Analysis of the Needs of Technology Applications in Differentiated Learning on Geometry Materials at Elementary School Semarang City

ABSTRACT

Differentiated learning practices include adjusting the learning process, learning material content, learning outcome products, and learning environment with students' abilities. Geometry is a material element in mathematics with a large proportion of material in elementary school. The purpose of this study is to identify and analyze the needs of elementary schools for the application of technology in differentiated learning on geometry materials. The research method used is quantitative descriptive. The research subjects were 47 people consisting of 41 4th-grade elementary school teachers and 6 elementary school principals in Semarang City. They filled out a questionnaire consisting of 14 questions about the urgency of differentiated learning applications in mathematics lessons, mainly on geometry materials. The results showed that 95.74% of the technology applications were needed in elementary schools, 87.77% were needed to differentiate learning on geometry materials, 78.72% were known to have a scope of ability in geometry including recognition, descriptive, and informal reasoning, 87.23% of problem-solving skills and spatial skills are needed in elementary school. The conclusion is that differentiated learning is an important strategy in basic education that aims to meet the diverse needs of students. The application of technology in differentiated learning in geometry material focuses on differences in initial abilities in the form of differences in the level of geometric thinking recognition and descriptive.

Keywords: elementary school, differentiated learning, geometric thinking level, technology application.

1. INTRODUCTION

Geometry, as one of the subjects in mathematics, is often considered difficult. Many elementary school students have difficulty understanding basic geometric concepts such as shapes, angles, and spatial relationships. This lack of basic knowledge often leads to difficulties in more complex topics later in life [1]. Geometry involves many abstract concepts that are difficult to understand, especially for students still developing concrete thinking skills. A study shows that

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students often have trouble understanding spatial constructs and the relationships between geometric shapes, which leads to low learning outcomes[2]. Students at the elementary and secondary levels often have difficulty connecting geometric concepts to real-world contexts, further worsening their understanding [2], [3].

Technology allows for differentiated learning, which is tailored to various learning preferences. For example, interactive simulations can engage visual learners while providing hands-on experience for kinesthetic learners. This adaptability can increase students' motivation and participation in geometry lessons [4].

The causes of difficulties in geometry are influenced by several things, including the use of learning media, motivation, and the level of student thinking. The lack of effective use of visual media is also an essential factor. Students often do not get a concrete learning experience, making it challenging to imagine geometric shapes. A negative mindset towards mathematics also contributes to the difficulty of learning geometry. Students often perceive mathematics, including geometry, as a difficult and daunting subject, which can demotivate them to learn [2], [3]. Van Hiele's theory explains that the understanding of geometry develops through five levels of thinking. Many students do not reach the level necessary to understand geometry concepts in depth, so they fail in geometry learning [5].

A person's ability in geometry can be seen from the level of geometric thinking. In this study, geometric thinking level indicators, according to Mayberry [6] and Fuys[7]. In one class, students' abilities vary from low to high. Not only that, but the learning style and other potentials that students have have an effect on the learning process and final results [8].

Adjustment of the learning process, learning material content, learning outcome products and learning environment with students' abilities is part of differentiated learning practices [9]–[11]. Where in the “Merdeka Curriculum”, differentiated learning is one of the characteristics that leads students to experience meaningful learning and independent learning. Content, processes, and learning products that are in accordance with students' abilities and needs can be facilitated with appropriate learning media.

The content or material is adjusted to the student's learning readiness in the form of initial abilities in student geometry. The categories in geometry ability, starting from lowest to highest, are introductive, descriptive, informal reasoning, formal reasoning, and mathematical [12]. But for elementary school students, in accordance with cognitive development, the scope of geometry material is limited to the categories of introduction, descriptive, and informal reasoning. Based on the initial ability of geometry and modalities possessed by students, it is necessary to facilitate the differentiation of content or materials and the learning process manifested in an application.

The use of technology and applications such as GeoGebra can help students visualize and understand geometry concepts, but there are still many schools

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that have not made optimal use of these tools [2], [13]. This technology facilitates the visualization and manipulation of shapes, which is essential for understanding the principles of abstract geometry. Studies show that students who use this tool tend to get better results compared to traditional textbook methods [4], [14], [15].

The purpose of this study is to identify and analyze the needs of elementary schools for the application of technology in differentiated learning on geometry materials. The findings of this research are expected to contribute to the next stage, namely the development of technology applications that suit the needs of elementary schools.

2. METHODOLOGY

The research method used is quantitative descriptive. The research subjects were 47 people consisting of 41 4th-grade elementary school teachers and 6 elementary school principals in Semarang City, Central Java Province, Indonesia. The selection of grade 4 level because grade 4 has at least the scope of basic and important geometry material mastered in elementary schools. The selection of teachers and school principals is based on the division of 16 sub-districts in Semarang City.

They filled out a questionnaire consisting of 14 questions about the urgency of the application of technology in differentiated learning, especially on geometry materials. This instrument has been validated by material and language experts. The collected data was analyzed descriptively using Excel to calculate the percentage and present it as a diagram for interpretation and analysis, and then conclusions were drawn.

3. RESULTS AND DISCUSSION

The first stage is to conduct a needs analysis. The needs analysis questionnaire was distributed in elementary schools in Semarang City. The following are the results of the needs analysis.

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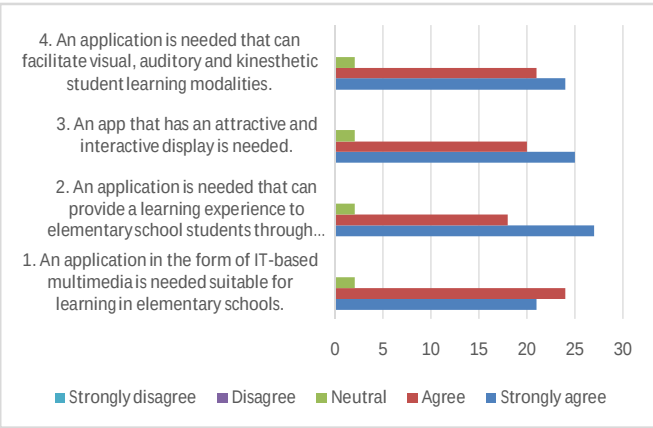

Fig 1. Results of Analysis of Elementary School Needs for Technology Applications

In **Fig 1**, it appears that more than 95.74% of respondents strongly agree and agree with the need for technology applications in geometry learning in elementary schools. An application of technology in mathematics learning geometry materials needed in elementary schools is necessary in addition to attracting students' attention to learning. Still, it can also provide a meaningful learning experience through images, text, animation, video, or music. The respondents expect this application to be in the form of technology-based multimedia that is suitable for elementary school students. The application is also expected to improve students' modalities, ranging from visual, auditory, and kinesthetic.

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Integrating IT-based multimedia in primary education has been shown to significantly improve the learning experience. Research shows that multimedia tools can create a more engaging and interactive learning environment, which is especially important for elementary school students. Multimedia apps grab students' attention and promote interaction. Research has shown that interactive multimedia can increase students' motivation and interest in learning activities, making lessons feel more contextual and fun [16], [17]. Multimedia can cater to various learning styles, such as visual, auditory, and kinesthetic. Thus, it facilitates a more inclusive education approach [4]. This adaptability is essential in primary education, where students exhibit varied preferences and abilities [18].

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The application of technology in primary school education presents a promising avenue to improve student engagement and learning outcomes. By addressing existing challenges, schools can leverage this technology to create a more effective learning environment. It is important to develop multimedia applications that suit the needs of elementary school students and ensure that learning content is accessible and engaging.

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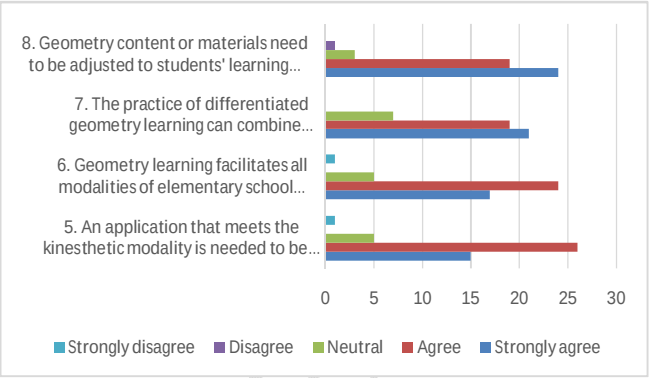

Fig 2. Results of Elementary School Needs Analysis on Differentiated Learning

Fig 2 shows that 87.77% of respondents agree and strongly agree with the need for differentiated learning in the application of technology to be developed on geometry materials. Differentiated learning can optimize the modalities of elementary school students who are still developing. Especially because elementary school students use more physical activities so that kinesthetically elementary school students can be facilitated through geometry learning experiences. Several studies have shown that the process of learning geometry is actively able to activate students' modalities as a whole, especially visual, audio, and kinesthetic.

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Differentiated learning is based on the belief that students come to class with different backgrounds, experiences, and learning styles. This approach seeks to tailor teaching strategies to maximize each student's potential by recognizing and utilizing the unique characteristics of students [19], [20]. Research shows that differentiated learning can increase student enthusiasm and participation in classroom activities. Students are more likely to engage when the material resonates with students' interests and learning styles [21], [22]. So the condition

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of students in one class is very diverse in terms of initial abilities and learning experiences that they have had before. Differentiated learning in geometry material is very possible to be implemented both from the aspects of differentiation of content, process, product [21], [22] as well as the student's learning environment.

The content of geometry material can be adjusted to the student's learning readiness and initial ability. This adjustment is facilitated by a geometric thinking level that starts from the bottom and fades to the next level. For elementary school students, the adaptive geometric thinking level is the introductory, descriptive, and informal reasoning levels. Figure 3 shows that 78.72% of respondents agree and strongly agree with the division of the cognitive level of elementary school students in learning geometry.

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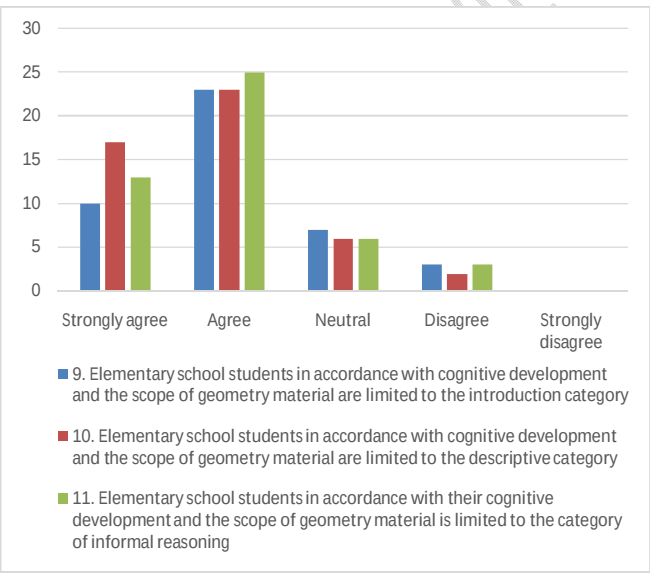

Fig3. Results of Analysis of Elementary School Needs for Differentiation Based on Cognitive Development in Learning Geometry

Students at the introductory level can identify the names and shapes of geometric objects. In elementary school, this level is characterized by the ability to recognize the names and shapes of flat buildings and spatial buildings and order various patterns in flat buildings and spatial buildings to compose and decompose various forms of flat buildings and spatial buildings. The descriptive level is characterized by the ability to recognize the characteristics of each flat and spatial building and begin to recognize its properties. At the level of informal reasoning, elementary school students are expected to be able to analyze various properties of flat and spatial buildings and start to see the relationship between flat buildings or spatial buildings based on the similarities in their properties [12].

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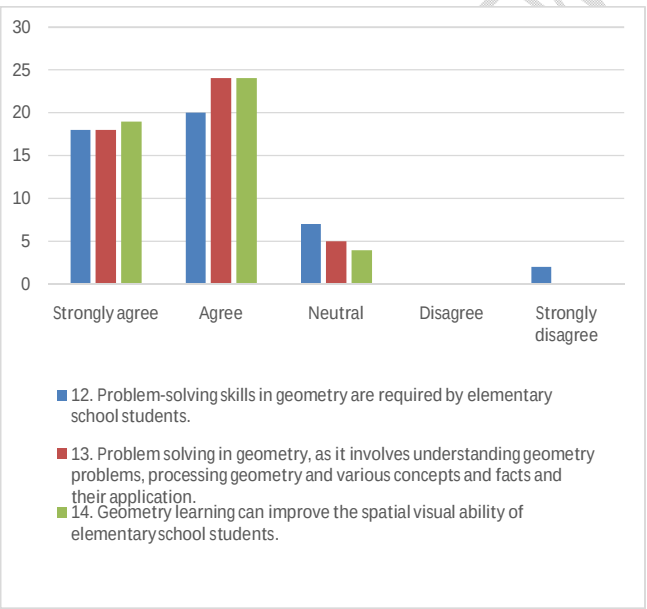

Fig 4. Results of Elementary School Needs Analysis on the Importance of Spatial Ability and Problem Solving in Learning Geometry

Based on several studies on geometry learning, it is identified that there are several abilities that can be improved, including spatial skills and problem-solving skills. This is in line with the results of the needs analysis presented in Figure 4. Respondents agreed (87.23%) that learning geometry material should be able to improve spatial skills and problem-solving skills. Spatial ability is essential for geometry, as it relates to the skills required to visualize and manipulate geometric figures mentally. Some activities in completing geometric tasks require spatial ability [1], [23]. To effectively address these challenges, educators need to implement targeted learning strategies that build foundational skills, correct misconceptions, and improve problem-solving abilities. A geometric thinking level framework can also provide a structured approach to improve students' understanding of geometry [1].

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4. CONCLUSION

The results of the needs analysis in elementary schools in Semarang City show that differentiated learning on geometry materials in elementary schools requires technology applications because it can motivate and activate students and facilitate differences in students' abilities and learning styles through differentiated learning. Differentiated learning is an important strategy in basic education that aims to meet the diverse needs of students. Differentiated learning applications on geometry materials focus on differences in initial abilities in the form of differences in the level of introductory and descriptive geometry thinking.

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Additional comments

1. Study should state the research questions that led to the findings in the study.

2. Study should make it clear the instrument’s validation and reliability value

3. Findings of the study should captured before conclusion

4. Discussions of the study should be elaborate

5. Recommendations and Suggestion for further studies should be provided