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Developing e-learning-based remedial learning videos on function for senior high schools

Rahmah Johar*, Amna Sri Rizeky, Mailizar

Universitas Syiah kuala, Aceh, Indonesia

* Correspondence: rahmah.johar@usk.ac.id

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Abstract

Mastery learning remains a critical challenge in education, often resulting in the need for remedial programs to support students in achieving competency. Despite their importance, existing remedial programs frequently fail to achieve their intended outcomes due to a lack of engaging and efficient instructional tools. To address this gap, this study introduces a novel e-learning-based remedial video designed to enhance student learning on the topic of functions. The research aimed to develop a remedial learning video that meets the criteria for validity, practicality, and effectiveness. The study employed a Research and Development (R&D) methodology following the Plomp model, which consists of three phases: preliminary research, prototyping, and assessment. The research was conducted in a high school in Banda Aceh, Indonesia, involving three distinct groups: nine students participated in the readability test, 60 students undertook the diagnostic test, and 18 students engaged in remedial learning activities. Data collection utilized validation sheets for the video, diagnostic and remedial tests, and student response questionnaires, with descriptive analysis applied to evaluate the findings. The results revealed that the e-learning-based remedial video demonstrated strong validity, with expert assessments yielding a score of 86.19% (very valid). Practicality was confirmed by positive student feedback, with a response rate of 92.62%. Effectiveness was also evident, as 95% of students achieved mastery learning following the remedial intervention, and the N-Gain score reflecting improvement in student performance was 0.72 (high). These outcomes underscore the effectiveness of e-learning-based remedial videos as an innovative and interactive solution to address students' lack of mastery learning. The findings contribute to educational practice by offering teachers and students an accessible and effective tool to enhance learning outcomes, with significant potential for broader application.

Keywords: E-learning, function, remedial learning video, research and development

Introduction

Education represents a purposeful and systematic endeavor to establish a supportive environment that fosters learning. Nevertheless, obstacles persist in achieving student proficiency during the learning process. Mastery learning is fundamentally linked to a student's ability to achieve predefined competencies (Gamiao, 2021). A significant proportion of students face difficulties meeting the minimum criteria for mastery learning, particularly in mathematics (Akhter & Akhter, 2018). These challenges often stem from various learning difficulties, including issues related to understanding functions.

Kamin et al. (2021) reported that students demonstrate limited comprehension of composition and inverse functions. Similarly, Pramesti & Ferdianto (2019) identified persistent difficulties among students in conceptual understanding, technical skills, and problem-solving related to these topics. Such challenges often arise due to students' inadequate understanding of the material delivered by teachers, highlighting the critical need for remedial learning interventions (Gusal et al., 2021).

Remedial learning serves as an educational intervention aimed at enhancing students' performance to meet predetermined standards (Myllykoski, 2016). This approach is typically initiated following diagnostic assessments that identify specific learning gaps (Sleeman et al., 1989). Furthermore, Ishmah et al. (2020) stated that remedial learning can be implemented through three primary strategies, such as re-teaching using alternative methods and instructional media when more than 50% of the class requires remediation, individualized guidance for up to 20% of students, and group assignments or peer tutoring for situations where 20%–50% of students require additional support. Subsequent to these interventions, post-remedial assessments are conducted to evaluate students' mastery of the targeted competencies.

Despite its significance, studies highlight deficiencies in the implementation of remedial learning. Lidi (2018) reported that 87% of teachers do not conduct remedial activities, with 37% lacking a comprehensive understanding of remedial teaching processes. Furthermore, remedial measures often fail to align with students' specific competencies (Apriliani et al., 2019). Limited instructional time is frequently cited as a major barrier to effective remedial practices (Marsandi et al., 2016). To overcome these limitations, innovative approaches, such as the integration of learning videos, are recommended to enhance the efficiency and effectiveness of remedial instruction (Priyadi et al., 2018).

Learning videos present a viable solution to address issues in student mastery by leveraging multiple sensory inputs to improve retention. Priadi et al. (2021) demonstrated that video-based learning media, which incorporate both auditory and visual components, can enhance memory retention by 14%–38%. Thus, videos provide a practical and impactful medium for teachers to facilitate students' understanding of the subject matter. Additionally, Hermita et al. (2021) emphasized that videos represent effective e-learning tools that integrate theoretical concepts with practical applications, thereby bridging educational content with real-world contexts.

Technological advancements have significantly enhanced various sectors, including education (Pulido, 2022). In the context of learning, technology supports e-learning as a modern

innovation that leverages internet-based platforms to facilitate the delivery of instructional materials and the development of student competencies (Fadrianto, 2019; Elizah et al., 2022). E-learning enables educational processes, including instruction and assessment, to occur seamlessly even in the absence of teachers' physical presence in the classroom (Gusal et al., 2021). Consequently, e-learning serves as a flexible medium for remedial learning, offering students the convenience of accessing educational resources anytime and anywhere.

One notable e-learning platform is Getmath, developed by the Research and Development Center for Realistic Mathematics Education Indonesia (PRP-PMRI) team at Universitas Syiah Kuala (USK). This platform, accessible at https://getmath.id, provides features such as diagnostic tests, remedial learning modules, and e-modules, catering to diverse learning needs.

The integration of technology into remedial learning has demonstrated numerous benefits in recent studies. For instance, Sasalia (2020) reported that over 75% of students found e-learning-based remedial programs advantageous, with an 83% improvement in learning outcomes. Similarly, Wijaya et al. (2020) emphasized the effectiveness of video-based learning in enhancing students' conceptual understanding and problem-solving skills. Mellawaty et al. (2022) further demonstrated that YouTube-based videos significantly improved students' performance in mastering composition and inverse functions. Moreover, Malihah and Sumargiyani (2023) showed that learning videos designed using the Canva application are both valid and practical, offering an effective approach to teaching composition functions.

Despite these advancements, no e-learning-based remedial videos specifically target the topic of functions. Therefore, this study aims to address this gap by developing remedial learning videos on functions for high school students. The study seeks to determine whether these videos meet the criteria of validity, practicality, and effectiveness.

Methods

The methodology adopted in this study follows the development research model proposed by Plomp & Nieveen (2013), which encompasses three systematic stages: (1) the preliminary phase, focusing on identifying curriculum requirements, analyzing student characteristics, and selecting appropriate materials; (2) the prototyping phase, involving the design and development of three remedial question packages aligned with eight predetermined indicators (refer to Table 1), as well as the creation of remedial learning videos. These prototypes were subsequently subjected to rigorous evaluations, including assessments of validity, readability, and practicality; and (3) the assessment phase, which included a large-scale implementation trial to determine the effectiveness of the remedial learning videos.

Table 1. Indicators of Remedial Test Questions

No	Indicator
1	Determining the domain, codomain, and range of a function
2	Determining the result of the operation of two or more functions
3	Explaining the conditions of a function that can be composed
4	Determining the composition of functions

No	Indicator
5	Determining the components that make up a function
6	Explaining the conditions and properties of a function having an inverse
7	Determining the inverse of a function
8	Solving problems related to the composition and inverse operations of a function

The Plomp development model was selected for its structured yet adaptable framework, prioritizing the criteria of validity, practicality, and effectiveness to ensure the educational relevance and applicability of the developed products. The research workflow is depicted in Figure 1.

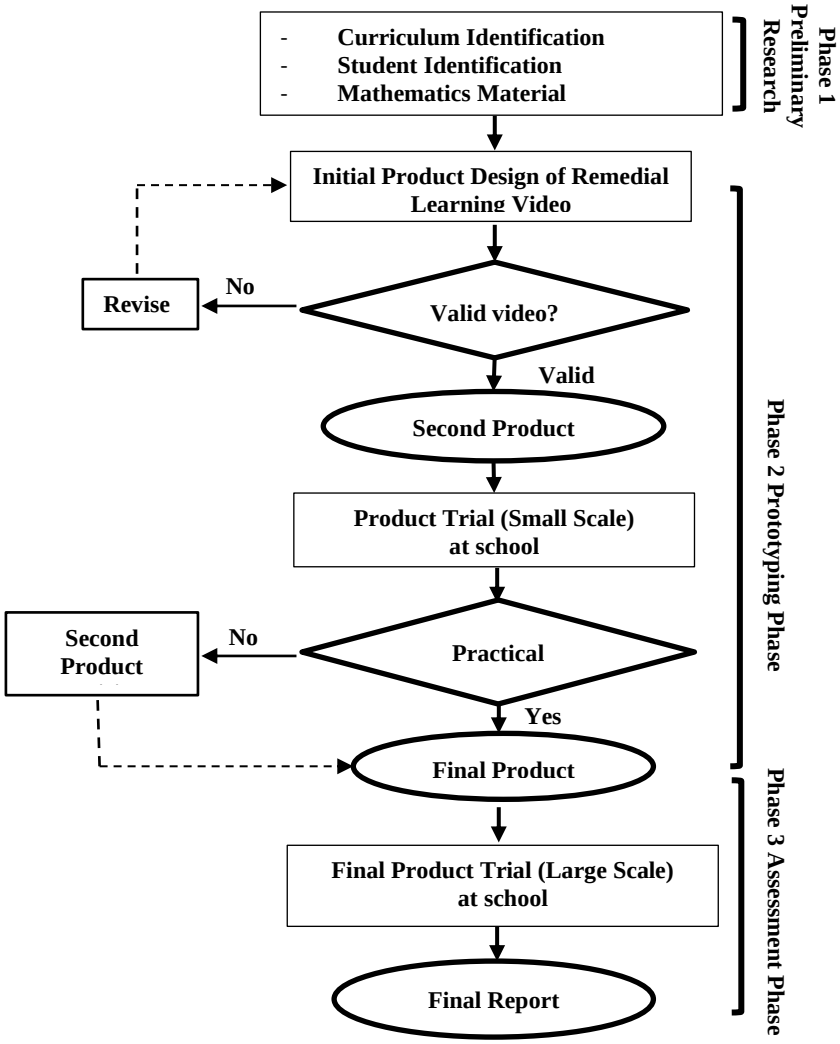

Figure 1. Flowchart of remedial learning video development

A pilot study was conducted with Year 11 students from a high school in Banda Aceh, Indonesia. The readability test involved a sample of five Year 11 students. Diagnostic tests were administered to 58 students across two classes. Results from these diagnostic tests revealed that 18 students did not achieve the Minimum Criteria of Mastery Learning, which was set at a score

of 75. These students were subsequently engaged in e-learning-based remedial learning sessions. The practicality and effectiveness of the e-learning-based remedial learning videos were subsequently evaluated.

The research employed various instruments, including tests, validation sheets, and questionnaires. The test items, designed by the researchers, consisted of multiple-choice questions with five response options. A total of 10 questions were prepared, each offered in three distinct packages. Validation sheets were utilized to obtain expert evaluations of the remedial test questions and the e-learning-based remedial learning videos. Experts assessed the materials using a five-point Likert scale: very good (5), good (4), adequate (3), less good (2), and not good (1). The assessment of the learning videos comprised two components: video content (3 items) and video design (14 items). The validation instrument for the remedial learning videos was adapted from the framework proposed by Brame (2016). Details of the validation sheet are summarized in Table 2.

Table 2. Validation Sheet of Remedial Learning Video

Aspects of video content		
No.	Indicator	Statement Number
1	The video is in line with the material being studied.	1,2,3
2	Questions are integrated into the video.	
3	Questions are used to guide students.	
Video display aspect		
No.	Indicator	Statement Number
1	Providing keywords for important sections.	4,5,6,7,8,9,10,11,12,13,14,15,16
2	Using color or contrast to emphasize the relationship between information.	
3	Containing a brief explanation of the purpose and context of the video.	
4	Avoiding excessive music.	
5	Avoiding complex backgrounds.	
6	Using animation.	
7	Creating multiple videos for 1 topic (maximum duration of 6 minutes).	
8	Engaging learners in the video by mentioning you.	
9	Speaking 185-254 words per minute.	
10	Choosing the appropriate size and font.	
11	Using clear text on the video.	
12	Using the appropriate layout of the text on the video.	
13	Image quality/video display.	
14	Excellent quality image or video display.	

A student response questionnaire was employed to assess the practicality of the remedial learning videos. Students rated their agreement with each statement on a five-point Likert scale: strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The questionnaire comprised seven statements, with two addressing usability and five focusing on

implementation aspects. This instrument was adapted from the framework proposed by Astafiria & Bayu (2021), and the details of the questionnaire are presented in Table 3.

Table 3. Student Response Questionnaire

User interface		
No.	Indicator	Statement number
1	I can use learning videos easily	1 and 2
2	Remedial learning video available starts from easiest to hardest material	
Benefit aspect		
No.	Indicator	Statement number
1	The remedial learning videos presented help me in learning	3,4,5,6,7
2	Remedial learning videos are interesting and motivate me to learn	
3	The voice on the remedial learning video makes me excited to pay attention to the material presented.	
4	Remedial learning videos improve my understanding of the material	
5	I can repeat learning materials that I have not understood using remedial learning videos	

Table 4 presents the percentage criteria for the validity of questions and learning videos.

Table 4. Percentage of Validity Criteria

Persentase	Criteria	Description
$81\% - 100\%$	Very Valid	No revision
$61\% - 80\%$	Valid	Partial revision
$41\% - 60\%$	Fairly Valid	Partial revision and reassessment
$21\% - 40\%$	Poorly Valid	Revision and thorough review of materials
$0\% - 21\%$	Invalid	Total revision

Source: Jannah & Julianto (2018)

The data collected from the student response questionnaires were analyzed using descriptive statistical techniques. The criteria for the percentage of student responses to the learning videos are outlined in Table 5.

Table 5. Percentage criteria for student response to learning videos

Persentase	Kriteria
$81\% - 100\%$	Excellent
$61\% - 80\%$	Good
$41\% - 60\%$	Moderate
$21\% - 40\%$	Poor

Persentase	Kriteria
0% – 21%	Very Poor

Source: Jannah & Julianto (2018)

E-learning-based remedial learning videos are considered practical when student responses fall within the "good" or "excellent" criteria, as defined by Wiratama (2019). Additionally, the videos are deemed effective if at least 85% of the students achieve the mastery learning threshold of 75, and the N-Gain of student scores post-remedial learning is classified within the medium category. The N-Gain calculation follows the formula proposed by Meltzer (2002).

Results and Discussion

This study resulted in the development of an e-learning-based remedial instructional video, designed using the Plomp model, which encompasses three stages: preliminary research, prototyping, and evaluation. The findings of each stage are summarized as follows.

Preliminary Research

During this phase, an initial needs assessment was conducted to identify the requirements for creating the remedial learning videos. Curriculum analysis for Year 10 students at a high school in Banda Aceh revealed that the institution implemented the Merdeka curriculum for Year 10, while Years 11 and 12 adhered to the 2013 curriculum. Interviews with students indicated that a significant number face challenges and exhibit a lack of interest in mathematics, particularly in comprehending concepts, applying mathematical skills, and solving problems, with a specific emphasis on the topic of functions.

An analysis of the Basic Competencies and Competency Achievement Indicators specified in the 2013 curriculum guided the selection of topics to be addressed in the e-learning-based remedial videos. The identified topics are outlined in Table 6.

Table 6. Topics on Remedial Learning Videos

Video	Topic	Duration
Video 1	Fraction function domain and root function domain	04:35 Minute
Video 2	Domain of fractional root function	04:11 Minute
Video 3	Operation of two or more functions	04:38 Minute
Video 4	Composition function	04:56 Minute
Video 5	Determines one of the functions that make up the composition function	03:59 Minute
Video 6	Determine the result of function composition when x is known	03:45 Minute
Video 7	Inverse function	04:53 Minute
Video 8	The inverse of a fractional function	03:12 Minute
Video 9	The inverse of the composition function	03:04 Minute

Table 6 demonstrates that the duration of the remedial learning videos varies between three to five minutes, with the shortest video, lasting 03:04 minutes, dedicated to the topic of the inverse of a composition function. This brief duration is strategically designed to sustain student engagement while ensuring the effective communication of the instructional content.

Prototyping Phase

During this phase, the video design and corresponding remedial exercises, which comprised three equivalent test versions, were developed. The remedial items were formulated based on the learning indicators related to functions, as outlined in Table 8. The video design was structured as a storyboard, with a focus on presenting the material, problems, and solutions. Each video integrates step-by-step problem-solving procedures, accompanied by detailed explanations of the pertinent concepts.

The tools and applications employed in the production of the remedial learning videos are depicted in Figure 2.

Figure 2. Tools and Applications for Making Remedial Learning Videos

Figure 2 illustrates the tools and applications employed in the creation of the remedial learning videos. These include CapCut, Pinterest, PowerPoint, a laptop, a pen tablet, and Zepeto. During the production phase, images were animated using Pinterest, while the problem-solving process was recorded via screen capture on an HP laptop using PowerPoint, with assistance from a pen tablet. The worksheet displaying the animation creation process and the video production of problem-solving is shown in Figure 3.

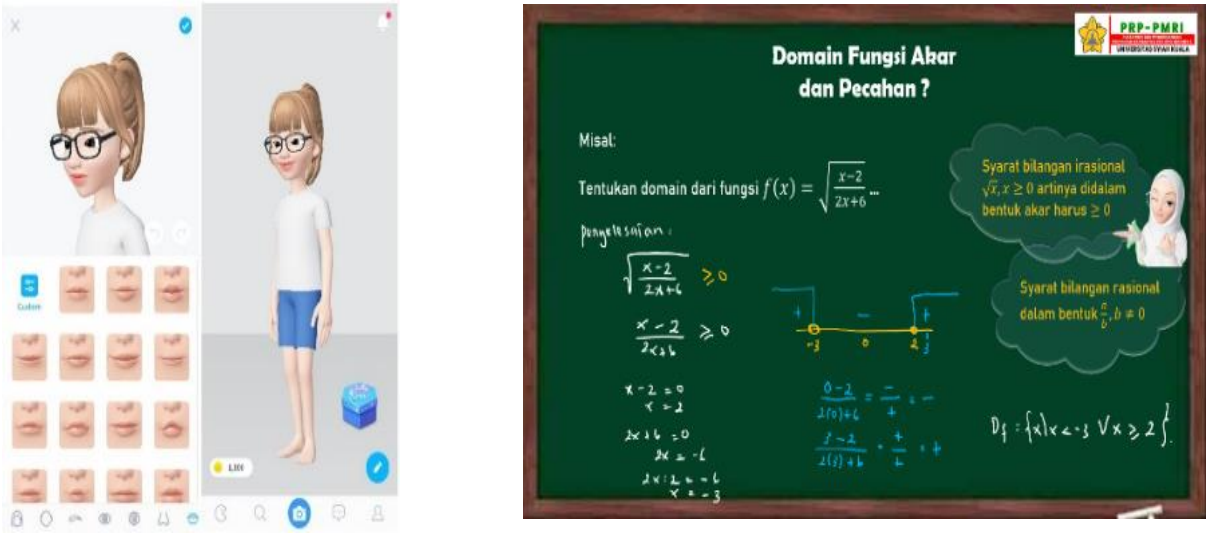

Figure 3. The process of creating animations using Zepeto and the process of solving problems in the video

Figure 3 depicts the process of animation creation using Zepeto, a game application that generates unique characters utilized as content for videos intended as audiovisual learning media. The subsequent stage involved video editing, which included tasks such as importing files, inserting animations, cutting and combining video segments, adding text, incorporating audio, applying transitions, and finalizing the video for export. The editing process is illustrated in Figure 4.

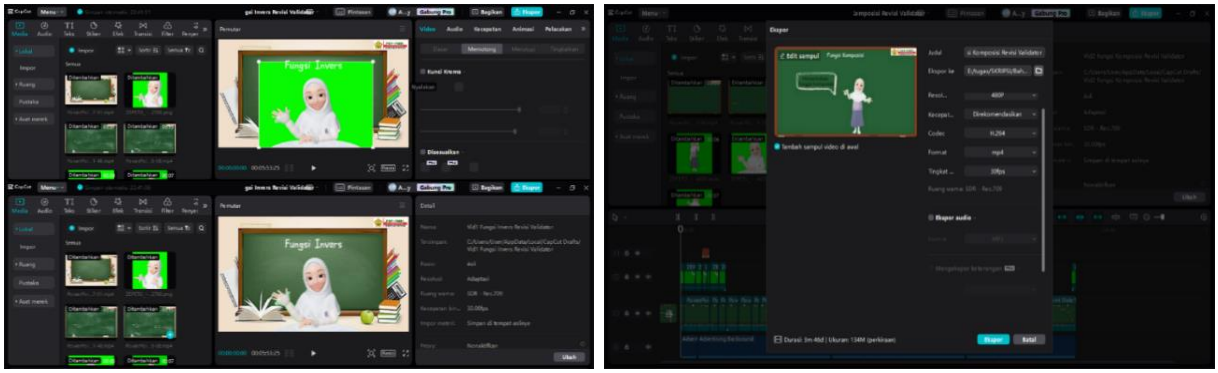

Figure 4. Video Editing Process

Figure 4 illustrates the editing process for the remedial video, emphasizing the use of the green screen feature to eliminate or replace the background. Additionally, it showcases the organization and arrangement of visual elements within the video editing software.

Validity of E-Learning-Based Remedial Learning Test Items and Videos

Table 7 presents the results of the validation process for the remedial test items.

Table 7. Results of the Validation of Remedial Test Items by Experts

Percentage of Validity (%)	Expert			Average	Level of Validity
	1	2	3		
S1	98.89%	87.78%	85.56%	90.74%	Very Valid
S2	98.89%	87.78%	85.56%	90.74%	Very Valid
S3	98.89%	78.89%	84.44%	87.41%	Very Valid
S4	94.44%	81.11%	86.67%	87.41%	Very Valid
S5	94.44%	86.67%	88.89%	90.00%	Very Valid
S6	94.44%	86.67%	90.00%	90.37%	Very Valid
S7	98.89%	91.11%	91.11%	93.70%	Very Valid
S8	98.89%	84.44%	92.22%	91.85%	Very Valid
S9	98.89%	90.00%	93.33%	94.07%	Very Valid
S10	98.89%	90.00%	92.22%	93.70%	Very Valid
Average	97.56%	86.45%	89.00%	91.00%	Very Valid

Furthermore, Table 7 displays the average assessment results of the experts for all remedial test items, which was 91.00% (categorized as very valid). The experts offered several recommendations for improvement, including refining grammar, adjusting the level of question difficulty, and utilizing more precise action verbs to enhance the clarity and quality of the items. A sample of a revised item, based on the experts' feedback, is also presented in Table 8.

Table 8. One of the Function Problems for Three Packages

Pack i	**Pack ii**	**Pack iii**
Given $f(x) = 2x^2 + 8$ and $g(x) = 7 - x$. $(f \circ g)(3)$ is	Given $f(x) = 2x^2 + 4$ and $g(x) = 5 - x$. $(f \circ g)(2)$ is....	Given $f(x) = x^2 + 6$ and $g(x) = 2 - 3x$. $(f \circ g)(2)$ is....
a. -19	a. -9	a. -32
b. -4	b. -2	b. -28
c. -3	c. 1	c. -4
d. 40	d. 22	d. 22
e. 58	e. 30	e. 34

Table 9 presents the validation results for the remedial learning video, based on expert assessments. The average validity assessment from four experts was 86.19% (classified as very valid). The experts provided several recommendations for improvement: Video 1 required additional explanations and visual elements to emphasize key information. Video 2 needed enhanced visuals, including additional shapes and varied text colors to clarify requirements. Video 3 required a more extensive explanation. Video 4 necessitated supplementary explanations, additional shapes, and text with varied colors. Videos 5 and 6 needed more shapes and colored text to improve the clarity of the requirements. Video 7 required adjustments to unclear text, better alignment between the background and text colors, and the inclusion of

additional shapes. Finally, Videos 8 and 9 needed additional shapes, varied text colors for requirements, and other enhancements.

Table 9. Results of the Validation of Remedial Learning Videos by Experts

Percentage of Validity (%)	Expert				Average	Level of Validity
	1	2	3	4		
V1	92.65%	75.00%	82.35%	83.82%	83.46%	Very Valid
V2	95.59%	79.41%	83.82%	79.41%	84.56%	Very Valid
V3	97.06%	79.41%	88.24%	86.76%	87.87%	Very Valid
V4	97.06%	72.06%	80.88%	85.29%	83.82%	Very Valid
V5	95.59%	76.47%	86.76%	88.24%	86.77%	Very Valid
V6	95.59%	83.82%	82.35%	83.82%	86.40%	Very Valid
V7	95.59%	69.12%	80.88%	86.76%	83.09%	Very Valid
V8	97.06%	89.71%	88.24%	82.35%	89.34%	Very Valid
V9	98.53%	95.59%	83.82%	83.82%	90.44%	Very Valid
Average	96.08%	80.07%	84.15%	84.47%	86.19%	Very Valid

Readability Test of Remedial Learning Video

A readability trial was conducted with five students: S9, S23, S37, S52, and S53. The trial consisted of 16 questions focused on the content and presentation of the remedial learning video. After viewing the video, the students participated in interviews where the researchers collected feedback and responses regarding the video. Table 10 presents the results of the readability test interviews.

Table 10. Results of student interviews for the readability test of remedial learning videos

No.	Question	Student group answers
1	Does the material in the video match the material you have learned?	Yes
2	Do the videos ask interactive questions?	Yes
3	Did the questions asked in the video help you to understand the material?	Yes, it is very helpful
4	Are there keywords in the video for the parts that you think are important?	Yes
5	Does the color or contrast used in the video match and help understand the information provided?	Very easy to understand the visuals
6	Does the video briefly explain the purpose and context of the video?	Yes
7	Is the background used attractive?	Interesting
8	Are the animations interesting and helpful in understanding the material?	Very good
9	Did you find the video duration fast/medium/slow?	Medium
10	Do you feel included in the video?	Yes

No.	Question	Student group answers
11	Is the articulation in the video fast/medium/slow and audible?	Medium
12	Does the voice on the video sound cheerful?	Not really, but it is audible
13	Is the font size small/medium/large and visible?	Medium
14	Is the text or writing in the video appropriate and visible?	Clear
15	Is the location of the text or writing appropriate?	Appropriate
16	Are the images and video displays of good quality?	Yes

Table 10 indicates that the remedial learning video was well-received by all students, particularly with respect to interactive questions, color schemes, objectives, animations, text clarity, student engagement, writing quality, and overall video animation. However, some limitations were identified, including video duration and sound quality. The revision process undertaken to address these issues is illustrated in Figure 5.

Figure 5. Duration and Audio Revision Process

Figure 5 illustrates the revision process for the duration and audio of the remedial video. The revised video was subsequently uploaded to the GetMath website, as depicted in Figure 6. It shows the process of uploading the remedial videos to the GetMath website. The uploaded videos meet the validity criteria and are deemed suitable for remedial learning.

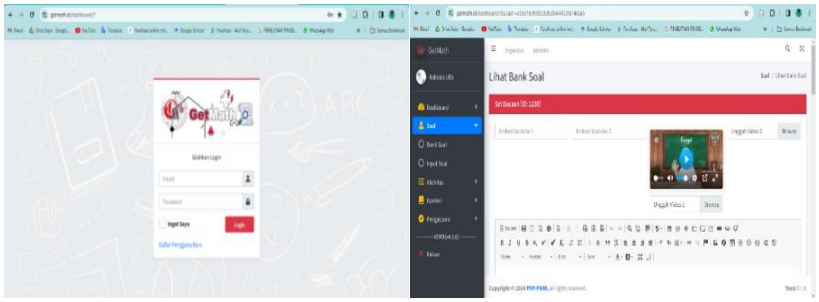

Figure 6. Uploading Learning Videos on the Website According to the Topic

Assessment Phase

At this stage, a field test was conducted, starting with the administration of diagnostic tests to two classes. Table 11 presents the percentage of student mastery on the diagnostic test. The data in Table 11 reveals that 18 out of 60 students (30%) did not meet the minimum mastery criteria. These students then participated in the remedial learning sessions offered through the GetMath Platform, following the procedure outlined by Johar et al. (2023).

Table 11. Diagnostic Test Results

Class	Mastery	Non-mastery	Total	Percentage of Mastery Learning
A	28	6	34	83.33%
B	14	12	26	53.85%

Upon completion of the video-assisted remedial learning, the students were asked to complete a questionnaire evaluating the practicality of the e-learning-based remedial learning videos. The results of the student response questionnaire are presented in Table 12.

Table 12. Results of Student Response to E-Learning-Based Remedial Learning Videos

Aspects	Indicator	Class		Average	Criteria
		A	B		
How to use	1	100.00%	85.00%	92.50%	Excellent
	2	100.00%	83.33%	91.67%	Excellent
Benefits	3	96.67%	86.67%	91.67%	Excellent
	4	100.00%	86.67%	93.34%	Excellent
	5	100.00%	85.00%	92.50%	Excellent
	6	96.67%	88.33%	92.50%	Excellent
	7	96.67%	91.67%	94.17%	Excellent
Average		98.57%	86.67%	92.62%	Excellent
Criteria		Excellent	Excellent	Excellent	

Table 12 shows that the average practicality score for the e-learning-based remedial learning videos is 92.62% (Excellent). This result suggests that the videos were user-friendly and effectively enhanced students' understanding of the function material. Furthermore, the videos provided students with the opportunity to revisit and review concepts they found challenging, thereby supporting their overall learning process. Table 13 presents the results of the remedial test.

Table 13. Remedial Test Results

No.	Student	Students' Score After Remedial																																		Total Score
		Item 1			Item 2			Item 3			Item 4			Item 5			Item 6			Item 7			Item 8			Item 9			Item 10									
		i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii					
1	1	1 [b]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [e]	1 [a]	x [x]	1 [c]	x [x]	x [x]	1 [c]	x [x]	x [x]	0 [d]	1 [b]	x [x]	1 [d]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [d]	1 [b]	x [x]	0 [c]	1 [c]	x [x]					100
2	2	1 [b]	x [x]	x [x]	0 [b]	1 [c]	x [x]	1 [b]	x [x]	x [x]	1 [c]	x [x]	x [x]	0 [b]	1 [d]	x [x]	1 [e]	x [x]	x [x]	0 [b]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [d]	1 [b]	x [x]	1 [a]	x [x]	x [x]					100
3	3	1 [b]	x [x]	x [x]	0 [b]	1 [c]	x [x]	0 [e]	1 [a]	x [x]	0 [b]	1 [e]	x [x]	0 [e]	1 [d]	x [x]	0 [c]	0 [a]	1 [c]	0 [a]	0 [a]	1 [d]	1 [d]	x [x]	x [x]	0 [a]	0 [a]	1 [d]	0 [b]	0 [b]	1 [e]					100
4	4	0 [e]	1 [e]	x [x]	0 [b]	0 [d]	1 [d]	0 [e]	0 [c]	1 [e]	0 [b]	1 [e]	x [x]	0 [d]	1 [d]	x [x]	0 [b]	0 [a]	1 [c]	0 [c]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [d]	1 [b]	x [x]	0 [c]	0 [b]	1 [e]					100
5	5	1 [b]	x [x]	x [x]	0 [e]	1 [c]	x [x]	0 [e]	0 [c]	1 [e]	1 [c]	x [x]	x [x]	0 [d]	1 [d]	x [x]	1 [e]	x [x]	x [x]	0 [e]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [a]	1 [b]	x [x]	0 [b]	0 [b]	1 [e]					100
6	6	0 [c]	1 [e]	x [x]	1 [d]	x [x]	x [x]	0 [c]	1 [a]	x [x]	1 [c]	x [x]	x [x]	0 [a]	1 [d]	x [x]	0 [a]	1 [b]	x [x]	0 [e]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [a]	0 [c]	1 [d]	0 [b]	0 [b]	1 [e]					100
7	7	1 [b]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [c]	1 [a]	x [x]	1 [c]	x [x]	x [x]	1 [c]	x [x]	x [x]	0 [b]	0 [e]	0 [a]	1 [d]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [b]	1 [b]	x [x]	0 [c]	1 [c]	x [x]					90
8	8	1 [b]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [c]	1 [a]	x [x]	0 [b]	0 [c]	1 [d]	0 [b]	0 [c]	0 [e]	0 [a]	1 [b]	x [x]	0 [c]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [b]	0 [c]	1 [d]	1 [a]	x [x]	x [x]					90
9	9	0 [c]	1 [e]	x [x]	0 [c]	1 [c]	x [x]	0 [c]	0 [c]	1 [e]	1 [c]	x [x]	x [x]	0 [d]	0 [c]	1 [a]	0 [c]	0 [a]	1 [c]	0 [c]	1 [d]	x [x]	0 [c]	0 [d]	1 [c]	0 [d]	1 [b]	x [x]	0 [b]	0 [b]	0 [a]					90
10	10	1 [b]	x [x]	x [x]	0 [c]	1 [c]	x [x]	0 [c]	0 [c]	1 [e]	1 [c]	x [x]	x [x]	0 [d]	1 [d]	x [x]	0 [a]	0 [a]	1 [c]	0 [e]	1 [d]	x [x]	0 [c]	0 [b]	1 [c]	0 [d]	1 [b]	x [x]	0 [c]	0 [b]	0 [a]					90
11	11	0 [d]	1 [e]	x [x]	0 [c]	1 [c]	x [x]	0 [c]	0 [e]	1 [e]	1 [c]	x [x]	x [x]	0 [a]	1 [d]	x [x]	0 [a]	0 [a]	1 [c]	0 [e]	1 [d]	x [x]	1 [d]	x [x]	x [x]	1 [e]	x [x]	x [x]	0 [b]	0 [e]	0 [a]					90
12	12	0 [d]	1 [e]	x [x]	0 [c]	1 [c]	x [x]	0 [c]	0 [e]	1 [e]	0 [b]	1 [e]	x [x]	0 [a]	0 [e]	1 [a]	0 [a]	1 [b]	x [x]	0 [e]	1 [d]	x [x]	1 [d]	x [x]	x [x]	0 [d]	0 [a]	1 [d]	0 [b]	0 [b]	0 [c]					90
13	13	1 [b]	x [x]	x [x]	0 [c]	0 [d]	1 [d]	0 [e]	0 [c]	0 [a]	0 [d]	0 [c]	0 [e]	1 [c]	x [x]	x [x]	0 [d]	0 [c]	1 [c]	1 [d]	x [x]	x [x]	0 [c]	0 [b]	1 [c]	1 [e]	x [x]	x [x]	1 [a]	x [x]	x [x]					80
14	14	0 [d]	0 [b]	1 [b]	0 [c]	1 [c]	x [x]	0 [c]	0 [b]	0 [d]	0 [b]	0 [a]	0 [e]	0 [b]	1 [d]	x [x]	0 [c]	1 [b]	x [x]	0 [a]	1 [d]	x [x]	1 [d]	x [x]	x [x]	1 [e]	x [x]	x [x]	0 [b]	1 [c]	x [x]					80
15	15	1 [b]	x [x]	x [x]	1 [d]	x [x]	x [x]	0 [e]	1 [a]	x [x]	0 [b]	1 [e]	x [x]	0 [d]	0 [c]	1 [a]	0 [b]	0 [a]	0 [b]	0 [e]	0 [a]	1 [d]	1 [d]	x [x]	x [x]	0 [d]	0 [c]	0 [e]	0 [b]	1 [c]	x [x]					80
16	16	0 [a]	0 [c]	1 [b]	0 [c]	0 [d]	1 [d]	0 [c]	0 [e]	0 [d]	0 [d]	0 [b]	1 [d]	0 [a]	0 [e]	1 [a]	0 [b]	0 [a]	1 [c]	0 [e]	0 [a]	0 [b]	0 [c]	1 [c]	x [x]	0 [a]	1 [b]	x [x]	0 [b]	1 [c]	x [x]					80
17	17	0 [c]	1 [e]	x [x]	1 [d]	x [x]	x [x]	0 [c]	0 [e]	1 [e]	1 [c]	x [x]	x [x]	0 [e]	0 [a]	1 [a]	0 [a]	0 [d]	1 [c]	0 [a]	0 [e]	0 [b]	1 [d]	x [x]	x [x]	0 [a]	0 [e]	0 [c]	1 [a]	x [x]	x [x]					80
18	18	0 [d]	0 [b]	0 [a]	1 [d]	x [x]	x [x]	0 [c]	0 [d]	0 [b]	0 [a]	0 [c]	1 [d]	1 [c]	x [x]	x [x]	0 [d]	1 [b]	x [x]	0 [a]	0 [c]	0 [e]	0 [c]	1 [c]	x [x]	0 [a]	0 [d]	0 [c]	0 [e]	0 [a]	0 [c]					50
Average																																				88,33
Standard of Deviation																																				12,13

In Table 13, "1" indicates a correct answer, "0" represents an incorrect answer, and "x" denotes that the student did not need to proceed to the second set of problems (Package II) because they had already answered correctly in the first set (Package I). From Table 13, it is evident that only 1 out of 18 students (5%) scored below 75. Therefore, it can be concluded that the overall percentage of mastery learning was successfully achieved. The N-gain, representing students' score improvement after remedial learning, is presented in Table 14.

Table 14. N-Gain Score of Students After Remedial Program

NO	STUDENT CODE	SCORE		N-Gain
		DIAGNOSTIC TEST	REMEDIAL TEST	
1	S4	21	50	0.37
2	S9	49	90	0.80
3	S11	63	90	0.73
4	S17	70	90	0.67
5	S23	70	80	0.33
6	S33	70	100	1.00
7	S36	70	90	0.67
8	S37	56	80	0.55
9	S43	70	90	0.67
10	S46	70	100	1.00
11	S47	49	100	1.00
12	S48	70	80	0.33
13	S50	70	100	1.00
14	S52	42	80	0.66
15	S53	70	90	0.67
16	S55	49	80	0.61
17	S57	70	100	1.00
18	S59	63	100	1.00
			Average	0.72

Table 14 shows an average N-Gain of 0.72 (High), indicating that the e-learning-based remedial learning video met the high effectiveness criteria outlined in Table 5. Therefore, it can be considered effective. The development of e-learning-based remedial learning videos aims to provide solutions for students who have not met the minimum criteria for mastery learning. Validity and practicality tests confirmed that these videos met the criteria for being valid and practical, making them suitable for addressing students' learning challenges and deficiencies (Salsabila & Rahmasari, 2023).

The remedial learning video was deemed valid because it adhered to the standards of a high-quality learning video, as outlined by Brame (2016). However, certain aspects, such as voice expression and volume, require improvement. As Priyantini et al. (2021) emphasized, audio quality plays a significant role in student engagement with learning materials. Additionally, improvements are needed in text formatting, color choices, and layout. This aligns with the findings of Lukman et al. (2019), who highlighted that appropriate animation, color, and font coordination are crucial for effectively conveying material to students.

Student responses to the e-learning-based remedial learning video resulted in a 92.62% satisfaction rate, meeting the practical criteria. This finding aligns with Firdaus & Hamdu (2020), who noted that e-learning-based remedial learning videos are user-friendly and accessible, supporting students in their studies. These videos assist students in grasping concepts and overcoming learning obstacles. According to Sulaeman (2021), students can independently utilize interactive multimedia, such as remedial learning videos. This study assessed student independence through a response questionnaire, revealing that Class A students responded more favorably than Class B. The lower response in Class B was primarily due to students' dislike of mathematics and their perception of all problems as equally challenging.

The remedial test results indicated that 95% of students achieved mastery learning, with an average N-Gain score of 0.72 (High). This demonstrates that e-learning-based remedial learning videos effectively enhance student learning outcomes, supporting the findings of Cut et al. (2023), who observed that e-learning-based remedial learning improves student performance. Meanwhile, Johar et al. (2024) found that e-learning-based remedial learning videos met validity and practicality criteria with very good ratings, achieving 54.23% completion and an average N-Gain of 0.5. In contrast, remedial learning videos in that study were categorized as moderate.

Overall, the e-learning-based remedial learning video on function material met the validity, practicality, and effectiveness criteria. It is a viable and accessible tool that helps students overcome learning difficulties, facilitating mastery of the subject matter. This conclusion aligns with Damayanti & Qohar (2019), who emphasized the value of interactive learning media in supporting remedial education and helping students achieve competency targets.

Conclusion

This study investigated the effectiveness of an e-learning-based remedial learning video on the topic of functions. The findings indicate that the remedial video demonstrated high validity, with an average validity score of 86.19%, which is categorized as very valid. The student response questionnaires revealed a high level of practicality, with a score of 92.62%, indicating that the video was well-received by students. Furthermore, 95% of students achieved

mastery in the remedial test, and the average N-Gain score of 0.72 confirmed that the video met the criteria for effectiveness. These results collectively suggest that the e-learning-based remedial learning video is a suitable and effective educational tool for enhancing student understanding of functions.

Despite the positive outcomes, this study has several limitations. First, the field test was conducted with only 60 students from two classes, which may limit the generalizability of the findings. A larger sample size would provide more robust and generalizable results. Additionally, this study did not employ inferential statistical analysis, which could offer deeper insights into the factors influencing the effectiveness of the remedial learning video. Another limitation pertains to the audio elements of the video, which, although functional, may not have been as engaging or motivating for students as desired. Enhancing the audio quality and incorporating more dynamic auditory elements could further improve the appeal of the video.

For future research, it is recommended to extend the study to a larger and more diverse sample to better understand the impact of the e-learning video on various student populations. Incorporating inferential statistical techniques would allow for more precise conclusions and a deeper understanding of the effectiveness of the remedial learning video. Additionally, future studies should focus on refining the audio aspects of the video, ensuring that it is both engaging and motivational, to further enhance its effectiveness as a learning tool.

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