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Development of Computer-Based Interactive Learning Applications for Logic Functions for V Grade Elementary School Students

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Abstract

This study aims to develop a computer-based interactive learning application on logical functions and to determine the improvement in fifth-grade elementary school students' understanding after using it. The method used is Research and Development (R&D) based on the Lee & Owens model, which includes the stages of analysis, design, development, implementation, and evaluation. The resulting product is an interactive digital application containing material on the logical functions IF, AND, OR, and NOT in Microsoft Excel, complete with text, images, animations, audio, video examples of formula application, and interactive quizzes. A test to measure improvements in learning outcomes was conducted on 22 students in Class VA at SDK Sang Timur Batu using pre-test and post-test consisting of 15 multiple-choice questions. The analysis results showed that the average pre-test score of 71,1 increased to 83,2 on the post-test, with an N-gain score of 0,41, which falls within the range of 0,3 ≤ (<g>) < 0,7 or classified as moderate category. These findings indicate that the use of computer-based interactive learning applications for logical functions has proven effective in improving students' understanding and learning outcomes in ICT education at the elementary school level.

Keywords: Interactive Learning Application, Logical Functions, Information and Communication Technology

1. Introduction

Education is a planned, conscious activity that creates learning conditions which encourage students to actively develop their potential. Through educational activities, individuals develop spiritual strength, self-control, good character, intelligence, noble morals, and beneficial skills. Education is generally understood as the development of human physical and mental abilities in harmony with prevailing cultural values and social norms (Rahman , et al., 2022). As technology has advanced, the learning process increasingly requires digital devices to make learning activities more effective, interactive, and relevant to the demands of the modern era. Technology expands access to information, facilitates interaction between teachers and students, and equips students with the competencies necessary to face future challenges (Kaharuddin et al., 2021).

Information and Communication Technology (ICT) learning is the process of teaching and learning to master the skills necessary for using computers, software, and communication networks to obtain, process, and present information. ICT is an important

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subject because it prepares students for technological developments in the digital age. Through ICT learning, students learn theory and are trained to practice basic skills, such as word processing, spreadsheet use, presentation creation, and graphics design. They also learn how to use the internet ethically and responsibly. Thus, ICT learning serves not only as a means of transferring knowledge about technology but also as a vehicle for fostering critical thinking, creativity, and problem-solving skills relevant to everyday life (Lestari et al., 2020).

However, the low use of ICT by teachers is due to several main factors. First, teachers lack the competence and ability to operate and integrate ICT into learning, including an inability to use programming languages and develop ICT-based teaching materials. Second, teachers perceive that the use of ICT does not have significant benefits, so they are less motivated to learn and adopt it. Third, limited facilities, such as the number of devices, internet networks, and adequate electricity in schools, especially in rural areas, are also major obstacles. In addition, age and lack of continuous training reinforce these obstacles. Overall, to increase the use of ICT by teachers, efforts are needed to improve competence through training and socialization, improve facilities and infrastructure, and change perceptions of the benefits of ICT in learning (Hartami, 2020).

Observations conducted on teachers and students at SDK Sang Timur Batu show that ICT learning, especially in the subject of logic functions, still faces obstacles. Teachers say that most students tend to memorize formulas without understanding the patterns and concepts, so they have difficulty when they have to solve problems with different contexts. The media used so far have only been computers and printed books with a project-based learning method, without any new interactive media. Although this has helped, it is considered not to be optimal. Teachers believe that computer-based applications with interactive elements have great potential to support learning, as they can increase interest and help students understand the concepts in logic functions. From the students' perspective, there is a low level of understanding in ICT learning. So far, learning has tended to be theoretical, teacher-centered, and uses limited media such as printed books or default computer applications without any novelty or high interactivity. This situation makes students less interested, quickly bored, and have difficulty understanding the material in depth. In fact, students show great enthusiasm for digital technology and want more interesting, interactive learning that provides opportunities for hands-on practice. The lack of learning media that suits their learning style is one of the main factors that hinders the optimization of student understanding.

Several previous studies have shown that using digital, interactive learning media can positively impact student understanding. Harsiwi, U. B., & Arini, L. D. D. (2020) found that using interactive media in elementary schools significantly improves learning outcomes. This media clarifies conceptual understanding, encourages motivation, and improves overall student achievement. This aligns with the findings of Afifah, N., Kurniaman, O., & Noviana, E. (2022), who stated that interactive learning media can enhance the effectiveness of the learning process by presenting messages that are clearer, more interesting, and easier to understand. Interactivity makes students more active participants rather than passive recipients of information. Based on previous research, this study examines the effectiveness of interactive learning media in helping elementary school students develop a deeper understanding of mathematical concepts (Hardian Muhammad et al., 2025).

Based on the above description, there is clearly a need to develop computer-based, interactive learning applications on logic functions for fifth-grade students. This application is expected to help students understand logic concepts that they have only memorized so far and provide a more interesting and meaningful learning environment. By utilizing technology with which students are familiar, ICT learning can be more interactive and contextual. This application enriches teachers' learning materials and enables students to learn independently, critically, creatively, and collaboratively. Thus, developing computer-based interactive learning applications will contribute to creating a basic education that meets the demands of the 21st century.

Based on the background description and problem identification results, the research questions in this study are formulated as follows:

1. How can we develop a computer-based interactive learning application that is suitable for teaching logic functions?
2. Can the use of computer-based interactive learning applications improve students' understanding of logic functions?

Based on initial observations and interviews with students at SDK Sang Timur Batu, this development aims to produce learning applications that are suitable in terms of content, appearance, and ease of use and determine the increase in fifth-grade elementary school students' understanding of logic functions through the use of computer-based interactive learning applications.

2. Method

This study applies the Research and Development (R&D) method. According to Richey, R. C., & Klein, J. D. (2007), research and development is a planned and structured process carried out in several stages, namely design, development, and evaluation, with the aim of producing an empirical basis for creating products. In this study, the development model applied is the Lee & Owens model. Lee & Owens (2004) explain that this model consists of five main stages, namely analysis (covering the identification of initial needs to final needs), design, development, implementation, and evaluation. This model was chosen because its stages are logically structured and emphasize the importance of initial analysis as a basis for understanding problems and needs before product development is carried out. The Lee & Owens (2004) research and development model includes five main stages. The assessment or analysis stage, which consists of needs analysis and initial and final analysis to identify problems and needs. The design stage, which focuses on planning concepts and development strategies. The development stage, which is the process of creating and refining the product. The implementation stage, which is the stage of applying the product in the field. The evaluation stage, which is to assess the overall effectiveness and quality of the development results.

2.1. Analysis Stage

The initial stage of this process involves assessment and analysis, which is divided into two main components, namely need assessment to identify problems and development needs and front-end analysis to understand the initial conditions and determine the desired

outcomes. The initial stage that needs to be carried out is analyzing the needs in order to collect important data as a basis for designing computer-based interactive learning applications. According to Lee and Owens (2004), this stage is carried out to identify the differences between the current situation and the desired conditions, as well as to determine the strategic steps that must be taken so that the development process can run optimally.

Through the results of the above needs analysis, the researcher created a design for the development of projection-based augmented reality learning media based on the Lee & Owens development model. The William W. Lee and Diana L. Owens (2004) Model Development Procedure can be seen in the following figure:

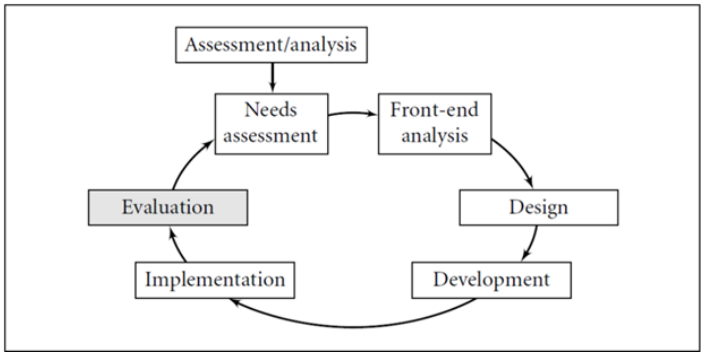


Figure 1. Stages of Model Development by William W. Lee and Diana L. Owens (2004)

During the development stage, user analysis was conducted to understand the background, characteristics, needs, and learning conditions of the students who would use the developed application. The application was intended for fifth-grade students at SDK Sang Timur Batu. The analysis was carried out through direct classroom observation and interviews with the ICT teacher and several fifth-grade students to obtain more detailed information regarding their learning needs and conditions. Based on the results of the interviews, it was found that one of the main problems experienced by students was their low level of understanding of ICT learning materials. The learning process tended to be theoretical and teacher-centered, with limited use of learning media, such as printed textbooks and computers without sufficient interactivity. These conditions caused students to become easily bored, less interested in learning activities, and experience difficulties in understanding the material comprehensively. However, students showed a high interest in digital technology and expressed a need for a more engaging and interactive learning experience that would allow them to explore the material and practice directly.

Technology analysis was conducted to identify the technological facilities and infrastructure available to support the implementation of computer-based interactive learning. This analysis focused on the facilities provided by SDK Sang Timur Batu that could be utilized during the learning process. The school already has a computer laboratory equipped with computers and an adequate internet network. The availability of these facilities supports the implementation of computer-based interactive learning applications and provides students with the opportunity to access and operate the developed application during learning activities.

Situation analysis was conducted to identify the environmental conditions in which the learning process takes place. SDK Sang Timur Batu is located in an area with relatively easy access to transportation, which supports accessibility to the school. The learning environment is considered conducive, supported by adequate lighting and good air circulation in the classroom. In addition, the availability of a computer laboratory equipped with an internet network provides an appropriate environment for conducting computer-based learning activities. These conditions support the implementation of interactive learning applications as an alternative learning medium for ICT instruction.

Task analysis was conducted to identify the knowledge, skills, and attitudes that students need to develop in order to complete learning activities using the computer-based interactive learning application. In terms of knowledge, students are expected to understand the concepts and characteristics of logical functions, including the IF, AND, OR, and NOT functions. In terms of skills, students are expected to be able to operate the computer-based interactive learning application independently and use its various features to explore and deepen their understanding of logical functions. Through these activities, students are expected to develop not only conceptual understanding but also the ability to apply the knowledge gained during the learning process.

Incident analysis was conducted to determine the types of learning activities and tasks that were relevant to the material being taught. The computer-based interactive learning application was specifically developed to present learning material related to logical functions. The material consists of four main topics, namely the IF, AND, OR, and NOT functions. The learning activities provided through the application include operating the application, exploring the presented material, completing interactive activities, and answering questions related to the four types of logical functions. Through these activities, students are expected to understand and explain the concepts of logical functions more comprehensively.

Goal analysis was conducted to determine the objectives to be achieved through the development of the computer-based interactive learning application. The development aims to produce a learning application that meets the required eligibility criteria and can support students in improving their understanding of logical functions. The analysis of learning objectives considered four main components: the audience, expected behavior, learning conditions, and degree of achievement. SDK Sang Timur Batu implements the Merdeka Curriculum; therefore, the learning objectives for ICT instruction, particularly those related to logical functions, were formulated based on the relevant learning content presented in the curriculum textbook. The objectives were then used as a foundation for determining the material, activities, and evaluation presented in the application.

Issue analysis was conducted to identify potential obstacles and constraints that could interfere with the learning process and hinder the achievement of learning objectives. One of the main issues identified was students' difficulty in understanding logical function concepts, particularly when the material was presented in a predominantly theoretical manner. Other issues included teachers' challenges in managing learning activities and maintaining students' attention, as well as students' relatively low levels of interest and engagement during the learning process. Therefore, the development of an interactive learning

application was considered necessary to provide a learning experience that was more engaging, varied, and responsive to students' learning needs.

Media analysis was conducted based on the results of the previous needs analyses to determine the appropriate learning medium for addressing the identified problems. The analysis indicated that learning media utilizing technology were needed to support students' understanding of logical functions. A computer-based interactive learning application was selected as an alternative solution because it can present learning content in a more attractive and interactive manner. The application incorporates various multimedia elements, including images, animations, audio, video, and quizzes, to support the delivery of learning material. In addition, the application is relatively easy to operate and can be accessed through available computer devices, allowing students to participate more actively and independently in the learning process.

Data analysis was conducted to identify and determine the sources of information required during the development process. Relevant data were obtained from several sources, including ICT teachers, fifth-grade students, subject matter experts, and media experts. The ICT teacher provided information regarding students' learning conditions, the scope of the logical functions material, and the learning needs that should be accommodated in the application. Students provided information regarding their experiences, difficulties, and preferences during the learning process. Meanwhile, subject matter experts and media experts were involved in providing assessments and feedback regarding the content and technical aspects of the developed application. The information obtained from these sources was used as a basis for developing and evaluating the computer-based interactive learning application.

Cost analysis was conducted to determine the resources and costs required to develop the computer-based interactive learning application. The application was developed using several platforms and supporting software. PowerPoint was used to organize and develop the interactive learning materials, while Pictoblox was used to create animations and other interactive visual elements, which can be accessed free of charge. In addition, DRMsoft was utilized as a supporting tool to convert the PowerPoint (.pptx) files into executable files. The use of these platforms enabled the development of the application while utilizing relatively accessible and cost-efficient resources.

2.1.1. Design Stage

At this stage, a plan is developed to create the product based on the results of the analysis conducted previously. According to Lee & Owens (2004), the design stage includes several important steps, namely: designing an activity schedule, forming a project team, media specifications, material structure, and configuration control.

The development process begins with the preparation of a development activity schedule, which aims to establish deadlines for each activity so that all stages of development can be carried out according to the predetermined plan. The scheduling process also ensures that the development activities are conducted systematically, sequentially, and efficiently, allowing each stage to be completed within the allocated time.

In addition to scheduling, the development process involves a project team consisting of two main groups, namely the development team and the validation team. The researcher serves as a member of the development team and is responsible for planning, designing, developing, and revising the product. Meanwhile, the validation team consists of a material expert and a media expert who are responsible for assessing the suitability of the learning content and the quality and feasibility of the developed media. The involvement of both teams is intended to ensure that the resulting product meets the required learning and media standards.

The product developed in this research is a computer-based interactive learning application designed to support fifth-grade elementary school students in understanding logical functions. The application consists of three main menus, namely Data Introduction, Use of Logical Functions, and Quiz. Each menu is designed to provide students with learning materials and interactive activities that support their understanding of logical functions. To provide a clear description of the content, navigation, and sequence of the application, a storyboard was prepared as a reference throughout the design and development process.

The material presented in the application focuses on logical functions, which are part of Information and Communication Technology (ICT) or Informatics learning and are commonly applied using Microsoft Excel. In general, logical functions are used to process data based on predetermined conditions, enabling computers to automatically produce decisions or results according to specific criteria. The material is systematically organized to introduce students to the components and use of logical functions, including the concepts and applications of the functions presented in the learning application.

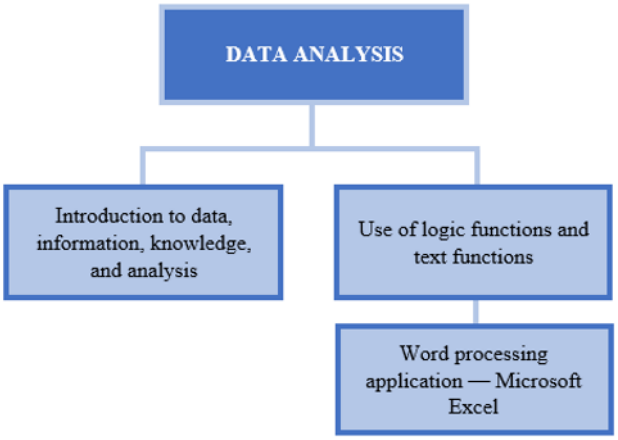


Figure 2. Material Structure

Furthermore, configuration control is conducted to maintain consistency and compatibility among the various components developed for the computer-based interactive learning application. This process involves coordinating and aligning the teaching materials, visual themes, images, animations, and slide layouts used throughout the application. Configuration control is intended to ensure that all components are consistently presented and properly integrated, thereby supporting the overall functionality, appearance, and quality of the developed learning application.

2.1.1.1. Development and Implementation Stage

The development stage is the third stage in Lee and Owens' (2004) development model, following the analysis and design stages. At this stage, all previously prepared designs are implemented into actual products in the form of computer-based interactive learning applications. The development process is carried out in five stages, namely: determining the type of product and platform to be used, creating and compiling media components, reviewing and revising the product, presenting the finished product, and preparing and organizing the session. The computer-based interactive learning application developed is tailored to material on logical functions. This application was developed using the PowerPoint platform because it has a number of advantages, such as ease of use, availability free of charge, and the availability of various supporting features. In addition, PowerPoint can be modified into interactive learning media, enabling students to actively participate in the learning process.

The stages in developing the components of a computer-based interactive learning application include the creation of slides, images, text, animations, audio, and quizzes. The text in the application is designed using a font that is easy to read, with contrasting sizes and colors so that information can be conveyed clearly to users. The process of designing images, text, and slides is done using the PowerPoint platform, while animations are developed through Pictoblox. For image editing purposes, developers also utilize the features available in PowerPoint. Furthermore, the content or material is inputted and arranged based on the basic competencies, indicators, and learning objectives that have been set beforehand, so that the material displayed is relevant to the students' needs.

2.1.1.2. Evaluation Stage

Each stage of development requires an evaluation process to ensure that the steps taken are appropriate, thereby preventing errors in the next stage. This evaluation is important to ensure that the resulting media is of good quality and suitable for use. After the implementation stage is complete, an evaluation is carried out to assess the extent to which the developed product meets the learning objectives and user needs, as well as to determine whether revisions are still necessary.

The evaluation stage focuses on testing the suitability of the product through expert validation and assessing the practicality and appeal of the media based on user response questionnaires. If the assessment results show that the product does not require revision, then the media is considered suitable, practical, and appealing for use in learning activities.

3. Results and Discussion

3.1 Result

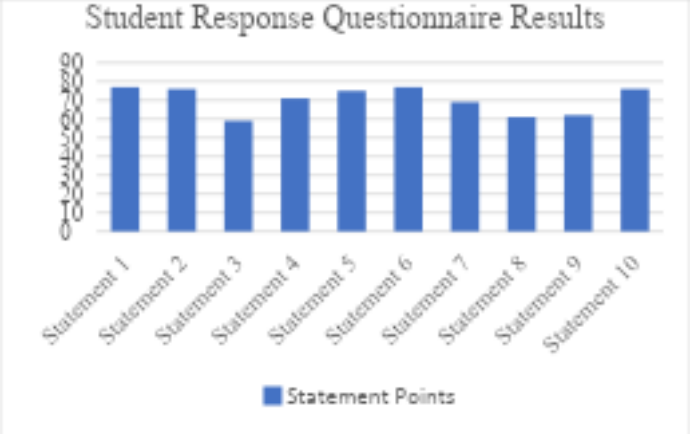
The assessment of product feasibility by subject matter experts was conducted based on four main aspects, namely content suitability, comprehensibility, presentation, relevance to learning objectives, and language use. The validation process for this computer-based interactive learning application was carried out by subject matter experts who are ICT teachers at SDK Sang Timur Batu.

The validation results from subject matter experts stated that the developed computer-based interactive learning application obtained an average percentage of 87,5% in terms of instrument suitability. Based on the product validity assessment criteria according to Riduwan (2012) in table 3.5, a score of 87,5% falls within the range of 80% – 100%, which is considered valid. Thus, the interactive learning application is ready to be tested in learning activities after improvements are made in accordance with the input and suggestions from subject matter experts. The product feasibility assessment by media experts was conducted based on four main aspects, namely media display, navigation and ease of use, interactivity and functionality, multimedia support, and technical performance of the application. The validation process of this computer-based interactive learning application was carried out by media experts who are lecturers in Educational Technology at Malang State University.

The validation results from media experts stated that the computer-based interactive learning application that was developed obtained an average percentage of 82,5% in terms of instrument suitability. Based on the product validity assessment criteria according to Riduwan (2012) in table 3.5, a value of 82,5% is in the range of 80% – 100%, which is classified as valid. Thus, the interactive learning application is ready to be tested in learning activities after improvements are made based on input and suggestions from media experts.

The computer-based interactive learning application on logic functions for fifth-grade students was tested at SDK Sang Timur Batu through two stages, namely a small group test with five students and a large group test with 22 students. After using the application, students were asked to fill out a response questionnaire to assess the level of suitability and comfort of using the media. In addition to filling out the questionnaire, a pre-test was conducted before the learning process and a post-test after the application was implemented. The pre-test aimed to evaluate the students' initial abilities, while the post-test was used to measure their increased understanding of the logical function material.

Based on a comparison of the pre-test results, no students fell into the very poor category (< 60) on the post-test. The disappearance of this category indicates that the use of interactive learning applications has had a significant impact on improving students' overall understanding. Even students who were previously in the very poor category now show considerable improvement, such as JDP, QYGS, and AS, who previously scored low but managed to achieve a score of 80 or higher on the post-test. However, there were 5 students whose post-test scores decreased compared to their pre-test scores, namely ALT (93,3 → 86,6), ECA (86,6 → 73,3), BPA (80 → 66,6), JA (80 → 73,3), and VPAW (93,3 → 86,6). This decline in scores may have been caused by a number of factors, including a lack of focus when working on the post-test questions, difficulty adapting to the question format, or a lack of reinforcement of certain concepts during learning. However, most of the students who experienced a decline remained in the fair to good category, so this decline did not indicate a loss of understanding, but rather instability in their mastery of certain concepts.



Graph 1. Student Response Questionnaire Results

There were 10 statements given to 22 students. Of these statements, 3 assessed the attractiveness of the media, 3 assessed ease of use, 2 assessed student activity and motivation, and 2 assessed the usefulness of the media. Based on the results of the student questionnaire, a total score of 703 out of a maximum score of 880 was obtained, equivalent to 79,8%, which shows that computer-based interactive learning applications are classified as quite suitable for use in the learning process.

Fifth-grade elementary school students, as research subjects, revealed that they were interested in the appearance and animations of the application. This helped them understand logical functions more easily through the use of interactive computer-based learning applications. From the results of the technological analysis, it was found that the use of computers can support learning activities in logical functions. In addition, the supporting facilities made students feel more comfortable during learning activities. Overall, student responses to this computer-based interactive learning application showed positive results.

3.2 Discussion

In the process of developing this computer-based interactive learning application, there are two main groups involved, namely the development team and the validation team. Researchers play a role as part of the development team, while the validation team involves subject matter experts and media experts who are tasked with assessing the suitability of the content and the quality of the media developed. This development aims to produce a product in the form of a computer-based interactive learning application designed to improve students' understanding of logic functions in fifth grade elementary school. This computer-based interactive learning application contains three main menus, namely data introduction, use of logic functions, and quizzes. To provide a clearer picture of the specifications and flow of the application, a storyboard was compiled as a guide in the design and development process.



Figure 3. Home Display



Figure 4. Main Menu

This research and development involved several subjects, namely subject matter experts who are ICT teachers from SDK Sang Timur Batu, as well as media experts who are lecturers in Educational Technology from Malang State University. In addition, this study also involved students from class VA SDK Sang Timur Batu as users. Small group trials were conducted on 5 randomly selected students, while large group trials involved 22 students. In this research and development, the researchers collected two types of data, namely qualitative and quantitative. Qualitative data was obtained through interviews with classroom teachers and through input and suggestions from subject matter experts and media experts during the product validation process. Meanwhile, quantitative data was presented descriptively and obtained from the assessments of subject matter experts, media experts, and student responses collected through questionnaires. In addition, quantitative data also included student learning outcomes obtained from pre-test and post-test scores. All questionnaire scores were analyzed to assess the feasibility of using the developed product. Data analysis is a stage that includes the systematic processing and arrangement of data obtained from research, using various synthesis methods, to draw conclusions from the research (Sugiyono, 2011: 244). In the research and development of computer-based interactive learning applications, data analysis can be carried out through qualitative and quantitative approaches.

The product validity analysis technique developed was based on the results of questionnaires completed by subject matter experts and media experts. Descriptive analysis was the analysis technique used, which served to convert quantitative data into descriptions in the form of sentences. The validity instrument given to students used a standard scale. Table 1 below shows the form of the assessment scale.

Table 1. Standard Scale

Score	Criteria
1	Very Unsuitable
2	Unsuitable
3	Suitable
4	Very Suitable

Source: Sugiyono (2016)

Next, the results of data analysis from product validation presented in descriptive percentages are interpreted using media validity assessment criteria. The purpose of this step is to determine the level of validity of the developed product. The media validity assessment criteria are shown in table 2.

Table 2. Product Validity Criteria

Achievement Criteria	Validity Category
0% – 49%	Invalid
50% – 59%	Less Valid
60% – 79%	Sufficiently Valid
80% – 100%	Valid

Source: Riduwan (2012)

The product feasibility analysis technique was developed based on the results of the student response questionnaire. Descriptive analysis was used as the analysis technique, which serves to convert quantitative data into descriptions in the form of sentences. The feasibility instrument given to students used a standard scale. Table 3 below shows the form of the assessment scale.

Table 3. Standard Scale

Score	Criteria
1	Strongly Disagree
2	Disagree
3	Agree
4	Strongly Agree

Source: Sugiyono (2016)

Next, the results of data analysis from product validation presented in descriptive percentages are interpreted using media validity assessment criteria. The purpose of this step is to determine the level of validity of the developed product. The media validity assessment criteria are shown in table 4.

Table 4. Product Eligibility Criteria

Achievement Criteria	Eligibility Category
0% – 49%	Not Suitable
50% – 59%	Less Suitable
60% – 79%	Sufficiently Suitable
80% – 100%	Suitable

Source: Modified from Riduwan (2012)

Student learning outcomes were analyzed using the N-gain formula proposed by Hake (1998). Before the treatment was applied, students were first given a pre-test, then after using the computer-based interactive learning application, they took a post-test. The purpose of this test was to identify and compare the differences in student learning outcomes before and after the application of the learning media. The learning outcome test was conducted in class VA with 22 students participating. The calculation formula is presented as follows.

$$< g > \frac{(Spost - Spre)}{100 - (Spre)}$$

Description:

Spost : Average score on the post-test

Spre : Average score on the pre-test

(Source: Hake in Yudi Guntara, 2021)

Next, the N-gain data is interpreted using the following criteria.

Table 5. Criteria for N-gain Level

N-gain Value	Criteria
(<g>) < 0,3	Low
0,3 ≤ (<g>) < 0,7	Moderate
(<g>) ≥ 0,7	High

Source: Hake (1998)

The validator for validating materials on computer-based interactive learning applications is an ICT teacher from SDK Sang Timur Batu. The validation process was carried out directly (face-to-face) on October 30, 2025. The results of the assessment by the material expert's are presented in table 6 below.

Table 6. Results of Material Expert Validation

No	Indicator	Score	Maximum Score	Percentage
1.	The material presented is in accordance with the fifth-grade elementary school curriculum	4	4	100%
2.	Logic functions are easy for students to understand	3	4	75%
3.	The material is organized systematically and coherently	4	4	100%
4.	The material covers all learning indicators of logical functions	3	4	75%

5.	The examples and exercises presented are relevant and support understanding	3	4	75%
6.	The language used is clear, age-appropriate, and easy for students to understand	3	4	75%
7.	The material can motivate students to learn	3	4	75%
8.	Materials that foster students' logical thinking skills	4	4	100%
9.	The material can be applied well in computer-based learning	4	4	100%
10.	Materials supporting the achievement of learning objectives for logical functions	4	4	100%
Total score obtained		35	40	875
Total percentage			87,5%	
Category			Valid	

Source: Primary Data Processing Results (Appendix)

Based on the product validity assessment criteria in table 2, an 87,5% score was obtained, which falls within the 80% – 100% range. This value indicates that the product is valid for use in learning activities. Therefore, it can be concluded that, after undergoing revisions in accordance with the input and suggestions from the material expert, the computer-based interactive learning application is suitable for testing.

The validator for media validation in computer-based interactive learning applications is a lecturer in Educational Technology at Malang State University. The validation process was conducted in person on October 30, 2025. The results of the media expert's assessment are presented in table 7 below.

Table 7. Results of Media Expert Validation

No	Indicator	Score	Maximum Score	Percentage
1.	The interface design is attractive and age-appropriate for students	3	4	75%
2.	Colors, fonts, and icons support learning comfort	3	4	75%
3.	The application elements are neatly arranged and easy to understand	4	4	100%
4.	Easy-to-use navigation between menus	4	4	100%
5.	There are clear instructions for use	2	4	50%
6.	The application enables students to interact actively	3	4	75%
7.	The application runs smoothly without errors	4	4	100%
8.	The use of images, animations, or sounds supports understanding	3	4	75%
9.	The application already uses interactive features that can increase user engagement	3	4	75%
10.	The application responds to user commands quickly	4	4	100%
Total score obtained		33	40	825
Total percentage			82,5%	
Category			Valid	

Source: Primary Data Processing Results (Appendix)

Based on the product validity assessment criteria in table 2, an 82,5% score was obtained, which falls within the 80% – 100% range. This value indicates that the product is valid for use in learning activities. Therefore, it can be concluded that, after undergoing

revisions in accordance with the input and suggestions from the media expert, the computer-based interactive learning application is suitable for testing.

The product trial was carried out after going through a revision stage and being declared feasible by subject matter experts and media experts. The trial was conducted on students in class VA of SDK Sang Timur Batu, divided into two stages, namely (1) a small group trial and (2) a large group trial. The data collected was quantitative, from student response questionnaires and learning outcomes, which were used to assess the students' level of understanding of the subject matter of logic functions. The small group trial was conducted on October 31, 2025, involving five students from class VA of SDK Sang Timur who were randomly selected as trial subjects. The trial was conducted in the computer lab, where teachers and students used computers to test the interactive computer-based learning application. The results of the student response questionnaire regarding the suitability of the product in the small group trial are presented in table 8.

Table 8. Small Group Trial Results

No	Indicator	Assessment Score (Student Frequency)				Student Scores	Maximum Score
		1	2	3	4		
1.	The app's interface is attractive and motivates me to learn	-	-	2	3	18	20
2.	The colors, text, and images in the application are easy to see	-	-	4	1	16	20
3.	An application that is easy to use without the help of a teacher	-	1	3	1	15	20
4.	I enjoy learning to use this application on the computer	-	1	3	1	15	20
5.	The buttons and menus in the app are easy to find and understand	-	1	2	2	15	20
6.	Animations in the app make learning more enjoyable	-	1	1	3	17	20
7.	This app makes me more active in learning.	-	-	4	1	16	20
8.	I can learn on my own using this application.	2	-	2	1	12	20
9.	This app helps me understand logical functions more easily.	1	-	4	-	14	20
10.	I would like to use an application like this again for other lessons.	-	1	2	2	16	20
Total score		3	5	27	15	154	200
Total percentage					77%		
Category					Sufficiently Suitable		

Source: Primary Data Processing Results (Appendix)

Based on the product feasibility assessment results in table 4, a percentage of 77% was obtained, which is in the range of 60% – 79%. This finding proves that computer-based interactive learning applications are quite feasible for use in learning activities. Therefore, these applications can be tested on larger groups of students.

The large group trial was conducted on November 3, 2025, involving 22 students from class VA SDK Sang Timur as test subjects. This trial was conducted in a computer lab, where teachers and students used computers to test the interactive computer-based learning application. The results of the student response questionnaire regarding product feasibility in the large group trial are presented in table 9.

Table 9. Large Group Trial Results

No	Indicator	Assessment Score (Student Frequency)				Student Scores	Maximum Score
		1	2	3	4		
1.	The app's interface is attractive and motivates me to learn	-	-	11	11	77	88
2.	The colors, text, and images in the application are easy to see	-	-	12	10	76	88
3.	An application that is easy to use without the help of a teacher	-	8	13	1	59	88
4.	I enjoy learning to use this application on the computer	-	2	13	7	71	88
5.	The buttons and menus in the app are easy to find and understand	-	2	9	11	75	88
6.	Animations in the app make learning more enjoyable	-	1	9	12	77	88
7.	This app makes me more active in learning.	-	1	17	4	69	88
8.	I can learn on my own using this application.	2	5	11	4	61	88
9.	This app helps me understand logical functions more easily.	2	3	14	3	62	88
10.	I would like to use an application like this again for other lessons.	-	1	10	11	76	88
Total score		4	23	119	74	703	880
Total percentage					79,8%		
Category					Sufficiently Suitable		

Source: Primary Data Processing Results (Appendix)

Based on the product feasibility assessment results in table 4, a percentage of 79,8% was obtained, which is in the range of 60% – 79%. This finding proves that computer-based interactive learning applications are quite feasible for use in learning activities. Therefore, these applications are feasible for use in learning activities.

From the results of the pre-test and post-test data obtained through the students' completion of questions. The test was in the form of multiple-choice questions, which aimed to assess the students' level of understanding of logical functions after participating in learning with computer-based interactive learning applications. The learning outcome improvement test was conducted on 22 students in class VA at SDK Sang Timur Batu for the ICT subject with the topic of logical functions. Data analysis was performed using the N-gain formula, which compares the pre-test and post-test scores obtained by students. The test instrument consisted of 15 multiple-choice questions, while the complete results of the students' pre-test and post-test are presented in table 10.

Table 10. Student Pre-Test and Post-Test Results

No	Student Name	Pre-Test	Post-Test
1.	ALAO	60	80
2.	AS	46,6	86,6
3.	ASP	80	80
4.	ALT	93,3	86,6
5.	AP	73,3	86,6
6.	BPA	80	66,6
7.	CL	73,3	93,3
8.	ECA	86,6	73,3
9.	EGL	73,3	80
10.	ETH	86,6	86,6
11.	FNS	60	73,3
12.	JLJ	73,3	73,3
13.	JRW	73,3	93,3
14.	JDP	20	93,3
15.	JA	80	73,3
16.	MAM	66,6	86,6
17.	MAC	73,3	86,6
18.	NAW	93,3	86,6
19.	QYGS	40	80
20.	SEC	73,3	93,3
21.	VPAW	93,3	86,6
22.	YAN	66,6	86,6

Source: Primary Data Processing Results (Appendix)

To determine the improvement in student learning outcomes, the N-gain formula can be used, as shown below.

Spre (Average score on the pre-test) $= \frac{1566}{22} \times 100\%$

$= 71,1\%$

Spost (Average score on the post-test) $= \frac{1832,4}{22} \times 100\%$

$= 83,2\%$

N-gain $= \frac{(Spost - Spre)}{100 - (Spre)}$

$= \frac{(83,2 - 71,1)}{100 - (71,1)}$

$= \frac{12,1}{28,9}$

$= 0,41$

From the results of the data analysis that has been carried out, it can be seen that there is a significant increase in the average score on the post-test compared to the average score on the pre-test. The N-gain calculation results show that the g value is 0,41. Based on the criteria in Table 5, this value is in the range of $0,3 \leq (<g>) < 0,7$, which means that there is a moderate improvement in learning outcomes between the pre-test and post-test scores. The N-gain improvement test also shows that there are 5 students who experienced a high improvement in learning outcomes, 7 students in the moderate category, 4 students in the low category, and 6 students in the failed/no improvement category. Overall, the average

N-gain value of 0,41 indicates that the use of computer-based interactive learning applications in logic function material in ICT subjects provides a moderate increase in learning outcomes. Therefore, it can be concluded that the use of computer-based interactive learning applications has been proven to support the ICT learning process.

4. Conclusion

This research and development resulted in a computer-based interactive learning application that was assessed through product validity testing, student response testing, and learning outcome evaluation. The product validity assessment showed that the material expert gave a percentage of 87,5%, while the media expert gave a percentage of 82,5%. Based on these results, the computer-based interactive learning application on logic functions for fifth-grade elementary school students was declared valid and suitable for use in learning activities after undergoing revisions based on the suggestions and recommendations provided by the material and media experts. Student responses to the use of the application were obtained through two stages of testing, namely a small group trial and a large group trial, which resulted in percentages of 77% and 79,8%, respectively. These results indicate that the computer-based interactive learning application on logic functions is sufficiently suitable for use in learning activities. Furthermore, the improvement in students' understanding of logic functions was evaluated through pre-test and post-test activities conducted after the students used the application. The N-gain calculation resulted in a value of 0,41, which falls within the moderate category based on the criteria in table 5, namely $0,3 \leq$ (<g>) $< 0,7$. This result indicates that the use of computer-based interactive learning applications in ICT learning on logic function material can improve students' learning outcomes. Overall, the product test results indicate that the development of the computer-based interactive learning application on logic functions for fifth-grade elementary school students at SDK Sang Timur Batu has achieved the predetermined objectives, namely producing a learning application that is feasible and useful in terms of content, appearance, and ease of use, as well as determining the improvement in students' understanding of logic functions through the use of the developed application, making it suitable for use in learning activities.

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