving students' conceptual understanding has become an important goal in biology education.

The integration of technology into education has provided new opportunities to improve the quality of learning processes, particularly through the development of innovative instructional media (Maritsa et al., 2021). Among various technological approaches, video-based learning has demonstrated considerable potential in supporting students' understanding of complex concepts. Dewi and Sukendra (2023)

reported that the use of technology, particularly instructional videos, can effectively enhance students' conceptual understanding. Through visualization of abstract concepts and opportunities for repeated exposure, video-based learning can improve students' ability to retain and process information (Styowati & Utami, 2022). Furthermore, audiovisual media can increase students' attention and concentration, accelerate comprehension, and reduce passive learning by providing engaging learning experiences (Dindariya, 2024). Consequently, interactive video-based learning has emerged as an effective approach for promoting student-centered learning through the integration of multimedia elements, personalized content, and interactive activities.

Despite these advantages, the implementation of technology-based learning media in biology classrooms remains challenging. Based on preliminary observations and interviews with a biology teacher at a public senior high school in Medan, learning activities primarily relied on PowerPoint presentations, textbooks, and YouTube videos. However, the learning process remained predominantly teacher-centered, and the available instructional resources had not been optimally utilized to support students' conceptual understanding (Nurhidayat et al., 2023). In addition, interactive learning platforms such as Edpuzzle had not yet been implemented as supplementary learning resources. This condition indicates the need for developing innovative instructional media that can encourage active student engagement and improve conceptual understanding in biology learning.

Edpuzzle is an interactive video-based learning platform that enables educators to modify videos by integrating questions, feedback, and learning activities (Khairunnisa & Jasiah, 2025). Through Edpuzzle, teachers can embed questions at specific points in instructional videos, allowing students to actively process information rather than passively watch the content (Wati et al., 2024). When students respond to embedded questions, the video can pause and continue after responses are submitted, enabling teachers to monitor student participation and understanding (Tirtanawati et al., 2021). In addition, teachers can provide feedback, clarification, and encouragement based on students' responses (Mardhiyana et al., 2022). These features make Edpuzzle a potential instructional tool for transforming conventional video viewing into an interactive learning experience.

Previous studies have demonstrated the potential of Edpuzzle in supporting learning outcomes. Saputra et al. (2025) reported that integrating Edpuzzle into classroom activities could improve students' ability to think critically about complex concepts. Similarly, Sinaga and Adlini (2025) emphasized that Edpuzzle can transform passive video consumption into interactive learning by encouraging students to engage with learning materials actively. However, further investigation is needed regarding its effectiveness in improving students' conceptual understanding, particularly in biology topics involving abstract processes.

The human digestive system was selected as the focus of this study because it is considered one of the biology topics that students find difficult to understand. This difficulty is associated with the characteristics of the topic, which involves multiple organs, mechanical and chemical digestion processes, and enzymatic activities that occur inside the human body and cannot be directly observed (Diana Nur et al., 2024). Previous studies have shown that students often have misconceptions regarding the functions of digestive organs involved in food processing (Prokop & Fancovicova, 2006). Furthermore, Aydin (2016) explained that the digestive system is challenging for students because many physiological processes are abstract and cannot be directly visualized, resulting in conceptual misunderstandings.

From an Islamic perspective, understanding the human digestive system can also be integrated with reflections on the signs of Allah's greatness through scientific inquiry. One relevant reference is Qur'an Surah Al-A'raf verse 31, which states:

يٰۤاَيُّهَا اٰدَمُ خُذْوَا زِيْنَتَكُمْ عِنْدَ كُلِّ مَسْجِدٍ وَكُلُوْا وَاشْرَبُوْا وَلَا تُسْرِفُوْا اِنَّهٗ لَا يُحِبُّ الْمُسْرِفِيْنَ

Meaning: "O children of Adam, wear your best attire at every mosque, and eat and drink, but do not exceed the limits. Indeed, He does not love those who are excessive."

The verse emphasizes moderation in eating and drinking. This principle can be associated with maintaining digestive health because excessive food consumption may negatively affect the digestive system (Walyafi et al., 2023). Therefore, a strong conceptual understanding of digestive processes, including the functions of organs and enzymes involved, is important to prevent misconceptions about human digestion (Anjarwati et al., 2022). Interactive learning media such as Edpuzzle may serve as an effective tool for integrating contextual and abstract content while supporting students' cognitive development (Afifah et al., 2023).

Although previous studies have demonstrated the educational potential of Edpuzzle, research specifically examining its role in improving students' conceptual understanding remains limited. Previous studies have applied Edpuzzle in various fields, including biology, mathematics, language learning, religious education, and other disciplines (Mardhiyana et al., 2022; Khairunnisa & Jasiah, 2025; Hesti & Jasiah, 2025). In biology education, previous research has primarily focused on improving cognitive learning outcomes and critical thinking skills. For example, Sinaga and Adlini (2025) developed Edpuzzle-based interactive multimedia to improve students' critical thinking skills in the respiratory system topic, while Afifah et al. (2023) investigated the use of Edpuzzle in improving students' cognitive abilities in the human digestive system topic. However, studies developing Edpuzzle-based instructional videos specifically designed to improve conceptual understanding based on Anderson and Krathwohl's cognitive indicators remain scarce.

Therefore, this study aims to develop an Edpuzzle-based instructional video for the human digestive system topic equipped with interactive questions designed according to Anderson and Krathwohl's indicators of conceptual understanding, including interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. The developed media was evaluated based on its validity, practicality, and effectiveness in improving students' conceptual understanding. This study is expected to contribute to the development of technology-based biology learning media that supports meaningful, interactive, and student-centered learning experiences.

METHOD

Research Design

This study employed a Research and Development (R&D) approach using the 4D development model, which consists of four stages: Define, Design, Develop, and Disseminate (Rahmi & Baharuddin, 2021). The 4D model was selected because it provides a systematic procedure for developing instructional media through several stages, including needs analysis, product design, development, expert validation, revision, and product testing before implementation in the learning process.

The 4D model was considered appropriate for this study because the main objective was to develop an Edpuzzle-based instructional video for biology learning that meets the criteria of validity, practicality, and effectiveness. The development procedure followed the stages of the 4D model, as presented in Figure 1.

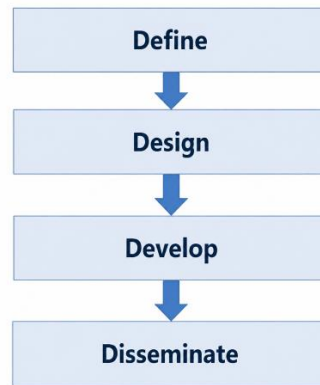


Figure 1. 4D Development Model

Development Procedure

The development process consisted of four stages. The Define stage involved identifying and analyzing learning needs, including problem analysis, media requirements, student characteristics, concept analysis, task analysis, and formulation of learning objectives. These analyses were conducted to determine the requirements for developing an Edpuzzle-based instructional video on the human digestive system.

The Design stage focused on designing the instructional video, including the preparation of learning scenarios, media appearance, interaction flow, storyboard development, and research instruments. The instructional video was designed by integrating learning materials, visual representations, and interactive questions embedded within the Edpuzzle platform to facilitate students' conceptual understanding.

The Develop stage involved producing the instructional video based on the designed framework. The developed media was then evaluated by experts, revised according to expert suggestions, and tested to determine its validity, practicality, and effectiveness in supporting students' conceptual understanding. The Disseminate stage involved the broader utilization and dissemination of the developed instructional media through scientific publication.

Research Subjects and Instruments

The subjects of this study were 25 eleventh-grade students at SMA Negeri 7 Medan. The research instruments consisted of three categories. First, validation instruments were used to evaluate the quality of the developed media. These instruments included media expert validation sheets, material expert validation sheets, and question expert validation sheets. The validation process was conducted to assess the suitability of the instructional video in terms of media quality, content appropriateness, and assessment instruments.

Second, practicality instruments were used to determine user responses toward the developed media. Teacher and student questionnaires were administered to evaluate the practicality of the Edpuzzle-based instructional video during the learning process. Third, conceptual understanding assessment instruments were used to measure the effectiveness of the developed media. The instrument consisted of 10 essay questions developed based on the conceptual understanding indicators proposed by Anderson and Krathwohl, including interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

Learning Implementation Procedure

During the implementation phase, the 25 students were divided into five groups, with each group consisting of five students. The grouping was conducted to optimize

internet data usage and facilitate collaboration among students while accessing the Edpuzzle-based instructional video and responding to the interactive questions embedded within the media.

Although the learning activities were conducted collaboratively, the pre-test and post-test were administered individually. Therefore, the improvement in students' conceptual understanding was analyzed based on individual achievement scores.

Data Analysis

The collected data were analyzed quantitatively. The validity and practicality of the developed instructional video were determined through percentage calculations. The interpretation of validity and practicality levels was based on the criteria presented in Tables 1 and 2.

The effectiveness of the Edpuzzle-based instructional video was evaluated by comparing students' pre-test and post-test scores using the normalized gain (N-Gain) analysis. The N-Gain value was used to determine the improvement in students' conceptual understanding after using the developed media. The effectiveness criteria were categorized into low, medium, and high levels based on the N-Gain interpretation presented in Table 3.

Table 1. Criteria for validation assessment

Percentage (%)	Criteria
80.00–100.00	Highly Valid
60.00–79.00	Valid
50.00–59.99	Moderately Valid
0.00–49.99	Invalid

Source: Rohmah & Bukhori (2020)

Table 2. Criteria for practicality assessment

Percentage (%)	Criteria
81–100	Highly Practical
61–80	Practical
41–60	Moderately Practical
21–40	Impractical

Source: Nasihah et al. (2024)

N-Gain Analysis

The effectiveness of the developed media was analyzed using the normalized gain (N-Gain) score. The N-Gain value was calculated based on the difference between students' pre-test and post-test scores to determine the improvement in conceptual understanding after the implementation of the Edpuzzle-based instructional video.

Table 3. N-Gain interpretation criteria

N-Gain Value	Criteria
$g > 0.7$	High
$0.3 < g < 0.7$	Medium
$g < 0.3$	Low

Source: Nasution & Rasyidah (2022)

RESULTS AND DISCUSSION

The main focus of this study was students' conceptual understanding of the human digestive system. The development research resulted in an Edpuzzle-based instructional video designed to evaluate students' conceptual understanding through attractive visual presentations, contextual storylines related to daily life, and embedded interactive questions. The media development process followed the 4D development model, consisting of Define, Design, Develop, and Disseminate stages. The results of each stage in the development of the Edpuzzle-based instructional video for the human digestive system topic are described as follows.

Define Stage

The define stage was conducted through a preliminary study at SMA Negeri 7 Medan to identify relevant problems in the learning process and provide a foundation for developing instructional media. Five types of analyses were conducted during this stage, including front-end analysis to identify learning needs, learner analysis to examine students' characteristics and initial abilities, concept analysis to review the digestive system material based on curriculum requirements, task analysis to map learning activities that support the development of conceptual understanding, and learning objective analysis to formulate the expected learning outcomes. The results of the define stage analysis are summarized in Table 4.

Table 4. Components and results of the define stage analysis in the development of instructional media

Component	Results of Analysis
Front-end analysis	Based on interviews with the biology teacher, several challenges were identified in teaching the human digestive system, particularly students' limited enthusiasm and difficulties in understanding Latin names and scientific terminology. The learning resources currently used mainly consisted of PowerPoint presentations, textbooks, and occasional YouTube videos, while interactive learning resources such as Edpuzzle had not yet been implemented. Nevertheless, teachers believed that students had a general understanding of the digestive system. To address these learning challenges, teachers used everyday objects to explain concepts and implemented group discussions to encourage students' active participation in problem-solving activities. Since Edpuzzle-based instructional media was considered an innovative approach with the potential to improve students' motivation and conceptual understanding, teachers responded positively to its development. Therefore, teachers expected that the developed Edpuzzle-based instructional video could be integrated into the curriculum, easily understood by students, and support a more efficient and engaging biology learning process.
Learner analysis	The results of student needs questionnaires and interviews with the biology teacher at SMA Negeri 7 Medan indicated that learning activities were still teacher-centered, with students tending to remain passive, rarely asking questions, and showing limited participation in discussions. Students demonstrated greater engagement when learning activities were connected with real-life situations. They also expressed the need for open learning resources that address real-world issues. In addition to theoretical explanations, students preferred learning resources that could stimulate critical thinking, discussion, and problem-solving skills.
Concept analysis	The selection of the human digestive system topic was based on its relevance to students' daily lives and its potential to improve conceptual understanding in biology. Concept analysis was conducted by referring to the learning outcomes established in the Kurikulum Merdeka.
Task analysis	Task analysis was conducted to fulfill the minimum competencies stated in the basic competencies (KD). This stage involved analyzing the required competencies to formulate the main learning tasks that students needed to master

Component	Results of Analysis
	in order to achieve the expected competency targets. The results of this analysis served as competency achievement indicators that guided the preparation of learning content and student evaluation instruments. The task analysis outcomes were presented in the form of competency achievement indicators (IPK).
Specification of learning objectives	The learning objectives were formulated based on Permendikbudristek No.32 Tahun 2024 and adjusted to the characteristics of Edpuzzle-based instructional videos. The objectives included: (1) students are able to understand nutrients required by the human body, including their components, functions, and the health impacts of nutritional deficiencies; (2) students are able to explain the structure and functions of the human digestive system, including digestive organs and glands and their roles in the digestive process; and (3) students are able to analyze disorders or diseases of the human digestive system and explain appropriate treatments.

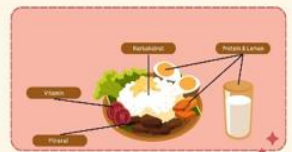
Design Stage

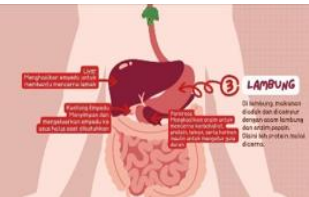
The purpose of the design stage was to develop a media design that fulfilled the requirements identified during the define stage. To enhance students' conceptual understanding, this stage emphasized the development of interactive learning sequences, visual presentation, and assessment integration in addition to content preparation. The instructional media was designed to include several components, including a cover page, learning objectives, an introductory storyline connected to daily life experiences, presentation of learning materials, embedded questions, evaluation activities, and reflection activities. The visual appearance of the media was arranged using an attractive graphic design with comfortable color combinations and user-friendly navigation to facilitate students' learning experiences.

At this stage, the Edpuzzle-based instructional video for the human digestive system topic was designed as presented in Table 5. The media was developed to facilitate engaging and interactive learning while supporting the development of students' conceptual understanding.

Table 5. Components and results of the design stage analysis in the development of instructional media

Media Component	Learning Activity	Conceptual Understanding Indicator
	Opening animation displaying illustrations of digestive organs accompanied by the introductory statement: "Let's get to know the digestive system!", designed to stimulate students' curiosity	Interpreting
	Presentation of learning objectives	Interpreting
	Presentation of a simple phenomenon related to Andi's eating habits illustrating the consequences of unhealthy dietary patterns	Interpreting

Media Component	Learning Activity	Conceptual Understanding Indicator
 Bagaimana kalau kita tidak pernah bisa menggunakan makanan yang baik dan bergizi untuk kita? PERTANYAAN PILIHAN GANDA Menurutmu, apa penyebab gangguan pencernaan yang sering terjadi? ☐ Pola makan tidak teratur ☐ Makanan bergizi ☐ Minum air putih ☐ Olahraga teratur	Displaying Edpuzzle embedded question number 1 as a problem statement on the screen	Explaining
 Zat Makanan Bagian Sistem Pencernaan Gangguan Pada Sistem Pencernaan	Presenting classification of nutrients, digestive system organs, and digestive system disorders	Summarizing
 Zat Makanan Makro Zat Makanan Mikro	Presenting nutrient materials to help students understand and differentiate macronutrients and micronutrients	Comparing
 Karbohidrat Protein & Lemak Vitamin Mineral	Presenting explanations of the functions of each nutrient type	Explaining
 Karbohidrat Protein & Lemak Vitamin Mineral Pertanyaan Pilihan Ganda Zat makanan yang berfungsi sebagai sumber energi utama adalah... ☐ Vitamin ☐ Mineral ☐ Karbohidrat ☐ Air	Edpuzzle Question 3 (Multiple Choice Question)	Classifying

Media Component	Learning Activity	Conceptual Understanding Indicator
(Alya Rahma) Sistem Pencernaan Ma Alya Rahma  PERTANYAAN TERBUKA Sebutkan dua contoh makanan yang mengandung protein! Ketik jawaban Anda di sini Tonton ulang Lewati Kirim	Edpuzzle Question 4 (Essay Question)	Exemplifying
	Presenting the sequential structure of human digestive organs (from mouth to anus)	Explaining
 PERTANYAAN PILIHAN GANDA Proses penyerapan sebagian besar zat makanan terjadi di... ☐ Lambung ☐ Usus halus ☐ Usus besar ☐ Kerongkongan	Edpuzzle Question 5 (Multiple Choice Question)	Classifying
	Explaining the functions of each digestive organ through animated illustrations	Explaining

Media Component	Learning Activity	Conceptual Understanding Indicator
(Alya Rahma) Sistem Pencernaan Ma Alya Rahma  PERTANYAAN TERBUKA Apa fungsi gigi dan lidah dalam proses pencernaan? Ketik jawaban Anda di sini. Tonton ulang Lewati Kirim	Edpuzzle Question 6 (Essay Question)	Exemplifying
Diare Diare dapat terjadi ketika selaput dinding usus besar si penderita mengalami iritasi 	Presenting various digestive system disorders or diseases	Explaining
Tukak Lambung Hal ini disebabkan karena terikiknya lapisan lambung itu sendiri  PERTANYAAN PILIHAN GANDA Kurangnya konsumsi serat dapat menyebabkan... ☐ Diare ☐ Sembelit ☐ Flu ☐ Batuk	Edpuzzle Question 7 (Multiple Choice Question)	Classifying
	Revisiting Andi's case scenario	Inferring

Media Component	Learning Activity	Conceptual Understanding Indicator
(Alya Rahma) Sistem Pencernaan Ma Alya Rahma 	Edpuzzle Question 8 (Essay Question)	Summarizing
(Alya Rahma) Sistem Pencernaan Ma Alya Rahma 	Presenting student self-evaluation in the form of a conclusion	Inferring
	Presenting a reflective question: "Is your eating pattern already healthy?"	Inferring

Development Stage

The development stage involved preparing the initial design of the Edpuzzle-based instructional video on the human digestive system, which was subsequently developed into a final product. The developed media was then subjected to expert validation to evaluate its content quality, visual presentation, and functionality before being implemented in the learning process.

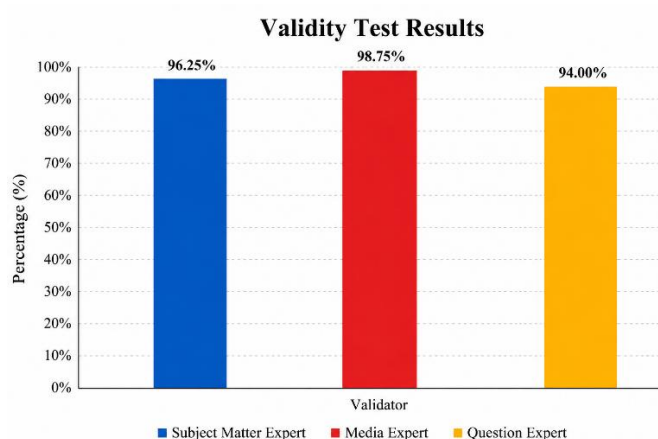
1. Media validation results

At this stage, the initial video draft and validation instruments were evaluated by three experts with expertise in media development, subject matter, and assessment instruments. The expert validation results are summarized in Table 6.

Table 6. Results of validity testing by media expert, material expert, and question expert validators

Validator	Obtained Score	Maximum Score	Percentage (%)	Category
Media Expert	79	80	98.75%	Highly Valid
Material Expert	77	80	96.25%	Highly Valid
Question Expert	34	36	94%	Highly Valid
Average	190	196	96.93%	Highly Valid

Based on the data presented in Table 6, the percentage scores obtained from each expert validation are illustrated in Figure 2.

**Figure 2.** Percentage of validation results for the edpuzzle-based instructional video by each expert

The validity of the instructional video was assessed through expert evaluation sheets and questionnaire data. Product validation was conducted as an internal evaluation process to examine the design quality and obtain expert judgments regarding the feasibility of the developed media.

The media expert evaluated the instructional video based on eight criteria: text presentation, image presentation, audio quality, video quality, color selection, physical appearance, practicality, and long-term usability. The obtained validation score of 98.75% indicated that the Edpuzzle-based instructional video was categorized as highly valid. This high percentage demonstrates that the developed media successfully fulfilled the requirements related to text clarity, visual presentation, audio quality, video presentation, color selection, physical design, practicality, and sustainability of use, allowing information to be delivered clearly and attractively.

The validity percentage was calculated by comparing the obtained score with the maximum possible score and multiplying the result by 100%. In addition, the integration of interactive questions within the video contributed to media feasibility because it allowed students to actively respond during the learning process. This finding is consistent with Basiroen et al. (2024), who emphasized the importance of graphical elements, including color, illustration, and typography, in improving readability and aesthetic quality. According to Purnamasari (2025), effective visualization can facilitate conceptual understanding and enhance learning motivation. From the content perspective, the score of 14 out of 16 indicated that the learning materials were relevant to the intended learning objectives, supporting the argument of Wulandari & Oktaviani (2021) that content validity determines the alignment between learning materials and curriculum requirements.

The material expert evaluation was conducted based on three aspects: content feasibility, language appropriateness, and presentation quality. The material expert obtained an average score of 96.25%, which was categorized as highly valid, indicating that the Edpuzzle-based instructional video fulfilled the requirements of content suitability, language clarity, and systematic presentation. This result aligns with Ali et al. (2024), who highlighted the importance of comprehensive material coverage to support effective learning processes. Furthermore, the contextual aspect received the maximum score, indicating that the developed material successfully connected scientific concepts with real-life phenomena, making learning more relevant and meaningful for students, consistent with the findings of Meliani & Suniasih (2022).

The question expert evaluation consisted of six assessment components: clarity, alignment with learning objectives, relevance, content validity, absence of bias, and language appropriateness. The validation results showed an average score of 94%, categorized as highly valid. This finding indicates that the assessment questions integrated into the Edpuzzle-based instructional video met the criteria of clarity, accuracy, relevance, validity, fairness, and appropriate language use.

Overall, the Edpuzzle-based instructional video obtained an average validation score of 96.93%, placing it in the highly valid category and indicating that the developed media was suitable for use as a biology learning resource. These findings demonstrate that the developed media fulfilled the required standards in terms of presentation quality, scientific content, and assessment instruments.

2. Practicality results of the media

A practicality test was conducted to determine the ease of use of the Edpuzzle-based instructional video by teachers and students during the learning process. The results of the practicality assessment, including the evaluation criteria, maximum scores, percentages, and total scores, are presented in Tables 7.

Table 7. Results of the practicality test based on teacher and student responses

Respondent	Total Score	Maximum Score	Percentage (%)	Category
Biology Teacher	39	40	97.50%	Highly Practical
Students	1770	1800	98.33%	Highly Practical

The proportion of practicality test results based on teacher and student responses is presented in Figure 3.

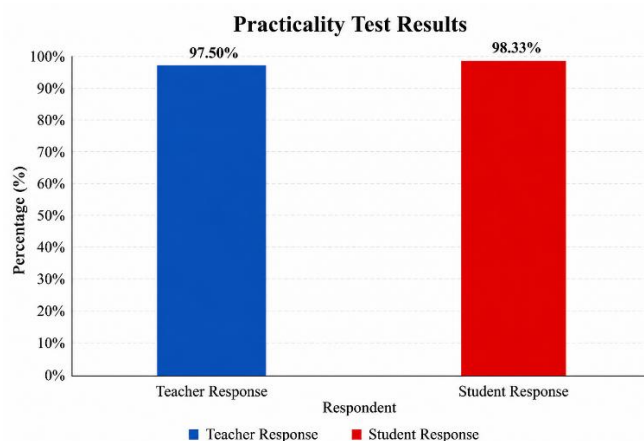


Figure 3. Percentage of practicality of the edpuzzle-based instructional video based on teacher and student responses

The practicality of the Edpuzzle-based instructional video was evaluated based on teacher and student responses using questionnaires. The assessment examined the media's usability, comprehensibility, and applicability during the learning process. The response data were analyzed by calculating the percentage of obtained scores relative to the maximum score and interpreting them according to the established practicality criteria.

The results showed that the practicality score reached 97.50% based on the biology teacher's response and 98.33% based on students' responses, indicating that the developed media was categorized as highly practical. These results demonstrate that the Edpuzzle-based instructional video was considered easy to use, understandable, and capable of supporting effective biology learning. The positive responses were attributed to the integration of visual illustrations, animations, structured explanations, and interactive questions that facilitated the delivery and understanding of complex concepts related to the human digestive system. The use of multimedia elements in learning media can improve information processing and support students' conceptual understanding by presenting abstract concepts in more accessible forms (Mayer, 2021).

The interactive questions embedded in Edpuzzle encouraged students to actively process information rather than passively watch the video. By pausing the video at specific points and requiring students to respond, Edpuzzle promotes cognitive engagement through activities such as interpreting, classifying, comparing, and explaining concepts. This finding is consistent with Wati et al. (2024), who reported that Edpuzzle-based interactive videos support active and enjoyable learning experiences by increasing student involvement during learning activities.

Furthermore, the contextual storyline and real-life examples presented in the video helped students connect biological concepts with everyday experiences. Such contextual learning approaches can facilitate deeper understanding because students are able to relate newly acquired knowledge to meaningful situations (Dewi et al., 2017). Therefore, the high practicality scores indicate that the developed Edpuzzle-based instructional video successfully met the learning needs of both teachers and students while promoting a more interactive and meaningful biology learning experience.

3. Effectiveness results of the media

Students were given pre-test and post-test assessments to evaluate their learning outcomes after using the Edpuzzle-based instructional video. The effectiveness of the developed instructional media was determined by analyzing the improvement in students' conceptual understanding using the N-Gain score analysis. The results of the effectiveness test are presented in Table 8.

Table 8. Effectiveness test results based on N-Gain analysis

Assessment	Average Score	Maximum Score	N-Gain	Criteria
Pre-test	49.52	40	0.72	High/Effective
Post-test	86.04	40		

The analysis of pre-test and post-test scores, along with the N-Gain calculation, demonstrated that the Edpuzzle-based instructional video fulfilled the effectiveness criteria for biology learning, particularly for the human digestive system topic. The students' average scores increased from 49.52 in the pre-test to 86.04 in the post-test, representing a 73.75% increase in the average score after using the developed

instructional media. Furthermore, the N-Gain analysis produced a score of 0.72, which was categorized as high.

The effectiveness of the media was evaluated based on the improvement in students' conceptual understanding scores from the pre-test to the post-test using N-Gain analysis. This analysis determined the magnitude of improvement by considering students' initial scores and the maximum achievable scores. The obtained N-Gain value indicated that students' conceptual understanding improved after using the Edpuzzle-based instructional video.

These findings demonstrate that the developed instructional video was effective in improving students' conceptual understanding of the human digestive system among Grade XI students. Figure 4 presents the effectiveness test results based on the comparison between students' pre-test and post-test scores.

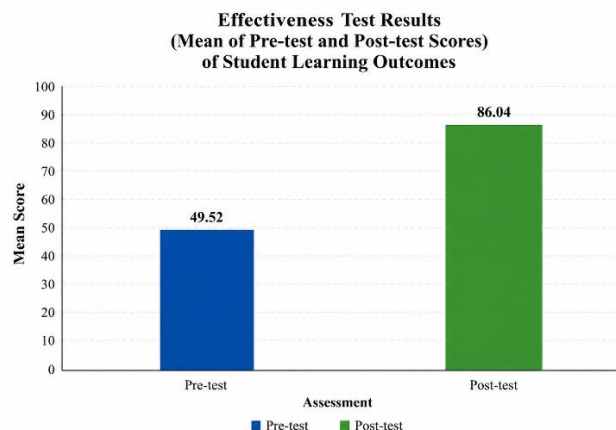


Figure 4. Effectiveness test results based on students' learning outcomes

The effectiveness of the Edpuzzle-based instructional video was evaluated by comparing students' mean pre-test and post-test scores, as presented in Figure 4. Before the implementation of the instructional media, students obtained an average pre-test score of 49.52, indicating that their initial conceptual understanding of the human digestive system was relatively limited. After participating in learning activities using the Edpuzzle-based instructional video, the average post-test score increased to 86.04. Furthermore, the N-Gain score of 0.72 was categorized as high, indicating a substantial improvement in students' conceptual understanding after the implementation of the developed media.

Although the improvement cannot be fully attributed solely to the media due to the absence of a control group, these findings suggest that the Edpuzzle-based instructional video has potential as an effective alternative learning resource for supporting biology learning among Grade XI students. The increase in students' conceptual understanding may be related to the characteristics of the developed media, which combines audiovisual representations with interactive questioning. Multimedia-based learning can facilitate students' understanding by integrating verbal and visual information, particularly when learning involves abstract processes that are difficult to observe directly (Mayer, 2021).

The human digestive system is one of the biology topics that requires students to understand complex physiological processes involving multiple organs and mechanisms that cannot be directly observed. The use of animations and visual representations in the developed video may help students construct more meaningful mental models of digestive processes. In addition, embedded questions in Edpuzzle

encourage students to actively process information rather than merely receive information passively. Interactive learning environments that require students to respond, reflect, and apply concepts can promote deeper cognitive engagement and improve learning outcomes (Chi & Wylie, 2014).

The improvement observed in this study was also related to students' engagement during the learning process. The Edpuzzle-based instructional video required students to answer questions inserted at specific points during video playback, allowing them to interpret, classify, compare, and explain concepts related to the digestive system. These activities corresponded with the conceptual understanding indicators developed based on Anderson and Krathwohl, including interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. Therefore, the improvement observed in this study reflects not only an increase in general achievement scores but also an enhancement in students' ability to process and construct biological concepts.

This finding supports Khairunnisa & Jasiah (2025), who reported that the implementation of Edpuzzle-based learning media could improve students' cognitive abilities. However, the present study provides a more specific contribution by evaluating the effectiveness of Edpuzzle media based on students' conceptual understanding indicators rather than general learning outcomes alone.

The interactive features of Edpuzzle may explain the positive learning outcomes observed in this study. Unlike conventional video-based learning, Edpuzzle allows educators to insert questions, provide feedback, and monitor students' responses throughout the learning process. Such interactive features transform video viewing from a passive activity into an active learning experience by encouraging students to engage with the content and reflect on their understanding (Zhang et al., 2006). Active engagement during learning is an important factor in supporting meaningful knowledge construction and long-term conceptual retention (Prince, 2004).

In this study, students were not only required to watch the instructional video but also participated in discussions and responded to contextual questions embedded within the media. These activities provided opportunities for students to exchange ideas, evaluate their understanding, and relate scientific concepts to real-life situations. The use of contextual learning approaches has been reported to support deeper understanding because students can connect newly acquired knowledge with their existing experiences (Dewi et al., 2017).

Edpuzzle provides a learning experience that differs from conventional resources previously used in the classroom, such as PowerPoint presentations and textbooks. Through interactive digital features, students can directly interact with learning materials, maintain attention, and actively participate throughout the learning process. This finding is consistent with Sinaga & Adlini (2025), who demonstrated that Edpuzzle-based interactive multimedia encourages students to actively construct understanding through reflection and literacy activities. Therefore, the integration of interactive video technology, contextual content, and formative questioning in Edpuzzle-based learning has the potential to create a more engaging and meaningful biology learning experience.

CONCLUSION

The Edpuzzle-based instructional video on the human digestive system developed using the 4D model met the criteria of validity, practicality, and effectiveness for Biology learning in Grade XI. The media obtained high validation scores from media experts (98.75%), material experts (96.25%), and assessment experts (94%), and was

considered highly practical based on teacher (97.50%) and student (98.33%) responses. The effectiveness test showed an increase in students' conceptual understanding, with the average score improving from 49.52 (pre-test) to 86.04 (post-test) and an N-Gain score of 0.72 (high category). These findings indicate that Edpuzzle-based instructional videos can support students' understanding of abstract biological concepts through audiovisual visualization and interactive questions based on conceptual understanding indicators.

RECOMMENDATION

The developed Edpuzzle-based instructional video can be used as an alternative interactive learning medium for Biology, particularly for topics involving abstract concepts such as the human digestive system. Further studies involving larger and more diverse samples are recommended to evaluate its broader applicability and explore its effects on other learning outcomes, such as critical thinking skills, motivation, and student engagement.

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