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Audiovisual Media Development for Conceptual Understanding in Elementary Science Education: An ADDIE Model Study

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Abstract: Conceptual understanding is a fundamental cognitive skill in elementary science education, yet many students struggle with abstract concepts such as the human digestive system, which involves invisible internal processes. This study aimed to develop and evaluate audiovisual media to enhance conceptual understanding of the human digestive system among fifth-grade elementary school students. Employing a Research and Development (R&D) methodology with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), the study involved 17 fifth-grade students from SD Negeri 101770 Tembung. Data were collected through expert-validation questionnaires, teacher and student response questionnaires, classroom observation, interviews, and pretest-posttest conceptual-understanding assessments. Validity assessments from the media expert (91.67%) and material expert (98.75%) categorized the media as highly feasible. Practicality testing yielded 96.67% from the teacher response and 84.12% from student responses, both within the highly feasible category. The mean conceptual-understanding score increased from 35 on the pretest to 93 on the posttest, producing an N-gain of 0.89 (89%), categorized as high. The audiovisual media visualized the sequence of digestive processes through synchronized visual and verbal representations, thereby helping students engage with processes that could not be observed directly. These findings indicate high validity, practicality, and potential effectiveness within the one-group trial. The study contributes an ADDIE-based example of how audiovisual media can make abstract elementary science content more concrete. Future studies should test the media with larger and more diverse samples, additional science topics, and controlled experimental designs.

Keywords: ADDIE Model, Audiovisual Learning Media, Conceptual Understanding, Elementary Science Education, Human Digestive System

A. Introduction

Conceptual understanding in science is more than the ability to recall terminology. It includes explaining a phenomenon in one's own words, classifying and comparing ideas, identifying relationships, sequencing a process, and applying a concept in a new situation. For elementary learners, these processes are essential because they form the basis for later scientific reasoning and problem solving (Priemer et al., 2020; Ye et al., 2023). Recent research on digital and multimedia learning similarly emphasizes that learning materials should support active knowledge construction rather than passive memorization.

The human digestive system presents a particular challenge for fifth-grade students because most of its processes occur inside the body and cannot be observed directly. Students may remember the names of organs while remaining unable to explain how food moves through the digestive tract, how the organs are related, or why each stage is necessary. From a developmental perspective, elementary learners benefit when abstract explanations are connected to concrete, visible representations. Visual sequences, narration, labels, and examples can therefore provide an external representation that students can inspect and connect with prior knowledge (Li et al., 2023; van Nooijen et al., 2024).

The Cognitive Theory of Multimedia Learning provides a relevant basis for designing such media. The theory proposes that learners process verbal and visual information through partly separate channels, that each channel has limited capacity, and that meaningful learning requires active selection, organization, and integration of information. Consequently, audiovisual media should not merely add decoration (Pawelec, 2022). Its narration and images should be aligned, the process should be segmented into manageable stages, important organs and transitions should be signaled, and unnecessary elements should be minimized. Reviews of video-based learning also show that visual, audio, textual, and interactive features must be intentionally coordinated because poorly designed multimedia may increase cognitive load rather than improve learning.

The media design also reflects discovery-oriented learning and cognitive learning objectives. Rather than presenting isolated facts, the video follows the digestive pathway and invites students to connect causes and effects, observe patterns, and explain the sequence. These activities correspond to conceptual processes such as interpreting, exemplifying, classifying, summarizing, comparing, and explaining. Thus, the media is expected to function as a structured representation that supports teacher questioning, student explanation, and discussion, rather than as a substitute for instruction.

Preliminary observation and an interview with the fifth-grade teacher at SD Negeri 101770 Tembung indicated that the school had access to an interactive whiteboard and had used audiovisual resources in several lessons. Nevertheless, science instruction was still frequently dominated by lectures, question-and-answer sessions, and student presentations. Some students were unable to explain the digestive process using their own words. Existing videos were not specifically organized around the conceptual sequence and learning needs identified in this class. This situation created a need for a concise audiovisual product that presented the organs, sequence, and functions of the digestive system in a coherent and age-appropriate manner (Liu et al., 2024).

Previous development studies have reported that animated or audiovisual materials can support science learning, student engagement, and the comprehension of difficult content. However, the contribution of a media product should be evaluated not only by student preference but also by its content and media validity, classroom practicality, and change in conceptual-understanding scores. Accordingly, the present study developed an audiovisual learning product through the ADDIE process and evaluated it through expert validation, user responses, and a one-group pretest-posttest trial. This study addresses three research questions: 1) How can audiovisual media on the human digestive system be developed to enhance fifth-grade students' conceptual understanding? 2) What are the validity and practicality of the developed audiovisual media based on expert validation and user responses? 3) How effective is the audiovisual media in improving students' conceptual understanding of the human digestive system within the one-group trial?

B. Methods

Research Design and Rationale

This study employed Research and Development (R&D) using the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. ADDIE was selected because it provides a systematic and iterative sequence that links the identification of learning needs with product design, expert review, classroom implementation, and evaluation (Shakeel et al., 2023). The model is also sufficiently flexible to allow revisions after expert feedback while retaining a traceable development process.

Setting and Participants

The study was conducted at SD Negeri 101770 Tembung. Participants comprised 17 fifth-grade students who took part in the classroom trial, one fifth-grade teacher who provided needs-analysis information and a practicality response, one media expert, and one subject-matter expert. The source manuscript did not retain individual demographic data such as age and gender; therefore, the participant description is limited to grade level and sample size (Atit et al., 2022; Mueller et al., 2021). This limitation is acknowledged when interpreting the generalizability of the findings.

ADDIE Development Procedure

During the analysis stage, the researchers observed science learning and interviewed the fifth-grade teacher to identify students' difficulties, the teaching approaches commonly used, the available classroom technology, and the need for media on the human digestive system. During the design stage, the learning content was organized into a sequential storyboard that moved from the mouth through the digestive organs to the elimination of waste. The design combined narration, images, short labels, and visual emphasis to make the internal process observable and to reduce unnecessary information. During the development stage, the audiovisual product was produced and reviewed by the media and material experts. Suggestions were used to revise the presentation, including the addition and improvement of on-screen text. During the implementation stage, the revised media was used in a science lesson with 17 fifth-grade students. During the evaluation stage, the researchers summarized expert validation, teacher and student responses, and pretest-posttest conceptual-understanding scores (Lichtenberger et al., 2025).

Data-Collection Instruments

Data were collected through observation, a teacher interview, expert-validation sheets, teacher and student response questionnaires, and conceptual-understanding tests. Observation and interview data were used during the needs analysis to identify classroom conditions and learning difficulties. The media-validation sheet contained nine scored items (maximum score 36), whereas the material-validation sheet contained 20 scored items (maximum score 80). The teacher response questionnaire contained 15 items (maximum score 60), and the student questionnaire contained 10 items. The validation forms addressed the appropriateness of the media's visual presentation, audio clarity, content accuracy, content sequence, and suitability for fifth-grade learners. The pretest and posttest generated scores on a 0-100 scale and were administered before and after the media-supported lesson. Item-level validation ratings, individual pretest-posttest scores, verbatim interview quotations, and instrument reliability coefficients were not available in the retained dataset; therefore, the present report does not fabricate or estimate these data.

Data Analysis

Expert-validation and user-response scores were converted into percentages using Equation (1):

Expert-validation and user-response scores were converted into percentages using Equation (1):

$$Percentage = (obtained\ score / maximum\ score) \times 100\%$$

The percentage was interpreted using the feasibility criteria in Tables 1 and 2. Improvement in conceptual understanding was calculated using normalized gain (N-gain):

$$g = (posttest\ score - pretest\ score) / (100 - pretest\ score)$$

An N-gain of 0.70 or higher was classified as high, 0.30-0.69 as moderate, and below 0.30 as low. Because the study used a small one-group trial without a control group or inferential statistical test, the analysis supports a descriptive claim of improvement and potential effectiveness rather than a causal claim (Toffalini et al., 2021; Van Simaeys et al., 2025).

Table 1. Assessment Criteria

No	Rating Category	Score
1	Very Good (VG)	**4**
2	Good (G)	**3**
3	Fair (F)	**2**
4	Poor (P)	**1**

Table 2. Feasibility Interpretation Criteria

N.	Feasibility Category	Percentage
1	Highly Feasible	81-100%
2	Feasible	61-80%
3	Moderately Feasible	41-60%
4	Less Feasible	21-40%
5	Not Feasible	0-20%

Table 3. N-Gain Classification

No	N-Gain Category	Criterion
1	High	g >= 0.70
2	Moderate	0.30 <= g < 0.70
3	Low	g < 0.30

C. Results and Discussion

1. Result

The results are presented according to the five ADDIE stages. The trial involved 17 fifth-grade students. The retained dataset contained aggregate scores only; consequently, item-level validation results, individual score distributions, and verbatim user comments could not be reported.

Analysis Stage Results

Observation and the teacher interview indicated that several students had difficulty explaining the digestive process in their own words (Allen et al., 2021; Jahic Pettersson et al., 2020). Learning activities relied mainly on oral explanation, questions and answers, and student presentations, while the available audiovisual resources were not specifically structured to clarify the complete sequence of digestion. The analysis therefore identified three product requirements: the process had to be shown sequentially, the language had to be appropriate for fifth-grade learners, and the visual and audio components had to emphasize the relationship between organs and functions.

Design Stage Results

The product was designed as an audiovisual learning video combining narration, illustrated organs, labels, and sequential transitions. The storyboard began with an introductory character and proceeded through the digestive pathway. The design aimed to make an internal biological process visible and to support students in identifying the sequence rather than memorizing isolated organ names.

Figure 1. Initial Audiovisual Media Design

Development Stage Results

The media was developed from the approved storyboard and then validated by one media expert and one material expert. The media expert awarded 33 of 36 points (91.67%), and the material expert awarded 79 of 80 points (98.75%) (Won et al., 2025). Both scores fell within the highly feasible category. The revision shown in Figures 2 and 3 added clearer on-screen text to reinforce the narrated sequence.

Figure 2. Product Before Revision

Figure 3. Product After Revision

Table 4. Expert-Validation Results

Validator	Obtained Score	Maximum Score	Percentage	Classification
Media expert	33	36	91.67%	Highly Feasible
Material expert	79	80	98.75%	Highly Feasible

Implementation Stage Results

The revised audiovisual media was implemented in a science lesson with 17 fifth-grade students. The video was presented using the available classroom display (Halabi, 2020). Students attended to the visual sequence and narration, and the teacher used the media as a shared reference for explaining the organs and stages of digestion (Tavares et al., 2023). The classroom trial generated the posttest and user-response data reported in the evaluation stage.

Evaluation Stage Results

The mean conceptual-understanding score increased from 35 on the pretest to 93 on the posttest. Applying the normalized-gain formula produced g = (93 - 35) / (100 - 35) = 0.89, or 89%, which is in the high category. This result describes a substantial increase after the media-supported lesson, although the design does not isolate the media effect from other instructional factors (Kerr et al., 2025).

Table 5. Summary of Pretest and Posttest Results

Measure	Pretest	Posttest
Mean conceptual-understanding score (n = 17)	35	93
Mean N-gain	-	0.89 (89%; High)

The teacher response reached 96.67%, and student responses reached 84.12% (Hu et al., 2024). The mean practicality percentage was 90.39%, categorized as highly feasible. These scores indicate that the teacher and students generally regarded the media as usable and appropriate for the lesson.

Table 6. Teacher and Student Response Results

Respondent	Number of Items	Obtained Score	Maximum Score	Percentage	Feasibility
Teacher	15	58	60	96.67%	Highly Feasible
Students (n = 17)	10	1,430	1,700	84.12%	Highly Feasible
Mean percentage	-	-	-	90.39%	Highly Feasible

2. Discussion

Interpretation of Findings

The findings address the three research questions (Ardoin et al., 2020; Kabudi et al., 2021; Radez et al., 2021; Seeber et al., 2020). First, the audiovisual product was developed through a needs-driven sequence in which classroom problems were translated into a storyboard, an audiovisual product, expert revisions, and a classroom trial. Second, the high media- and material-validation percentages indicate that the product was considered appropriate in presentation and content, while the teacher and student response percentages indicate high practicality. Third, the increase from 35 to 93 and the N-gain of 0.89 indicate high improvement within the one-group trial. The combination of validity, practicality, and score improvement is more informative than relying on student preference alone (Oates & Johnson, 2025; R. Preston et al., 2020).

Comparison with Previous Studies

The results are consistent with previous development studies reporting that video, animation, and digital learning resources can make elementary science content more accessible and engaging (Fitzgerald & Evans, 2024). Experiment-based learning videos developed through ADDIE have similarly achieved high feasibility and improved learning outcomes, while a science digital library produced a high normalized gain in elementary science literacy. Audiovisual and animated products have also been reported as feasible for supporting critical thinking and concept learning in elementary classrooms. The present study extends this pattern to the human digestive system and focuses specifically on students' ability to understand an internal biological sequence (Andersson et al., 2020).

Theoretical Implications

The score improvement is theoretically plausible because the product transformed an invisible process into coordinated visual and verbal representations (Nielsen et al., 2022; C. M. Preston et al., 2022). In line with multimedia-learning theory, narration could guide the auditory-verbal channel while images and transitions represented the organs and their sequence in the visual-pictorial channel. The revision that added on-screen text also functioned as signaling, provided it remained concise and synchronized with the narration. Reviews of educational video emphasize that effective learning depends on the alignment of visual, textual, audio, and learner-activity features rather than on video format by itself. For elementary learners, these representations also provide concrete supports for reasoning about processes that cannot be observed directly (Götze & Baiker, 2021; Sterner et al., 2020).

Practical Implications

For classroom practice, the media can be used before explanation to activate prior knowledge, during instruction to pause and discuss each digestive stage, or after instruction as a review resource (Trenholm & Peschke, 2020). Teachers should ask students to predict the next organ, explain cause-and-effect relationships, compare organ functions, and retell the process in their own words. These activities help ensure that students actively process the video rather than watch passively. The product is particularly suitable for classrooms with a shared digital display because it does not require each student to have an individual device (Fransson et al., 2020).

Study Limitations

Several limitations constrain the interpretation of the findings. The trial included only 17 students from one class and one school, and the content was limited to one science topic. The one-group pretest-posttest design did not include a control group, random assignment, delayed retention test, or inferential significance test. Detailed participant demographics, individual score distributions, item-level expert ratings, verbatim qualitative comments, and instrument reliability coefficients were unavailable. Consequently, the observed improvement should be interpreted as promising descriptive evidence rather than definitive proof that the media alone caused the increase (Hansen et al., 2025; Orben, 2020). These limitations also identify priorities for a larger follow-up study.

D. Conclusions

This study developed audiovisual media on the human digestive system through the five stages of the ADDIE model and evaluated its validity, practicality, and potential effectiveness for fifth-grade elementary science learning. The analysis stage identified students' difficulty in explaining the digestive process and the need for a sequential representation of internal biological events. These needs were translated into a storyboard and an audiovisual product combining narration, illustrations, labels, and visual transitions. Expert review produced high feasibility ratings from the media expert (91.67%) and material expert (98.75%). The classroom users also responded positively: the teacher response reached 96.67%, student responses reached 84.12%, and the combined practicality percentage was 90.39%, all within the highly feasible category. Mean conceptual-understanding scores increased from 35 on the pretest to 93 on the posttest, yielding an N-gain of 0.89 or 89%, classified as high. The main contribution of the product is its ability to transform an invisible and abstract digestive sequence into coordinated visual and verbal representations that can be paused, discussed, and explained. In practice, teachers can use the media as a shared visual reference while asking students to identify organs, predict the next stage, compare functions, and retell the process in their own words. Such active use is important because the value of audiovisual media depends on instructional integration rather than viewing alone. The findings should nevertheless be interpreted cautiously because the trial involved 17 students from one school, one science topic, and no comparison group. The available dataset also lacked individual score distributions, detailed demographic information, item-level validation data, qualitative quotations, and reliability coefficients for the instruments. Future research should test the product with larger and more diverse samples, controlled or quasi-experimental designs, delayed retention measures, and validated concept-understanding instruments. Further development should also examine other science topics, grade levels, accessibility features, and the effects of specific design elements such as segmenting, signaling, narration, and embedded questions.

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