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Development of an Animaker-Based Animated Learning Video to Enhance Seventh-Grade Students' Mathematical Conceptual Understanding of One-Variable Linear Equations and Inequalities

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ABSTRACT

This study developed an Animaker-based animated learning video to support seventh-grade students' mathematical conceptual understanding of one-variable linear equations and inequalities. The study used a research and development approach guided by the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) framework. Needs analysis, expert review, individual teacher appraisal, small-group testing, and field implementation were conducted at State Islamic Junior High School (Madrasah Tsanawiyah Negeri/MTsN) 4 Merangin. Two university lecturers reviewed the media, content, and assessment instruments; one mathematics teacher, eight students in the small-group trial, and 30 students in the field implementation evaluated usability. The final product comprised curriculum-aligned animated explanations, worked examples, guided pauses, and practice prompts. Expert review classified the product and instruments as valid after revision. Practicality scores were 3.78 from the teacher, 4.12 from the small group, and 4.15 from the field group on a five-point scale. Students' mean conceptual-understanding score increased from 10.867 on the pre-test to 18.200 on the post-test, with a normalized gain of 0.67 (moderate). Students' predominant perception category was agree. The product is a feasible digital-learning resource for concept-focused mathematics instruction, while broader controlled evaluations are needed to establish comparative effectiveness.

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INTRODUCTION

Mathematical conceptual understanding is central to lower-secondary mathematics because students must interpret relationships, distinguish relevant attributes, and select procedures rather than merely reproduce a memorized example. Recent Indonesian evidence continues to report uneven conceptual understanding, particularly when learners are asked to explain relationships among representations or justify the procedure used (Giriansyah et al., 2023; Rahmawati & Roesdiana, 2022; Suendarti & Liberna, 2021). For one-variable linear equations and inequalities, these difficulties may appear when students confuse an equality with an inequality, operate on both sides inconsistently, or cannot connect a symbolic procedure with its meaning. A concept-focused instructional resource is therefore needed to make the sequence of reasoning visible and revisitable.

Educational technology can support this need when it is designed as an instructional representation rather than added as decoration. Meta-analytic and review evidence indicates that well-designed computer-based mathematics learning can improve mathematical outcomes, but results vary by instructional design, learner characteristics, and the role assigned to the technology (Rahma & Nurlaelah, 2024; Tamur et al., 2023; Turmuzi & Lu'luilmaknun, 2023). Multimedia lessons are more likely to be useful when visual, verbal, and task elements are coordinated to reduce irrelevant processing and direct attention to the target relation (Çeken & Taşkın, 2022; Noetel et al., 2022; Schroeder & Cenkci, 2020). Animated video is promising for this purpose because it can show a transformation step by step while narration and on-screen cues explain why a particular operation is valid.

Recent studies have documented the feasibility of animated mathematics videos created with accessible authoring platforms. For example, Animaker-based or comparable animated videos have been developed for statistics, comparison, and other mathematics topics, often receiving positive feasibility or usability evaluations (Farihah & Nurafita, 2024; Nabila et al., 2023; Rachmavita, 2020; Sofnidar et al., 2023). Other work has reported that animation-supported resources can contribute to conceptual understanding or mathematical problem solving when the video is embedded in purposeful instructional activity (Nasution & Lailia, 2023; Rambe et al., 2024; Yasri & Wulantina, 2024). Nevertheless, many development reports emphasize general learning outcomes or users' satisfaction, while the relation between particular video segments and explicit indicators of mathematical conceptual understanding is less clearly articulated.

This study responds to that gap by developing an Animaker-based animated learning video that explicitly maps the learning sequence to four conceptual-understanding indicators: restating a concept, discriminating the components of a concept, choosing and performing an appropriate procedure or operation, and applying a concept or algorithm to solve a problem. The study is situated in a State Islamic Junior High School (Madrasah Tsanawiyah Negeri/MTsN), a term used here to make the Indonesian institutional context internationally intelligible. Rather than treating the software platform itself as the innovation, the study examines a design configuration that combines curriculum alignment, concise animated explanation, examples and nonexamples, worked procedures, guided pauses, and practice prompts. Accordingly, the study aimed to develop and evaluate the validity, practicality, and preliminary learning-gain evidence of the video for seventh-grade students learning one-variable linear equations and inequalities.

METHOD

Research Design and Development Model

The study used research and development (R&D) with the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) framework. ADDIE was selected because its iterative logic allows instructional problems, learner needs, media design, formative review, field use, and revision to be connected within a single development process. Recent mathematics-video development studies have similarly used staged design and formative evaluation to connect a digital product to curriculum content and learner feedback (Farihah & Nurafita, 2024; Firdaus et al., 2023; Nasution & Lailia, 2023). The purpose was not to test Animaker as an isolated treatment, but to develop a usable video resource and document evidence of its quality and preliminary learning outcomes.

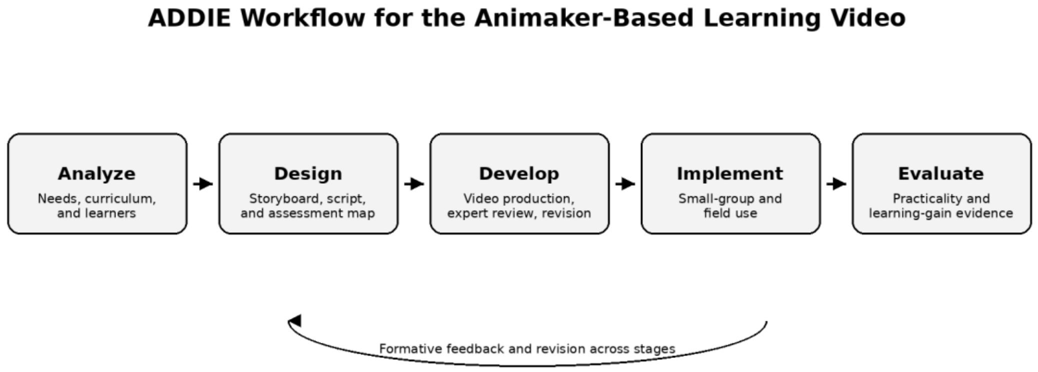

Figure 1. *ADDIE Workflow for Designing and Evaluating the Animaker-Based Learning Video*

Setting and Participants

The development was conducted at State Islamic Junior High School (Madrasah Tsanawiyah Negeri/MTsN) 4 Merangin during the 2025/2026 academic year. The needs analysis identified that students had access to smartphones, a projector, and school Wi-Fi, whereas mathematics instruction was still commonly organized around teacher explanation and textbook examples. The formative evaluation involved two university lecturers who reviewed the media, learning content, and research instruments; one mathematics teacher who appraised individual usability; eight students in a small-group trial; and 30 seventh-grade students in the field implementation. The small group included students with varied prior achievement levels, while the field implementation was conducted in one intact Grade VII class.

Product Development and Instruments

At the analysis stage, the developers reviewed the target curriculum, discussed students' learning difficulties with the mathematics teacher, and identified students' preference for animated audiovisual materials. The design stage produced a storyboard and script that organized the video around concept introduction, examples and nonexamples, stepwise operations, guided pauses, and short practice prompts. The development stage used Animaker to combine simple character animation, mathematical symbols, voice-over explanation, and visual highlighting. The product was revised after expert feedback before small-group and field use. The design decisions were informed by current research emphasizing purposeful visual-verbal integration, coherence, and active processing rather than excessive visual embellishment (Cavanagh & Kiersch, 2023; Cromley & Chen, 2025; Kleftodimos, 2024; Sundararajan & Adesope, 2020).

Table 1. Design Specifications of the Animaker-Based Animated Learning Video

Component	Design Specification	Target Conceptual-Understanding Indicator
Concept exposition	Concise narration and animated symbolic representations introduce the meaning of equations and inequalities.	Restate the concept.
Examples and nonexamples	Contrasting cases direct attention to defining features and common confusions.	Discriminate concept components.

Component	Design Specification	Target Conceptual-Understanding Indicator
Worked procedures	Stepwise visual cues model equivalent operations and solution checking.	Choose and perform an appropriate procedure.
Guided pauses and prompts	Students are invited to predict, solve, and review before the next sequence.	Apply a concept or algorithm to solve a problem.

The instruments comprised expert-review forms, teacher and student practicality questionnaires, a student perception questionnaire, and pre-test and post-test items measuring mathematical conceptual understanding. The expert-review forms addressed content accuracy, curriculum alignment, instructional design, visual and audio presentation, usability, and instrument clarity. Teacher practicality was examined through attractiveness, ease of use, content quality, and support for conceptual understanding. Student practicality focused on attractiveness and ease of use. The conceptual-understanding test was organized around the four indicators stated in the introduction. The original study archive contains experts' qualitative validation decisions and revised instruments, but not item-level validation coefficients; therefore, the evidence is reported as a qualitative validity decision rather than a numerical psychometric claim.

Data Collection and Analysis

Data collection followed the ADDIE sequence. Qualitative comments were collected during expert review and used to revise the product. Practicality data were collected through five-point questionnaires during individual teacher appraisal, small-group use, and field use. Scores of 3.40 to less than 4.20 were interpreted as practical in accordance with the original study's classification. At field implementation, students completed a pre-test before learning with the video and a post-test after the instructional sequence. The field implementation involved three meetings. Learning improvement was summarized using the normalized gain, calculated as the difference between post-test and pre-test scores divided by the possible gain. A normalized gain of 0.67 was interpreted as moderate. Student perceptions were summarized descriptively from response categories. Because the field phase used one class and no comparison group, the pre-test/post-test results are interpreted as preliminary within-group evidence, not as a causal estimate of the video's effect.

RESULTS AND DISCUSSION

Needs Analysis and Learning-Video Specification

The needs analysis indicated three connected problems. First, students tended to follow textbook examples or the teacher's demonstrated steps without articulating the concept that justified those steps. Second, a dedicated digital resource for revisiting the material independently was not yet available. Third, students reported strong interest in animation viewed through smartphones. These findings supported a video format that could be replayed, projected in class, or used for individual review. The product was therefore designed as a compact animated learning video, not as a replacement for the teacher or a stand-alone automated tutor.

The video sequence was aligned with one-variable linear equations and inequalities and was deliberately organized around four conceptual-understanding indicators. The opening segment introduced the target concept and its notation. The following segment contrasted examples and nonexamples to make defining attributes visible. Subsequent scenes modeled equivalent operations in a stepwise manner, with visual emphasis on actions performed on both sides of an

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equation or inequality. Guided pauses and practice prompts were included to invite prediction and application. This alignment is summarized in Table 1 and Figure 1.

Expert Review and Formative Revision

Two university lecturers reviewed the media, learning content, and instruments. The final product was judged valid and feasible after revision. The available dataset records the qualitative validity decision and revision-oriented feedback rather than numerical expert scores. Accordingly, Table 2 reports the evidence at the level supported by the original dataset. The review process was important because it checked that the instructional message, the visual presentation, and the assessment prompts addressed the same intended concepts.

Table 2. Expert Review Decisions and Formative Revision Focus

Review Domain	Evidence from the Original Development Process	Final Decision
Media design	Review of visual presentation, audio, navigation, and usability; suggestions were incorporated before trials.	Valid after revision.
Learning content	Review of content accuracy, curriculum alignment, clarity of explanation, and language appropriateness.	Valid after revision.
Assessment and questionnaires	Review of conceptual-understanding items and questionnaire clarity against the intended indicators.	Valid after revision.

Practicality Across Formative and Field Evaluation

Practicality evidence was collected from the mathematics teacher, the small-group trial, and the field implementation. As shown in Table 3, all mean ratings met the original study's practical criterion. The teacher's individual appraisal produced a mean of 3.78, indicating that the product was judged practical in terms of attractiveness, ease of use, content quality, and its support for conceptual understanding. The student mean increased to 4.12 in the small-group trial and 4.15 in the field implementation. These results suggest that students considered the final video usable and engaging under the available classroom conditions.

Table 3. Practicality Ratings of the Animaker-Based Learning Video

Evaluation Stage	Respondents	Mean Score (5-Point Scale)	Interpretation
Individual teacher appraisal	1 mathematics teacher	3.78	Practical
Small-group trial	8 Grade VII students	4.12	Practical
Field implementation	30 Grade VII students	4.15	Practical

The progression from the teacher appraisal to student use also shows that the product did not become less usable when transferred from review conditions to an intact class. However, these ratings describe perceived practicality; they do not independently establish that the animated video is superior to other media or teaching approaches.

Conceptual Understanding and Student Perceptions

The pre-test and post-test results indicated higher mean conceptual-understanding scores after the three-meeting implementation. The mean increased from 10.867 to 18.200, producing a normalized gain of 0.67, which was categorized as moderate in the original study. Students' predominant perception response was agree, indicating an overall positive reception of the video. Exact percentage distributions for each perception item were not preserved in the available dataset; therefore, the result is reported at the supported categorical level rather than reconstructed as a percentage.

Table 4. Preliminary Learning-Gain Evidence and Student Perception

Indicator	Result	Interpretation
Mean pre-test score	10.867	Baseline conceptual-understanding score before video-supported instruction.
Mean post-test score	18.200	Higher mean score after the three-meeting implementation.
Normalized gain	0.67	Moderate improvement category.
Dominant student-perception category	Agree	Overall positive reception of the learning video.

The gain pattern is consistent with the design expectation that students benefit from a representation that exposes the sequence and rationale of mathematical operations. It should nevertheless be interpreted carefully. Without a control group, random assignment, or delayed test, the observed gain cannot be attributed exclusively to the video. It may also reflect teacher facilitation, practice opportunities, repeated testing, or other classroom factors.

Discussion

The study demonstrates that an accessible animation-authoring tool can support a concept-focused mathematics resource when the instructional design, rather than the novelty of the software, organizes learners' attention. The practical ratings and moderate normalized gain are coherent with contemporary evidence that digital mathematics resources are most promising when they make mathematical relations explicit and structure learners' active processing (Rahma & Nurlaelah, 2024; Tamur et al., 2023; Tamur et al., 2021). In the present product, the animated sequence was not intended merely to increase visual interest. Its central function was to externalize the reasoning that connects a definition, an equivalent operation, and a solution. This distinction matters because video-based learning is not automatically effective simply because it is animated; its value depends on the coherence of verbal explanation, visual representations, task prompts, and opportunities to retrieve or apply the idea (Cavanagh & Kiersch, 2023; Noetel et al., 2021; Noetel et al., 2022).

The field result is broadly consistent with studies of animated mathematics videos in Indonesia. Nasution and Lailia (2023) reported improved conceptual understanding and mathematical problem solving through animated video media, while Farihah and Nurafita (2024) documented positive development outcomes for an Animaker-based contextual video. Nabila et al. (2023) and Sofnidar et al. (2023) likewise showed that animated video can be developed into an acceptable learning resource when content and interface quality are considered together. The present study extends this body of work in a more focused way: its success criteria were connected to four indicators of conceptual understanding rather than to broad achievement alone. The moderate normalized gain of 0.67 should not be compared mechanically with gains in other studies because topics, instruments, durations, and learners differ. Instead, it provides preliminary evidence that the video's design supported meaningful progress within this specific Grade VII context.

The results also align with evidence that multimedia learning requires disciplined control of cognitive load. A video can support explanation when visual highlighting and narration direct learners to a relevant transformation, but extraneous animated details can distract from the mathematical relation. Recent reviews indicate that coherence, signaling, temporal coordination, and the fit between learning task and medium remain central design conditions (Çeken & Taşkın, 2022; Cromley & Chen, 2025; Schroeder & Cenkci, 2020; Sundararajan & Adesope, 2020). Accordingly, the product used simple animation, concise narration, and a stepwise progression. This approach is consistent with Kleftodimos's (2024) review, which emphasizes that pedagogical planning and teachers' design choices are more consequential than animation alone. The positive practicality ratings from both teacher and students suggest that this restrained design was feasible under the school's available technological conditions.

The novelty of this study lies in the integration of a concept-indicator map into an Animaker-based video for one-variable linear equations and inequalities in a State Islamic Junior High School context. The design links each video segment to a distinct conceptual action: stating the concept, discriminating features, selecting valid operations, and applying the algorithm. This provides a replicable design logic for teachers and developers who need more than an attractive explanatory video. It also responds to a practical digital-transformation issue: schools may use comparatively accessible creation platforms to develop locally aligned resources instead of relying only on generic content. Such locally responsive technology integration is consistent with wider calls for student-centered and context-sensitive digital learning (Cirneanu & Moldoveanu, 2024; Kerimbayev et al., 2023; Laakso et al., 2021).

Several implications follow. For mathematics teachers, the video should be used as a structured learning episode: pause before the model reveals a solution, ask learners to explain why an operation preserves equivalence, and follow viewing with problem solving and feedback. This use is more likely to promote conceptual understanding than passive viewing. For school leaders, the product illustrates that a modest digital infrastructure - smartphones, a projector, and stable access where available - can support carefully designed technology-enhanced mathematics learning. For developers, future versions should add learner-control features, captions, accessible audio options, and embedded response opportunities so that the resource can better accommodate diverse learners. These implications resonate with evidence that educational-video research should move beyond production quality toward instructional integration, active learning, and evaluation across authentic contexts (Paino & Hutagalung, 2022; Polat et al., 2025; Puspaningtyas & Ulfa, 2020; Sidarta & Yunianta, 2022).

Finally, the discussion must retain an appropriately cautious interpretation of effectiveness. The observed pre-test/post-test improvement is encouraging but does not establish a comparative causal effect. Future studies should use larger multisite samples, comparison conditions, retention tests, and more complete psychometric reporting for the conceptual-understanding assessment. Studies could also examine how teacher facilitation, students' prior digital skills, and the location of guided pauses alter learning outcomes. Such work would strengthen the evidence base for Animaker-based video and help distinguish the contribution of animation, pedagogy, and classroom implementation (Afni & Hartono, 2020; Apriatna et al., 2020; Basyarewan et al., 2022; Hamidi et al., 2023; Rijal & Azimi, 2021).

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CONCLUSIONS

This study developed an Animaker-based animated learning video for seventh-grade students studying one-variable linear equations and inequalities at State Islamic Junior High School (Madrasah Tsanawiyah Negeri/MTsN) 4 Merangin. The product was judged valid after expert revision and practical across teacher appraisal (3.78), small-group use (4.12), and field use (4.15). Students' mean conceptual-understanding score increased from 10.867 to 18.200, with a normalized gain of 0.67, and their predominant perception category was agree. The main contribution is not the use of animation in isolation, but a replicable concept-aligned design that connects animated explanations, examples and nonexamples, worked procedures, and guided practice to four indicators of mathematical conceptual understanding. The findings support the video as a feasible digital-learning resource for classroom use. Because the implementation involved one class, a short duration, and no comparison group, future research should test the resource across schools and against alternative instructional conditions before making stronger effectiveness claims.

AUTHOR CONTRIBUTION STATEMENT

MZ conceptualization, methodology, software and media development, data curation, formal analysis, investigation, visualization, and original draft preparation. JM supervision, methodology refinement, validation, and manuscript review and editing. MM supervision, validation, interpretation of findings, and manuscript review and editing. All authors approved the final manuscript and accept responsibility for the integrity of the work.

AI DISCLOSURE STATEMENT

The authors used a generative artificial intelligence tool for English-language editing, structural organization, and reference-format checking during manuscript preparation. All generated output was critically reviewed, verified, and revised by the authors. The tool was not used to generate, alter, or fabricate research data, participant information, images, results, or conclusions. The authors remain fully responsible for the accuracy, originality, and integrity of the manuscript.

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