The application of ICT learning through Hippani: the effects on mathematical reasoning ability

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Abstract. The use of ICT in learning mathematics is not something new in order to maximize students' mathematical abilities, especially in this modern era of industrial revolution 4.0. One of the mathematical abilities that focus on students’ development is mathematical reasoning ability. Based on this, the purpose of this study was to determine the effectiveness of ICT learning that developed through Hippani Animator Software on students' mathematical reasoning abilities. This is a quasi-experimental study with non-equivalent control group design involving 72 students in different classes. Learning in the experimental class was carried out using ICT conducted in computer laboratories while in the control class did not use ICT learning. The experimental class was given a treatment using ICT, while the control class was given a conventional method but with the same mathematical reasoning abilities. The research was conducted for grade VII students at the Public Islamic Junior High School called State of Madrasah Tsanawiyah (MTsN) 3 Kuningan to introducing statistical data presentation. The results showed that the mathematical reasoning ability of the experimental class was better than control class. It indicates that the use of ICT in mathematics learning is effective in developing students' reasoning abilities.

1. Introduction

The use of ICT in learning is quite demanding in this modern era as the 4.0 industrial revolution coming through. The rapid development of technology is currently the main reason for the use of ICT as a learning media. Through ICT, learning can be limitless through space and time. However, this is a challenge, as well as teachers, are motivated to innovate their style of teaching. Teachers in the digital era need to master the material or concepts that will be taught and are able to deliver material as well as developing digital-based learning media. The instructional media developed is known as ICT-based media, or some know it with multimedia terms. Both of these terms are often used both simultaneously and separately. Although it is actually not appropriate if we equate the two terms. Multimedia is a combination of media consisting of notes, images, sounds, animations, and videos that can be delivered with computer devices or other equipment [1]. The rapid development of ICT supports the development of multimedia learning for the purpose of improving the quality of learning to be better.
In this ever-changing era, schools must maximize the contribution of new technologies that can be implemented in teaching and learning [2]. Technological integration in learning activities is known as Technological Pedagogical Content Knowledge (TPACK) as one of the skills that must be owned by 21st-century teachers [3], through mastering technological, content, and pedagogical knowledge which is a mandatory element in TPACK [4].

Better visualization compared to common learning resources can be a basis for someone to represent problems presented through ICT devices. ICT is categorized as a new tool that can be used by individuals or groups to help children learn about through technology [5]. In Indonesia, the implementation of ICT began to be widely used in the early 1990s. At that time many schools built computer laboratories that were used as media as a means of learning to be more interesting and challenging by introducing the latest technology to students [6]. In reality, most of teachers still have no idea how to master and explore existing technological tools to be developed into learning media. This happens because of the limited ability of teachers to use or integrate the use of ICT-based media in learning and understanding of computer-based learning is still very minimal because mathematics teachers have not received special training [7]. This is the biggest issue that causes their distrust of ICT learning. At the level of high school students, the use of ICT is able to make mathematics learning more active and enjoyable by displaying examples of images produced in ICT-based media [8]. At first they were quite worried about participating in the ICT usage course, but in the end, they enjoyed the course so changing the teacher's perception of the use of ICT mainly changed the way teachers see and design problems in the learning environment solving mathematical problems [9].

In this article, the use of computers in subsequent learning is intended to increase students' mathematical abilities significantly, considering the reality in the field shows that mathematics learning is perceived as not yet in line with expectations. Computers can be used as a tool for facilitating mathematical thinking in various ways [10]. Computer programs are like an expert who can solve various problems by simulating reasoning in supporting decision making from various problems encountered, in ICT this is known as an artificial intelligence program [11]. Increasing and developing mathematical concepts through the use of technology can reduce algorithmic skills, save time, and provide an alternative for students to explore mathematical concepts so that computer power provides fundamental changes in teaching mathematics [9]. The mathematical abilities developed in this study are mathematical reasoning abilities. Mathematical reasoning is a person's ability to make guesses declare proof and construct arguments mathematically [12]. Mathematical reasoning ability can influence one's mathematical activities, especially in conclusions based on processes and the peculiarities of ways of thinking.

The ability of reasoning can be seen as the ability to integrate all mathematical knowledge and ideas that are possessed to produce a truth about a mathematical concept. The reasoning is an alternative thinking process in achieving reasonable results by considering various elements of mathematical thinking [13]. A person's reasoning ability can actually be seen from one's ability to argue. Those who can be involved in reasoning have the capacity to do analysis, explore, make estimations, defend opinions, draw conclusions, interpret and maintain conclusions that are believed [14]. The important role of mathematical reasoning was then shown by Säfström (2013) by showing that mathematical reasoning is an ability that can be used from an early age and is an independent skill developed before developing other competencies [15], even mathematical achievements at higher levels can be predicted through previous mathematical reasoning [16].

The process skills and mathematical thinking that can be supported through mathematical reasoning are the main objectives in our research. We view that ICT-based learning will be able to affect the development of mathematical reasoning. One software that can be used to develop learning media is Hippani Animator. Hippani is the acronym for Hippo Animator. The advantages of this application are very light when compared to other software animators, so Hippani can be run on computers with medium specifications. Hippani is also equipped with a tutorial in the form of *.ml extension files that provide experience for beginners to learn self-taught. Learning media developed with Hippani are very easy to operate because it supports HTML 5, which can be directly accessed.
through a browser, without using the player animator. Furthermore, for advanced development, Hippani supports javascript so that it will make it easier for media developers to explore in producing quality ICT learning. Hippani is a popular HTML animation studio that is very easy to use to create interactive scalable animations, complex games, videos, presentations, applications, multimedia web sites [17]. Based on the above exposure, the purpose of this research is to develop and test the effectiveness of multimedia learning based on ICT to the mathematical reasoning ability of students.

2. Methods
The study was conducted at the 3 Kuningan State Madrasah (MTsN 3) located at Jalan Mayasih No. 880 Cigugur Kuningan. The researchers used educational research and development models [18] adapted from the design of systematic design of instruction [19] which was later modified into five stages. These stages are illustrated in the Figure 1.

![Figure 1. R & D Procedure in Multimedia Development](image)

The first phase serves to plan, design, develop and produce learning media that are compiled based on the results of the needs analysis and justified through expert validation and limited media testing on subjects. The needs analysis carried out in this study consisted of an analysis of literature studies and field studies. The literature study serves to determine the theoretical basis for ICT learning which will be developed so that it has a strong foundation as the basis for multimedia development while the field study serves to determine the type of media that is considered suitable to be developed. Based on the literature study, we chose hippani as a media development software because it has hippani very easy to operate through a web browser without the need for special player software. Hippani can be published on more web browsers and devices than other HTML5. At the learning design stage, analysis and determination of basic competencies are carried out, identification of competency standards, formulation of learning indicators, identification of the initial character of students, selection and development of instructional materials and determination of suitable learning strategies to implement multimedia to be developed. Meanwhile, the stages of media production are carried out by steps: collecting materials; compilation of flowcharts, storyboards, and script writing arranged based on the outline of media development that has been developed previously; insert material into the computer; and modular tests.

The last stage in the first phase was to test the feasibility and quality of multimedia developed based on expert analysis and validation. Expert validation serves to ensure that media are developed in accordance with the basic principles of media development. Expert validation is carried out by media experts and material experts. Media experts are tasked with evaluating the media developed by conducting validations based on the suitability of storyboards and engineering aspects of soft anchors, aspects of audio-visual communication, aspects of presentation and aspects of appearance. The suitability of the media produced with flowcharts and storyboards must also be the main assessment of
media experts. Meanwhile, the content expert conducts validation based on competence and learning objectives, conformity with material indicators, quality of material content and the content of the material presented. Criteria for expert judgment are based on the following criteria (Table 1).

| Interval Value | Category  |
|----------------|-----------|
| 1.00-2.00      | Not valid |
| 2.01-3.00      | Less valid|
| 3.01-4.00      | Valid     |
| 4.01-5.00      | Very valid|

After analyzing and revising the media based on the direction of the experts, a media trial was conducted consisting of one to one try out evaluation, small group evaluation, and field evaluation [20]. The instruments used in the first phase consisted of questionnaires, interview sheets, and observation sheets. The resulting data is processed descriptively and quantitatively by reduction, presentation, and conclusion of data. Based on the stages carried out in this phase can be referred to as the qualitative phase. The second phase functions as a multimedia effectiveness test that will be used. This phase uses quasi-experiment with non-equivalent design group control design. The instrument used is the question of the ability of mathematical reasoning to be compiled using inductive reasoning components to recognize and construct alleged patterns, develop various mathematical arguments, use spatial reasoning and comparison to solve problems, use deductive reasoning in verifying conclusions, validating arguments, and construct valid arguments, and analyze situations in determining general properties and structures[21]. Data were analyzed by a comparative test using an average comparison test by first performing a classic assumption test.

3. Result and Discussion
Based on the needs analysis, researchers considered the use of hippani animators as development software. In the learning design phase, we did a number of things, namely: analyzing and establishing basic competencies in accordance with the material concepts to be developed, developing competency standards, formulating learning indicators and objectives, identifying initial character of students, developing test items, developing learning materials and developing learning strategies which will be used in the learning process. At the production stage, we complete the media in the form of prototypes, considering that the media developed must pass the formative evaluation stage before the final product is produced. Formative evaluation was carried out in an effort to ensure that media was developed through the quality control stage, so it must be validated and tested. The validation results are shown in Table 2.

| Validator       | Value | Category  |
|-----------------|-------|-----------|
| Media expert I  | 4.70  | Very valid|
| Media expert II | 4.66  | Very valid|
| Content expert I| 4.79  | Very valid|
| Content expert II| 4.81  | Very valid|

All experts gave high scores with the whole category were very valid. The average of the four validators reaches 4.74. Based on this, the media developed seemed to satisfy the experts who gave the assessment. However, there is still room for improvement. We made this suggestion as an improvement material to revise the developed media. After repairs to the media based on advice from experts, the media is then tested on students in one to one try out evaluation, small group evaluation, and field evaluation. Of the three trials, students suggested that the letters and alloys of the background color be adjusted to make it easy to read. Students provide some very good responses to several things, namely: the media of mathematics learning can make students more excited and not boring in learning
mathematics. Furthermore, students stated that the delivery of material in the mathematics learning media was related to everyday life so that they were able to master mathematical concepts.

The second stage is also known as the effectiveness test. The effectiveness test was carried out through the use of ICT in learning through quasi-experimental research involving 72 students in different classes. Learning in the experimental class was carried out using ICT conducted in computer laboratories while in the control class did not use ICT learning. Research began with passing prestige in both classes. In accordance with the design of the study used, the research at the summative evaluation test phase was preceded by the pretest in both research classes. A pretest is done with the aim of knowing the initial abilities of students. Independent Test - The Mann-Whitney U Test sample was used to analyze pretest data because the prerequisite test was not fulfilled, where both data were not normally distributed and homogeneous. The complete analysis results can be seen in the following Table 3.

Table 3. Results of pretest data analysis

| Analysis          | Value  |
|-------------------|--------|
| Mann-Whitney U    | 545,000|
| Wilcoxon W        | 1175,000|
| Z                 | -1.186 |
| Asymp. Sig. (2-tailed) | 0.236 |

The pretest results show that there are similarities in the students' initial abilities, it can be seen that the Asymp.Sig (2-tailed) value = 0.236> α = 0.05. This means the null hypothesis (H₀) is rejected and shows that the mathematical reasoning ability of the experimental class students is the same as the control class. Meanwhile, to find out the effectiveness of the use of interactive multimedia, post-test results were analyzed. Posttest data analysis also used the Independent-Sample Mann-Whitney U Test because the prerequisite test was not fulfilled, where both data were not normally distributed and not homogeneous. The complete analysis results can be seen in the following table 4.

Table 4. Results of posttest data analysis

| Analysis          | Value  |
|-------------------|--------|
| Mann-Whitney U    | 311,500|
| Wilcoxon W        | 941,500|
| Z                 | -3.892 |
| Asymp. Sig. (2-tailed) | 0.000 |

Post-test results showed Asymp.Sig (2-tailed) = 0,000 <α = 0.05. This means the null hypothesis (H₀) is received and shows that the mathematical reasoning ability of the experimental class students is better than the control class. The effectiveness of ICT learning on mathematical reasoning abilities in this study is influenced by several factors because of the advantages of ICT learning that it has, including the interest of students in ICT learning which is rarely implemented in mathematics learning; the media concepts developed in this study are communicative, interactive, and able to provide feedback to students; attractive media display for students; able to provide motivation; and the existence of animation in the media developed in accordance with the context relating to the day-to-day. Interactive animation allows students to quickly find effective ways of solving mathematical problems designed in mathematics learning [22]. In addition, ICT can reduce student learning difficulties by helping to visualize abstract mathematical concepts, besides that ICT is also able to involve the active role of students in learning [3].

The enthusiasm of students in learning can be one of the factors that influence the effectiveness of the use of ICT in learning. The multimedia concept developed through ICT was able to display interesting animations, the learning videos used were able to lead the students in finding mathematical concepts, instrumental use of music that can be heard as long as students learn to make a calm effect. Students' interest in learning and focusing their attention on the concept of the material being studied can be supported interactively in ICT learning with content consisting of images, sounds, or images.
directly from the subject being studied [23]. This is a motivation for students to learn mathematical concepts that are initially difficult and less attractive to students.

However, the development of ICT learning should not only focus on the appearance and content that is interesting and overrides the feasibility of the content, the substance of the material, the feasibility of presenting the material, and the contextual assessment. Substantive and deep material should be displayed coherently to make multimedia more effective and efficient [24]. The effectiveness of ICT learning was also conveyed by other researchers, ICT is seen as having great potential in expanding and increasing the availability of learning aids for students who can provide opportunities for students to be creative, have skills, sharpen their talents, and train their social skills in the learning process [25]. Research findings are relevant to similar studies which show there are significant differences in reasoning skills of students participating in programming courses compared to non-students [15], mathematical connection skills through animated content developed using Macromedia flash students are far better than conventional approaches in upper secondary students [26], then the use of computer programs as learning resources can improve student achievement with moderate criteria [27], and make mathematics learning more active and enjoyable [8], however the use of ICT in learning should be done with teacher supervision and guidance.

4. Conclusion
Learning ICT by developing interactive multimedia using Hippani software meets the standards in the research and development process. Media production that begins with a needs analysis and learning design is able to produce quality media that are shown based on the results of evaluators who are experts in their respective fields. Based on summative evaluation results, it is known that the use of ICT in learning has a significant effect on students' mathematical reasoning abilities so that it can be considered to be done also in developing other mathematical abilities. In further research it is necessary to develop distance learning with a framework that can support the embedding of interactive multimedia content developed with Hippani, considering that the research we conducted is still done through face to face in class.

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