

Countering Digital Health Misinformation Through Youtube-Based Biology Instruction: An ADDIE Design And Evaluation Of Learning Independence And Digital Literacy Outcomes

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Abstract

The spread of health misinformation online is a globally recognized threat to public understanding of science, and biology classrooms are a natural, underused setting for building the digital literacy skills students need to resist it. This study developed and evaluated a YouTube-based biology learning medium on the human circulatory system, explicitly designed to build both learning independence and digital literacy -- including the ability to identify health-related hoaxes -- among eleventh-grade students at MAN Manggarai Barat, Indonesia. Using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), the medium was developed and tested with 25 students, one content expert, and one media expert. Data were collected through expert validation sheets, teacher and student response questionnaires, a learning-independence questionnaire, and a digital-literacy pretest-posttest, and analyzed using descriptive criteria for feasibility and practicality and the N-Gain test for effectiveness. The medium was rated highly feasible (content validation 87.06%, media validation 89%; mean 88.03%) and highly practical (teacher response 89%, student response 89.72%). Learning independence after use reached 72.96% (good category). Digital literacy rose from a mean of 64.93 at pretest to 87.67 at posttest, N-gain = 0.63 (moderate), with 88% of students reaching at least a moderate gain. These results indicate that a purpose-built YouTube video, paired with structured follow-up activity, is a

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feasible, practical, and effective way to strengthen both self-directed learning and the specific capacity to evaluate online health information among secondary biology students.

Keywords: YouTube-based learning media; digital literacy; health misinformation; learning independence; ADDIE

INTRODUCTION

Online misinformation about health -- what the World Health Organization has termed an "infodemic" -- circulates fastest on exactly the platforms where adolescents now spend much of their time, and biology topics such as blood type, transfusion, and circulatory disease are recurring targets for viral health hoaxes. Equipping students to evaluate the credibility of digital health claims is therefore not only a biology-instruction goal but a digital-citizenship one, and it depends on two capacities that conventional, teacher-centered instruction rarely builds directly: learning independence -- the capacity to initiate, monitor, and evaluate one's own learning -- and digital literacy, the capacity to locate, analyze, and verify information encountered online (Gilster, 1997; UNESCO, 2018).

YouTube is an obvious, low-barrier channel for addressing both capacities at once, since it is already where many students go first when they want to understand a topic or check a claim, and it supports the self-paced review, replay, and search behaviors that self-directed learning requires (Berk, 2009; Moghavvemi et al., 2018). Yet simply posting a lecture video to YouTube does not automatically build digital literacy; without deliberate design around multimedia-learning principles and explicit verification-oriented content, a video can inform without teaching students how to evaluate information for themselves (Mayer, 2009).

At MAN Manggarai Barat, in eastern Indonesia, Biology instruction on the circulatory system has relied primarily on conventional teacher-centered delivery, with limited structured opportunity for independent study or explicit practice in verifying health-related information. This combination of an information topic prone to viral misinformation (blood type and transfusion claims among them), a largely untapped instructional channel already embedded in students' daily media habits, and a conventional classroom model that does little to build either self-directed learning or verification skill motivated this research-and-development study. It aimed to (1) develop a YouTube-based Biology learning medium on the circulatory system suited to the characteristics and needs of MAN Manggarai Barat students; (2) determine the medium's



feasibility in terms of content, presentation, and implementation; and (3) evaluate its effectiveness in improving students' learning independence and digital literacy.

LITERATURE REVIEW

YouTube as Instructional Media

Instructional media are commonly evaluated by how well they help learners construct accurate mental models from presented content (Arsyad, 2017). Mayer's (2009) cognitive theory of multimedia learning identifies several design principles relevant to video-based instruction -- coherence, signaling, spatial and temporal contiguity, and segmenting -- each aimed at managing learners' limited cognitive capacity so that attention is directed toward material relevant to the learning goal rather than toward extraneous or competing visual and auditory information. As a delivery channel, YouTube has been shown to improve the flexibility and efficiency of instructional delivery relative to classroom-only teaching, supporting learner engagement when content is well produced (Berk, 2009; Moghavvemi et al., 2018).

Learning Independence

Learning independence is conceptualized here through Zimmerman's (2002) model of self-regulated learning, a cyclical process spanning forethought (goal-setting, planning), performance (monitoring, persistence), and self-reflection (self-evaluation). A medium that is accessible on students' own schedule, replayable, and paired with follow-up tasks has the structural potential to support all three phases, though evidence suggests that access alone most reliably strengthens the performance phase -- persistence and use of supplementary resources - - while the self-reflection phase, including self-evaluation and note-taking habits, typically requires more deliberate scaffolding (Sulisworo, 2017).

Digital Literacy and Health Misinformation

Digital literacy is defined as the ability to locate, organize, understand, evaluate, and create information using digital technology (Gilster, 1997), operationalized in this study through UNESCO's (2018) global framework of reference, which emphasizes information and data literacy -- including the evaluation of source credibility -- alongside communication and content-creation competencies. Within a biology curriculum, the circulatory system offers a natural point of entry for this competency, since topics such as blood type compatibility and transfusion are both



curricular content and a recurring category of health-related viral misinformation, making source-credibility judgment and claim verification a skill directly exercisable within ordinary subject-matter instruction rather than a separate media-literacy unit (Hidayati, 2021; Saputra & Noor, 2025).

Research and Development Framework

This study followed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), a widely used instructional-design framework in which each phase's output feeds directly into the next, from a needs analysis through iterative design and development to classroom implementation and evaluation of outcomes (Branch, 2009). Product quality was assessed against two complementary standards common in design research: content and construct validity, evaluated by subject-matter and media experts, and practicality, evaluated through user (teacher and student) response (Van den Akker et al., 1999). On this basis, the study expected that a well-designed, expert-validated YouTube medium would be rated feasible and practical by its users, and would be associated with measurable gains in both learning independence and digital literacy following its implementation.

METHOD

Research Design and Participants

This study used a research and development (R&D) design following the ADDIE model. In the Analysis phase, classroom observation and teacher consultation identified conventional, teacher-centered delivery of the circulatory-system topic and limited structured practice in independent study or information verification as the needs the product should address. The Design and Development phases produced a YouTube-based video medium on the circulatory system, incorporating explicit segments on verifying health-related claims (for example, blood-type and transfusion misinformation), which was then reviewed by one content expert (a Biology teacher) and one media expert before revision. In the Implementation phase, the revised medium was trialed with all 25 students of class XI F at MAN Manggarai Barat, together with their Biology teacher as a practicality respondent. The Evaluation phase assessed feasibility, practicality, and effectiveness using the instruments described below.



Instruments and Data Analysis

Four primary instruments were used: a content-expert validation sheet (17 indicators, informed by content and construct validity criteria; Van den Akker et al., 1999), a media-expert validation sheet (20 indicators, informed by Mayer's 2009 multimedia-design principles), a teacher response questionnaire (20 items across six aspects), and a student response questionnaire (20 Likert items). These were supplemented by a 15-item learning-independence questionnaire adapted from Zimmerman's (2002) self-regulated learning indicators, and a five-item, 15-indicator digital-literacy pretest-posttest instrument adapted from Gilster (1997) and the UNESCO (2018) digital-literacy framework. Feasibility and practicality scores were analyzed descriptively as percentages and interpreted against Riduwan's (2010) criteria for descriptive score interpretation. Effectiveness in improving digital literacy was evaluated using the normalized gain (N-Gain) test, $g = (\text{posttest} - \text{pretest}) / (100 - \text{pretest})$, categorized as high ($g \geq .70$), moderate ($.30 \leq g < .70$), or low ($g < .30$), following Hake's (1998) convention.

RESULTS AND DISCUSSION**Expert Validation (Feasibility)**

Content-expert validation, covering the 17-indicator instrument on curricular alignment, scientific accuracy, depth, and support for learning independence and digital literacy, produced a total score of 74 out of 85 (87.06%), categorized as highly feasible. The lowest-rated indicator concerned the balance of material supporting both learning independence and digital literacy simultaneously; the highest-rated indicators concerned scientific accuracy, material currency, and the relevance of the health-hoax case examples used. Media-expert validation, covering 20 indicators on graphic design and Mayer's (2009) multimedia principles, produced a total score of 89 out of 100 (89%), also highly feasible; the lowest-rated indicators concerned content segmenting and editing polish, while navigation, device compatibility, and audio clarity scored highest. The mean of the two validations was 88.03%, indicating the medium met both content and construct validity requirements before classroom trial.

Table 1. Summary of Expert Validation, Teacher Response, and Student Response

Instrument	Score	Max	%	Category
Content-expert validation	74	85	87.06	Highly feasible
Media-expert validation	89	100	89.00	Highly feasible



Teacher response	89	100	89.00	Highly practical
Student response (n = 25)	89.72	100	89.72	Highly practical

Source: Validation and questionnaire data, 2026.

Practicality: Teacher and Student Response

The Biology teacher rated the medium 89 of 100 (89%, highly practical), with the highest-rated aspects being material accuracy and time efficiency (93.33% each) and the lowest, though still positive, being alignment with learning objectives (80%). Students rated the medium 89.72%, also highly practical, with all 25 students (100%) responding in the highly positive category. The highest-rated student items concerned ease of understanding concepts through the video's examples and understanding how to select trustworthy digital sources (97.6% each); the lowest-rated, though still positive, item concerned students' carefulness and critical attitude toward health information circulating on social media (75.2%), alongside visual presentation and material sequencing (76.8% each) -- indicating room to strengthen the visual and critical-evaluation dimensions in future revisions even though overall reception was strongly positive.

Effectiveness: Learning Independence

After using the medium, students' mean learning-independence score was 54.72 of 75 (72.96%, good category), with all 25 students (100%) reaching at least the good category. The highest-rated indicator was persistence -- continuing to try to understand difficult material (92.8%) -- while three indicators remained in the fair category: rechecking one's own understanding after studying (56.8%), making notes or summaries after watching (57.6%), and confidence in learning independently without continuous teacher guidance (46.4%). These three indicators all correspond to the self-reflection phase of Zimmerman's (2002) self-regulated learning cycle, indicating that while the medium strongly supported performance-phase behaviors such as persistence, the self-reflection phase remains the area most in need of additional scaffolding.



Effectiveness: Digital Literacy

Digital literacy scores increased from a mean of 38.96 (64.93%) at pretest to 52.60 (87.67%) at posttest, an improvement evident on all five test items. The largest per-item gain was on the item addressing information verification and blood-type concepts (+2.96 of 12 points) -- the item most directly tied to health-misinformation evaluation -- while the smallest gain was on identifying source credibility (+2.36).

Table 2. Distribution of N-Gain Categories for Digital Literacy (n = 25)

N-Gain Category	Criterion	n	%
High	$g \geq 0.70$	7	28.0
Moderate	$0.30 \leq g < 0.70$	15	60.0
Low	$g < 0.30$	3	12.0

Source: Pretest-posttest data, 2026. Mean N-Gain = 0.63 (moderate).

The mean N-Gain across all 25 students was 0.63, in the moderate category; 7 students (28%) reached a high gain, 15 (60%) a moderate gain, and 3 (12%) a low gain, including one student whose posttest score declined slightly relative to pretest. In aggregate, 88% of students (22 of 25) reached at least a moderate gain, indicating that the medium's contribution to digital literacy was broad-based rather than concentrated in a few high-performing students, though the remaining 12% suggests that prior ability and the intensity of independent engagement with the medium continued to moderate how much individual students gained (Sulisworo, 2017).

DISCUSSION

Taken together, the feasibility, practicality, and effectiveness results answer this study's three objectives. First, a YouTube-based Biology medium on the circulatory system was successfully developed through the ADDIE cycle, with expert feedback from both the Analysis/Design and Development phases directly shaping the final product -- most visibly in revisions to content balance and video segmenting flagged by the two experts. Second, the medium met feasibility and practicality criteria by a wide margin (all four instruments above 85%), consistent with the view that media combining accurate content with sound multimedia design



principles are well received by both teachers and students (Arsyad, 2017; Mayer, 2009; Moghavvemi et al., 2018).

Third, and most relevant to this study's broader motivation, the medium was effective in building both learning independence and digital literacy, but unevenly across their sub-components. Learning independence gains concentrated in the performance phase of self-regulated learning -- persistence and use of supplementary resources -- while the self-reflection phase lagged, suggesting that access to a replayable, self-paced video is sufficient to support effortful engagement but not, by itself, sufficient to build habits of self-monitoring; explicit scaffolds such as embedded reflection prompts or a structured note-taking template would plausibly close this gap (Zimmerman, 2002). Digital literacy gains were broad-based (88% of students at or above moderate N-Gain) and concentrated most strongly on the information-verification item tied directly to health misinformation, which is the result most directly relevant to this study's framing: embedding explicit verification practice inside ordinary subject-matter video content, rather than treating digital literacy as a separate add-on lesson, appears to be a workable way to build resistance to health misinformation within existing biology instruction (Gilster, 1997; UNESCO, 2018).

Three limitations qualify these conclusions: the trial involved a single class of 25 students with one content expert and one media expert, limiting generalizability; there was no control group, so the observed gains cannot be fully separated from ordinary classroom learning over the same period; and effectiveness was measured within a limited trial window without a delayed follow-up to assess retention. Future development and research would benefit from testing the medium across a larger and more varied set of schools, incorporating a control group, and adding explicit self-reflection scaffolds to the product itself.

CONCLUSION

This study developed a YouTube-based Biology learning medium on the circulatory system using the ADDIE model and found it highly feasible (mean expert validation 88.03%) and highly practical (teacher response 89%, student response 89.72%). Following implementation, students' learning independence reached a good category (72.96%), strongest in persistence and weakest in self-reflection habits, while digital literacy improved significantly from 64.93% to 87.67% (N-Gain = 0.63, moderate), with gains concentrated on the item most directly tied to verifying health-related information. These results indicate that a carefully designed, expert-validated YouTube



medium, built around explicit information-verification content rather than lecture delivery alone, is a feasible and effective way to strengthen both self-directed learning and digital literacy -- including resistance to health misinformation -- within ordinary secondary biology instruction.

RECOMMENDATIONS

Teachers are encouraged to use the medium as a complement to, rather than a replacement for, classroom instruction, pairing video viewing with follow-up tasks such as summaries, questions, and comparison of additional sources. Students are encouraged to use the medium actively -- setting learning targets, taking notes, and rechecking their own understanding -- rather than passively watching. Schools are encouraged to support internet access and digital devices that make self-paced video learning practical for all students. Future developers and researchers are encouraged to embed explicit self-reflection scaffolds into the product itself, test the medium across a larger and more varied set of schools with a control group, and extend the model to other biology topics and other outcome variables such as learning achievement or critical-thinking skill.

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